EUROPEAN COMMISSION
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Joint Research Centre

ies
Institute for
Environment and
Sustainability

ENERGY EFFICIENCY IN DOMESTIC APPLIANCES AND LIGHTING

PROCEEDINGS OF THE
4TH INTERNATIONAL CONFERENCE
EEDAL'06

21-23 June 2006, London, United Kingdom

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VOLUME 1

Institute for Environment and Sustainability

2006 EUR 22317 EN

The mission of Institute Environment and Sustainability is to provide scientific and technical support of EU policies for protecting the environment and the EU Strategy for Sustainable Development.

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Directorate-General Joint Research Centre
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EUR 22317 EN
ISBN 92-79-02750-6
ISSN 1018-5593
Luxembourg: Office for Official Publications of the European Communities

Printed in Italy

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Introduction

The residential sector is responsible for a large and increasing share of energy and electricity consumption and the related emissions into the atmosphere. Residential energy demand is also rapidly increasing putting a strain on the available finances and infrastructures of several developed and developing countries. Although recent progress in energy efficiency of major domestic appliances and lighting equipment, new and larger appliances are continuously added to the existing stock. Recently the rapid introduction and expansion of ICT and consumer electronics has contributed to the additional power demand of the domestic sector, together with the request for more comfort and larger dwellings. This has resulted not only in additional CO_2 emissions, but also in a larger strain on the electricity network, contributing to electricity blackouts and other electricity supply problems in a number of OECD and developing countries.

By improving energy efficiency of domestic appliances and lighting, countries can afford to maintain the present level of comfort, and at the same time avoid large investments in the energy and electricity infrastructure, and even more importantly, avoid an irreversible impact on the environment. Domestic appliances and lighting offers a large untapped energy efficiency potential, which in most cases is cost-effective for the users, as well for the society as a whole.

Energy efficiency improvements in residential appliances and lighting can play a key role in assuring a sustainable energy future and socio-economic development, and at the same time mitigate climate change. Energy efficiency measures related to residential appliances and lighting are among the most cost-effective CO_2 emission reduction actions, and offer the best opportunity to increase the security and reliability of energy supply. In developing countries efficient residential appliances and lighting are vital to improve living conditions and reduce local pollution.

However market, policy, trade and information barriers impede the further penetration of energy efficient residential appliances and lighting, resulting in a missed opportunity for climate change mitigation and socio-economic development.

The International **Energy Efficiency in Domestic Appliances and Lighting (EEDAL)** conference started in 1997 in Florence, filling a gap: there was no energy efficiency conference dedicated entirely to residential appliances and lighting. The EEDAL conference has established itself as an influential and recognised international event where participants can discuss the latest developments and build international partnerships among stakeholders.

The fourth EEDAL conference was organised in London on 21 to 23 June 2006. EEDAL’06 was of the most successful conferences in the series, with over 300 participants coming from all continents, representing 40 countries.

The international community of stakeholders dealing with residential appliances and lighting (including manufacturers, retailers, consumers, governments, international organisations and agencies, academia and experts) gathered to discuss the progress achieved in technologies and policies, and the strategies to be implemented to further this progress.

The EEDAL’06 conference has been very successful in attracting an international audience, representing a wide variety of stakeholders involved in policy implementation and development, research and programme implementation, manufacturing and promotion of energy efficient residential appliances and lighting.

EEDAL'06 has provided a unique forum to discuss and debate the latest developments in energy and environmental impact of residential appliances and installed equipment, and lighting. The presentations were made by the leading experts coming from all continents. The presentations covered policies and programmes adopted and planned in several geographical areas and countries, as well as the technical and commercial advances in the dissemination and penetration of energy efficient residential appliances and lighting.

The three-day conference included plenary sessions where key representatives of governments and international organisations and manufacturers presented their views and programmes to advance energy efficiency in residential appliances and lighting. Concurrent sessions on specific themes, dealing both with technologies, socio-economic issues and policies, allowed in-depth discussions among participants.

The conference presentations highlighted the available technologies to improve efficiency, as well as the numerous programmes and policies adopted by developed and developing countries. Among them it emerged that standards and labels are essential component of any country policy set, and these two instruments have delivered remarkable results in a very cost-effective manner. Other market transformation programmes such as procurements, increased information, and demand response are as well important and more efforts in this area have started. The often forgotten components of the energy demand, the consumer behaviours and the usage patterns, is still a topic of research, and it demands more attention both from policy makers and from programme design and managers. Energy efficiency in the residential sector is an important component of climate change and sustainable development policies and as such it should be further supported, including financing support and an adequate legislative and organisational framework, by national and international organisation.

This year's conference focussed on how to improve the energy efficiency of appliances and lighting products traded around the world, through improved technology, better information for consumers, and effective product standards and policies, posing two basic questions:

How can we

- Raise consumer expectations that products - lighting and appliances – should be sustainable and meet good standards of energy efficiency?
- Create the conditions for the manufacturers, retailers and service providers to respond to these expectations – and to supply more resource-efficient goods and services?

The overwhelming body of opinion was that while much has been achieved, we need to make further efforts to:

- Ensure that, for consumers, the use of sustainable products is 'easy, affordable and attractive'.
- Develop policies aimed at the supply chain, which are coherent, long-term and clearly signalled encouraging forward investment in product research, development and marketing.

This dual approach should be underpinned by:

- Reliable test methods, which are acceptable throughout the world;
- Clear labels and product performance information;
- Ambitious performance standards; and
- Firm compliance and enforcement actions.

In all parallel sessions a combination of technologies, programmes and policies were presented.

From the oral presentations emerged that:

- In most countries residential energy consumption, and in particular electricity, is still growing;
- There is still a large, cost-effective saving potential in developed and developing countries, despite the several policies and programmes implemented (a lot of work in front of us). This saving potential is among the most cost-effective option to reduce CO_2.
- Lighting is of particular importance, and it offers a fast solution (CFLs). Standby is still increasing and needs more attention (could become the largest electricity use, including on-mode of CE and ITC). Cold appliances are still predominant in residential electricity consumption. HVAC and water heating still need attention. Cooking is important for developing countries.
- The need for more data collection on the installed equipment, user, real technical options to better quantify the large saving achieved (in the EU 1994 – 2003, about 30 TWh) through programme evaluation, and the remaining.

Among the policy options in many sessions there has been a call for:

- More aggressive and progressive efficiency standards, more use of labels on more equipment, and a stronger enforcement;
- Market based policies to support energy services in the residential sector and rebalancing investments between supply and demand (including distributed generation). This may include white certificates and 'personal' carbon allowances.
- More attention to metering, demand response, billing, and consumer feedback.
- International Collaborations and partnerships on test methods, efficiency levels and quality levels, labels (where possible, as for Energy Star for office equipment): there is general agreement that there were many benefits to work internationally; international ongoing activities on CFLs, STBs, TVs, and Motors need support and participation from many countries and experts.
- The need to build a strong case for energy efficiency (including carbon and financial benefits), to assure policy makers on the real saving potential, and bring private investors money.

EEDAL Conference Recommendations

The product policy area addressed by EEDAL represents a truly international agenda. Similar products are used worldwide, giving rise to similar problems. Consumers will not stop buying new products, but effective product policies, co-ordinated across the trading zones can encourage products that are as environmentally sustainable as possible. What is clear is that Government, business and consumers all have a role to play and a responsibility to act. In summary, the conference reinforced the need for:

- Reliable test methods, which are acceptable throughout the world;
- Clear labels and product performance information for consumers;
- Ambitious performance standards;
- Firm enforcement to ensure compliance.

However, the overwhelming view expressed at the conference was that it is the responsibility of governments to create a policy framework within which manufacturers are encouraged to provide the most efficient products. Furthermore, with markets for these products becoming increasingly global in nature, the framework must be long-term and truly international. Uncertainty in climate change policy beyond 2012 restraining investment was a recurrent theme. Many of the representatives from manufacturing industry asked for such a long term policy framework to encourage them to invest in producing and promoting the purchase of more energy efficient products. Such a framework would include:

- Clear targets for improving the efficiency of energy use;
- A regulatory framework for standards and labelling that provides a level playing field internationally and gives clear signals on future performance standards;
- Where required, tough measures to penalise inefficient practices, for example the relentless increase in standby electricity consumption;
- Market incentives (covering a wide range e.g. financial, fiscal, regulatory, etc.) that reward the most efficient products (or a move to the provision of more efficient services);
- Agreement on mechanisms to evaluate the resource efficiency of products, in particular covering whole life environmental impacts, and mechanisms to decide when accelerated replacement of products should be encouraged;
- Clear information provided to consumers to help them choose the best products and use them most efficiently;
- Removal of institutional and regulatory barriers to penetration of the most efficient products;
- A holistic approach covering renewables and energy efficiency. For example the rise in air conditioning use can be offset through passive solar architecture and the appropriate use of renewable energy technologies;
- Continuous public support for R&D directed at innovative and highly efficient technologies for domestic appliances and heating systems, consumer electronics and lighting.

In particular, manufacturers and industry representatives called for the following measures:

- Policymakers to avoid overlapping legislation and regulations ("putting them under one roof") and to close any legislative gaps. Manufacturers want to see an increasing move towards international rules;
- Test methodologies and labelling to be fair and transparent;
- Support for installer training to ensure that equipment is properly installed and supplemented by consumer advice on its optimum use.

The conclusion was, therefore, that action at the international level is essential to create such a framework. This will require governments to work together increasingly to provide a common labelling and standards framework and to establish common goals for achieving improved resource efficiency.

Co-operation can be achieved by encouraging the “3 C’s”:

Communication: sharing current practice with standards, labelling and incentive schemes between countries with the goal of identifying and promoting best practice.

Co-ordination: identifying opportunities for the harmonisation of test methodologies, standards and labelling approaches.

Collaboration: encouraging international co-operation for the development of new technologies and approaches that can provide equivalent services for much reduced energy input. Similarly, there is potential to collaborate on the evidence to underpin policy. There is also enormous scope for collaboration between developed and developing countries to achieve the transfer of efficient technology to the latter. (The conference noted that developing countries often have the highest growth rates in energy use coupled with inefficient existing products, therefore the scope for improvement is enormous.)

The book contains the papers presented in the concurrent sessions.

It is hoped that the availability of this book will enable a large audience to benefit from the presentations made at the conference. Potential readers who may benefit from this book include energy and environment researchers, engineers and equipment manufacturers, policy makers, energy agencies and energy efficiency programme managers, energy supply companies, energy regulatory authorities.

The EEDAL’06 conference was organised by the UK’s Market Transformation Programme and the European Commission Directorate General Joint Research Centre, with sponsorship from the UK’s Department for Environment, Food and Rural Affairs (Defra), the Energy Saving Trust (EST) and the Intelligent Energy Europe Programme (IEE). Further support was provided by the Australian Greenhouse Office (AGO), the International Energy Agency (IEA), the United Nations Development Programme, Global Environment Facility (UNDP – GEF) and the Collaborative Labelling and Appliance Standards Programme (CLASP).

Information about the EEDAL conference, including speakers’ presentations and pre-conference papers is available at Defra’s Market Transformation Programme website www.mtprog.com.

Paolo Bertoldi

Energy Services and White Certificates

ESCO's for Households : a New Phenomena in Europe ?

Wim De Groote

e-ster bvba

Abstract

e-ster is a young Factor-4 energy services company which focuses mainly on households. Our main activities are energy audits in existing houses, followed by a wide range of services to improve the energy efficiency of electric appliances, lighting and installations. The energy audits are based on short-term measurements of most electric appliances, and on a close inspection of building shell, heating and DHW installations, appliances and lighting. After the energy-audit, the energy consumption is followed during 2 years.

Our clients are almost all families which want to reduce their energy consumption in a profitable way on a voluntary basis, without subsidies. So far, over 250 energy audits in private dwellings have been carried out. Of ca. 50 families, we have monitored the energy consumption on a bimonthly basis (almost) one year.

In this paper, some results with the focus on electric appliances and lighting will be presented.

Illustrated by case-studies, the following aspects will be treated : analysis of the electricity consumption, based on short-term end-use metering ; benchmarking of the electricity consumption ; realized electricity savings after one year.

The challenges for running an ESCO for households in a profitable way will be discussed. We will end with a reflection on the potential future of ESCO’s for households in Europe.

1. Background

e-ster is a young Factor-4 energy services company which focuses mainly on households. With Factor-4, we refer to the concept of Ernst von Weiszacker, Hunter and Amory Lovins to use energy 4 times more efficiently than today [1]. With a doubling of the global welfare the coming 40 years, this would result in halving the world’s energy use and related problems such as climate change, increasing geo-political tensions, terrorist risks towards radio-active material etc.

e-ster supports this concept and want to contribute its modest share in it. Our clients are almost all families which want to reduce their energy consumption in a profitable way on a voluntary basis, without subsidies.

Why is it important to focus on households in energy policy ?

A first reason of course is that households are important direct energy consumers (not just Domestic Appliances & Lighting). For the EU-25, the share of households in the final energy use is 26,4 % ; the energy consumption would increase with 27 % in a trend scenario [2].

Aside from the fact that they are important energy consumers, there are 3 other distinctive reasons why it is important to address households’ energy consumption [3] :

- households contain **voters**. Households are not only the object of policies, but as a voter they also are a part of the policy-making process. They have a right to be informed about the reasons, aims and results of policies. And when they are better informed, they will in general accept them better, which in turn improves the effectiveness of the policy and might also protect it from being voted against it in elections
- households also contain workers or **professionals**. That is : people who also use energy at their job. So attitude or behavioral change in the homes might also influence energy use at work.
- A fourth reason is that families raise the energy consumers of tomorrow, namely **children**. Making energy efficiency an attitude among children and kids might indirectly promote future energy conservation.

2. Energy services offered by e-ster

Which energy services does e-ster offer to households ? Our main activities are energy audits in existing houses. A second service is sales and direct installation of A++/A+/hot-fill machines, hard-to-find CFL's and energy-efficient lighting. A third service is consultancy-on-demand e.g. advice for (r)enovation of dwellings, IR scans, blower-door tests, …

Energy Audits in Dwellings

The energy audits are based on short-term measurements of most electric appliances, and on a close inspection of building shell, heating and DHW installations, appliances and lighting. The on-field energy audit takes on average 1,5 hour per dwelling. During this audit, all rooms are inspected where appliances with a significant energy use can be expected. During 2 weeks, the consumption is measured of typically 15 to 20 electric appliances.

The short-term measurements allow us to gather many data on the energy use of appliances, which we use to benchmark individual appliances (see e.g. figure 1)

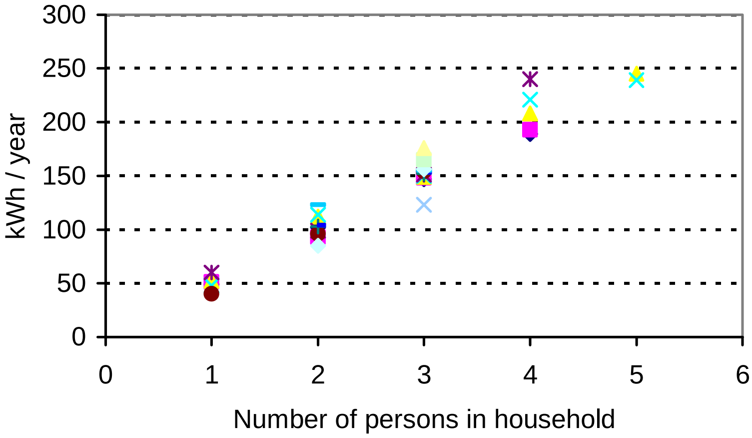

Figure 1: Annual consumption of washing machines
Source: e-ster bvba

An energy audit report is made which contains the following elements :

- benchmarking of the household's normalized fuel consumption and total electricity consumption (in function of dwelling type, fuel type for DHW and for cooking, and seize of household), and per appliance (for appliances with abnormal high/low consumption)
- end-use analysis for fuel and electricity
- main recommendations to reduce the energy bill
- cost/benefit analysis of the package of proposed measures.

In Annexes to the audit report, tailored information is given. E.g. if it advised to replace an energy-inefficient freezer, a list with the most energy-efficient freezers will be included.

After the energy-audit, the energy consumption is followed during 2 years. So far, over 250 energy audits in private dwellings have been carried out.

Sales and direct installation of A++/A+/hotfill machines and energy-efficient lighting

Our second service, sales and direct installation of A++/A+/hotfill machines, hard-to-find CFL's and energy-efficient lighting, is similar to delivering turn-key installations by large, 'traditional' ESCO's.

To our experience, this is very important to speed up the implementation of energy efficient appliances and lighting. As long as we did not offer this service and only gave advice, people went to their traditional shop, where the sales staff would say , "A++ freezers, we don't have that in stock Madame, we can order it but it will take 3 weeks, but look here we have a model which is almost as efficient , …". And the opportunity for an A+ or A++ freezer would be lost for 15 years. Offering this service also generates profit for us, which allows us to lower the price of the audit.

3. Results, illustrated by some case studies

Fermette in Wilsele, drastically renovated in 2001-2002

This old farm was drastically renovated "by one of the most famous ecolological architects from Flanders". On demand of the owner, much attention was given, to lower the energy use : some features include a very good insulation of roof and walls, mechanical ventilation with heat recovery, and a solar boiler. The owner estimated the total extra-investment as 10.000 to 12.500 EUR. However, the energy audit done by e-ster showed that the energy use could be lowered significantly without lowering comfort. The main measures proposed and taken were stopping most leaking losses, replacing an old freezer, and replacing the most often used 20 halogen bulbs with CFL's. In 1 year time, the electricity consumption decreased with 41 % (figure 2). To achieve this, the owners did an investment of netto 761 EUR (marginal costs) with a payback of 2 years. Also gas consumption will be lowered next year by replacing the 20-years old boiler.

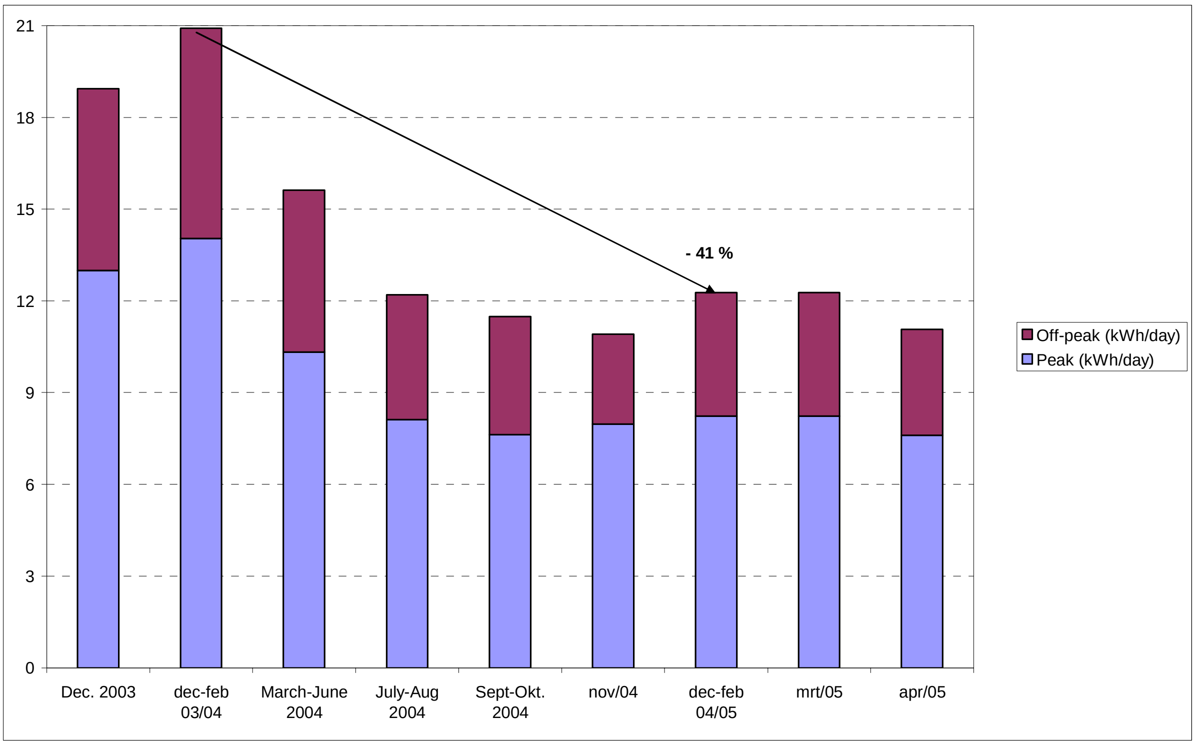

Figure 2: Case-study 1 : Evolution of the electricity consumption
Source: e-ster bvba

Dwelling in Merelbeke, drastically renovated in 1995
This family has 3 children and lives in a semi-detached house. Before the energy audit, the fuel consumption (natural gas) was below average, and the electricity consumption was average. Heating was done with a 15-years old central boiler and an advanced wood stove. Domestic hot water (DHW) was produced with an old electric boiler which had to be replaced urgently.
The energy audit showed that the family could reduce its energy use drastically without comfort loss. Main measures proposed (and taken) were replacing the old boiler and the electric DHW boiler by one condensing gas system ; cutting many leaking losses (TV, fax, DVD, &) ; and replacing an old refrigerator. Total extra investment: 400 € with a payback time of 2 years [1]. Still planned : replacing a part of the halogen lighting with an energy-efficient lighting system.

In figure 3, the results are shown for the evolution of the electricity consumption.

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[1] Compared to replacing the gas boiler by a standard gas boiler and the electric DHW boiler by a new electric DHW boiler. The comparison is not entirely correct because the savings claimed should be for the savings over a modern non-condensing boiler. The latter is however unknown and could only be an estimate.

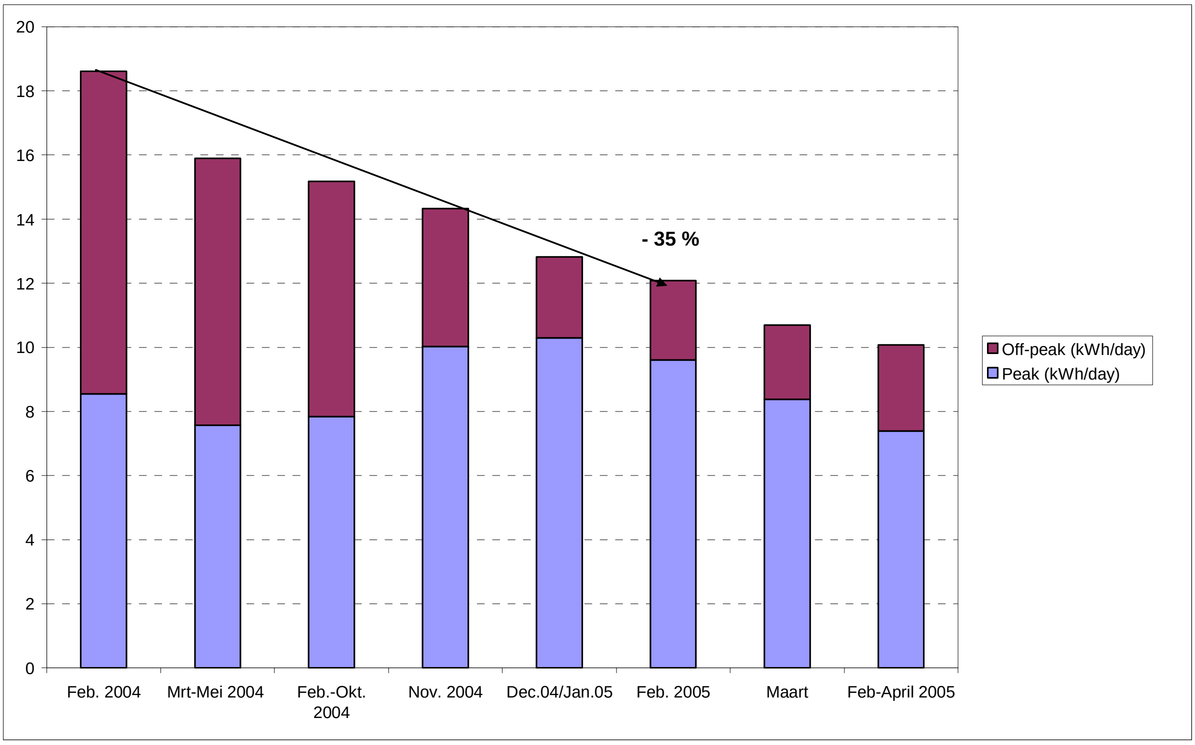

Figure 3: Case-study 2 : Evolution of the electricity consumption

Domestic hot water is now produced with gas instead of electricity. Nevertheless, due to the new condensing boiler, the consumption of gas has not increased but on the contrary decreased with 32 % (figure 4).

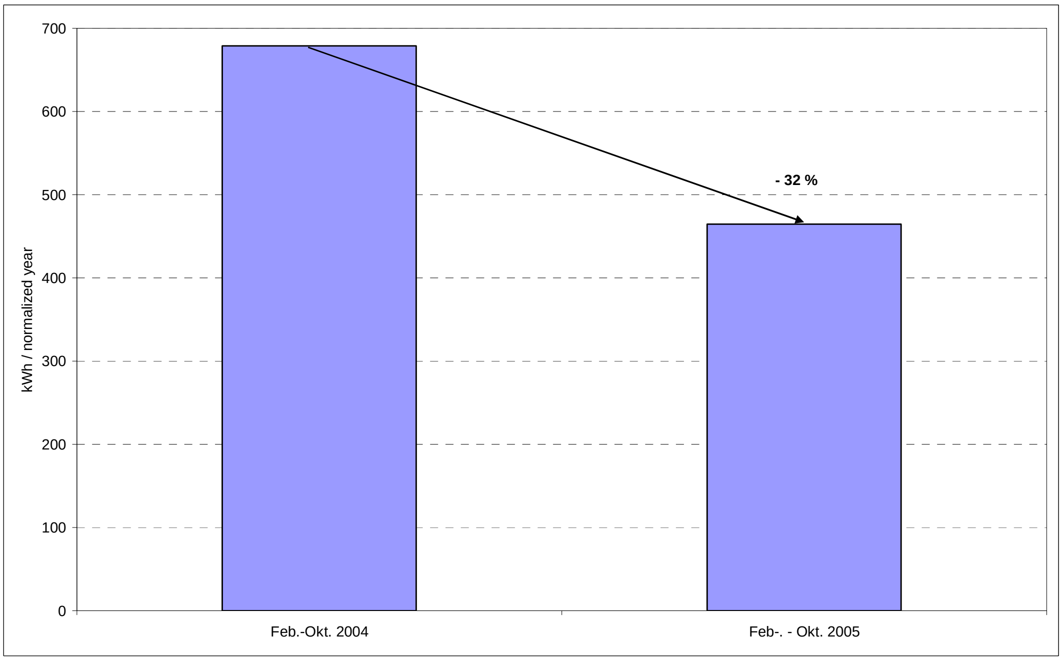

Figure 4: Case-study 2: Evolution of the (weather-normalized) natural gas consumption

4. Conclusions

From the more than 250 energy audits which have been done already, some trends appear. In figure 5, we compare simple pay-back time (although this is a very bad concept) of some main measures that we recommended.

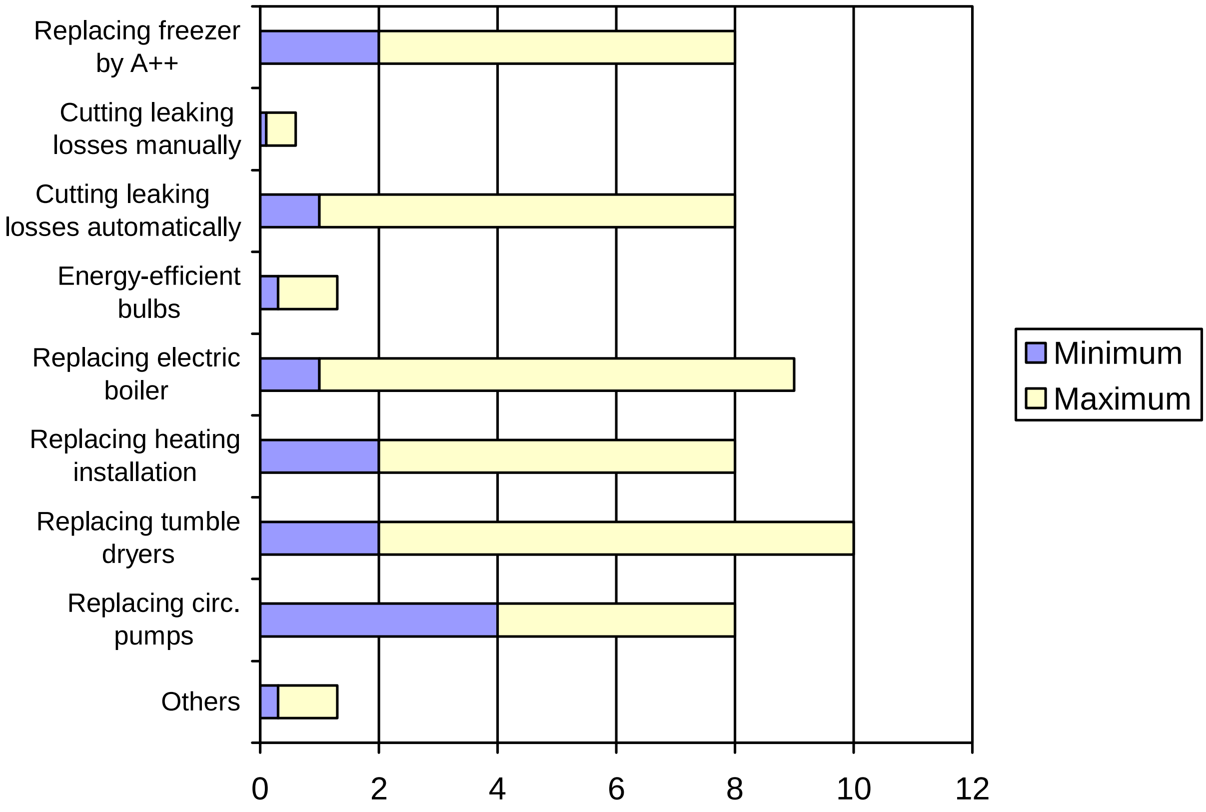

Figure 5: Pay-back of selected recommended measures
Source : e-ster bvba

Figure 5 shows the first conclusion : only by measuring (or close inspection), it can be determined whether an energy efficiency measure is cost-effective. No one fits all !

Our second conclusion is that we confirm from our experience the most often quoted barriers for energy efficiency in households : a lack of time, and a lack of money. Roughly speaking, one could argue say that are two groups of households. The group which needs most desperately support to lower its energy bills, the poor, cannot afford an energy audit. The other group, middle and upper class, can afford it but often has no time for it : "Most human decision-making (…) is concerned with the discovery and selection of satisfactory alternatives ; only in exceptional cases is it concerned with the discovery and selection of optimal alternatives " [4].
Further perceived barriers for selling energy efficiency services to households are :
- energy services are unknown among households (new product)
- there are no guaranteed savings, and the monitoring costs by submetering seems for the moment too high
- subsidies, as this will create a distorted and artificial 'market'. E.g. in Belgium there is since recently a tax deduction for residential energy audits if these are carried out following a standard procedure set out by the government. This procedure takes typically 8 hours, as a result this type of energy audits costs 600 EUR and more, and almost no one is interested in such an expensive audit. The same phenomena has been observed in The Netherlands, where the 'market' for residential energy audits has collapsed after the Dutch government stopped the 80 % subsidies for it.

Some possible positive government incentives could be :

- giving the good example in public buildings (energy audits, followed by taking measures and disseminating the results)
- allowing ESCO's the CO2-credits which they save (on average 5 to 10 tons per dwelling if all recommended measures are taken). This would of course require a monitoring and verification protocol.

Is there a future for ESCO's for households in Europe ? We think so, if some things are kept in mind :

- energy services have to be seen in the broadest sense, not in the narrow sense of guaranteed savings [5]. We do however guarantee savings for specific amenities and

services. E.g. and old freezer with a measured consumption which we replace by an A++ freezer : in this case the savings are more or less guaranteed. The same for e.g. solar cells (photovoltaic's). We cannot guarantee savings on the total energy consumption in the house, because we cannot control behavior (including and especially the behavior when buying additional appliances and lighting).
- Information only does not work very effective and is too expensive. Our business model combines tailored information with selling and installing some of the best opportunities found. This is more effective (removing barriers for energy efficiency) and helps us to lower the price for a first energy audit
- fuel switching makes often sense from an primary energy point of view and also from a financial point of view. As one of the case-studies showed, it is often a golden opportunity for energy efficiency

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Is Performance Contracting a Real Business Opportunity for Residential Consumers?

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Abstract

In Brazil, the residential sector represents roughly 15% of total final energy consumption, and 22% of total electricity consumption. Since 1999, electricity utilities have to invest 1% of annual revenues in activities related to energy efficiency and losses reduction; from 2001, part of this amount is allocated to research and technology investments. Utilities allocated financial resources for residential consumers, offering from appliances replacement to financial support, but not creating a significant or permanent market. One consequence of these mandatory investments was the emerging of several ESCOs, counting on such a strong financial source, but not focused on residential consumers as attractive market. The paper summarizes the transformation of Brazilian electricity sector and its impacts on ESCO industry, highlighting utility initiatives oriented to residential consumers. It presents results from interviews with ESCOs, utilities and end-users, in order to assess why the residential market did not achieve significant role for performance contracts in Brazil.

The evolution of electricity market in Brazil and its consequences for energy efficiency investments

As in many countries, Brazil faced severe changes in infra-structure sectors, including electricity. In 1988, the passed National Constitution defined as Union's competence, directly or using regulated mechanisms (authorizations, permissions or concessions), services and assets of electric energy [1]. From 1995 on - in accordance to international trends [2] – the sector left the traditional monopolist and state-owned model and was restructured to private and regulated companies, aiming to increase competition, attract new investments and reduce tariffs to end users. A regulatory body (ANEEL – Agencia Nacional de Energia Eletrica, Electricity National Agency) was created and became responsible for regulating sector activities and contractual obligations between utilities and the government.

The "1%" fund

These contractual obligations introduced a new element: the obligation to incentive energy efficiency, improve Brazilian research capability and reduce losses. As example, a contract signed in 1992 defined that utilities would implement measures for energy conservation: annual programs, targeting technical and commercial losses reduction, orienting consumers for rational and efficient electricity use. These annual programs were limited (ceiling) to 1% of utility's annual revenues [3].

This obligation was revised from 1% "maximum" to 1% "minimum": in 1997, a concession contract signed with a generation utility defined a minimum amount of 1% of annual revenues to increase efficiency in supply and demand sides. Other decisions: 25% of the annual investments are necessarily to end-use measures, and 10% to R&D [4].

In 1998, ANEEL published a set of regulations in order to harmonize utilities' programs. A Guideline, describing requirements for expenditures, project submission and monitoring, became a reference for utilities and, in general, revised every year.

Only in 2000, with Law 9991/2000 published, the destination of financial resources was defined[1]. The Law represents the wishes of legislators, and then is superior than an ANEEL normative act, so it would represent the final (or at least for long term) decision on how utilities will invest their 1% obligation. It's necessary to mention that a new Law is under discussion in Brazilian Deputy Chamber, and eventually will change resources allocation for energy efficiency and R&D[2].

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[1] Before this Law was published, ANEEL defined trhough normative acts the terms for expenditures in energy efficiency and R&D.

[2] This "new Law" defines that distribution utilities would invest 50% in end-use efficiency projects.

The significant point is that, in opposite to common sense now in Brazil, the initial concept was to promote energy efficiency in both (demand and supply) sides, and preserve R&D investments to governmental sources. As the entire model was revised, and especially the governmental sources for investments were reduced year by year, the authority rearranged the resources expenditures to specific destinations:

- R&D resources managed by the utilities, following regulator criteria, corresponding to 40% of R&D investment obligation;
- A fund managed by the Ministry of Sciences and Technology – FNDCT[3] (Fund for National Science and Technology Development), corresponding to 40% of R&D investment obligation;
- 20% of R&D investment obligation, directly to the Ministry of Mines and Energy, to be spent in studies related to the expansion of Brazilian energy sector, including feasibility studies.

These sources created a significant source for R&D investments and counted on market maturity for end use financing. This point will be retaken later in this paper.

Current situation

The table bellow presents how the resources are allocated, according to each utility category, from 2006 on.

Table 1: Destination of 1% funds

Utility category	Share – End use projects (demand side)	Share – Research and Development
Generation and Transmission	0%	100%
Distribution	25%	75%

Table adapted from Law 9991/2000

Results for end use projects

ANNEL did not publish details of utilities' programs, but only overall results. According to Jannuzzi [5], a total of US$ 343.4 million was invested in efficiency programs from 1998 to 2004. The following table presents the amounts invested in energy efficiency projects.

Table 2: Amounts invested in mandatory programs – energy efficiency (do not include R&D)

Period	Total investment in energy efficiency programs (US$ millions)	End use expenditures (US$ millions)
1998/1999	68.3	21.9
1999/2000	75.9	30.4
2000/2001	35.4	33.3
2002/2003	39.8	39.8
2003/2004	66.8	66.8

Table adapted from Jannuzzi [5]

From 2002 on, only previously approved projects in demand side were continued, and new projects were not allowed, in accordance to ANEEL revision on expenditures criteria.

PROCEL [6] reports that for 1998/1999 only 3% of total expenditures were oriented to residential sector. There's no specific reason for this small amount invested in residences, but utilities were free to decide in which area the resources would be invested since at least one project in each consuming (residential, commercial, industrial and governmental) sector was included.

ESCO industry in Brazil

According to Bullok and Careaghiaur [7], a defining characteristic of an energy service company (ESCO) is that it will accept payment for energy projects installed based on the performance of those projects. It's important to mention that "ESCO" in Brazil has a different meaning: all companies involved with energy efficiency project implementation – not necessarily paid by the measured

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[3] FNDCT – Fundo Nacional de Desenvolvimento Científico e Tecnológico, in Portuguese.

performance – are designated as an ESCO. This mean that not all companies are necessarily interested in taking the risk of a performance contract, and simply work as consulting or conventional engineering firms.

Such companies exploring energy efficiency business are active in Brazil for more than thirty years, but only in 1997 they decided to create an organization to represent them – ABESCO (Brazilian Energy Service Companies Association), founded with 15 members and presently joining 40 companies. According to ABESCO [8], Brazil has 72 active ESCOs (in 1997, 15 companies founded ABESCO) and since 2001 the average market growth is estimated in 16% per year.

ABESCO also presents market potentials for several sectors (2001 data). As can be seen in the table bellow, the residential sector is represented only by multi-residential buildings, and excludes private areas.

Table 3: Energy Efficiency Market Potential – Brazil (2001 data)

Sector	Energy reduction (GWh/yr)	Costs reduction (1,000 R$/yr)[4]
Commercial	5,642	1,090,277
Industrial	9,716	912,077
Public Services	1471	283,046
Governmental Buildings	1,575	301,888
Multi-residential buildings (excluding private areas)	560	125,180

Source: ABESCO [8]

A preliminary conclusion would be that even the key market agent (the ESCO, as project developer) does not consider unitary residential consumers as an interesting market.

Survey with stakeholders

General description

In order to investigate transactions using performance contracts in residential sector, a survey was conducted involving three categories:

1. **ESCOS**, considered a key agent since is usually responsible for project identification, development, design, construction, monitoring and financing.
2. **Utilities**, since they play a relevant role in Brazil as the main source for financing energy efficiency projects.
3. **Residential consumers** (end users), as the target of appliance innovations and the subject of our investigation.

The survey was conducted with a small number of interviews. The main objective was not to obtain a statistical quantitative model but more a qualitative understanding on what happens, or not, in terms of driven forces that facilitate transactions involving implementing measures related to energy efficiency in residential sector, based on a performance contact mechanism.

Results - ESCOs

Four ESCOs were contacted and interviewed. All interviews were conducted with a preliminary presentation of the survey, a simple questionnaire and a telephone interview. The contacted person on each ESCO is responsible for market development or sales[5].

All ESCOs implemented projects in the residential sector, but only two used a performance contract mechanism: one with resources from utilities and another using other financial source. All four ESCOs reported that residential sector is not a primary target market, and described main reasons for preferring other sectors for business development. According to them, the main disadvantages of exploring residential sector are:

1. High transaction costs, in comparison with financial results.
2. Lack of understanding: this sector is not a traditional one in terms of energy efficiency, so there’s no relevant information disseminated to this sector, delaying negotiation and making it more difficult.

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[4] R$ (Real) is the Brazilian currency. 1 US$ = R$ 2.20 (April 2006 rate).

[5] The number of interviewed ESCOs is small, and eventually other active companies would present different answers; an expansion of this sample would be convenient for more significant results.

3. Complexity of decision process: when dealing with multi-residential buildings, the difficult identification of a decision maker and a collective process makes the negotiation long and non conclusive.

Based on this, and with the increased opportunities in other areas, ESCOs preferred to not prioritize residential sector and concentrate initiatives with industrial and commercial prospects, even if technologies involved in residences are known and represent reduced technical risks.

This issue became an interesting subject when directly asked to the ESCOs. All of them agreed that, compared with other areas where technical aspects are more relevant and represent a real risk, the residential sector bring good opportunities – since unitary costs for this kind of consumers are normally higher then those for industries and large commercial unities – with adoption of known and tested solutions.

Results – Utilities

Two electricity utilities were contacted, and both worked with residential sector in their annual 1% programs. But both declared that this decision followed conditions imposed by the regulatory body (ANEEL), and were exclusive to low-income clients. ANEEL defined, for 2006 programs, that at least 50% of all investments in end-use (DSM) projects have to be invest in low-income users, and utilities concentrated resources to reduce commercial (non technical) losses and reduce consumption but not using any type of performance contract. These investments might be monitored and verified, but clients do not return the investment.

Regarding projects with performance contracts, both utilities are familiar to them but use them only with large consumers such as industries and supermarkets. They indicate as main barriers to implement such model:

1. The reduced number of clients who expressed intention of pay for investments done by utilities in energy efficiency projects[6].
2. The complexity of negotiations and monitoring and verification activities, inherent to performance contracts.
3. The simplicity of just replacing bulbs and fixtures for residential consumers or donating equipments instead of proposing a more complex engineering project.

Both utilities developed projects with discounts for acquisition of new and efficient appliances, specially refrigerators and unitary air-conditioners. But they cannot be considered performance contracts since did not involve any kind of evaluation: the support consisted only in offering discount bond attached with the bills; one decided to return the investment in monthly payments in the bills if the consumer decided to use the bond, but the results were poor – less than 5% of initial projections. The utility decided then to simply pay the bonus and let the consumer choose the appliance and take the benefit of a more efficient appliance.

Results – consumers

This segment was divided into two groups. The first group is comprised of ten individuals, in upper financial classes according to Brazilian standards, and with average consumptions higher than 200 kWh/month (according to ABRADEE [9], Brazilian Utilities Association, the average consumption in residential sector was around 140 kWh/month). The second group is comprised of multi-familiar building administrators or responsible, in a total of four buildings and responsible only for non private areas, and one has implemented a project based on performance contract.

The results, excluding this last interview, are similar. To them, implement energy savings is interesting but not under a performance basis, since measures are simple and the amount to be invested not significant to their budgets, and appliances can be replaced progressively.

The administrator who decided to accept the performance contract took the decision based on:

1. Amount to be invested: this unity consists on several buildings with one common meter, so the investments are significant compared with monthly budget.
2. Professional and independent administration: the residents decided to contract a specialized firm to manage and be responsible for all common areas, operating with a defined budget for investments (additional investments would require a previous approval from residents and a long decision process).
3. ESCO contractually takes the risks of performance, so the worst situation would be that the electricity costs remain the same.

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[6] One utility related that consumers expressed their reluctance in the "real reason" why a company that sells energy would invest in reducing sales.

The final result did not exceed initial projections, and the implemented measures were perceived for several residents as usual in terms of technology. In other words, some residents expected more in terms of new resources to be implemented by the ESCO.

Barriers to be addressed

As results from interviews, some barriers were identified, and need to be addressed in order to facilitate the adoption of performance contracts in Brazilian residences:

- **Lack of awareness**: stakeholders (utilities, ESCOs and governmental agencies) need to disseminate the ESCO industry concepts, emphasizing that the ESCO or the utility is taking the risk and assuming the capital expenditures. The dissemination of success stories is another alternative to improve the dissemination of performance contract concept.
- **High transaction costs**: the dissemination of performance contract concepts would reduce the time needed to negotiate and celebrate contracts with prospects. In addition, a simplified contract template and M&V requirements would create a positive environment for transactions.
- **Treat residential consumers as prospects**. Many utilities consider residential consumers as mere “consumers” and not as “clients”, meaning that no additional services are offered and loosing opportunities for increasing profits. It’s relevant to say that the electricity market is a regulated activity and margins are limited; a performance contract can result in better financial results to investors than those obtained with distribution services.
- **Present more than conventional alternatives**. As the building administrator who signed a performance contract explained, most of the improvements were perceived as “conventional”. ESCOs would investigate more interesting alternatives as solar thermal or PV, integrate water savings in the offer or automation as solutions to be offered, creating a differential for their clients.

From consumers’ side, receiving a proposal from a respected firm (specially when partnered with a utility) interested in investing and taking the risks, in an accessible way – a contract with clear but simple rules – can reverse the current sense of “non attractive” for performance contracts.

Conclusions

The residential sector in Brazil offers a significant potential for savings, estimated by Almeida and others [10] in 28% (technical) and 12% (market) of electricity consumption, and an opportunity for business involving energy savings contracts – but the adoption of this arrangement is still a challenge. To change the perception of end users and financers (in this case, specially the utilities) is a long way. Even implementers (ESCOs) have to change their perception about this market, and start considering as an interesting alternative.

Another point, not expressed but implicit in answers, is that contractual mechanisms need to be simplified and adopted. Instead of long contracts with clauses that scare parties, a less sophisticated contract could facilitate and increase transactions between ESCOs and end users.

Utilities can play a more significant role, using resources from the 1% fund to promote energy efficiency and performance contracts, even in a simplified way – controlling the total consumption, for example. This would create an opportunity of doing business but more importantly creating a closer relationship with clients.

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Liberating the Power of Energy Services and ESCOs in a Liberalised Energy Market

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Abstract

Energy Services Companies (ESCOs) could help to address barriers to energy efficiency and micro-generation, by providing information, finance, installation, operation and maintenance under a long-term contract.

Three distinct types of market for energy services are identified in the UK. First, the commercial and industrial sector, using a '**facilities management'** or '**performance contract**' model, where the ESCO offering is most developed, and where there remains great potential. Second a **community model**, where decisions are taken by or on behalf of a group of customers in the same location (for example, but not exclusively, a Community Heating scheme). There is particular opportunity in new build, and in social housing. Third, a **household model**, where energy suppliers, contractors or equipment suppliers to existing residential customers may evolve to include energy efficiency and micro-generation. The facilities model is well known, while ESCOs specialized in servicing households are virtually almost non-existent. What is new in this paper is the outlining of the communities model (especially the opportunities in new build) as an opportunity to transfer the ESCOs model to smaller customers as an intermediate step to serving households and discussing the opportunities of diffusing the ESCO concept among households via equipment and service suppliers.

The paper explores opportunities and barriers as well as policy options to promote each of the three models. The paper takes the UK as a case study to demonstrate opportunities and barriers. Liberating Energy Services could make a range of measures on the customers side of the meter competitive with new supply, and is therefore the logical completion of a fully competitive market, albeit one that could at the same time achieve economic efficiencies and carbon reductions.

Introduction - the need for energy services

Energy Services Companies (ESCOs) could help to address barriers to energy efficiency and micro-generation, by providing information, finance, installation, operation and maintenance under a long-term contract.

There are a range of reasons why the potential for energy efficiency is not achieved. These include:

- Lack of understanding of the saving opportunity;
- Lack of time to address energy, since energy forms a small portion of overall expenditure;
- Lack of capital, or a high cost associated with borrowing capital;
- A lack of capacity to install measures;
- Consumers' and financial institutions' aversion to risk and to new technologies and service delivery routes;

There are a range of reasons why the potential for micro-generation[1] may not be achieved including all the above reasons plus:

- Issues associated with installation such as connection, metering, notification to network operators
- Difficulties in securing top-up and back up sources of electricity and heat (when demand is greater than output) and sale of surplus electricity to other customers (when output is greater than demand)

Where ESCOs were once seen as a way of addressing these issues for energy efficiency, they are also important for generation of low carbon heat and electricity, and at all scales from above 100 MW

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[1] Micro-generation is taken to include a portfolio of plant that deliver heat and or power and or cooling with no or low carbon content compared to conventional supplies. They may serve an individual site or a community or a single household.

on an industrial site, to 1KW in the home. Energy services packages may overcome many of the barriers described above through some combination of design, build, finance, operation and maintenance of installations.

If governments are committed to serious cuts in carbon emissions, the potential for energy savings and for micro-generation will need to be achieved. Energy services may be useful in delivering across a range of sectors and timescales, for example, in the UK, around three quarters of CHP in buildings or recently installed on industrial sites is thought to have been installed on an energy services basis. Energy Services may be crucial to achieve future targets for CHP and renewable energies. Longer term, the *40% House* report [1] suggested that in order to achieve the scale of change needed in housing, more than half of households might be supplied on an energy services basis by 2050. The potential is not a UK potential but could benefit all G8 countries [2].

Indeed, ensuring demand management options are assessed on a level playing field with new forms of supply, and ensuring that embedded generation is assessed on a level playing field with central generation is arguably nothing more than the completion of a properly and fully liberalised energy market. This is as true at the European scale as at the national level, and the European Union has a longstanding interest in promotion of energy services.

What Energy Services offer

An industry seminar organised by the UK Energy research Centre [3] put considerable emphasis on the need to get the definition of energy services consistent and more widely understood, not just among consumers but practitioners, potential purchasers, and policy-makers too. In particular ‘Energy Service’ and ESCO are different concepts, which too often have different meanings and are confused.

Customers’ service needs vary widely. Thus service provision need to be tailored to satisfy particular market niches such as: billing and metering; joint utility supply (e.g. electricity, gas, heat, water, telecommunications); energy analyses of buildings and industrial processes; energy, lighting and building management (including security); installing, financing and operating efficient equipment and CHP schemes on customers’ premises; ‘green’ electricity provision, possibly at premium prices; equipment maintenance and leasing contracts; individual building renovation and insulation; and possibly involvement in large-scale urban development and renovation [4]. Energy service contracts allow the client to reduce operating costs, transfer risk and concentrate attention on core activities. Energy service contracting is a form of outsourcing. It will only be chosen where the expected reduction in the *production cost* of supplying energy services can more than offset the *transactions cost* of negotiating and managing the relationship with the energy service provider. [5]

Energy Services encompass a range of activities, such as energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property/facility management, energy and/or equipment supply, provision of service (space heating/cooling, lighting, etc.).

Energy Service Companies (ESCOs) create the focus needed to implement economically sound energy efficiency ideas [6]. Their experience is valuable to facility owners who:

- Do not understand their energy bills,
- Do not believe they have any wastage,
- Do not understand their energy use and where savings opportunities may lie or how to design retrofits,
- Do not know how to raise finance without debt, or
- Do not recognise the role of operational monitoring in controlling energy costs.

ESCOs provide a valuable service for facility owners and the environment by finding and implementing self-financing energy savings opportunities, which reduce energy waste and emissions.

An ESCO is a company that fulfils some or all the following requirements:

- An ESCO can provide integrated energy services to their customers (mainly large energy users, but also utilities), which may include implementing energy-efficiency projects (and also renewable energy projects), frequently on a turn-key basis.
- An ESCO can provide performance and savings guarantees, and its remuneration is directly tied to the energy savings achieved. In this case an ESCO risks its payments on the performance of equipment and services implemented. Some ESCOs finance projects, recovering their investment cost from the resulting savings. Some ESCOs assist their clients in acquiring financing by providing a savings guarantee, which acts as a safeguard for financing institutions.
- The financing of the project can be ensured through two main types of contracts: Guaranteed Savings and Shared Savings. In a shared savings contract the ESCO guarantees the cost of

energy saved; the cost savings are split for a pre-determined length of time in accordance with a pre-arranged percentage; this division is dependent on the cost of the project, the length of the contract and the risks taken by the ESCO and the consumer. In a guaranteed savings contract the ESCO guarantees a certain level of energy savings; the performance guarantee is the level of energy saved. In the shared saving contract, the ESCO assumes the performance and credit risk; in the guaranteed savings contract, the client assumes the credit risk, while the ESCO assumes the risk for the savings.

Bertoldi and Rezessy [6] have characterized the EU ESCO market. Most ESCOs have been founded either by large companies or as subsidiaries of large companies (equipment manufacturers, facility management companies, energy utilities). The objectives for these companies do not necessarily focus solely on exploiting the financial opportunity of energy savings; other factors also act as strong drivers for offering energy services, such as selling energy, financing sale of their equipment, retaining a large energy customer or acquiring a new customer by adding value via energy services to the supply of otherwise homogenous commodities such as electricity or gas. Most ESCO projects in Europe have been based on the shared savings concept. Chauffage (supply of energy) contracts are also commonly used. The guaranteed savings concept has been used rarely; There is some “build, own, operate, transfer” of ownership to the site (BOOT). ESCOs have so far mostly provided financing themselves (mainly in France, Italy and Germany); Only recently have more ESCOs started using third party finance (e.g. banks). More third party finance and guaranteed saving contracts are needed, otherwise investment is limited by company capital availability and their credit line. This makes ESCO markets illiquid by locking out small companies; in addition the ESCO market in Europe is segmented in ‘functionally specialised’ companiesThe recent energy industry restructuring has stimulated projects in CHP for large commercial centres, hospitals, and industrial facilities; it has also triggered public lighting projects, where municipalities tendered lighting operation, including the supply of electricity. The majority of ESCOs’ projects in EU MS have focused on co-generation; public lighting; HVAC and EMS. The majority of ESCO projects in Europe have been undertaken in the public sector, which is perceived as a safer client that never goes out of business or changes production volumes or operation. According to Bertoldi and Rezessy [6], Germany and Austria are the premier ESCO markets. In Germany in 2003, there were around 500 ESCOs, with a turnover circa 3bn Euro, serving around 120,000 sites, estimated to be around 9% of the market potential. Investment is led by public buildings as a way of outsourcing. Berlin alone has 1,500 buildings served by an ESCO; the buildings are grouped in a number of pools to minimize transaction costs. The total guaranteed savings in Berlin is 9,5 million Euro/year (25,4%), with a total CO2-Reduction (1993-2003) in excess of 145.000 tonnes. This required a total Investment of 40.3 million Euro [7, 8]. Austria has 35 companies; in Austria 600 to 700 buildings have received an energy performance contract, which represent roughly 6-7 % of all public and private service building sector and about 4% of total floor area. Projects have been implemented in about 300-400 federal buildings (about 50% of total floor area of federal buildings) grouped in 12 pools. France is a mature market dominated by a few large companies. Hungary has 29 companies, and about two thirds of customers are municipalities. In Holland energy management is common but there is almost no energy performance contracting. In Denmark there are few ESCOs, though there are a lot of municipal energy companies running CHP on district heating and a great number of Government energy efficiency programmes. Denmark and the Netherlands being European leaders in energy efficiency action with very limited ESCO activity demonstrate that ESCOs are only one way of achieving investment in energy efficiency projects. Bertoldi and Rezessy viewed the UK as a leader in Europe in the development of the ESCO market. However, in recent years, with the implementation of new electricity trading arrangements in 2002 and falling electricity prices, together with rising gas prices, many indigenous ESCO companies have withdrawn from the market. Those companies that remain are predominantly French, Danish or Swedish in origin.

The Energy Services Directive, which has been under development in the Commission for a number of years, was adopted in May 2006 [11]. The Directive sets targets for Member States for energy end-use savings resulting from policies and programmes of 1% per year, cumulative, for 9 years, (from 2008 until 2017). The Directive covers households; agriculture; commercial and public sectors; as well as (with some exceptions) transport and industry. All types of energy will be taken into account, from electricity and natural gas to district heating and cooling, heating fuel, transport fuels, coal, and biomass. The practical implications of the Directive are that it requires much more intelligent metering and billing; the Directive gives encouragement to explore the use of white certificates, allowing trading of energy savings across a number of sectors. Both these measures would encourage development of energy services.

Market opportunities for ESCOs

A seminar organized by the UK Energy Research Centre identified three broad models of energy services as shown below [3]. Three distinct types of market are identified, with different opportunities and barriers. First, the commercial and industrial sector, using a '**facilities management'** or '**performance contract**' model, where the ESCO offering is most developed, and where there remains great potential. Second a **community model**, where decisions are taken by or on behalf of a group of customers in the same location (for example, but not exclusively, a Community Heating scheme). There is particular opportunity in new build, and in social housing. Third, a **household model**, where the energy supply, contractors or equipment suppliers offering to existing residential customers may evolve to include energy efficiency and micro-generation. This is the hardest market for ESCOs to break into, especially in the short term, since the transaction costs of servicing millions of small (and skeptical) consumer is large compared to the savings without significant policy intervention. There is a well-established incumbent model of supply with significant barriers to new market entry for an alternative business model.

Table 1: The three broad models of energy services

	A facilities management model	A community model	A domestic energy supplier model
Description	• Energy services as a way of retaining large **industrial** customers on a long term supply contract • Energy services as part of a facilities management approach to **commercial** and **public** sector buildings • Energy service as a mean of delivering engineering services or new equipment	• Energy services companies managing design, build, finance and operation of community Heating schemes, often as a partnership between a private sector company and a Local Authority, or a new-build housing developer. • Large **new build housing developments** could follow a community ESCO model where the developer involves an ESCO partner with exclusive responsibility for a the operation, maintenance and possibly energy supply to a defined area (at least for a period of say 10 yrs), even if the solution adopted is solar thermal and microCHP not community heating.	• Energy services offerings to existing households by utilities companies, contractors or equipment manufacturers and suppliers • In Great Britain, under the Energy Efficiency Commitment, suppliers can receive a 50%-uplift on the savings of energy efficiency measures promoted via through energy service activities. This uplift, however, is limited to 10 % of the overall activity. Of the six major suppliers with an EEC target three submitted schemes that would take them over the 10 % threshold if take up had been as forecasted; in reality the energy services uplift was only 3.6% of all insulation activity, and in reality, the definition of energy services fell well short of what is commonly understood to be ESCO activity • Micro-generation adds significantly to the range of options that could be included in an ESCO offering
UK Examples	• CIBSE have had Guidance on Contract Energy Management since 1991 [12] • Around 1200 CHP schemes in buildings, totalling almost 350 MW of capacity, of which 80% are estimated to be offered on an energy services basis [13]	• Woking BC partnership company Thameswey Energy[14], Southampton Geothermal Heating [15], Aberdeen Heat and power, and a range of schemes delivered under the Community Energy programme [16] • Large new build housing development is Greenwich Millennium Village, which has both community heating and solar PV.	• Some EEC programmes have sought partners (eg Housing associations or local authorities to help deliver measures

	A facilities management model	A community model	A domestic energy supplier model
The UK potential	- Potential – a proportion of 1.7 million industrial commercial and public sector sites in the UK.	- Potential market of around 175,000 new homes per annum, or an estimated 10M new homes by 2050 - Some 5M existing homes are rented from a Social Landlord in the UK (Registered Social Landlord or Local Authority) [17]. Around 5m existing homes could be served by community heating [18] but they are not necessarily the same dwellings.	- Around 18m homes are currently owner-occupied. These are homes where the individuals that occupy the building are responsible for managing the energy inputs and infrastructure, and where evolution of traditional suppliers are the main route for ESCOs.

It is important to recognise the full range of opportunities. There is more experience with larger customers, but there is also significant opportunity to extend the market to medium- and smaller customers. From the householder perspective, an energy service offering will mean the provision of heat, light and power for the home, paid for through a financing arrangement linked to the ongoing reduction of fuel bills (compared to the business as usual case). The installation of smart meters, energy efficiency measures, or micro-generation, would be needed to create ongoing and guaranteed reductions in energy consumption.

Opportunities and barriers

Each of these models is currently faced with a number of opportunities and barriers.

Barriers

There are a number of generic barriers to energy service provision in liberalised energy markets.

- The dominant **business model** in liberalised gas and electricity markets has an emphasis on size to reduce kWh price. A customer base of some 4 or 5 million customers is seen as the minimum size to create appropriate economies of scale. In the UK there are thus only around 5 major suppliers, with little real price or service quality differentiation of offering.
- **Barriers to new entrants**: costs of securing and retaining a household supply license; exposure to risk in energy wholesale markets without upstream assets; high entry costs through the need for substantial marketing. Partnerships with energy suppliers and/or contractors are therefore the most likely models for involving other commercial players in the market.
- Potential new suppliers feel **it is difficult to be innovative** in this commercial and regulatory environment ,.
- Customers (whether households or businesses) will not want to buy into a medium or long term **commitment** since another supplier might prove to be cheaper, or they might move.
- Inadequate consumer protection frameworks against “cowboys” in the energy service provision business. **Consumer protection frameworks** are needed, e.g. affiliation with the Energy Services Trade Association could be encouraged if a mechanism could be put in place to enable the removal of affiliation from poor-performers. ESCO accreditation schemes by another party (e.g. in the UK EST or OFGEM) is also a valuable option.

Table 2 provides an overview of other barriers to the provision of energy services specific to each ESCO model in the UK.

Table 2: Other barriers are specific to each type of ESCO model in the UK

Barriers specific to the facilities management model	Barriers specific to the community model	Barriers specific to the domestic energy supplier model
• **Energy as a fixed or variable cost** - many clients mistakenly see energy as an uncontrollable overhead rather than a risk or opportunity. • **Cheap energy and short fixed contracts** mean companies have been less concerned about energy. Recent price rises and contracts up for renewal mean this might change. • **Organisational structure** – a company's grouping into departments, reporting lines and budgets often make the complete outsourcing of energy services very difficult • There are **other investment priorities**; lack of budget for energy investment; no life-cycle costing • Much **commercial space is rented,** meaning the costs lie with landlords and often bills lie with tenants. The market potential is there but there is no motivation for lessors or lessees to make changes. • **ESCO offerings can be very different and thus hard to compare** - and may not be easily matched to customers needs. • Lack of **services integration** e.g. there may be an incumbent M&E contractor which does not offer energy management services, and unless the energy service provider can work effectively with or replace the maintenance contractor then savings in practice may be difficult.	• **Housing developers want to get in and get out** and have no commitment to a site. An ESCO may have to be a separate organisation from the developer. • The **upfront cost** of lower carbon solutions can be high compared to standards heating systems, even if carbon emissions and life cycle costs are lower. • **There is little evidence that people prefer homes that have lower environmental impact or low energy cost**. New housing developers cannot recover the cost of an upfront investment • **Lower carbon solutions are not needed to get through planning and building regulations hurdles**. • **There is very little experience with this kind of model** except in social housing. Housing developers are risk and cost averse. • **Some technologies have a bad reputation** (like old community heating) because they have in the past been badly maintained. This colours perceptions of new schemes. • **Consumers often prefer individual rather than communal solutions**. • **Bill collection is expensive for small numbers of consumers**. The Energy suppliers can spread costs over millions of households.	• **Consumers** show little recognition of the concept of energy services and there are difficult issues with consumer trust, largely because the motivation for the approach is not understood [19]. Energy efficiency is not a priority for consumers; actions can not be 'shown off' to peers; not much interest in fuel bills due to low energy prices and bills often show credit; most people don't get round to actions; perceived disruption to the home and hassle; upfront cost; concern with borrowing with a 2-5 year tie-in; suspicion of energy suppliers and fear of commitment • Confidence in relevant trades to carry out works to **quality standards** – some form of accreditation is required • **Transaction costs** can be high compared to the savings. The cost savings won't go far if they have to be shared between audit, investment, ESCO profit and householder. Need to either increase cost savings (e.g. micro-generation) or enhance the value of savings, also by bundling numerous similar projects in pools to reduce transaction costs. • The **Energy Services offering needs commercial development**. The Design Council recently did some work on what an ESCO or HOUSE Co might look like [20]. • **Barriers to new market entrants**(energy suppliers) are high, e.g. costs of securing and maintaining a supply license; exposure to risk in wholesale markets without upstream assets (reduced ability to hedge); high entry costs such as marketing • **Meters** are currently installed by suppliers, who have no incentive to upgrade to more expensive smart meters due to the risk the customer will switch supplier, leaving a 'stranded asset'. Longer term contracts, or change in meter ownership model may help. • Customers are free to switch suppliers with 28 days notice (the **28-day rule**), though a pilot is exploring the implication of longer tie-ins. • Home owners may be resistant to losing **control**.

Opportunities

There are a number of generic opportunities for energy service provision in liberalized energy markets.

- The potential for sale of electricity via **private wire** (i.e. a private electricity network not owned by the distribution company, and thus incurring no use of system charges for export) to facilitate a package of measures.
- A **micro-generation commitment** could help to enhance the value of ESCOs and improve the business case for them.

- **Energy price rises** are an opportunity, - the commercial sector will be more inclined to take interest; domestic consumers concerned about energy prices are often more interested in price freeze tariffs.
- ESCOs might naturally develop an advantage if and when energy prices rise, with higher demand in relation to supply, or through mechanisms that put a **price on carbon**, or through White Certificates

It is important to remember that competition in electricity and gas supply began in the UK with a small number of large players and thresholds were gradually lowered to include all customers including households. The development of the energy services market could follow a similar pattern.

Other opportunities are specific to each model as listed in Table 3.

Table 3: Other opportunities are specific to each type of ESCO model in the UK

opportunities specific to the facilities management model	**opportunities specific to the community model**	**opportunities specific to the domestic energy supplier model**
• **Public procurement** is currently limited (e.g. the Private Finance Initiative has a poor record on energy performance contracting) – needs to play a much greater role. This would help to develop a more consistent definition of Energy Services. • **The public sector can borrow money at lower rates than the private sector.** It could lever third party finance. • Incentives much greater for those companies included in the EU Emissions Trading Scheme (**EU ETS)** • There is a lack of knowledge of **grants/subsidies** available. Better communication about these is needed.	• **Key sectors such as local government or social housing could take a lead. T**he London Mayor is understood to be exploring setting up an ESCO for London, and English Partnerships and the Housing Corporation could be active in supporting developments they are involved in, in developing ESCOs. • **Housing developers could contract out** all energy infrastructure on a site to an ESCO to design build operate maintain and bill. The ESCO can design and manage the assets to achieve least life cycle costs • In new build developments, the **cost of energy efficiency and micro-generation is the marginal cost over and above what would be installed anyway** (e.g. gas boilers, gas network). If scaffolding is present to install a roof, the marginal cost of installing PV and solar thermal at the same time is lower than in retrofit situations dedicated solely to renewable technologies installation. Economies of scale can be made to install devices in a thousand homes in one go. Systems (e.g. metering and generation systems) can be integrated from the start. • In new build developments, an electrical network has to be installed to each home, which is usually given to the distribution network operator (DNO) to manage because it is seen as a liability. If this is designed and installed by an ESCO it can be **retained and used to sell surplus electricity by private wire**. This attracts 8p p kWh rather than 2p, and completely changes the economics of electricity generation • **An ESCO could be a facilitator of services** within a community including car clubs, IT, or other community goals. **Involvement** is key with local stewardship and a local dividend • Many programmes (Renewables Obligation and EEC) are invisible to people. Yet to achieve a 60% CO2 (?) reduction needs **behaviour change**. ESCOs are big enough to start behaviour change, as a communication route for and to get buy-in to deep carbon cuts.	• **Schemes established under the community model could take a lead** in connecting homes close to the core community. In the UK, district heating schemes grow their connected load at an estimated 5% per annum once established. • Although they raise the transaction costs, there is considerable consumer interest in **home energy audits** – people are keen to know how energy efficient they are. Audit support schemes may be linked with a provision to implement all no- and low-cost measures identified. • **Micro-generation** might be a new opportunity partly because of the cost of the asset and the income stream, but also because many technologies reduce peak demand (i.e. expensive energy). • **Energy Suppliers need to differentiate their offerings**; the current churn levels of customers between suppliers is unsustainable. Whilst there is currently much emphasis in market-place on switching energy suppliers, encouraging **loyalty** is cost-effective business for suppliers because it costs 5 times as much to acquire a new customer as to retain an existing one. But there are easier and cheaper ways for energy suppliers to obtain loyalty than energy service provision e.g. reward schemes

Policy Recommendations

Given these opportunities and barriers, a number of policy recommendations flow. Again, many of these are particular to the model of ESCO envisaged.

Table 4: Policy Recommendation to support ESCO development

A facilities management model	A community model	A domestic energy supplier model
• Organisation of training courses for energy managers, making them aware of ESCO activities, ESCO-type projects, and measurement and verification methods and protocols for measuring energy savings. • Ensure that ESCOs provide a qualified and reliable service. Define the minimum set of qualifications for ESCOs, together with a system to assure the quality of service.. • Create more information for financial institutions, and provide incentives to the “first movers” in this sector. • Develop funding sources. Funding feasibility studies, energy audits and the preparation of financing applications would increase their ability to secure additional information and decrease the amount of equity capital required. A revolving fund to finance energy efficiency measures could be set up. Dedicated debt organisations offering 80-100% financing for projects could be established as a link between the market and conventional lending institutions. Under this option, a master loan agreement would be standardised and executed between an ESCO and the debt facility which would commit the lender to provide financing according to defined terms and conditions. Cash-flow based financing matches better the specifics of energy efficiency projects than traditional asset-based financing. Benefits of forfeiting of energy savings. • Standardise contracts and proposals and measurement and verification (M&V). The development of standard procedures for M&V of savings as well as for standard contract terms can help both end users and the financial community better understand performance contracting. • Promote energy performance contracting in government buildings. Government-owned property is a major energy user and can represent a significant proportion of the potential ESCO market. ESCOs can provide government organisations with valuable expertise and private sector investment capital. However, energy performance contracting is very often regarded as unconventional finance by government authorities. Rules and regulations may simply not allow energy performance contracting on government	• The **organisational model** developed to implement community heating is more developed than many realize, eg Woking and Thamesway, Merton though more public**business models** or templates would be useful, • ***Surestart*** could be a good model for a national framework for development of local services[2]. • How to **develop the capacity of individuals and champions** • Encourage **Local Authorities** to use powers they already have to partner in such schemes • Require Almos the **Housing Corporation** to develop plans for ESCOs • **Planning requirement** - at least 10% of energy used in housing developments to be generated on site, though the planning regime • There is a need for a **different type of license** (other than a standard Electricity Supply License) for energy services or bundled services. Review license exempt supply regime to make it easier for small schemes to sell power • Require distribution network operators to reach agreement with community schemes over ownership of private wires to enable private wire supply to households	• The **consumer appetite** for energy services is low, and the deals that suppliers offer largely do not meet consumer wishes. In this market condition it would be more effective to concentrate on improving consumer information about their energy use, and ways of reducing it. • In the short term, better information and access to information is required through **smart metering and billing**. If Bills were on the web, with frequent updates from meters, customers could input their own surveys and do on-line option appraisals. Finance and contacts with installers could be offered on-line. • **Information on energy use** is hard to come by for installers. Some claimed it was easier to get info on the selling price of a house (eg via www.ourproperty.co.uk) than to get information on the energy used by it. • Implement a **microgeneration obligation** on domestic suppliers • Allow ESCOs to claim **Enhanced Capital Allowances** on investments in households • Creation of further **incentives for new market entrants** • Establishing **white certificates** scheme should enable new market entrants to participate. • Implementing a scheme of **Personal Carbon Allowances**[3] • Creating Awareness in small contractors. Small contractor *training* and support is needed for selling, financing, predicting and demonstrating of energy savings, • Energy efficiency financial products for households need to be packaged so that there is minimal incremental effort for the small contractor, and the contractors must learn how to represent and work with the financing

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[2] http://www.surestart.gov.uk/aboutsurestart/ . Sure Start is a Government programme which aims to achieve better outcomes for children, parents and communities. It promotes services such as childcare, health and emotional development for young children, and support for parents. It works by helping services development in disadvantaged areas alongside targeted financial help for parents to afford childcare, and ensuring local service provision is underpinned nationally by a common set of principles.

[3] Personal Carbon Trading or personal carbon allowances are like the EU emissions trading regime but extended to households. Emissions rights would be granted for domestic energy use, personal travel and aviation. Households that used less than their allowance could sell it to households that used more. A cap on emissions could be slowly tightened. UKERC is researching implementation of Personal Carbon Trading, see http://www.ukerc.ac.uk/component/option,com_events/task,view_detail/agid,22/Itemid,0/

property and need urgent review. There might be a key role for PFI.		

A large part of most nations' energy savings potential is usually contained within SMEs and households who have little ability to make energy savings. However, there is a large energy efficiency potential to be tapped by *diffusing ESCO concepts* amongst all existing small contractors serving the SME and household sector. There are three main approaches to encouraging uptake of ESCOs in homes, these are:

- Developing ESCOs in new build and in communities such as social housing
- developing existing energy suppliers into ESCOs , and
- developing existing equipment and service suppliers into ESCOs.

These routes are explored next.

Developing ESCOs in new build

As outlined above, ESCOs in new build are a particular opportunity, since there is the opportunity to make decisions on behalf of a community that is yet to exist, and to install energy efficiency at marginal cost (compared to levels of ex-post insulation or replacement of boilers that would have existed anyway). There is also the opportunity for economies of scale for equipment purchase. For the builder or developer who wants to build and move onto the next project and retain no ongoing interest in a site, contracting out provision of energy infrastructure simplifies construction, and allows a more sophisticated and integrated provision of energy, with the ESCO retaining an operational billing and maintenance role. The key policy drivers to such an approach in new build are planning regulations (e.g. a raft of authorities now require at least 10% of electricity to be generated on site from renewables or CHP) and revisions to building regulations in 2006, with further regulations every 5 years. There is much interest in aiming for zero net carbon new build for the UK by 2020 (equivalent to the top end of an A on the new energy label for homes, based on the Energy Performance of Buildings Directive). **Managing the infrastructure** necessary to this objective would be an opportunity for ESCOs.

Developing Energy Suppliers into ESCOs: White Certificate Schemes

A new policy tool to foster investments in energy efficiency has been recently introduced in a number of EU Member States. A tradable certificate for energy savings (TCES) portfolio involves four key elements [22]: (a) the creation and framing of the demand, by an obligation to save energy imposed on some market actor in the energy sector; (b) the tradable instrument (certificate) certifying the obtained savings and the rules for trading; (c) institutional infrastructure to support the scheme and the market (measurement and verification, evaluation methods and rules for issuing certificates, a data management and certificate tracking system and a registry); (d) cost recovery mechanism in some cases.

Variations of this policy mix have been introduced in Italy, Great Britain, and since 2006, also in France. In the Flemish region of Belgium there are savings obligations imposed on electricity distributors without certificate trading option. In **Great Britain**, the Energy Efficiency Commitment (EEC) runs in 3-year cycles from 2002 to 2011. It replaced the previously existing Energy Efficiency Standards of Performance (EESOP), which ran from 1994 to 2002establishing the principle of pooled spending on energy efficiency for **domestic consumers**. EEC-1 program required that all gas and electricity suppliers with 15,000 or more domestic customers deliver a certain quantity of 'fuel standardised energy benefits' by encouraging or assisting customers to take energy-efficiency measures in their homes. The overall savings target was 62 fuel standardised TWh (lifetime discounted) and the total delivered savings reached 86.8 TWh. In EEC-2 (2005-2008) the threshold for obligation has been increased to 50,000 domestic customers. The target has been increased to 130 TWh; however also due to carrying over of savings from EEC-1 already in 2005 more than a quarter of this target has already been achieved. Suppliers must achieve at least half of their energy savings in households on income-related benefits and tax credits. Projects can be related to electricity, gas, coal, oil and LPG. Suppliers are not limited to assisting their own customers only and can achieve improvements in relation to any domestic consumers in the UK. Carbon benefits estimations take into account the rebound effect – the likely proportion of the investment to be taken up by improved comfort – by adjusting the benefits to 'comfort factors'; in addition dead-weight factors are considered to account for the effect of investments that would be made anyway. At present saving certificate trading is not a feature of the scheme in Great Britain, but suppliers can trade obligations.

White certificates could in principle support the development of energy services and ESCOs to the residential sector. Some white certificate schemes allow ESCOs (in Italy) or any project developer that aggregates savings above a certain size threshold (France) to certify their energy saving projects and sell them in the certificate market (either on a spot market or via over-the-counter bilateral contracts). This would bring additional cash to the ESCO project and could increase the confidence of finance institutions in energy efficiency projects. In addition, white certificates schemes could mandate a certain level of savings in the residential sector, or by making residential project more attractive (e.g. through easier measurements and verification procedures or through giving bonus for action in the residential sector). The relationship between White certificates and the new carbon market needs further exploration.

Developing equipment and service suppliers into ESCOs

Most households already have trusted contractors who know their premises and facilities well. These firms provide maintenance, breakdown repairs and sometimes small capital upgrades. Though these contractors are often very small (often employing only 1-2 people) and local in scope, they are backed by large organisations (e.g. boiler manufacturers who provide training and support for their products, many of whom are investigating micro CHP and other forms of micro-generation) as well as some larger suppliers of maintenance and breakdown cover (e.g. British Gas). There is a lot of room for aggregation of companies into larger organisations. Such providers could become "*mini-ESCO*s" for the SME and residential sectors.

There is already an ongoing working relationship between small contractors and their customers. As a result the small contractors do not incur any additional costs to build credibility with their client. They do not have to provide formal savings guarantees to convince customers of their capabilities. Both contractor and client know that the larger ongoing relationship could easily be broken if the client feels it is not getting what it expected. Small contractors are particularly sensitive to maintaining good customer relations. The ongoing **client/small contractor relationship** for other services could be the foundation for an "ESCO-type" sale of incremental energy efficiency products and services, without the overhead of building a new relationship with a new ESCO. To begin behaving as mini-ESCOs, there are three areas where small contractors typically need development and help:

- Selling Energy Efficiency: Small contractors need to recognise that there is incremental profit from selling more products or services to their existing clients. Often small contractors are conservative and will prefer to stick to their successful and well-established business model, even though they usually know of savings opportunities within customer facilities. Pursuit of the opportunity to expand their business will require small contractors to: a) decide to tackle a new opportunity, and b) learn how to sell their clients on energy efficiency measures.
- Financing Energy Efficiency: In many markets there may need to introduce new financial products for savings-based financing of small energy efficiency projects (cash flow based financing). Such financing typically must find ways to accommodate the specifics of energy efficiency projects (energy savings generate a stream of financial savings) and to handle the credit risks of small energy users. A credit enhancement role may be adopted by governments as part of their commitment to the environment. Energy efficiency financial products for households need to be packaged so that there is minimal incremental effort for the small contractor, and the contractors must learn how to represent and work with the financing.
- Saving Evaluation Techniques Effort should be focussed on making the estimation of savings simple to perform and easy for the customer to understand. Though equipment suppliers may provide information about typical potential savings from their product, few situations are 'typical.' Small contractors need to understand possible areas of savings prediction error and evaluate how much precision is needed for each customer. They also need procedures to manage any new performance risks they might undertake.

Successful integration of ESCO-type techniques into the business methods of small contractors, i.e. making them mini-ESCOs, will require training and support. Unfortunately, the natural tendency of a small contractor is to continue with its successful business model. Only competitive forces are likely to move a contractor to try something new. The natural rate of diffusion of energy efficiency techniques to small contractors can be accelerated beyond the speed of competitive forces by exposing and explaining the opportunities to small contractors. This "expose and explain" effort involves *confronting* small contractors with the real opportunity to increase their business volumes, and then *training* and supporting them. There are some common themes that may be addressed centrally, such as the co-ordination of banks and public bodies in the development of pre-approved energy efficiency loans for small and medium sized enterprises

Conclusions and next steps

Three distinct types of market are identified in this paper. First, the commercial and industrial sector, using a '**facilities management'** or '**performance contract**' model, where the ESCO offering is most developed, and where there remains great potential. Second a **community model**, where decisions are taken by or on behalf of a group of customers in the same location (for example, but not exclusively, a Community Heating scheme). There is particular opportunity in new build, and in refurbishing existing social housing. Third, a **household model**, where energy suppliers' or contractors' offer to existing residential customers may evolve to include energy efficiency and micro-generation. This is the hardest market for ESCOs since the transaction costs of servicing millions of small (and skeptical) consumer is currently large compared to the savings. There is a well-established incumbent industry with significant barriers to new market entry for an alternative business model. The paper explores opportunities and barriers as well as policy options to promote each of the three models, and in particular the residential sector,

The facilities model is well known, and ESCOs for households much talked about (almost as a holy grail). What is new in this paper is the outlining of the communities model (especially the opportunities in new build and in social housing) and the use of contractor as an opportunity to transfer the ESCOs model to smaller customers as an intermediate step to serving households.

For policy makers, performance contracting could be the preferred model for energy procurement in the public sector; the public sector could support low cost borrowing; savings could be traded through emissions trading or white certificates; consistency of product offering would help. For communities, both the planning framework and building regulations could require micro-generation. Central government, local government and social housing providers can all play a key role. For households, changes to the current regulatory environment are needed to reduce barriers to new entrants. The Energy Efficiency Commitment (or similar scheme under the Energy Services Directive) could be expanded to cover more sectors, and tradable elements could be introduced for saving projects (e.g. through white certificates). Promoting information to consumers through audits, smart metering and informative billing will raise awareness. Contractors and financial institutions are two additional important players that need to be engaged in the provision of energy services to the residential sector. The issue remains a live one. The UK is likely to miss its 2010 target for a 10% cut in CO2, and other governments look to be struggling to meet Kyoto obligations. Further measures are needed. Liberating Energy Services could make a range of measures on the customers side of the meter competitive with new supply, and is therefore the logical completion of a fully competitive market, albeit one that could at the same time achieve economic efficiencies and carbon reductions. In policy terms the UK Treasury is continuing to explore with industry, ways to develop the ESCO market [21]. In research terms, in the UK the University of Oxford is researching new build housing as a particular opportunity for ESCOs. DG JRC of the European Commission has reviewed and analyzed national experiences with ESCO development in Europe concluding with a set of suggestions that may form the foundation of a possible long-term strategy to further the development of ESCOs in Europe [6].

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How Can DSM Programmes Be Optimised for Successful Delivery?

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Abstract

The trend towards greater policy making on a regional or local basis leads to greater complexity in delivering programmes for energy efficiency. How can we ensure that one programme (for example to deliver better appliance standards) doesn't prevent investment in other energy saving measures? How can policy makers determine whether to support one developing technology, or would it have been successful due to market forces without policy support? What roles do stakeholder engagement and support activities have in the success of policy schemes?

Research carried out within the EU ALTENER funded project INVERT investigated both how to optimise financial mechanisms within programme delivery and what influence on scheme success is provided by issues such as education and demonstration. The simulation tool developed is based on a very disaggregated bottom-up modelling of energy services. The decision making processes between various options for providing these energy services (e.g. hot water) is modelled. However it is recognised that consumers are not always rational in their decisions from a pure monetary economic point of view. Therefore the analysis of the role that different stakeholders play in delivering policy is vital to gain a more complete picture.

In this paper, the findings are examined to present a framework for energy efficiency delivery systems. These address the cost of carbon saving, the success factors for getting stakeholders to play their part in delivering the programme and the overall cost of the project, taking account of the market forces in energy systems. This framework is tested in a real-world context to give an effective strategy for delivery of carbon savings in a discrete region. Finally we will present suggestions how the model described can be applied by energy suppliers in designing DSM programmes.

Introduction

Within the last years, energy policies have imposed a number of targets at European and national level for rational use of energy (RUE), renewable energy sources (RES) and related CO2-reductions. In some countries, these targets are further devolved, to constituent nations or semi-autonomous regions. As a result, numerous different policy instruments are implemented, sometimes by different authorities directed at similar end-users and similar end-uses. In one European country a home-owner might find it possible, knowingly or not, to access many different policy instruments simultaneously to achieve a carbon reduction in their home (see example in table 1). Which is the most cost-effective for the owner? How should they choose? Which is most cost effective for the country? How should the country choose?

Table 1: Examples of policy instruments applicable to a home-owner age over 60 in UK

Policy instrument	Type	Applies to	End-user Criteria	Source/authority
Warm Front	Subsidy	Insulation and heating systems	age/income	Defra
Clear Skies	Subsidy	RES exc. pv	Community group	DTI
PV demonstration	Subsidy	Solar pv	None	DTI
Renewables obligation	Quota/feed-in tariff	Grid connected domestic pv	Domestic pv / micro-power owner	Energy generator / distributor
Market Transformation Programme	Labelling	Appliances	n/a	DTI
Energy Efficiency Commitment	Cash back	'A' labelled Appliances	none	Energy supplier
e.g. 'Warm and Well'	Subsidy	RUE measures	Age/income, location	Local authority
Energy advice	Education	RES & RUE	None	Defra/LA
Building Regulations	Minimum standards	Building fabric	None	ODPM/LA (enforcement)
Fuel tax	tax	Gas, electricity, oil use in the home	none	Treasury

A comprehensive review of current policies for promoting RES and RUE technologies (Joergensen et al, 2004) gives a broad range of financial and non-financial push and pull instruments in Europe. The following gives a short summary of the sector specific characteristics:

- Energy taxes have a strong impact on both RUE and – because of broad exemptions for renewables – also for RES. All considered countries considered have at least some kind of energy taxes. The most important ones are taxes on transportation fuels, heating oil and electricity.
- With respect to RUE non-financial strategies dominate. In the field of electricity the main focus is on labelling and in the field of heat it is on regulation such as building standards. Once the building directive will be implemented in all EU countries, a stronger focus on certificates in the building sector will occur.
- Compared to RUE in general there is much more focus on use of financial incentives when it comes to RES. In the field of electricity generation from RES, feed-in-tariffs strongly dominate and are partly combined with subsidies. Some countries have implemented quotas based on tradable green certificates.
- In the field of heat generation from RES, strong emphasis is given to investment subsidies which that are often a combined with tax incentive schemes, – especially reduction of VAT and income tax.
- Promotion schemes in the field of transport are heavily dominated by tax exemptions for bio-fuels and relatively high taxation of fossil fuels. Moreover the biofuel directive has created additional incentives in form of the quota to be reached up to the year 2010.

Now, the question arises: how can these instruments be designed in a way to reach the maximum policy target with the minimum public money spent?

The core objective of the project INVERT was to provide a tool and recommendations for saving public money through efficient design of promotion schemes for RES and RUE technologies in buildings and transport.

The project, supported by the European Commission in the frame of the Altener programme, investigated ways and developed the INVERT simulation tool for identifying such efficient policy options. Case studies have been carried out applying this computer model. The deeper understanding of numerous interactions and interdependencies helps design efficient policies for RES and RUE technologies ensuring that a higher share of RES as well as substantial efficiency improvements are brought about with less public money, especially in the view of the Energy Performance of Buildings Directive and the Energy End-use and Energy Services Directive.

The original view was to consider the application through public policy processes where one actor had responsibility for setting policy. However it became obvious that policies and programmes can be developed by different policy actors, partly because of the differences in policy goals that can be addressed by policies for RES and RUE. However, programmes from one government department must be able to be compared with one from another department. Further, devolution of responsibilities towards regional energy strategies means that complexities increase. If the regional authority has sufficient power then the option to create different incentives needs very careful analysis or conflicts with national incentives could occur. Moreover, differences in regions can lead to failure of the incentive as cross-communication occurs (Pett et al 2004). If the impetus for energy saving switches at least in part to energy suppliers, as proposed in the Energy End-use and Energy Services Directive (ESD), then how do incentives and programmes become targeted to individuals in a cost-effective way. Is this cost-effective for government, for energy suppliers or for the country as a whole?

The complexity of this system suggests that some tools for optimising are needed. Even if the optimisation cannot take place at all levels and with all actors at the same time, the ability to compare an optimum approach at one level can at least inform solutions at another. Without any optimised solutions, however, there is chaos. The concept of rational economic decision making breaks down as there is no hope of a perfect understanding or even of a bounded understanding of the market as a whole.

Hence this paper presents research that enables optimisation of programmes at a single level, discussing the various financial and non-financial issues that reduce the risk of programme failure. These ideas are brought together in a robust and well-tested tool, INVERT , which is demonstrated through application to a real-world case study. This is then extrapolated to consider the development of DSM programmes by actors other than governments, in order to consider the approach needed for delivery of the ESD.

Investigating financial mechanisms

Whenever it comes to the design of energy policy instruments, decision makers are faced with the question: how they can reach their policy goal(s) in a most efficient way? Assuming that CO_2-reduction is a dominant target for promotion schemes in the field of RES & RUE, they have to find a solution to the problem: how can the most CO_2 reduction be achieved with the least public money? Hence, policy makers have to find methods for comparing various policy options with respect to the degree to which the target (e.g. CO_2-reduction) is reached and the amount of money required.

Within the project INVERT this question has been investigated. The core approach for this was the simulation of the decision making process of consumers and investors who are faced with various technology options (e.g. heating systems, insulation, window replacement …) and related financial incentives due to promotion schemes. By modelling this decision making process we can identify the impact of various types of financial incentives (including taxation and price controls) and compare the effectiveness (in terms of CO2-reduction) and efficiency (in terms of costs per kg CO2 saved).

INVERT simulation tool includes building related energy systems (heating, domestic hot water, cooling and corresponding efficiency measures), renewable electricity systems and bio-fuels. In this paper we focus on the building related sector. The modelling approach and main algorithm are described below.

Building Sector simulation

In INVERT simulation tool the building sector is based on a disaggregated description of the building stock. Various building categories (e.g. single dwellings) can be distinguished, each of which is split up into several construction periods. This results in building classes (e.g. single dwelling, 1945-1960) which are assigned to typical, average building parameters (geometry data, U-values etc). From these building related data and climate data, the useful energy for each building class can be derived. The next step is to classify the building classes according to the currently installed heating, domestic hot water (DHW) and cooling systems. Typically, this procedure results in a final number of about 100 to 500 building types for the region considered. From the efficiency and the service factor assigned to each heating, DHW and cooling system, the final energy demand can be calculated for each building type.

This core procedure for describing the current building stock is the basis for the further calculations and actual simulation runs.

For each building type an option based algorithm is used. Within this approach the decision making process of various consumers and investors is modelled by comparing different options (e.g. heating systems). At the end of life of an existing system (e.g. heating system), different new system options exist. The decision maker (e.g. house owner, renter) selects a new technology option on basis of the new system costs (a function of investment, operation and maintenance costs), the savings compared to the old system, the change in comfort and the promotion scheme support (e.g. investment subsidies). In reality there are also a number of non-monetary economic decision parameters like comfort issues, trends, information bias etc. All these non-monetary aspects are depicted by so called "soft barriers" modifying the pure monetary costs and gains. These 'soft barriers' are quantified by a calibration process comparing the real historical observed energy consumptions and the calculated monetary costs for each building type and investor group, adjusted to align the historical energy consumption with the calculated energy consumption. With these 'soft barriers' and replacement rates, the impacts of different promotion schemes, energy prices and strategies can be simulated dynamically till 2020.

The calculation of the 'option costs' is shown in Figure 1. Starting with the technology data (investment costs, lifetime, OM costs, and efficiency), the risk evaluation of the future (Individual Payback Time[1]), the fuel costs and the average interest rate, the yearly costs for all possible replacement options are calculated.

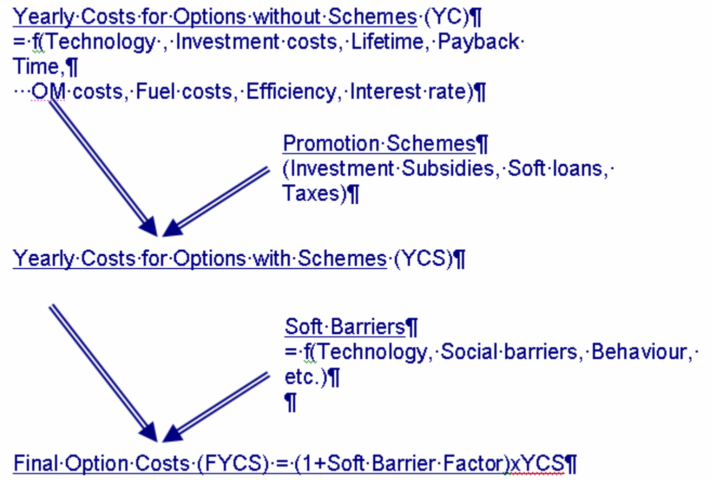

Figure 1: Calculation of option costs in the building sector in INVERT

Having calculated all option costs and using no promotion schemes or soft barriers the option costs are represented by YC. The cheapest option in each consumer group (will be used. However, without promotion schemes almost no renewable energy sources or RUE measures may be applied because of high yearly option costs compared to conventional energy systems and therefore it could be necessary to use promotion schemes. The promotion scheme produce cheaper options than before leading to a different level of take up, and consequently different energy use and CO2 profiles.

Results

The results achievable with INVERT can be displayed on an aggregated as well as disaggregated level. All outputs according technologies, energy carriers, RES-E/CHP as well as bio-fuel technologies are displayable on a disaggregated level. All outputs necessary for the estimation of the promotion scheme efficiency in the different (sub)-sectors (building, electricity, bio-fuel, heating, cooling, etc.) are displayable on an aggregated level (CO2 emissions and transfer costs). These main outputs are:

General Outputs (for Heating, Cooling, DHW, DSM, RES-E/CHP, Bio-Fuel):

- Public transfer costs for promoting RES & RUE technologies (Mio Euro/year)
- CO2-emissions (total and reductions due to promotion schemes) (kt/year)

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[1] The calculation of the Capital Recovery Factor is either based on the lifetime or individual payback time. The user of the model is able to *select* between 'Individual Payback Time' and 'Lifetime' of the equipment for the simulation of the investors' decision making process. If the user selects the 'Individual Payback Time' the tool considers all costs and benefits (e.g. due to solar thermal systems and 'Insulation' as well as 'Windows'). With this approach INVERT is able to calculate the maximum yearly costs seen by the consumer. These costs are the important decision making parameters for the so-called Landlord problem. However, this approach corresponds with a risk evaluation of the future. For more information please see Stadler et al 2004.

Heating, Cooling and DHW:

- Energy demand reductions due to insulation and window replacement (DSM) for various building types (GWh/year)
- Mix of energy carriers for heating, domestic hot water and cooling systems (numbers of systems (1); numbers of buildings (1));
- final energy demand (GWh/year)
- District heating related outputs

Electricity/District Heating:

- Output from RES-E plants (GWh)
- Installed capacity of RES-E plants (MWel)
- Heat output from RES-CHP plants (GWh)
- Installed capacity of RES-CHP plants (MWel)
- Heat output from conventional Heat /CHP plants (GWh)

Bio-fuels:

- Total production of various types of biofuels (l)
- Entire agricultural surface needed for the bio-fuel production (ha)

As it has been pointed out above, the usual approach of a policy decision maker is to compare promotion schemes and strategies for the reduction of CO_2-emissions in the different sectors (building, electricity and transport). The core question for this comparison is: *“How efficient and how effective is a certain mix of promotion schemes in reducing CO_2-emissions?”*

Deriving efficient policy mixes: the concept of the efficiency-CO_2-graph

Changing the promotion schemes for RES & RUE technologies, will result both in a change of CO_2-emissions as well as of transfer costs. Assuming that we can achieve a CO_2-reduction compared to the reference scenario, we consider those schemes that can reach this reduction with a lower amount of public money (transfer costs) *more efficient* than others. Hence, we are searching for instruments that result in high CO_2-reductions requiring low public money (transfer costs).

“Promotion scheme efficiency” was defined to investigate this issue. The promotion scheme efficiency estimates the efficiency of a certain strategy compared to a reference scenario by comparing the CO_2 emissions and transfer costs (public budget relevant expenditure for promoting a certain technology) of the reference scenario with the CO_2 emissions and transfer costs of the sensitivity scenario. The most efficient schemes are indicated by high CO_2 reductions and low increases (or even decreases) of transfer costs compared to the reference scenario. In order to derive this indicator for the whole simulation period, CO_2-emissions are summed and transfer costs are discounted over the whole considered period. Promotion scheme efficiency is therefore the ratio of the change in CO_2-emissions and the change in transfer costs compared to a reference scenario.

Looking at the results gained from the case studies in the original project, we discover that the efficiency for various measures within one region can vary between less than 4 and up to more than 80 kg CO_2/€ in typical regions within the EU-15 countries (Ragwitz et al 2005). In the new member states the range may be higher partly because currently even cheap energy saving potentials are not tapped.

However, it turns out that the measures with the highest efficiency are often those resulting in the lowest CO_2 reduction. This goes along with the intuitive presumption that the amounts of public budget required for reducing higher amounts of CO_2-emissions increases on a progressive scale. When it comes to evaluating and comparing promotion schemes it is necessary to consider both the efficiency (kg CO_2 saved per €) and the effectiveness (kg CO_2 saved) of an instrument in an integrated manner.

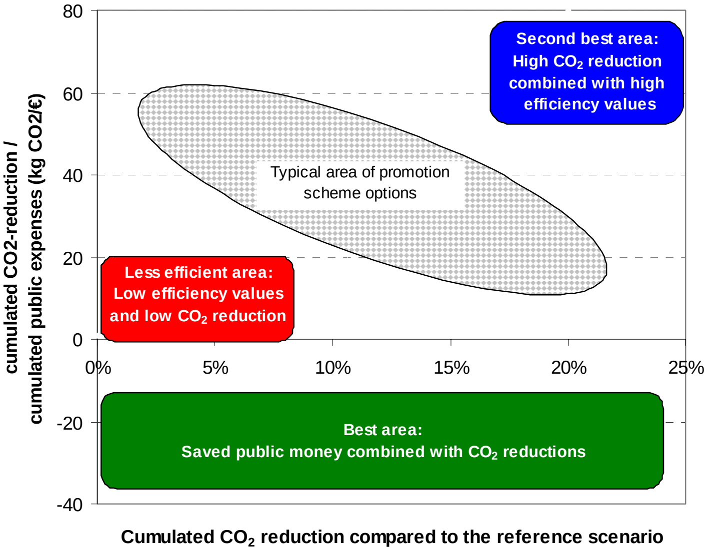

Figure 2: Efficiency-CO$_2$ graph – basic principle

Figure 2 shows the basic principle of an efficiency-CO$_2$ graph integrating these two important aspects for evaluating promotion schemes: efficiency and effectiveness. It can be seen that there is one area where CO$_2$-reductions can be achieved with negative costs (on the bottom of the figure). Measures in this area typically refer to the abolishment of counterproductive subsidies for fossil energy technologies. Besides these measures of course it would be most favourable to find instruments resulting in a very high reduction of CO$_2$-emissions at very high efficiency levels. This refers to the area on the top and the right hand side of the figure. However as it is well known, cheap CO$_2$-reduction potentials are limited and so the typical area of promotion scheme options are in the middle of the graph: increasing the level of a scheme typically increases the CO$_2$-reduction but decreases the efficiency. Measures (and mixes of measures) situated in the left bottom part can be regarded as not efficient, because the same amount of CO$_2$ could be saved with a higher efficiency, i.e. with a lower amount of public budget.

So, single promotion schemes can be compared to each other with respect to the efficiency and achievable CO$_2$-reductions by using this graph. However, when it comes to promotion scheme design, the whole policy mix consisting of various measures for various technologies has to be considered. The options for the policy maker usually consist of a large number of combinations of different levels of promotion for different technologies. By varying the level of each of these promotion schemes we can gain curves indicating the efficiency and effectiveness of promotion schemes.

In Figure 4 the case of increasing the level of a certain promotion scheme coming from the current policy mix has been considered for two typical cases. In both cases, the promotion scheme efficiency of the currently implemented policy mix is 15 kgCO$_2$/€.

In the upper curve, the promotion scheme efficiency at the beginning strongly rises by increasing the level of incentive for efficient promotion scheme (or rather technology) compared to the efficiency of the current policy mix. Therefore, total efficiency of the whole promotion mix rises. The same amount of CO$_2$-reduction could be achieved with a smaller amount of public money compared to the case of extending the current policy mix for all technologies in the same magnitude. Or in other words, the additional reduction of CO$_2$-emissions does not lead to an increase of specific CO$_2$-abatement costs. Hence, this technology currently is under-represented.

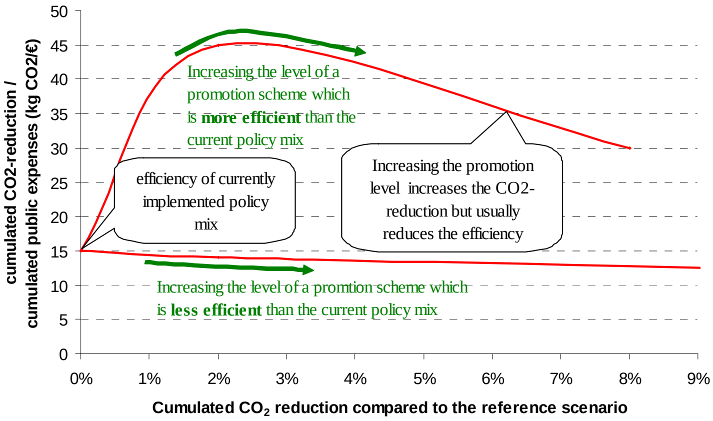

Figure 3*: Efficiency-CO2 graph – typical* characteristics

However, it turns out that the efficiency declines again with higher values of promotion. This has two major reasons: First, the scheme now addresses more expensive CO_2-reduction potentials. This results in higher costs and thus a lower efficiency. Second, for an increasing number of people, those high promotion levels represent over-subsidisation. The lower curve in the figure shows the case of a promotion scheme, which can reduce CO_2-emissions, but not with a higher efficiency than in the current policy mix. This curve represents an extension of the currently existing policy.

Combining a number of different policy options, we can create a set of such curves. This set corresponds to the variety of policy options resulting in different levels of CO_2-emissions with different levels of efficiency. The envelope of this set represents the optimum policy mix for a certain CO_2-reduction target.[2] Of course, the policy maker may conclude that with respect to other policy goals it may be reasonable to decide for a portfolio that is not exactly on the envelope curve, but a little bit lower. However, in this case the envelope may be a guide for the specific policy strategy selection.
Summing up, the optimum policy mix strongly depends on the amount of CO_2-reduction, which shall be achieved. Moreover, the curve indicates whether the current mix of policy instruments is the most efficient one in terms of saved CO_2-emissions per Euro of public budget spent[3]: if a point on the envelope exists with a higher value of CO2-reduction per Euro compared to the current policy mix, an efficiency improvement takes place.

Investigating 'soft' design features including stakeholder involvement

As well as investigating the economic aspects of programme success, the role of stakeholders in designing and delivery of the programme concerned was investigated. It is recognised that there are many seemingly well designed programmes that have lower success than anticipated, and also that a good design in one country does not necessarily transfer directly to another. These issues were investigated by making a detailed analysis of the design and development factors of 46 programmes that had been identified under the INVERT project (Pett et al, 2004), the cultural and organisational characteristics of the 226 stakeholder organisations involved and whether stakeholders carried out the role that was expected of them in the programmes.
The first part of the analysis established that there was a significant difference between the success of schemes when stakeholders did, or did not carry out the expected. As shown in Figure 4, nearly all stakeholders in successful schemes carried out their expected role, whereas 40% of those in unsuccessful schemes did not. What is not known is the causality of this relationship; do schemes fail because stakeholders do not get involved, or is there something about the scheme itself that cause stakeholders to fail to participate?

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[2] It has to be noted that the exact shape of the envelope-curve depends on the number and type of combinations, which are carried out for deriving the set of curves. Therefore, the concept relies on the assumption that the most efficient combinations are included within the simulation runs.

[3] Of course, it has to be noted that there are always additional other policy goals (e.g. energy saving, employment, welfare, …)

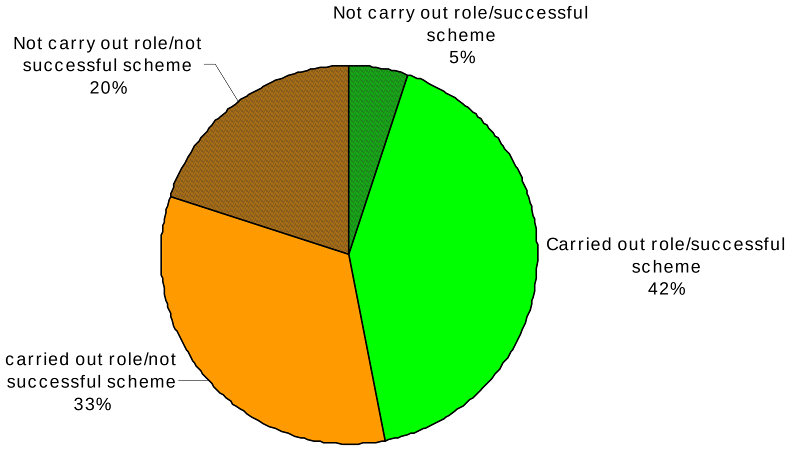

Figure 4: Relationship between scheme success and stakeholders carrying out their expected roles

Analysis produced a number of key issues. These are described as risk issues, as it is still not possible to determine a causal relationship, but existence of these factors is associated with a more risky scheme.

- *The type of organisation that initiated the programme*
  Where programmes were initiated by organisations *other than* national government (or a government agency acting for the government), there was a lower success rating. This may be influenced by the relatively small number of programmes surveyed initiated by regional government, where rapidly changing political landscapes seemed to influence scheme success. Consequently the first issue in the design of programmes is whether the stakeholder initiating the programme has the political will, power and ability to see the programme through.
- *The role this organisation plays in design or managing or funding the programme*
  The most regularly successful combination of the combination design, manage and fund was government body setting up the scheme and handing it to a third party to run. However, where a government body was responsible only for funding a scheme, there was a high risk of lack of success.
- *The type of organisation required to certify, inspect, licence or give any specific approvals for the scheme to be taken up*
  The existence of a requirement for inspection or approval was shown to be a critical incident in scheme execution. Examples include:
  - Verification of installation of measures before a grant is paid
  - Inspection and approval of building standards
  - Licensing or planning consent for renewable energy plant

  The most successful approach was to contract the inspection to a commercial organisation; there was a business benefit for this work to be done. The least successful appeared to be when the task was allocated to a government or local government department.
- *Whether end-users are likely to rely on third parties to influence their decision to participate in the scheme*
  The risks are that end-users place their trust in advisers who do not agree with the change being promoted, or it is not in the adviser's own interest to persuade the end-user to take up the scheme. Where there was a positive information flow that enabled clearer understanding especially of the technical issues, it offset the reliance on those acting in their own self-interest, or those just out of touch with modern science and building practice.
- *The type of marketing planned for the programme*
  Linked with the above, where marketing was included and directed by the scheme owner to the end-user, it increased the chance of success. The suggestion is that it is well focused and professionally handled.
- *The way the technologies are to be introduced*
  For early stage programmes, including support for R&D meant they were more likely to be successful; the availability of reference sites was linked to success for later stages. The factor best linked with success, however, was the inclusion of a demonstration programme, and the

more proactive this was, the more likely it was to be successful. Other combinations that did not include demonstration were highly likely to risk low achievement of objectives.

- *Whether intermediate stakeholders are involved in the design of the scheme*
  For most of the countries surveyed, only the policy owner and managing agent were involved in scheme design, and the factors shown above gave a robust relationship for a wide variety of subsets.. The subset that did not work well was ‘activity culture’. Denmark and UK were the only countries were programmes were assessed as taking place within a culture where partnership with commercial organisations was necessary for success. There tended to be a much wider consultation with stakeholders in Denmark and UK, so wide consultation was used as a proxy indicator as it is easily measured. However, more robust investigation was beyond the scope of the available data.

These findings were fed into the INVERT model as risk factors, but only to highlight the ’soft’ factor for how likely a given technology was to be acceptable to the stakeholders. However in formulating a framework for system delivery, these risk elements relating to both system design and role of the stakeholders need to be taken into account in order for them to optimise the programme for successful delivery (see Kranzl et al 2005).

Optimising energy efficiency delivery: the case of Northern Ireland

How can INVERT be used to enable public policy to optimised in practice? It was applied recently during research on the delivery of energy demand reduction in Northern Ireland. The geographical situation of Northern Ireland (NI) distinguishes its energy policy from the rest of the UK as it does not benefit from direct linkage with North Sea oil and gas supplies. It has not benefited from the ‘dash for gas’ which has characterised the British energy and carbon emissions reductions profiles since the 1970s. However the fuel mix in NI is changing, with the development of gas interconnectors (the third coming on stream in 2005) with the Republic of Ireland and with Scotland, and investment in wind energy. The principal mode of domestic heating remains oil, although in some parts coal predominates. In NI energy is a devolved issue, unlike the situation in England, Scotland and Wales where control is by the UK government. The development of an Energy Strategy has taken priority (DETI, 2004) with the publication of an aim to reduce electricity use by 1% a year in real terms from 2007 to 2012.

A detailed baseline model of Northern Ireland’s residential housing stock (650,000 dwellings) was created in INVERT using data from the 2001 House Condition Survey (NIHE 2005). This incorporates conservative estimates for fuel price development over the next 20 years, includes a technological database of different heating systems, insulation materials and window replacement options. It takes account of the rate of stock refurbishment, maintenance costs of heating systems and appropriate boiler sizing. A three-year ‘stakeholder-payback time’ has been chosen for the baseline. This short payback time forces the model to accept that in the UK, the accepted cost-payback horizon of consumers is unrealistic. Even building measures in government programmes are expected to payback within five to seven years to be ‘cost-effective’ (Smith et al 2005). The baseline also assumes full availability of natural gas; in practice this will be limited to those with easy access to the gas network but the stated policy aim is to have as many households connected as feasible, and the gas pipelines bring this fuel to the most populated areas, consequently no alteration of the baseline is considered appropriate.

Figure 5 illustrates the development of the number of different central heating systems under the baseline scenario.

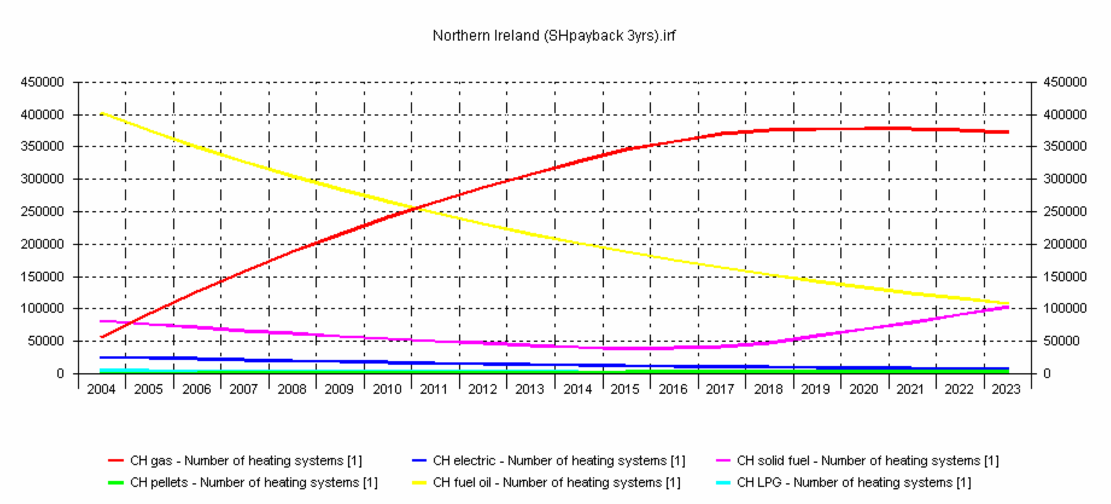

Figure 5: Baseline scenario, number of central heating systems

The baseline shows high take-up of gas central heating systems, mainly replacing oil central heating, and is higher than might be expected but for the unusual situation of Northern Ireland's geography and resources. This take-up tails off slightly around 2018, when households would start taking up solid fuel central heating up again if they make decisions based on cost alone. This is plausible on the basis of the development of the cost of coal compared to gas over time, but of course would not be if building regulations proscribed the installation of solid fuel central heating. The number of electric central heating systems declines steadily throughout.

However with the baseline as described, it might be necessary to promote a renewable heating option that compensated for a restricted gas network. The incentive in Figure 6 illustrates what happens if a 50% subsidy is provided on the cost of a wood pellet boiler – this would prevent any increase in the number of coal[4] central heating systems and has the additional benefit of containing the take-up of gas central heating to less than 50% of the households without forcing an artificial constraint on growth.

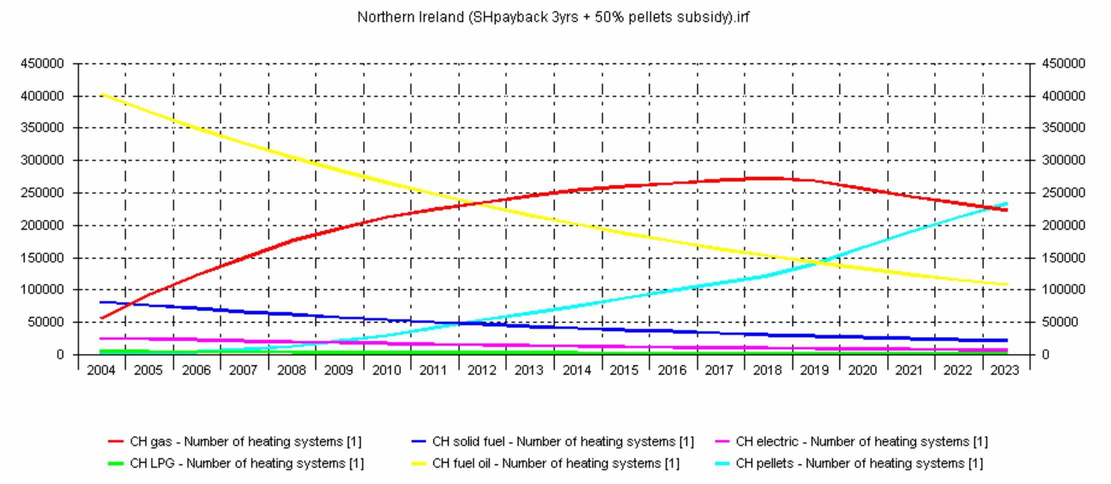

Figure 6: Baseline scenario with 50% subsidy on wood pellet heating systems

In the same way as the model places no constraint on the gas connection, there is no constraint on the supply of wood pellets. In practice, opportunities for biomass development could be attractive to the Regional Development authorities and are consistent with the Energy Strategy (DETI op. cit.), but the potential has only been analysed by others on a scenarios basis at this stage (Carbon Trust 2006). INVERT indicates that substantial take-up of wood pellet boilers could be encouraged, even against the assumption of short-termism amongst households.

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[4] Solid fuel boilers provide the technology to use coal or wood logs, but coal is the most available solid fuel in Northern Ireland

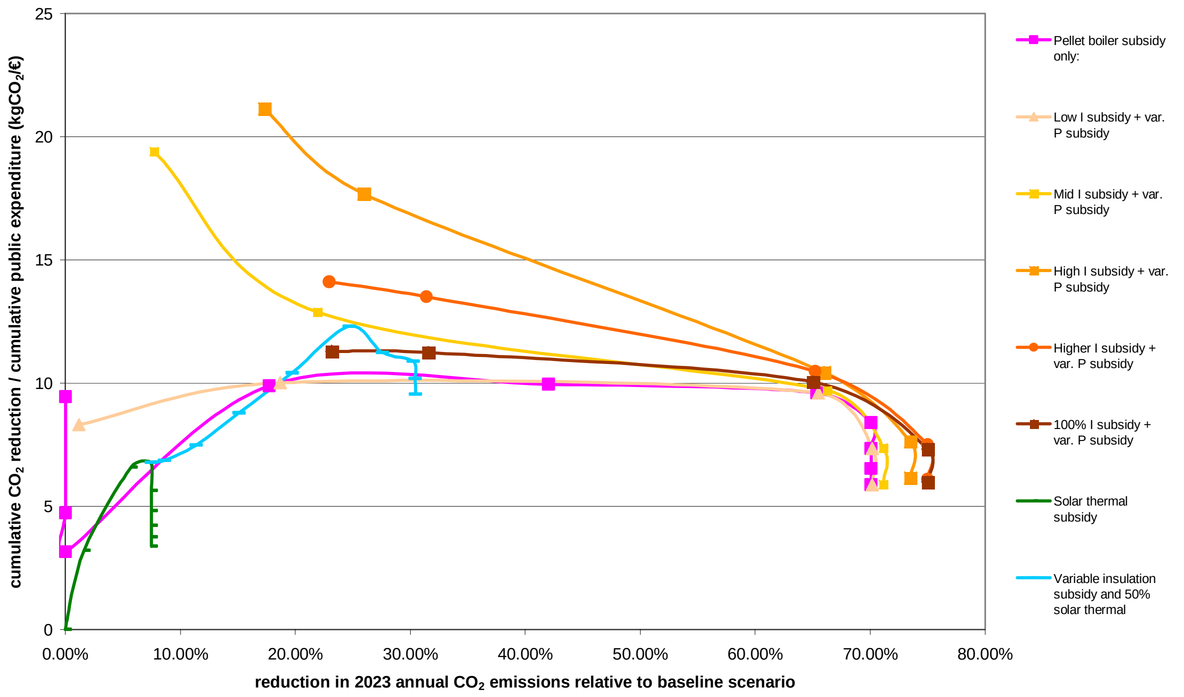

Figure 7: Efficiency-CO2 curve for Northern Ireland

In Figure 7 the option of promoting wood pellet boilers compared with solar thermal technology is considered, each combined with insulation measures with varied levels of subsidy. Some interesting points emerge:

- At the extreme left hand side, wood pellet boilers on their own have such little take up until a 40% incentive is applied, that the early points on the graph are anomalous. However, when combined with insulation subsidies at various levels, wood pellet boilers become increasingly attractive. High subsidies for insulation promote initial take up at high (how high exactly?! I would include this, because increasing the level further, dramatically reduces efficiency!) levels of efficiency for the programme in terms of CO2 saving per unit cost.
- For solar thermal, the peak take up is when a 50% subsidy is applied, after which increasing the subsidy leads to little additional take up and it is public money wasted. However, adding a 60% insulation subsidy to the 50% subsidy for solar thermal on its own leads to additional take up so that this combination peaks in terms of efficiency at around 12 tonnes CO2 per unit cost delivering nearly 25% reduction in CO2 emissions in 2023 over the baseline.
- However this same effect could be delivered with a medium (40%) subsidy on insulation and 40% subsidy on wood pellet boilers.
- All the combinations of wood pellet boiler plus insulation subsidies lead to a point at which a 65% reduction in CO2 emissions could be achieved at around the same total cost of CO2. This suggests a limiting factor on the take up of this technology compared with other available systems. It also suggests that if NI wished to reduce its emissions further, some other combination would be needed, such as changes to building codes.

To what extent would programmes such as this be feasible? The indication of a cost-effective combination of measures does not assist programme designers to identify the total societal cost of the programme. A programme has to fit the budgetary constraints and sources of public finance. With the example of wood pellet boilers, this technology is currently in its infancy in NI. A UK government grant funded a plant in Enniskillen which now produces 50,000 tonnes per year from wood chippings and wood waste, sufficient to fuel 10,000 homes annually (RCEP 2004), and this technology had been identified as a considerable contributor to a low carbon future for Northern Ireland (Carbon Trust, op. cit.). As this report says:

> The successful development of local bio-energy resources will require substantial Government support, particularly in the early stages of development when new infrastructure for collecting, processing and transporting biomass will be required. Support will also be needed to develop the local skills base, to raise public awareness of the environmental benefits of the technology, and to establish a competitive market for bio-energy.

This statement highlights the key stakeholder risk areas that the INVERT project identified for promotion schemes, particularly the need for a strong commitment from government, involvement of the stakeholders in the new supply chain, and support for the technology including education, demonstration and marketing. The choice of which programme, or combination of programmes to choose will depend to a great extent of the involvement of stakeholders, their capacity to produce the necessary systems and fuels, and the rate of change in societal understanding of the technologies. However the cost of these programmes can be seen through the INVERT model, and the benefits clearly described. If such an approach is adopted in NI it will also require interdepartmental working of a high order. At present there is some division of accountability and therefore need for agreement on priorities and objectives, but the evidence of Invest NI working with the Carbon Trust, and the Housing Executive's success in promoting multi-stakeholder investment programmes in the domestic sector (Pett et al 2006) point to the ability to makes these changes should the political will (and ministerial commitment) be there.

Application in DSM programmes

The issue of how much it costs to produce a reduction in CO2 emissions for a given investment cost is as relevant to energy suppliers as it is to the public purse. The End-Use Efficiency and Energy Services Directive (ESD) will require energy suppliers to promote demand-side reductions. What choices should they make, or will their choices be prescribed by their governments? The Energy Efficiency Action plans to be submitted by each country to the Commission will determine how these decisions are made.

The case of the Energy Efficiency Commitment (EEC) in the UK is often cited as an example of how energy suppliers can deliver DSM. The design of the EEC specifies the range of cost-effective DSM measures that can be applied, and a target energy saving (in TJ) which is divided between suppliers on the basis of their market share. It leaves it to the energy supplier to take sufficient action to achieve their target, assuming that 'the market knows best'.

The outcome of the first phase of this programme was very successful, with energy suppliers delivering more than the target, so that savings were allowed to be carried through to the next phase EEC2, currently in progress (Ofgem, 2005). What becomes more difficult for suppliers is to know what options would work best for them in what is becoming a more competitive market, with the first phase having addressed the 'low hanging fruit' of improvements that were easy to find and deliver. We suggest that a tool such as INVERT might assist them in determining the most cost effective solutions for building related energy savings in exactly the same way as described above, although suppliers do not have an option to impose carbon taxes.

Two difficulties arise:

- Focus on carbon saving versus energy reduction
- Lack of data on or transparency for the internal costs of demand side programmes

In the first case, targets are proposed in terms of energy saving in both the ESD and the EEC. ESD uses an indicative target of 9% energy saving over 9 years, which could be translated into actual TJ or TWh by governments if they so chose. INVERT is designed to calculate the cost of carbon saved, with a view to overall Kyoto commitments; the ESD is more geared towards energy supply and security issues, despite its link with Kyoto mechanisms. INVERT could readily identify energy savings as an alternative cost-effectiveness measure, and this makes it easier to show the value of demand side measures in a multi-stakeholder environment where a positive incentive for 'negawatts' is required.

A consortium led by Wuppertal Institute attempted to identify the potential for optimizing internal costs of DSM programmes but was unable to secure commitment for shared data from enough energy suppliers to enable the project to go forward. Indeed, the issue provides a commercial opportunity for INVERT, as one supplier responded to the request for data:

"I think you will struggle to get any detailed responses partly due to confidentiality but also because the programmes have become more closely aligned to core business activity and are no longer ring fenced as they were. EEC is such a significant cost to suppliers now that they would not be willing to divulge any information that might lose any market advantage they may have established." (Sykes, pers.comm)

We believe that INVERT could assist energy suppliers who have not yet had to develop such internal programmes. Optimising DSM programmes will be vital to their commercial interests and to the success of the ESD.

Summary and conclusions

Although an economically rational model can be derived to assess the most efficient programme to reduce energy use and CO2 emissions, it needs also to take account of scheme design and risk factors from the human elements. The INVERT model provides the simulation tool and the context for scheme design to minimise those risks. Finding the optimum mix of promotion measures is only the start, as a good scheme designer will know.

One of the core messages of this paper is that for a comprehensive analysis and optimisation of policy instruments two aspects have to be taken into consideration: efficiency and effectiveness. The efficiency of a promotion scheme indicates how much of a target (e.g. energy savings) can be achieved by using a certain amount of public money in terms of saved kWh/€. The effectiveness measures how much this instrument can contribute to reaching a certain target in absolute terms (e.g. kWh energy saving). Both aspects have to be considered at the same time. Isolating only one of these aspects, may lead to distortion. In this paper, CO_2-efficiency graphs are presented, combining these two aspects. They clearly show that the optimum policy mix is a matter of the target: which level of CO_2-reduction should be achieved by a certain year? What additional targets should be met (energy security, energy saving, reduction of other emissions, development of a new manufacturing stream)?

Finding an optimum of efficiency and effectiveness requires taking into account a lot of interconnected circumstances and side conditions. The following lists and briefly describes the most important of them:

- Interactions of technologies and policies
  Technologies and policies show multiple interdependencies. They influence each other and thus can help increasing the efficiency and effectiveness of the policy mix or in contrary can hinder each other. For example, in the building sector supply and demand side measures are influencing each other, in particular due to different levels of energy prices for different energy carriers. Hence, a change in the policy for DSM usually simultaneously causes an impact on the energy carrier mix. Moreover, the improvement in the thermal building quality will reduce the total heating demand in particular that part supplied by district heating. This leads to a decline of options for cogeneration plants.
- New technologies
  For new technologies that have not yet reached the maturity to enter the market, the efficiency criteria may not be applied. In the case of new technologies, efficiency turns out to be of minor importance as long as they have not reached effectiveness. The reason is that the loss of public money is very low even in case of high promotion because the absolute number of those plants is still very low. However, as soon as the technology becomes mature and the promotion scheme becomes effective, the efficiency criteria should be applied.
- Reducing the free-rider effect
  A key element for setting up efficient promotion schemes is reducing the free-rider effect. This is possible by differentiation among consumer types, technologies (and efficiency levels of technologies) as well as efficiency levels of demand side measures and must be linked to incentive compatible support schemes.
- Incentive compatibility
  The incentive compatible design of promotion schemes is one of the basic requirements for efficient policies. It has to be considered that each public intervention can lead to side-effects. E.g. subsidies granted as a percentage of investment costs show the tendency to decrease the incentive for cost reductions, subsidies granted per kW of installed power may lead to over dimensioning e.g. of heating boilers. Thus, schemes should be based on parameters leading to incentives that support the target of the policy and hence are incentive compatible. E.g. subsidies for insulation granted in €/m² living area, depending on the achieved energy savings and building quality show less negative bias than investment subsidies granted as a fixed percentage of investment costs.

The case of Northern Ireland indicates possible paths for a dynamic and changing energy and cultural region that has multiple and sometimes conflicting priorities. However, identifying these economically rational approaches against the background of strategic change allows choices to be made that support social change and developments in industry and environmental technologies.

The use of the efficiency-CO2 curve in this instance showed the value of combinations of measures in promoting take up of new technologies plus the benefit of identifying the desired levels of decrease in emissions at a future year compared with the baseline. It also showed the limitations of certain technologies, in this case solar thermal, although the effect of a combined promotion with insulation was dramatically different in both cost effectiveness and emissions reduction.

A strong lead from government would identify paths, consult with the key stakeholders such as manufacturers and the actors in the supply chain, in order to make decisions on capacity, industry growth, and training for operatives as part of the whole programme package. Discussion with farmers and Regional Development would be needed to analyse raw material availability. The reduction of risk to a programme through understanding of the key risk factors is essential for a robust design.

If INVERT simulation tool can help governments design programmes that make optimum use of public money for their CO2 reduction programmes, then surely energy suppliers would also like to maximise their achievement of energy savings at least cost. How do they know if they are taking a least cost approach? It is quite possible that sophisticated modelling tools are already being applied, and it is certain that considerable knowledge of how energy saving programmes can be designed exists within the energy suppliers in the UK. How will this be applied more widely once the End Use Efficiency and Energy Services Directive is implemented? We suggest that a tool such as INVERT (which can be tested free of charge) might form the basis of some sophisticated modelling that creates the basis for well designed practical schemes that benefit society as well as the energy supplier in question. As such we suggest that the principles and findings of INVERT, both in terms of promotion efficiency and scheme risk factors, must be taken into account.

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Accelerated Replacement

Actual Energy Consumption of Top-Runner Refrigerators in Japan

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Abstract

In Japan, energy efficiency standards for domestic refrigerators were established in 1999 in accordance with the guidelines delineated by the Top-Runner program. The goal was an improvement in energy efficiency of approximately 30% compared with the year 1998 by the year 2004. This goal has been not only met but exceeded: the average annual electricity consumption of products shipped in 2004 was 290 kWh/year, a 55% reduction of the 1998 figure.

Electricity consumption of refrigerators is measured using the Japan Industrial Standards (JIS) test procedures. However, existing surveys show significant difference in electricity consumption between the actual and the labeled.

This paper analyzes the difference between actual values and labeled values of electricity consumption. Actual values were obtained by conducting two experiments. The first experiment measured electricity consumption of two high efficient refrigerators in a laboratory simulating actual use conditions. The refrigerators were found to consume two to three times more electricity than under JIS test conditions. The second experiment monitored over 100 refrigerators in households. According to the first year's result, the average annual electricity consumption was 65% larger than the JIS test value.

Energy efficiency of refrigerator has been improved, but the significant difference in electricity consumption between the actual and the labeled might damage the public trust in labeling. The government began studying new standard and test procedure of refrigerators in September 2005. The JIS test procedures were revised to be much similar to real usage in January 2006 and the standards will be established by the end of the year.

Introduction

In 1998, the Japanese government started to revise energy efficiency standards for machinery and equipments by using the Top-Runner approach which was how to establish standards based on the efficiency of the most efficient product at the time [1].

The standards were set in 1999 for domestic refrigerators and freezers which accounted for approximately 17% of electricity consumption in the residential sector. The target year of the standards was 2004.

The annual electricity consumption standard is defined as a function of adjusted rated volume for each category (see **Table 1**). The most popular type of refrigerator-freezer is Category VI. A typical Category VI refrigerator-freezer has 300 liters of fresh-food storage capacity and 100 liters of three-star freezer capacity. As its adjusted rated volume is 515 (=300 + 100 x 2.15) liters, the standard electricity consumption value is 408 kWh/year.

Manufacturers are required to label their products with an annual electricity consumption value that is measured by JIS test procedures. In each manufacturer and category, the average electricity consumption weighted by shipment may not exceed the standard value. In case the weighted average remarkably exceeds the standard value, the Minister of Ministry of Economy, Trade and Industry recommends manufacturers to improve the annual electricity consumption. If they do not follow the recommendation, the Minister announces to the public and may order the manufacturer to follow recommendations.

Table 1: Energy efficiency standards for refrigerators and freezers

Category		**Target standard value**
Refrigerator	I refrigerator (natural convection)	E (kWh/year) = 0.427 x Vadj (L) + 178
	II refrigerator (forced circulation)	
Freezer	III freezer (natural convection)	E (kWh/year) = 0.281 x Vadj (L) + 353
	IV freezer (forced circulation)	
Refrigerator -freezer	V refrigerator-freezer (natural convection)	E (kWh/year) = 0.433 x Vadj (L) + 320
	VI refrigerator-freezer (forced circulation, with a specific technology)	E (kWh/year) = 0.507 x Vadj (L) + 147
	VII refrigerator-freezer (forced circulation, without a specific technology)	E (kWh/year) = 0.433 x Vadj (L) + 340

Source: [2]

Note 1: Specific technologies refer to inverter technology and vacuum insulation. An appliance that incorporates either or both of these technologies is categorized as VI.

Note 2: Vadj : Adjusted rated volume

JIS test procedures of refrigerators were made in 1979 and revised twice. The revision in 1993 was carried out in order to follow the international standard, but the procedures were revised again to resemble actual use conditions when the standards were set. In this paper three testing methods, Method A, B and C are described. (See **Table 2**).

Table 2: Changes in JIS test procedures of refrigerators over time

Testing method		A	B	C	
Name of standard		**JIS C9607**	**JIS C9607**	**JIS C9801**	
Year		1979	1993	1999	
Type				Forced circulation	Natural convection
Ambient temperature		30°C : 100days 15°C : 265days	25°C	25°C	
Relative humidity		75%±5%	45% - 85%	70%±5%	
Installation	back	On the wall			
	sides	300mm away from walls			
Load	fresh food	No	No	No	No
	freezer	No	Yes	No	Yes
Storage temperature	fresh food	3°C±0.5°C	≦5°C	≦5°C	
	freezer(***)	-18°C±0.5°C	≦-18°C	≦-18°C	
Open/close door	fresh food	50 times	no	25 times	
	freezer	15 times	no	8 times	

Since 1999, labeled annual electricity consumption of refrigerator-freezers by testing Method C has been rapidly reduced (See **Table 3**). In particular, the improvement from 1999 to 2004 was more than 60% n appliances belonging to the 400+ liters category. The labeled value of the Top-Runner product in 2004 achieved energy efficiency as low as 150 kWh/year.

Due to such improvements, the weighted average annual electricity consumption of shipped refrigerator-freezers and refrigerators in 2004 was 290 kWh/year, a reduction of 55% from the base year and substantially below the target. Freezers also met the requirement easily (see **Table 4**).

Table 3: Labeled annual electricity consumption of refrigerator-freezers

Year	141L - 200L				351L - 400L				401L - 450L				451L - 500L			
	min.	avg.	max.	#	min.	avg.	max.	#	min.	avg.	max.	#	min.	avg.	max.	#
1999	490	577	640	7	470	630	830	26	450	619	980	21	460	725	1030	17
2000	500	572	630	5	380	556	760	18	370	447	710	18	380	584	1030	22
2001	420	533	630	4	340	464	690	19	330	404	710	16	340	466	960	15
2002	390	475	630	8	300	432	690	18	280	342	440	18	280	412	960	19
2003	370	442	580	6	190	372	690	17	200	318	440	25	200	336	690	16
2004	350	376	420	7	180	299	390	15	150	236	440	22	180	253	370	15
'04/'99	71%	65%	66%		38%	47%	47%		33%	38%	45%		39%	35%	36%	

Source: Energy Conservation Center, Japan [5]
Note: unit* kWh/year

Table 4: Energy efficiency improvement of refrigerators and freezers

Type	Year		Weighted average electricity consumption of shipped products	Improvement rate
Refrigerator and Refrigerator-freezer	1998	Actual	647.3 kWh/year	Base year
	2004	Target	449.7 kWh/year	30.5%
		Actual	290.3 kWh/year	55.2%
Freezer	1998	Actual	524.8 kWh/year	Base year
	2004	Target	404.7 kWh/year	22.9%
		Actual	369.7 kWh/year	29.6%

Source: [3]

However actual electricity consumption does not seem to have been rapidly reduced during this period. Three laboratory tests conducted between 2001 and 2004 by Japan Consumer's Association (JCA) and National Consumer Affairs Center of Japan (NCAC) show considerable difference between actual and tested electricity consumption (see **Figure 1**). In particular, existing survey A shows that actual values were twice or more than three times as large as labeled values.

Each test condition was similar to JIS test conditions with the exception of installation place and load. Products tested by JCA [5][7] were installed 5 millimeters away from both side walls while products tested by JIS were installed 300 millimeters away. Also, both the JCA test and the NCAC test placed load in the form of items to be cooled/frozen into the fresh food and freezer compartments before testing, while the JIS test did not do so for appliances with forced circulation. Additionally, the NCAC test [6] varies the load during the test period.

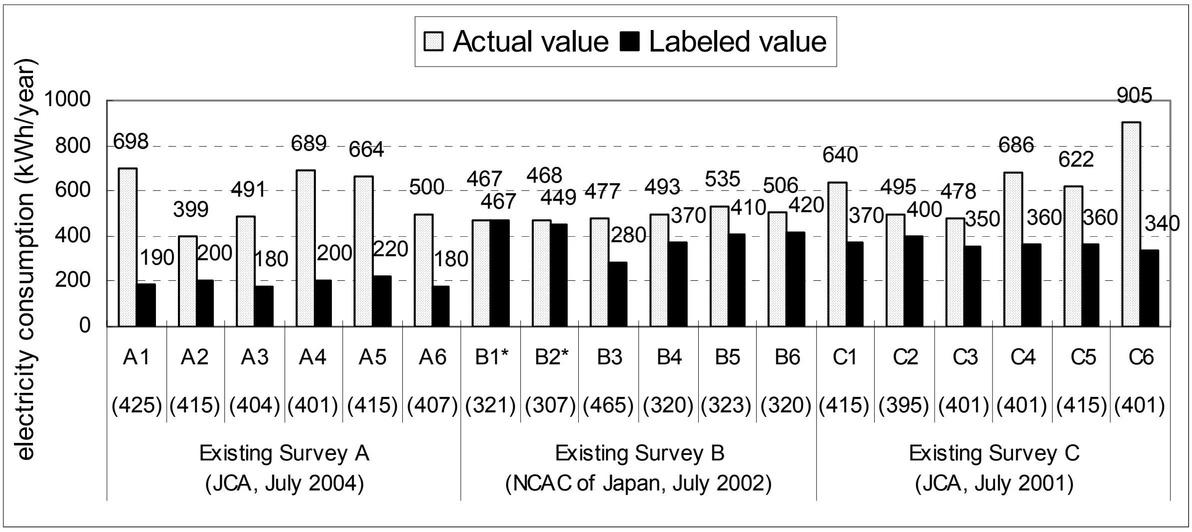


Figure 1: Examples of comparison of actual versus labeled electricity consumption of refrigerator-freezers

Source: [5], [6] and [7]

Note1: B1 and B2 are natural convection types made by European manufacturers. The others are forced circulation types made by Japanese manufacturers.

Note2: Value in parentheses refers to the rated volume.

Laboratory test

Jyukankyo Research Institute (JYURI) tested the electricity consumption of two Top-Runner refrigerator-freezers in 2004 (see **Table 5**). The test was conducted as part of survey on how users' actions could influence energy consumption [9]. JYURI was entrusted with the testing and evaluation by Energy Conservation Center, Japan (ECCJ).

Test conditions are shown in **Table 6**. They are based on the JIS test conditions, with the exception of ambient temperature and relative humidity, which were set to simulate actual use conditions. The purpose of the test is to figure out the effect of user's actions, such as appropriate installation, mild temperature setting, refrainment from stuffing, etc.

Japan Electrical Safety and Environment Technology Laboratories (JET) provided a temperature and humidity controlled laboratory. The testing procedure is as follows:

1. All storage compartments, water tank, and ice box shall be empty. Automatic ice making function is off. Every switch that can be turned off is off.
2. Storage compartments' temperature is set to "middle". Twelve hours (twenty four hours for the first time of testing) after appliances are turned on, defrosting and monitoring commence simultaneously.
3. Three hours after monitoring begins, the door of the fresh food compartment is opened and closed 25 times every 12 minutes and the door of the freezer compartment is opened and closed 8 times every 40 minutes. (This step is the same as the JIS testing procedure.)
4. Monitoring is complete after 36 hours.

Table 5: Tested products

Product	Type	Volume	Number of doors	Category	Labeled electricity consumption
Refrigerator-freezer A	Forced circulation	401L	5	VI	200 kWh/year
Refrigerator-freezer B	Forced circulation	404L	5	VI	180 kWh/year

Table 6: Test conditions

Feature		JYURI Test	JIS C9801 (Forced circulation)
Ambient temperature		22°C	25°C
Relative humidity		60%±10%	70%±5%
Installation	back	On the wall	On the wall
	sides	5mm away from wall (one side only)	300mm away from walls
Load	fresh food	No	No
	freezer	No	No
Strorage temperature	fresh food	Middle	≦ 5°C
	freezer	Middle	≦-18°C (***)
Open/close door	fresh food	25 times	25 times
	freezer	8 times	8 times
Defrosting		Monitoring and defrosting begin simultaneously.	Monitoring begins after defrosting.
Automatic ice making		Off	Off

The results are shown in **Table 7**. Annual electricity consumption was more than twice or three times as much as the labeled value. This was similar to the results of existing surveys. Although storage compartment temperature does not follow the JIS testing procedure, there is no significant difference.

Table 7: Results of JYURI test

Product	Annual electricity consumption	Comparison with the labeled value	Storage temperature	
			fresh food	freezer
Refrigerator-freezer A	604.8 kWh/year	+202%	4.9°C	-19.2°C
Refrigerator-freezer B	423.8 kWh/year	+135%	3.8°C	-17.2°C

The manufacturers of Refrigerator-freezer A and Refrigerator-freezer B analyzed the factors for the significant difference in actual versus labeled electricity consumption. The findings regarding Refrigerator-freezer B were reported in September 2005 [3]. According to the report, the main reason for the discrepancy was the operation of heaters under actual conditions, which caused an increase in cooling load and leaded to increased electricity consumption (see **Table 8**).

The difference can be attributed to the embedded control program which minimizes the operation of heaters under a stable condition (ambient temperature: 25°C, fresh food compartment: 5°C, freezer: -18°C). In order to hinder such schemes, the testing procedures are required to be more complicated and to contain several conditions.

Table 8: Contributing factors to the difference in electricity consumption between actual and labeled (Refrigerator-freezer B)

Factor	Contribution
Installation (distance from wall)	+24%
Ambient temperature	-13%
Operation of temperature compensating heaters	+21%
Operation of heaters for the prevention of ice formation on pipes	+29%
Operation of heaters for defrosting	+7%
Increase of cooling load by frequent heater operation	+39%
Other (individual difference, unknown)	+28%
Total	+135%

Source: [3]

End-use monitoring

In July 2004, JYURI started a large end-use monitoring survey on electricity demand. The survey was entrusted by Central Research Institute of Electric Power Industry (CRIEPI) and was funded by Ministry of Economy, Trade and Industry (METI).

Major appliances, including refrigerators and freezers, in ninety-six households were monitored. In these households, room temperature was also measured (see **Table 9**). One hundred five refrigerators or freezers, accounting for 97% of all units owned by monitored households, were monitored (see **Table 10**).

Monitoring interval is 30 minutes. Each meter sends its data to a parent meter installed on a power distribution board through a power line carrier (PLC). Data in parent meters are remotely accessed through a public line.

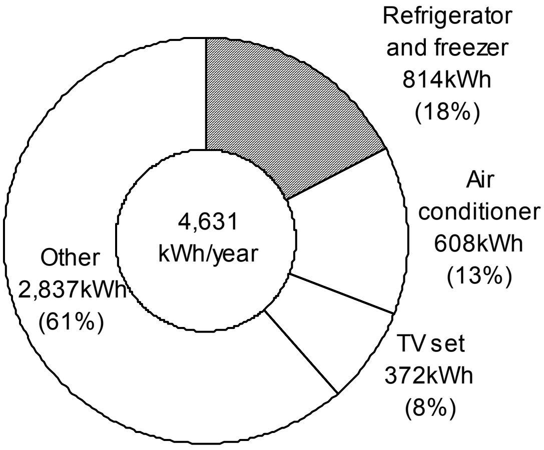
Table 9: Number of monitored households

Area	Number of households
Metropolitan Area	31
Osaka-Kobe Area	65
Total	96

Table 10: Monitored units

Item	Number of units (total)	Number of monitored units	Percentage of monitored units
Air conditioner	256	192	75%
Refrigerator and freezer	**108**	**105**	**97%**
TV set	192	162	84%
Personal Computer	180	34	19%
Other (heater, etc)	—	70	—
Total (Appliance)	—	563	—
Room temperature	—	171	—

Annual electricity use in monitored households is 4,631 kWh/year on average, excluding use by metering equipment. Refrigerators and freezers consume 18% of the total, making them the largest consumers of electricity of all appliances (lighting equipment excluded) (see **Figure 2**). Daily electricity use by refrigerators and freezers varies seasonally, from 1.6 kWh/day to 3.0 kWh/day (see **Figure 3**).



Period : September 2004 - August 2005
N=96 in 2004/9 , N=92 in 2005/8

Figure 2: Annual electricity consumption in monitored households

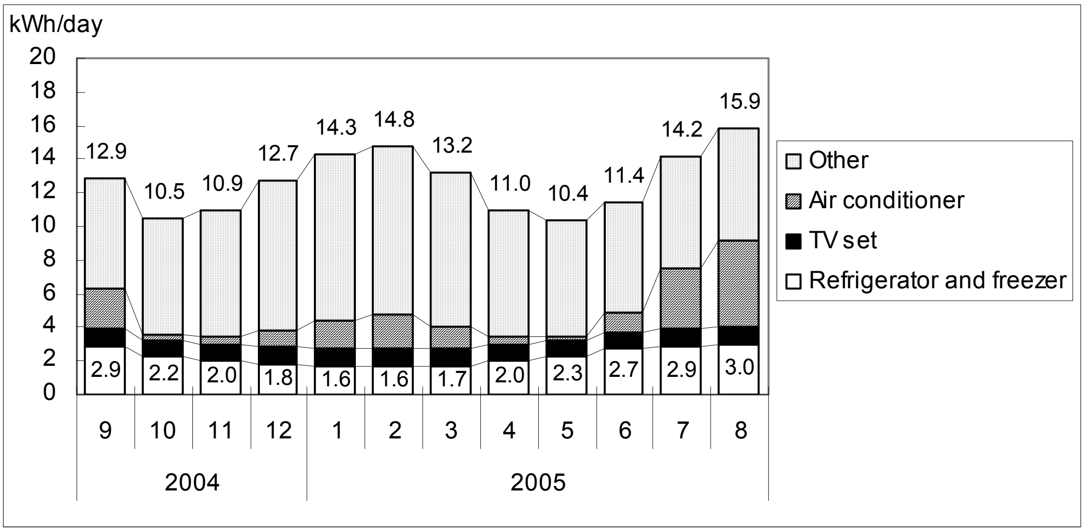


Figure 3: Monthly electricity consumption in monitored households

Unit electricity consumption (UEC) of refrigerators and freezers is shown in **Table 11**. The average UEC is 734 kWh/year, which is 65% larger than the labeled value. In particular, UEC of products manufactured between 2002 and 2004 is 662 kWh/year, which is almost twice as much as the labeled value.

It is evident that energy efficiency of refrigerators and freezers has improved. Average UEC of those products manufactured before the Top-Runner standard was established (subtotal of Testing Method A and Testing Method B) was 751 kWh/year. An improvement of over 10% was achieved in the few years since then, despite an 18% increase in storage capacity (from 325L to 383L).

Figure 4 shows the correlation between electricity consumption by refrigerators and freezers and room temperature by year of manufacture. When room temperature is over 20°C, the difference of electricity consumption is apparent. Electricity consumption increases by 5% when room temperature rises by one degree around 25°C.

Table 11: Comparison of measured electricity consumption and labeled value

Testing method	**Year**	**UEC : Unit electricity consumption (kWh/unit/year)**		**Ratio of actual to labeled**	**Rated volume (L)**	**Room temperature (°C)**	**#**
		actual	**labeled**				
A	-'94	679	413	1.65	305	23.2	18
B	'95-'96	842	594	1.42	328	23.6	19
	'97-'98	733	420	1.74	337	23.7	23
Subtotal of A and B		751	473	1.59	325	23.5	60
C	'99-'01	720	416	1.73	392	24.7	14
	'02-'04	662	327	2.03	383	24.2	12
Total		734	443	1.65	344	23.8	86

Note: Test method was changed twice, so labeled values of one method can not be directly compared with those of another method (See **Table 2**).

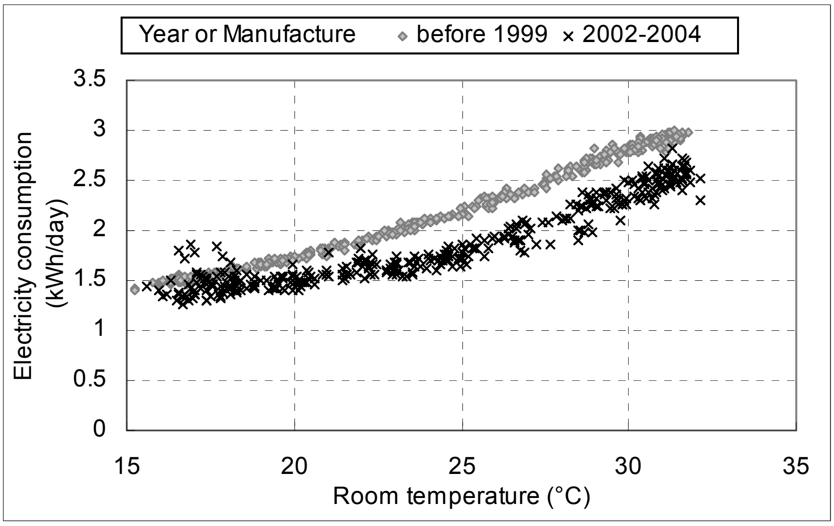


Figure 4: Correlation between electricity consumption by refrigerators and freezers and room temperature

Note: Data was collected from September 2004 to August 2005.

Lessons learned

Both the government and the manufacturers recognized the discrepancy between actual and labeled values of electricity consumption as a problem. The government began studying new testing procedures and new energy efficiency standards in September 2005.

As shown in **Table 12**, JIS C 9801 was revised by JIS Committee in January 2006 so that testing conditions more closely resembled actual use conditions. Two features of the revision are especially noteworthy: (1) two testing conditions (15°C and 30°C) and (2) the placement of load in the fresh food and freezer compartments in process of testing. It is considered that these complicated conditions make it virtually impossible for an embedded program to distinguish the testing from the actual use. The new value of annual electricity consumption is labeled on products manufactured after 1st May 2006 and new energy efficiency standards for refrigerators and freezers will be established by the end of the year.

Table 13 shows new labeled values of typical refrigerator-freezers. Comparing to the results of monitoring shown in **Table 11**, new test procedure seems to be more reasonable so far. In general, product testing procedure should be simple, but should not be at the expense of accuracy and credibility. It is strongly hoped that the revision of JIS testing procedure will restore the credibility of labeling and contribute to further energy efficiency.

Fortunately, remarkable difference in energy use between the actual and labeled has not been found in any other equipment. However, it is recommended that the government should check testing procedures of other equipments and carry out a continuous field survey on actual energy use of equipments including refrigerators and freezers.

Table 12: Revision of JIS C 9801

		JIS C9801(old)		JIS C9801 (revised)	
Year		1999		2006	
Type		Forced circulation	Natural convection	Forced circulation	Natural convection
Ambient temperature		25°C		30°C : 180days 15°C : 185days	
Relative humidity		70%±5%		30°C : 70%±5% 15°C : 55%±5%	
Installation	back	On the wall		On the wall	
	sides	300mm away from walls		50mm away from walls	
Load	fresh food	No	No	Put in during testing	No
	freezer	No	Yes		Yes
Storage temperature	fresh food	≦5°C		≦4°C	
	freezer (***)	≦-18°C		≦-18°C	
	vesitable	Set to minimize energy use		Set to factory preset mode	
Open/close door	fresh food	25 times		35 times	No
	freezer	8 times		8 times	No
Automatic ice making		Off		On	Off
Other optional function such as deodorizing		Off (if users can turn on/off)		Set to factory preset mode	

Source: [4]

Table 13: Unit electricity consumption of refrigerator-freezer tested by revised JIS C 9801

Rated volume	UEC by revised **JIS C 9801** (kWh/year)			Number of products
	minimum	average	maximum	
141L-200L	430	475	570	8
351L-400L	490	577	710	17
401L-450L	530	629	790	26
451L-500L	590	691	840	12

Source: The Japan Electrical Manufacturers' Association

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Old Washing Machines Wash Less Efficient and Consume More Resources

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Abstract

In German households washing machines can be found which are up to 40 years old and still in use. The target of this investigation was to measure performance, water and energy consumption values for old machines under today’s washing conditions and especially when using a modern detergent. Comparing this data with that of new washing machines, allows conclusions about the sustainability of the continued use of old machines to be made. When this information is combined with data about the real usage time of washing machines, saving potentials in terms of water, energy and costs may be calculated.

The energy and water usage of washing machines has lowered significantly over the last few decades. Although this is ecologically and economically sound, it is possible that this trend may have been at the expense of declining washing performance. As this has not previously been investigated, it forms one of the major components of this paper. First, an investigation into the age distribution of washing machines in German households is reported. This is established by examining the age of washing machines delivered for recycling at recycling plants. Second, this paper tries to give a picture of the development of average-energy and water usage values for washing machines in Germany over the last 30 years. Third, washing machines up to 30 years old were subjected to washing performance tests conducted in accordance with current washing conditions. Surprisingly, new washing machines with significantly reduced water and energy usage do not suffer from lower washing performance.

The results show that, in order to achieve the same washing performance as a modern machine does in a 40 °C wash, a 15-year-old washing machine must be operated in a 60 °C programme, and a 30-year-old one in a 90 °C programme (on average). By contrast, on average a 15-year-old washing machine requires approximately twice as much energy and water as a new one to achieve the same level of performance, and a 30-year-old washing machine about four times as much.

1 Introduction

Why think about one's old washing machine as long as it is doing its job? Such is the dominant attitude towards household appliances. Totally unlike automobiles or leisure appliances, household appliances are not regarded as being subject to fashion or rapid innovation. In most households they do not attract much attention.

Accordingly, household appliances normally remain in operation for as long as possible, to be replaced only when they break down completely and without a chance of repair at reasonable cost. A washing machine's durability depends on its design and quality, but also on how it is used (i.e..the number of cycles completed or hours used) and on the user's willingness to have smaller defects repaired.

In appliances in which the main stress results from specific operations, such as washing cycles, durability can be measured in cycles. This measure has the advantage of being more or less independent of user behaviour: in households with many cycles per week/month, washing machines will last for a shorter period than in households which use their washing machines less often. Consumer organisations (*e.g. Stiftung Warentest*) use this approach in investigating the durability of appliances, using them over a short period of time but in as many cycles as would occur over a normal lifespan, assuming the ‘normal’ lifespan of washing machines to be ten years.

Very little is known about the actual lifespan of washing machines or about the total number of cycles they withstand. Neither is there much information on the actual lifespan of washing machines in households, lifespan here referring to the number of years for which an appliance is in existence, i.e. from the date of manufacture to the date of disassembly. As mentioned before, this has little to do with the durability of appliances calculated in cycles.

Therefore, the first aim of this investigation is to determine - with a focus on Germany - what is the actual lifespan of washing machines. This is done by investigating washing machines at the end of their life: at the recycling stage.

The second aim is to examine the development of washing machines in terms of performance (cleaning effect), water and energy usage over time. Here our approach follows two routes. First, historically published data about the measured performance of new washing machines is collected and analysed. Second, tests are done and reported on a limited number of old washing machines to verify their performance under current washing conditons i.e. conditions that are close to those under normal household use. Methodologically, this is done in accordance with the test procedure used under the present European energy labelling scheme by comparing these results with results from actual machines.

A third aim – deriving from the first two – is to assess the implications of the actual lifespans of washing machines and the evolution of their usage conditions in terms of their economic and environmental impacts.

2 Age distribution of used washing machines

How old are the washing machines in German households? We examined this question in 2004 by looking at end of life washing machines. In Germany electric waste is collected by municipalities or retailers and recycled at specialized recycling plants. At three such plants hundreds of washing machines were examined for the following classes of data:

1. brand and model
2. product identification code
3. date of manufacture on the built-in capacitor.

Retrieving all relevant information from all machines proved impossible. While information on brand and model give only a rough indication of a washing machine's date of manufacture, the product identification code requires the manufacturer’s key on every single washing machine's rating plate to be decoded.

There is no direct link between a washing machine's date of manufacture and that of its capacitor, but with all washing machines having a capacitor, and with every capacitor having to be removed before shredding, capacitors are the most reliable source of information concerning the age of a washing machine, providing that there is a correlation between the production dates of the capacitor and of the machine. This was proven for washing machines in which the dates of manufacture both of the machine and of the capacitor could be decoded (112 machines); in these cases the time difference was verified to be small (the average month of production being October 1987 in the case of the capacitors and November 1987 in the case of the washing machines). Thus, the capacitors' dates of manufacture (Fig. 1) were good indicators of the washing machines' dates of manufacture. While the newest ones were only a few years old, the oldest machine found was almost 40 years old. With 1988 being the average year of manufacture, the machines were approximately 16 years old at the time of disassembly. Assuming an interval of about one year between manufacture and original installation, and assuming another six months to pass between a washing machine's end of use in a household and its being transported to a recycling plant, the average useful lifetime of washing machines in Germany is approximately 14 years. The accumulated percentages by year (Fig. 2) show a characteristic lifespan of 17.5 years (at 63.2 % failure rate), while 20 % of washing machines have a lifespan of more than 22 years. As washing machine technology did not change drastically within the last few decades, this figure may be representative for the life-span distribution independent of the year of collection of the data used in this investigation.

3 Published historical data

Consumer organisations regularly test household appliances and publish data on water, energy and performance. Many consumers appreciate this information as useful guidance in buying new appliances. Although testing always takes place under well-defined conditions, a comparison of publications by different institutions and from different times suggests that results are not always 100 % comparable. Moreover, tests usually refer to specific wash cycles.

Stiftung Warentest is the best-known consumer organisation in Germany. It has tested washing machines on a regular basis, usually once a year. By examining their publications [1] from 1973 to 1991, it is possible to retrace the history of water and energy usage values of old washing machines

(Fig. 3). In total 318 published data records were found. However, the published energy consumption and water usage values are only reported per kg of textile load and comparability cannot be taken for granted. In the early nineties, tests started using 60 °C programmes in place of the earlier 90 °C programmes and switched to 40 °C programmes not long after. At that time, too, the kind of programme (for moderately or heavily soiled textiles) used in the tests also changed.

In view of the uncertainty that these changes may make on the comparability of data tested under different test conditions, European averages of water and energy usage determined by the methods set out for the European Energy Label, which was introduced in 1996, seem more reliable. The data collected by CECED, the European Committee of Domestic Equipment Manufacturers [2] have been averaged over all of Europe and are the best estimate available (Note: Differences between the market offer of washing machines in Germany and the rest of Europe have been narrowed since the introduction of the Energy Label).

These averages were fitted by a linear curve and multiplied by five to calculate water and energy usage per cycle (this is done because the most common rated load capacity of washing machines is 5 kg). Conversion factors deriving from thermodynamic calculations of an ‘average European washing machine’ [3] and used for official purposes [4] were used to calculate energy usage at different wash temperatures (Table 1), whereas water usage was assumed to be the same for all wash temperatures. Extrapolations for 1995 were possible both from earlier and from later years, averages of both were used to calculate what would be the most realistic usage value for 1995.

In general, this results in a consistent picture (Fig. 4 and Table 2) of the likely development of average energy and water consumption values of washing machines in Germany since the beginning of the seventies. This picture is somehow different to what is published elsewhere [5], as here the focus is on the average of the market offer (as represented in the selection of models of Stiftung Warentest and CECED database) and not on the best available technology in this specific year. As millions of washing machines are sold per year, new technologies will not be introduced in all machines at the same time but rather in a more continuous process. Therefore a smooth improvement of the average consumption values each year is the more likely trend to be observed and a linear interpolation as shown in Fig. 3 fits the data reasonably well.

However, it must be stressed that our picture is based on a number of assumptions, that it required a number of corrections, and that individual machines may have diverged significantly from this picture. Nevertheless, there have been significant improvements in the energy and water usage of washing machines over the last three decades. For example, water usage was about four times as high in 1970 as in 2004, and more than two times as high only 15 years ago! The reductions in energy use over time for a defined washing temperature were also impressive, but not as great as for water. In recent years, however, the reduction in water usage has slowed significantly, showing that it is becoming increasingly difficult to further reduce water and energy usage values.

4 Performance of old washing machines

As a rule, the performance of a washing machine will stay the same – or even deteriorate - throughout its lifespan. Declines in performance due to material fatigue resulting from prolonged use can be detected in accelerated life tests, but what wash-performance, water and energy usage levels do older appliances attain when functioning under current operating conditions?

While households use appliances for ten or even many more years, other factors change more rapidly. For example, the textiles to be washed are changing constantly, not only due to fashion, but also as a result of new fibres or finishings being put on the market. Detergents are yet another field of constant change. Consumers usually purchase detergents in quantities sufficient for a few weeks, but the next purchase may already have different ingredients and a different chemical formulation. Thus, innovations in detergents enter the market much more rapidly than innovations in the washing machines for which the detergents are bought. Therefore, the aim of studying the characteristics of old washing machines tested under comparable conditions, could only be done by using real old machines and testing them under today’s washing conditions, especially with respect to the use of detergent.

4.1 Testing methodology

Tests were carried out on eight washing machines between 9 and 29 years old and previously used in households in Bonn/Germany. For comparison, two new washing machines (manufactured in 2002 and 2004) were tested under the same conditions (Table 3). As the composition of the IEC reference detergent [6] is quite similar to that of modern compact detergents, only programmes without pre-wash were selected.

To ensure comparability, all washing machines were loaded with the same amount of textiles. Washloads of 4 kg were used in order to ensure that none of the machines under study would be operated under extreme loading conditions; overloading might have caused unrealistic problems in cleaning performance. Moreover, studies have found that, on average, consumers only use about ¾ of washing machines' maximum rated capacities.

Four test runs were carried out for each parameter setting, and water usage, energy consumption and performance data were recorded. Performance was measured (as is common practice in testing washing machines) by adding artificially soiled swatches to the wash and measuring their level of whiteness afterwards. A Wascator CLS washing machine was used as a reference machine to calculate the index of washing performance and to transfer it to the performance class used in the European Energy Label system [7]. All other conditions followed international standards [6].

Tests using nominal (100 %) detergent doses were performed for 40, 60 and 90 °C cotton programmes. In addition, the machines were operated with reduced (50 %) and increased (150 %) doses of detergent in the 60 °C cotton programme. This was intended to take account of the flexibility of users in adjusting the performance of their washing machines by choosing different temperatures or by varying the amount of detergent.

4.2 Test results

The results are presented here in terms of the washing performance index and class definitions used in the European energy labelling scheme, although the test conditions were not all in accordance with those used in this system. Nevertheless, a three-dimensional plot of the performance fields (Fig. 5) which washing machines can achieve depending on the amount of detergent used and on the temperature selected, provides the best overview of the results. It is evident that the same level of performance can be achieved (Fig. 5, a) in a 90 °C programme with only 50 % of the rated detergent dose, in a 60 °C programme with the rated detergent dosage, or in a 40 °C programme with 150 % of the rated detergent dose. Thus, consumers are basically free to select any one of these options to achieve a specific level of cleaning performance, the only limitation being the temperature stability of the fabrics to be washed.

Other washing machines, particularly older ones, have similar performance fields, but their absolute values are considerably lower, and their slopes show an increased influence of dosage and temperature on washing performance (Fig. 5,b). A synopsis of the 60 °C cotton cycle measurements for all three detergent dosages (Fig. 6) shows that performance, in addition to varying greatly between machines, can be adjusted effectively via detergent dosage. This becomes even more obvious if the results are rated according to the European Energy Label index of washing performance, in which machines are graded in classes of 0.03 width ranging from A (best) to G (worst). Older machines rarely achieve class A performance ratings, which are common in new washing machines (at rated capacity – which is not used here); and for doing so they usually require increased doses of detergent. Moreover, the slopes of older washing machines' performance fields differ significantly from that of newer machines, the loss in performance from 100 % to 50 % detergent dosage being significantly greater than from 150 % to 100 %. This may be due to the fact that in older washing machines there is nothing to prevent sump losses of detergent. Accordingly, large proportions of the detergent probably go unused.

A comparison of the washing performances achieved in 40, 60 and 90 °C programmes with the corresponding amounts of energy used (Fig. 7) produces results that are even more surprising. The distribution of the curves is even less uniform, and it becomes clear that older washing machines need much more energy to achieve a good washing performance. Indeed, to achieve the same washing performance as new machines in a 40 °C programme, old machines must be operated in 90 °C cycles! Moreover, at 40 °C (the point furthest left in the graphs), the washing performance of old washing machines is much lower than that of new ones.

By taking class A performance as a fixed level of required washing performance, it is possible to assess the efficiency of a washing machine, in terms of the amount of energy needed to achieve this level of performance. Although some linear extrapolations are needed in older machines, it becomes possible to compare the efficiency of different washing machines over time (Fig. 8). As expected, the efficiency values are distributed rather unevenly, but the general trend is that older machines require a much higher energy input than newer machines for the same washing performance. The trend line shows a much higher level of improvement compared to the comparison based on constant wash temperature (compared to Fig. 3). This is the influence of the improved washing performance. A typical new machine uses about half as much energy as 15-year-old machines and one-fourth of the energy used by 30-year-old machines to reach the same class A washing performance. A

comparison of the amounts of water used for washing a fixed amount of load (Fig. 8) yields similar factors of improvement over time. Due to simple reasons, this trend can not continue forever.
Assuming that a household washes 5 cycles per week in a new washing machine, its washing will consume about 76 € annually at average German rates for water (3.96 €/m³) [8] and electricity (0.1719 € / kWh) [9] (tab. 4). Accordingly, a 15 year old washing machine would cost about twice as much (150 €/year) and a 30 year old machine about four times as much (250 €/year) in water and energy running costs when the same program mix is used as in a new one . If the effect of degrading performance of older washing machines is taken into account, these costs would additionally increase by about 20% for 15 year old and by about 40% for 30 year old machines.

5 Conclusion

This series of investigations has shown that a considerable number of rather old washing machines are being used in German households. Their efficiency under current washing conditions is worse than expected. This is probably due to innovations in detergents and to continuous adjustments of new washing machines to these innovations. In consequence, households owning old machines need to spend much more money to operate their machines on the performance level reached by new washing machines. Early replacement, meaning replacing old appliances with new ones after a certain time of use, may be a viable strategy to realise energy and water savings at national or global level. Similarly the possibility to update the programming of a washing machine, e.g. via internet, after it has left the manufacturing plant, may be a good way of keeping washing programmes up to date and of realising energy savings and performance upgrades.

Acknowledgment

This work was supported by Stiftung Warentest, Rethmann Elektrorecycling GmbH and EMPA Testmaterialien. Thanks to all.

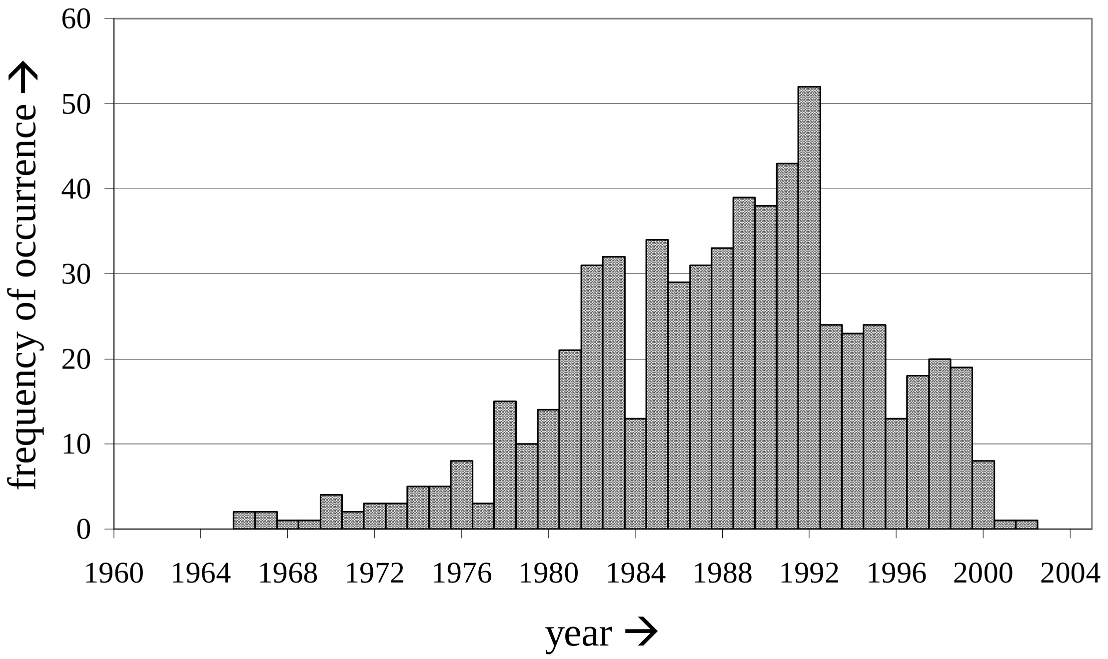


Figure 1: Occurrence of capacitors in washing machines by year of manufacture of capacitor (n=625); data collected between middle and end of 2004 in Germany.

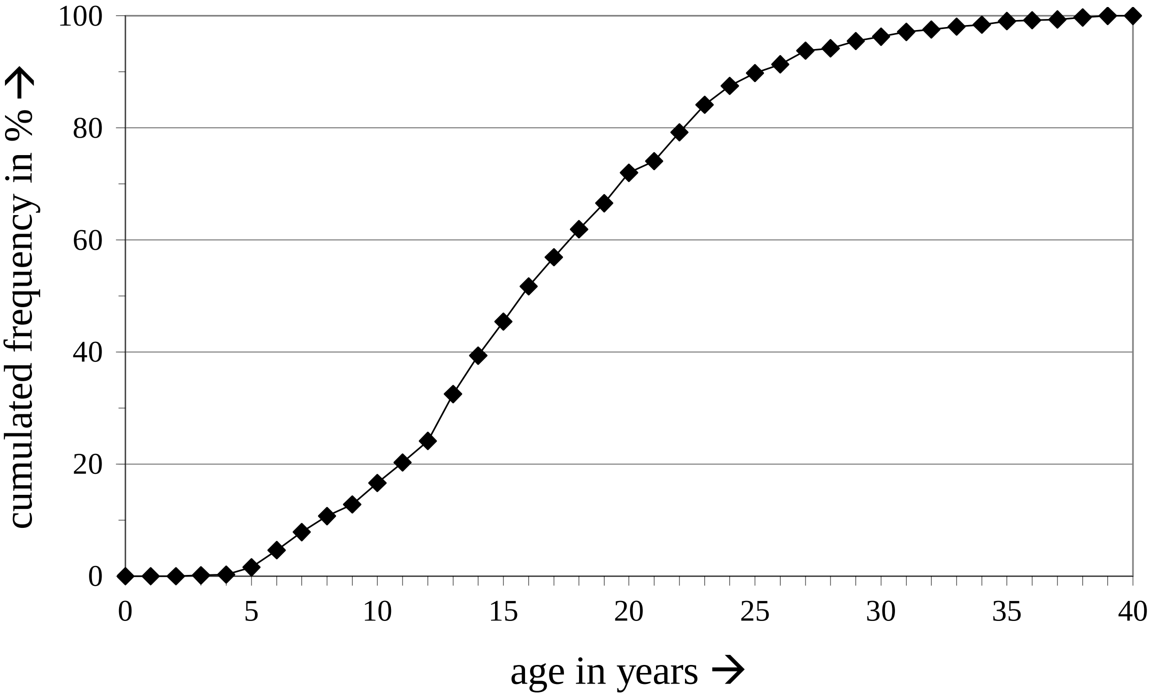


Figure 2: Cumulated frequency of washing machine capacitors with their age at recycling state. Line is for visualisation only.

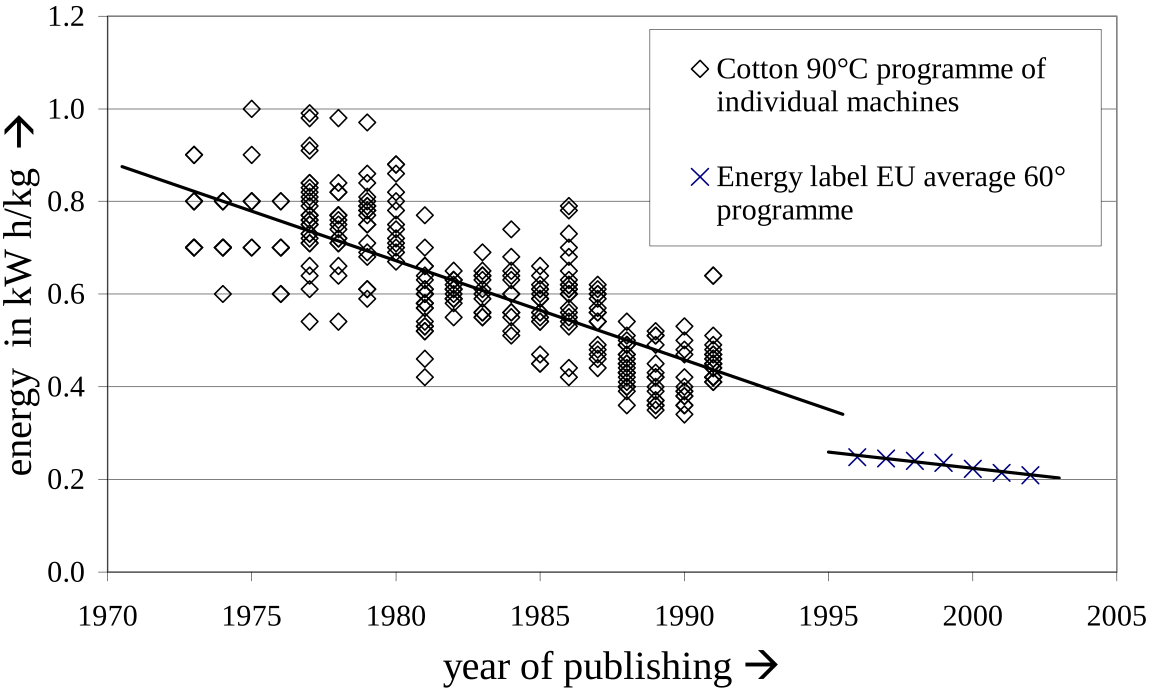


Figure 3: Specific energy usage values for washing machines as published by *Stiftung Warentest* for the years 1973 through 1991 [1] and average specific energy usage values for the energy labelling programme as published by CECED for 1996 through 2002 [2].

Regression line $y = e_r + \varepsilon (x - x_r)$ characteristics are with:

y = specific energy in kWh/kg
e_r = specific energy used in reference year (a)
ε = annual improvement in specific energy usage
x = year
x_r = reference year

for 1973 – 1991: x_r = 1970
ε = -0.0214 kW h/(kg a)
e_r = 0.866 kW h/kg
R² = 0.6353

1996 – 2002: x_r = 1995
ε = -0.007 kW h/(kg a)
e_r = 0.259 kW h/kg
R² = 0.9612

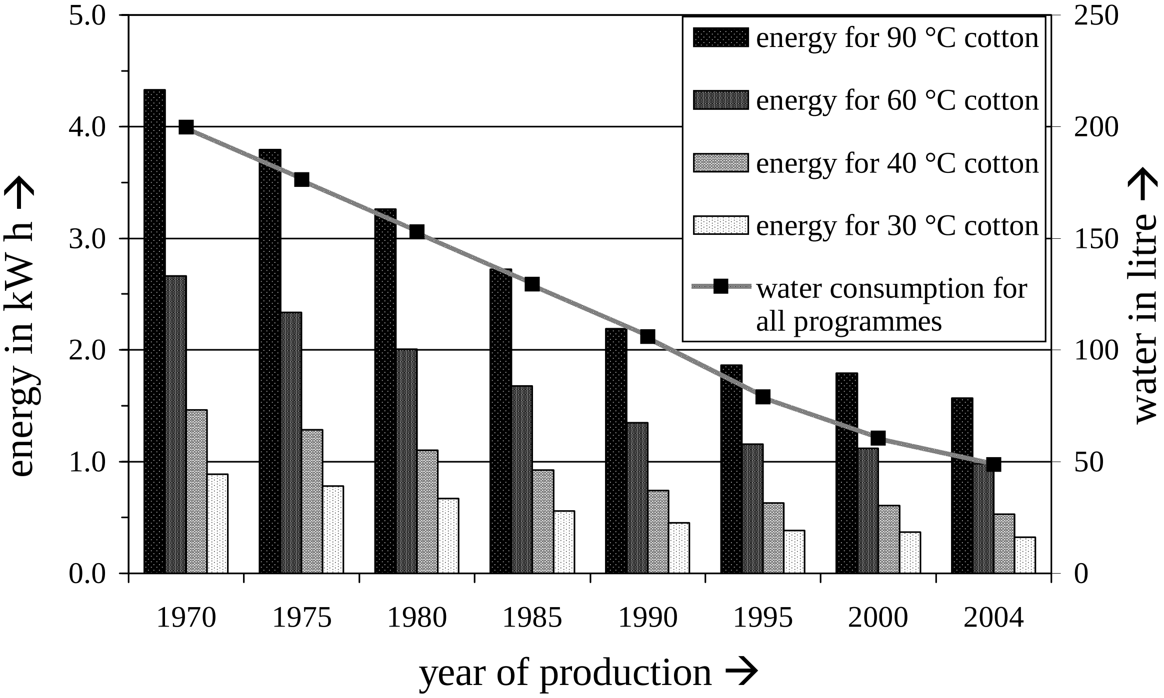
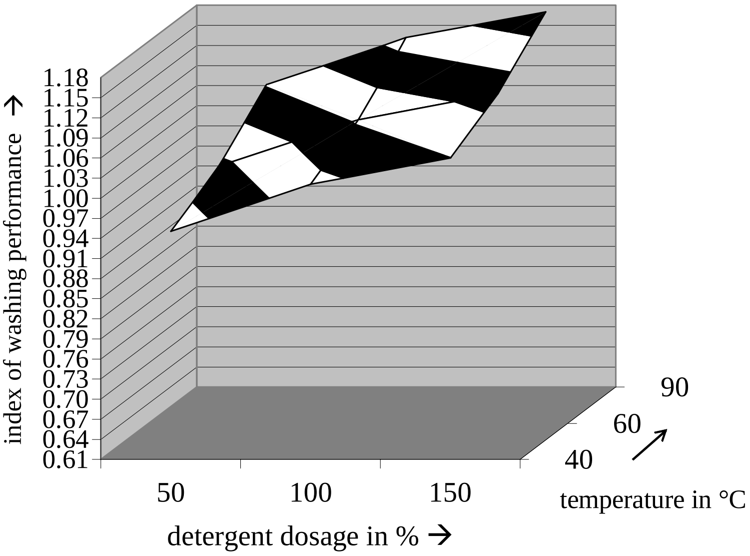


Figure 4: Calculated average energy and water usage for a 5 kg cotton wash by year of washing machine manufacture. Line is for visualisation only.

a: new washing machine



b: washing machine from 1975

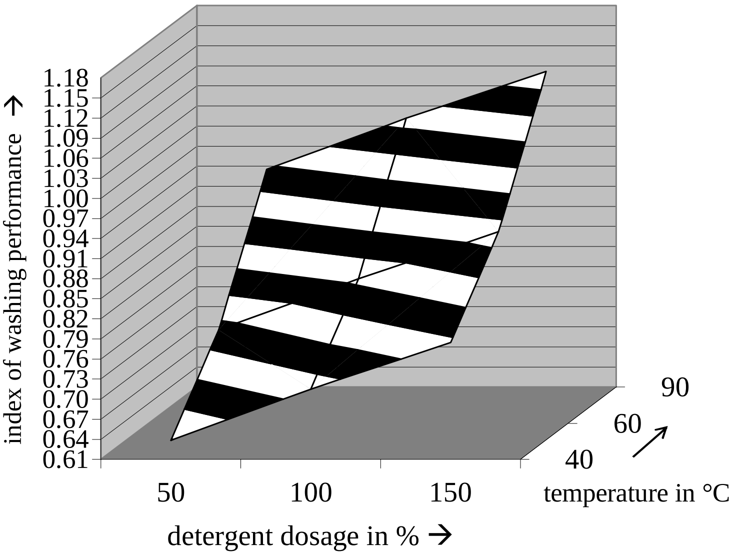


Figure 5: Index of washing performance of a new and an old washing machine respectively under varying conditions. Shaded areas represent classes of washing performance according to the European Energy Label system and are for visualisation only. The machines' performance with reduced and increased doses of detergent at 40 and 90 °C was calculated by linear extrapolation.

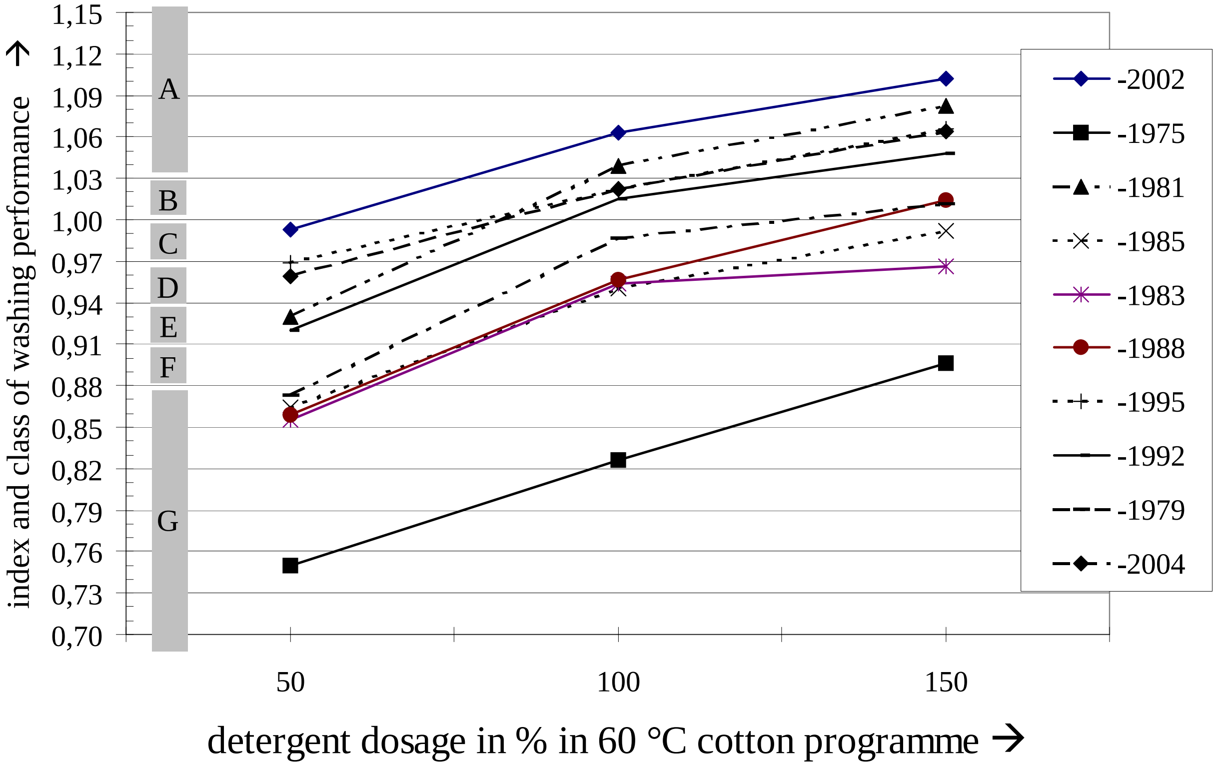


Figure 6: Washing performance in 60 °C cotton programme dependent on detergent dosage (machines are coded by year of production). Washing performance is given according to the index and corresponding class A to G as used by the European Energy Label. The standard deviation of washing performance index is of the same order of magnitude as given in Figure 7. Lines are for visualisation only.

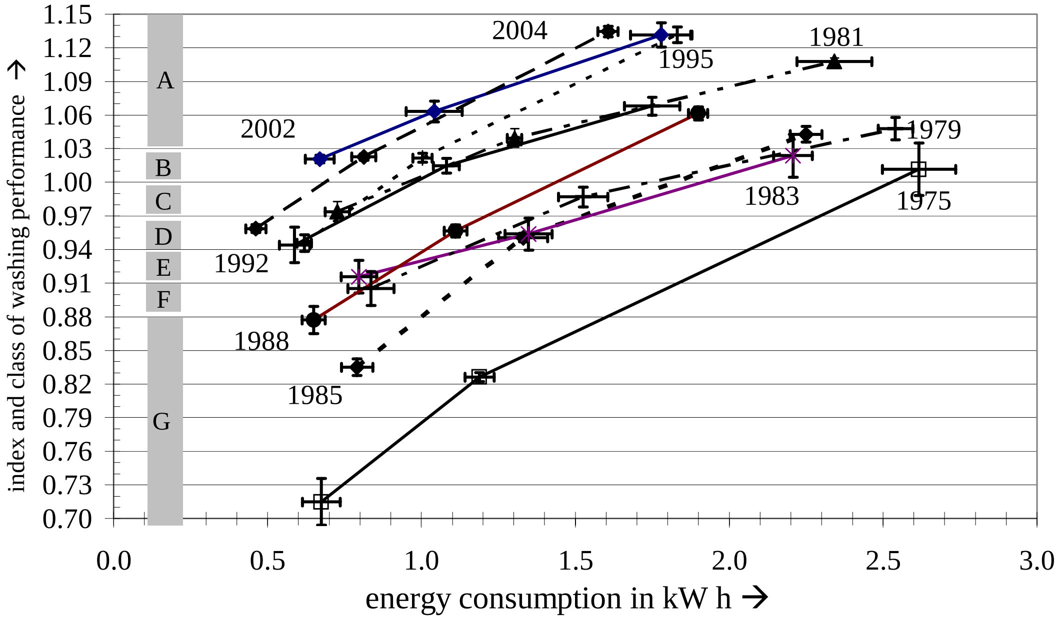


Figure 7: Washing performance versus energy usage values for all machines under study (coded by year of production). Reading from left to right the energy values indicate the machines' energy use for 40, 60 and 90 °C programmes; washing performance is given both as the index and corresponding class A to G as used in the European Energy Label. Error bars indicate standard deviation of washing performance index and energy measured. Lines are for visualisation only.

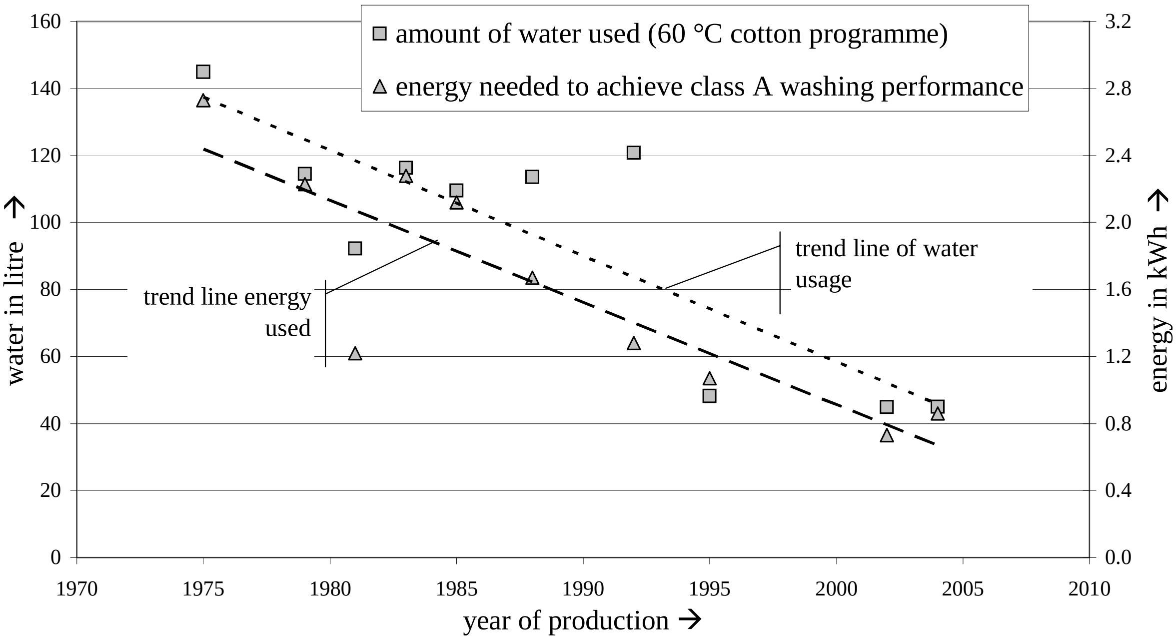


Figure 8: Water usage and calculated energy usage for achieving class A washing performance by year of manufacture of washing machine.

Regression line $y = e_r + \varepsilon\,(x - 1970)$ characteristics are with:

y = energy in kWh or water in litre per cycle
e_r = energy or water used in the reference year
ε = annual improvement in energy or water usage
x = year

for water: ε = -3.16 l/a
e_r = 153.2 l
R^2 = 0.7204

energy: ε = -0.061 kW h/a
e_r = 2.73 kW h
R^2 = 0.7444

Table 1: Conversion factors to calculate the energy usage for washing programmes at different temperatures depending on initial value

Washing programme temperature in °C	Conversion factor used	
	based on 90 °C	based on 60 °C
90	1.000	1.600
60	0.615	1.000
40	0.335	0.540
30	0.200	0.330

Table 2: Calculated average energy and water usage for washing machines manufactured between 1970 and 2004 (for 5 kg cotton load)

Program	**Year of washing machine production**							
Energy in kWh	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**
30°C cotton	0,89	0,78	0,67	0,56	0,45	0,38	0,37	0,31
40°C cotton	1,47	1,28	1,10	0,92	0,74	0,63	0,60	0,51
60°C cotton	2,66	2,34	2,01	1,68	1,35	1,16	**1,12**	**0,95**
90°C cotton	**4,33**	**3,80**	**3,26**	**2,73**	**2,19**	1,86	1,79	1,51
Water usage in litre	**200**	**176**	**153**	**129**	**106**	**79**	**61**	**46**

Note: bold figures are averages from data bases as described in text – others are calculated as described

Table 3: Test conditions for all washing machines

Characteristics	Data and parameters
Load	
Mass	4.0 kg
Textiles (IEC 60456)	2 sheets, 4 pillowcases, 14 terry towels
Programme	
Kind	Cotton without pre-wash
Temperature	40 °C, 60 °C, 90 °C
Detergent (IEC 60456)	
Composition	77 % IEC A*, 20 % SPB4, 3 % TAED
Dosage at	
- 40 °C	118 g (= 100 %)
- 60 °C	59 g (= 50 %), 118 g (= 100 %), 177 g (= 150 %)
- 90 °C	118 g (= 100 %)

Table 4: Average running costs per cycle and costs per year for washing machines of a given year under the assumptions mentioned.

Program	**Year of washing machine production**							
	1970	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**
Running costs	**Energy: 0,1719 € / kWh**				**Water and sewage: 3,96 € / m³**			
in € per cycle								
30°C cotton	0,94 €	0,83 €	0,72 €	0,61 €	0,50 €	0,38 €	0,30 €	0,23 €
40°C cotton	1,04 €	0,92 €	0,79 €	0,67 €	0,55 €	0,42 €	0,34 €	0,27 €
60°C cotton	1,25 €	1,10 €	0,95 €	0,80 €	0,65 €	0,51 €	0,43 €	0,34 €
90°C cotton	1,53 €	1,35 €	1,17 €	0,98 €	0,80 €	0,63 €	0,55 €	0,44 €
Annual costs at 5 cycles per week = 260 cycles per year (16 x 90°, 81 x 60°, 91 x 40°, 72 x 30°)								
in € per year	288,48 €	254,10 €	219,72 €	185,34 €	150,96 €	117,04 €	96,85 €	76,19 €
Additional running costs compared to washing machine from 2005	212,29 €	177,91 €	143,53 €	109,15 €	74,77 €	40,86 €	20,66 €	- €

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Accelerated Replacement of Refrigerators and Freezers – Does It Make Sense?

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Abstract

The goal of this study was to assess the environmental and economic implications of the accelerated replacement of refrigerators and freezers of different age, used in private households. The evaluation was conducted in an individual households' perspective. The question "Does it make sense to further use an old refrigerator or freezer or is it better to buy a new one?" depends on the question, in what time the additional environmental impacts through the production of the new appliance and end-of-life-treatment of the old one are compensated through the lower electricity demand of the new one. The same question has to be answered on the cost side.

In the study at hand first a life cycle assessment and life cycle cost analysis of new cold appliances was conducted. Then the differences between appliances of different age were assessed. Finally the further use of appliances in stock (manufactured in 1980, 1985, 1990, 1995 and 2000) was compared with the acquisition and use of a new one of 2005 (including the recycling of the old appliance). Four appliance categories were investigated: refrigerators, fridge-freezers, upright and chest freezers. To evaluate, if and how much the results depend on the energy efficiency of the new appliance, next to the base case (with an A+-appliance) two sensitivity analyses with A- and A++-appliances were conducted.

Under environmental aspects the accelerated replacement of cold appliances in stock with new A+ and A++-appliances makes sense for refrigerators, fridge-freezers and upright freezers which are older than five to ten years.

Introduction

In Germany the market saturation rate of refrigerators in 2003 was 115 % and of freezers 74 % [1]. Both figures were quite stable in recent years, which indicates that the market is saturated and purchasing activities are dominated by replacement of existing appliances.

Next to the failure of the old appliance or changing needs of households another reason for the replacement of an existing appliance could be the presumably lower energy demand of a new one (even though the old one is still working). For an individual household the question "Does it make sense to further use an old refrigerator or freezer or is it better (in environmental and economic terms) to buy a new one?" depends on the question, in what time the additional environmental impacts through production of the new appliance and end-of-life-treatment of the old one are compensated through the lower electricity demand of the new one. The same question has to be answered on the cost side (acquisition costs versus lower running costs).

Considering the share of refrigerating and freezing at the total residential electricity consumption in Europe and the age distribution in stock a considerable saving potential in energy demand and the emission of greenhouse gases is foreseeable when older appliances are replaced.

Goal of the study

The goal of this study was to assess the environmental and economic implications of the accelerated replacement of refrigerators and freezers of different age, used in private households. The evaluation was conducted in an individual households' perspective.

This study was commissioned by the European Committee of Manufacturers of Domestic Equipment (CECED). The results were meant for internal and external communication purposes.

Methodological approach

To meet the goal of the study, the environmental impacts of the further use of existing cold appliances in stock of different age had to be compared to the acquisition and use of a new appliance in 2005.

To get an idea of the magnitude of the different life cycle stages, first a streamlined life cycle assessment (LCA) and life cycle cost analysis (LCC) of new cold appliances was conducted. The LCA was accomplished according to ISO 14040 ff., the LCC takes into account all costs, which occur for private households along the life cycle of the appliance.

Then, the differences between the cold appliances according to their age were assessed. Relevant differences mainly occur during the use phase (decreasing energy demand with later years of manufacture) and regarding the environmental impacts caused during the end-of-life treatment (due to different refrigerants and foaming agents used).

Finally the further use of cold appliances in stock (of different age) was compared to the acquisition and use of a new one. Two important assumptions regarding the allocation of certain impacts were made: firstly, the environmental impacts of the production and the costs of the acquisition of the old appliances are assumed to be already depreciated (i.e. no annual costs are considered). Secondly, the recycling of the old appliance is allocated to the alternative “acquisition of a new appliance”. Both assumptions are not unambiguous, as for example the recycling will take place anyway sometime. However these decisions result in a realistic picture of the amount of the environmental impacts and costs, and at what point in time these occur, if one or the other alternative is chosen. Especially the end-of-life treatment of older appliances might result in an initial increase of the total emissions of greenhouse gases or ozone depleting substances as CFCs were used as cooling and foaming agents.

For each alternative the environmental impacts and the costs connected to the considered life cycle phases were calculated on an annual basis (per year). These annual values are then cumulated to give the total environmental impacts and costs after one, two, three … up to some 20 years of use. Thus it can be determined after what time period the initial environmental impact through acquisition and recycling is compensated by the lower impacts during the use phase through the more efficient new appliance (= payback period). The same applies for the cost side. Usually these payback periods are not calculated by the households themselves.

Scope of the study and system modelling

Functional Unit

The functional unit of the system under consideration is defined as “use of a cold appliance of the below specified category, age, size and energy efficiency class in private households”. For the streamlined LCA the use period is the life span of the product under consideration (14 years for refrigerators and fridge-freezers, 17 years for upright and chest freezers [2]). For the evaluation of the accelerated replacement the environmental impacts and costs are calculated on an annual basis for the years from 2005 to 2025 (21 years).

Regarded product categories and alternatives

Four categories of cold appliances were distinguished: refrigerators (155 litres), 2-Door fridge-freezer (200 + 90 litres), upright and chest freezers (190 litres). For the assessment of the accelerated replacement, for each category six alternatives were compared: The further use of old appliances of 1980, 1985, 1990, 1995 and 2000 and the acquisition and use of a new appliance in 2005. The latter alternative includes the recycling of the existing appliance.

System boundaries

For the environmental assessment three main life cycle phases of cold appliances were distinguished: *Production and Distribution*, *Use phase* and *End-of-Life treatment*.

To represent different sizes of appliances the production and distribution of a “small” and a “large” appliance was modelled. Included were the material supply, the manufacturing process itself and the distribution.

The use phase is mainly characterised by the electricity demand of the appliances. The electricity demand and the connected impacts were differentiated according to the four product categories (see above) and according to their year of manufacture (1980, 1985, 1990, 1995 and 2005). For the appliances in stock the energy demand was derived from fleet average figures and average energy efficiency indices for refrigerators and freezers [3, 4]. As electricity demand of the new appliances in all four categories the standard electricity consumption of an ‘A+’-class appliance was assumed. Potential differences between the actual and the stated energy demand due to different user habits or ageing of materials were not considered. As sensitivity analysis the acquisition of ‘A’- (less efficient than in base case) and ‘A++’-appliances (more efficient than in base case) was calculated.

The impacts through the end-of-life treatment (here: re-distribution and recycling) vary according to the age of the old appliance due to different used refrigerants and foaming agents [5]. Depending on their year of manufacture the appliances were assigned to four types, which differ with respect to type and amount of refrigerant and foaming agent used. Type I (before 1988) contains chlorofluorocarbons (CFCs) as refrigerant and foaming agent. From 1988 onwards the amount of CFCs used could be reduced (type II). Type III appliances (between 1993 and 1997) use the fluorinated hydrocarbon R134a as refrigerant and foaming agent. Type IV-appliances (from 1994 onwards) use isobutane as refrigerant and pentane as foaming agent.

The costs were calculated for private households. Considered cost types were acquisition costs and costs for electricity supply. Cost for repair or maintenance were not considered. The costs for the recycling were assumed to be included in the purchase price. For the next 21 years (2005 with 2025) the annual costs and the net present value (in 2005) were calculated. In the calculations regarding the accelerated replacement, future costs were discounted with a discounting rate of 5 % to give the net present value (NPV) in 2005.

Impact assessment

The following environmental indicators and impact categories were considered as relevant for the system under consideration: primary energy demand (indicator: cumulative energy demand, CED), global warming potential (GWP) and ozone depletion potential (ODP). Additionally the total environmental burden (determined by the method EcoGrade [6]) was calculated which includes the indicators GWP, photochemical ozone creation potential (POCP), eutrophication potential (EP) and acidification potential (AP).

Summary of assumptions

The following tables give an overview of the assumptions (size, volume, prices, electricity demand, electricity price and recycling type) regarding the four appliance categories and with respect to year of manufacture (where applicable).

Table 1: Specification of the size, volume and purchase prices of the regarded appliances

	Size of appliance	**Fresh food volume**	**Frozen food volume**	**Purchase price (A, A+)**	**Purchase price (A+)**	**Average life span**
refrigerator	"small"	155 litres		290,00 €	435,00 €	14 years
fridge-freezer	"large"	200 litres	90 litres	510,00 €	765,00 €	14 years
upright freezer	"large"	--	190 litres	350,00 €	525,00 €	17 years
chest freezer	"large"	--	190 litres	340,00 €	510,00 €	17 years

Purchase prices A, A+: Information received from Bosch/Siemens/Hausgeräte 2005 (Average prices for different cold appliance categories between February 2004 and January 2005); purchase prices A++: estimation (price A, A+ times 1,5), based on own market survey and data base of domestic appliances of Niedrig-Energie-Institut (NEI), 2004; Detmold 2004.

Table 2: Specification of the electricity demand and electricity price, and of the recycling type of the regarded appliances with respect to the year of manufacture

electricity demand (in kWh / appliance and year)	**1980**	**1985**	**1990**	**1995**	**2000**	**2005 (A+)**
refrigerator	360	330	300	250	210	118
fridge-freezer	760	610	600	480	430	254
upright freezer	700	570	530	500	470	224
chest freezer	530	410	380	350	310	201
electricity costs in 2005 (in €/ kWh)						
for all appliances (increase to 0,249 in 2020)						0,192
recycling type						
refrigerator	I	I	II	III	IV	IV
fridge-freezer	I	I	II	III	IV	IV
upright freezer	I	I	II	III	IV	IV
chest freezer	I	I	II	III	IV	IV

Limitations

When using and interpreting the results of the study, the following limitations have to be born in mind:

- Next to the type and age, the electricity demand of both the old and the new appliance depends on parameters like specific energy efficiency or volume (e.g. the size of refrigerators on the German market varies between some 50 and 400 litres!). In this study, for the appliances in stock only the average energy consumption is considered. For households with a more or less efficient appliance the result might differ from the results given in this report. Similarly only appliances with a certain volume are regarded.
- Potential differences between the actual and the stated energy demand due to different user habits, ambient conditions or ageing of materials are not considered.
- A proper recycling according to the WEEE directive is assumed without any deficits in its implementation.
- The recycling of the old appliance is fully allocated to the alternative “acquisition of a new appliance”. This assumption is questionable however this allocation problem cannot be solved in an ideal way.
- Due to a big variation in market prices (between but also within certain energy efficiency classes) an estimation of purchase prices for new appliances is difficult and bears the risk of being not representative for an individual purchasing decision.

Results

Life Cycle Assessment and Life Cycle Costing of new appliances

The results of the LCA and LCC show the environmental impacts and the costs over the whole life span of the regarded product categories (14 and 17 years respectively).

Regarding the environmental impacts the following figures (figure 1 and 2) show that the use phase is the most important life cycle phase. It contributes to the total impact category results between approximately 75 % (GWP) and 90 % (CED). From a cost point of view the purchase contribute to approximately 35 % to 45 % to the life cycle costs of the appliances (figure 3). This means the purchase is more relevant in financial terms than the production in environmental terms. The environmental impact (CED, GWP) of the recycling phase is negative, which means that the environmental benefits from the recycling of materials overweigh the impacts from re-distribution and the recycling process itself.s

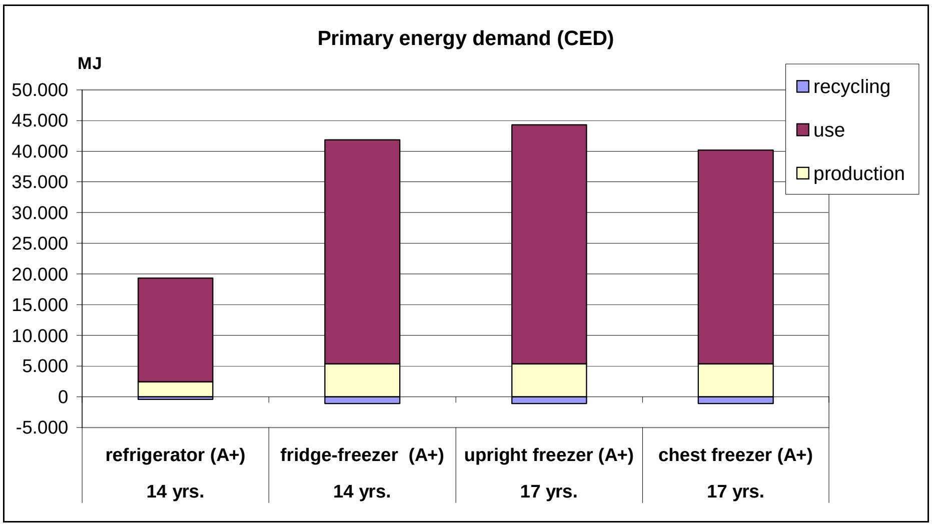

Figure 1: Primary energy demand (CED) of the production, use and recycling of cold appliances of the four regarded categories

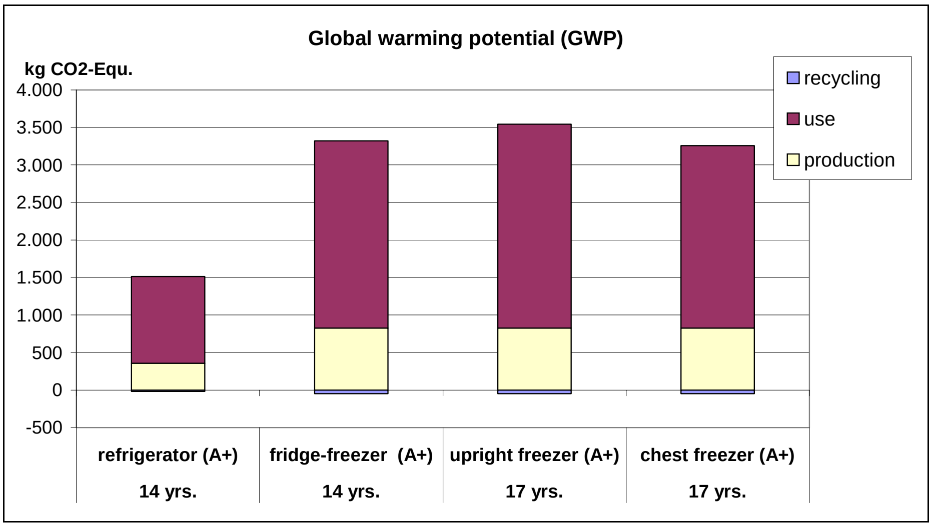

Figure 2: Global warming potential (GWP) of the production, use and recycling of cold appliances of the four regarded categories

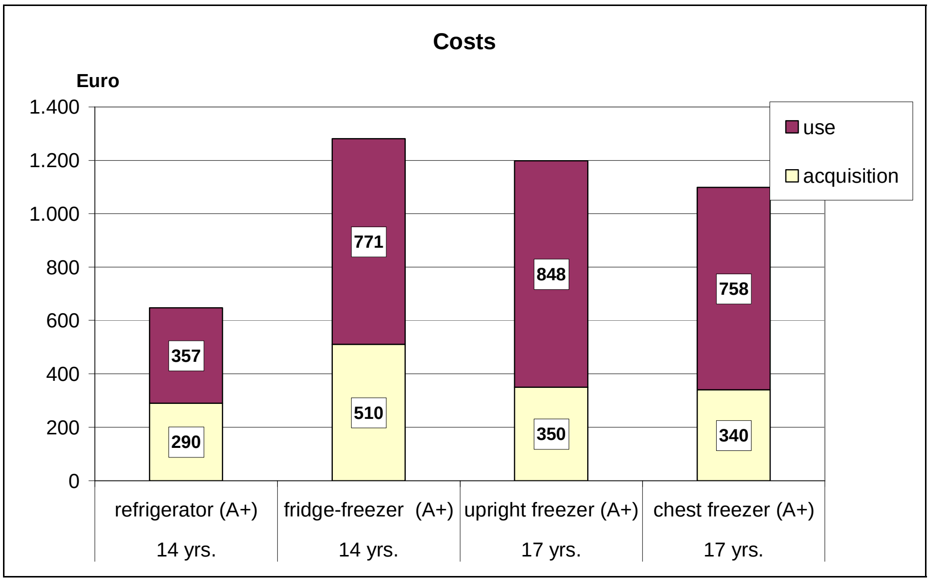

Figure 3: Costs of the purchase and use of cold appliances of the four regarded categories

Development of electricity demand in recent years

Figure 4 shows that in all categories the electricity consumption was decreasing with later years of manufacture. Especially in case of the upright freezer the electricity consumption of older appliances is much higher than that of a new ‘A+’-class model.

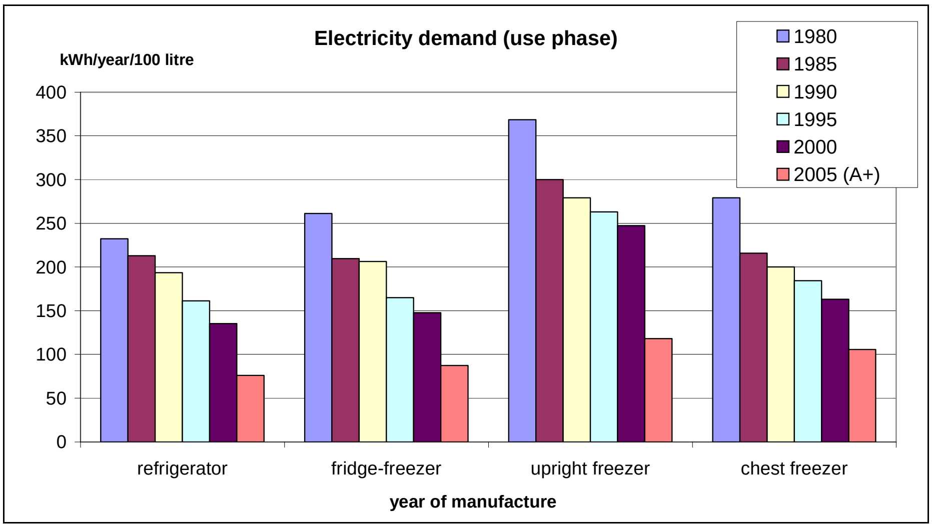

Figure 4: Electricity demand of cold appliances in the use phase

Environmental impacts through end-of-life treatment

The primary energy demand (CED) of the recycling does not vary according to the year of manufacture as it is independent from the used refrigerant and foaming agent.

Figure 5 shows that the GWP through recycling decreases significantly with later years of manufacture. Even though it is assumed that only 10 % of the amount of refrigerants and foaming agent is released into the atmosphere, the total GWP of the recycling of older appliances is quite high. A similar picture as the GWP gives the ODP (figure 6).

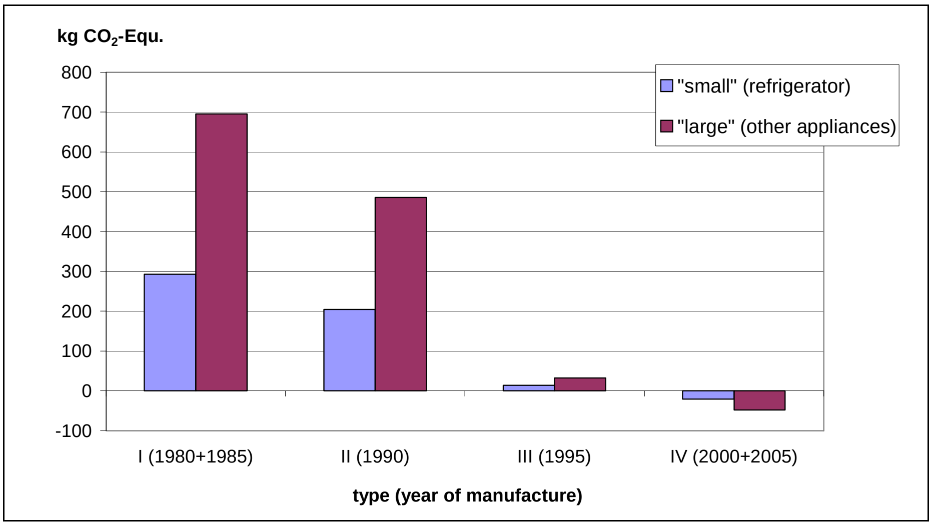

Figure 5: Global warming potential (GWP) of the recycling of "small" and "large" cold appliances of different age.

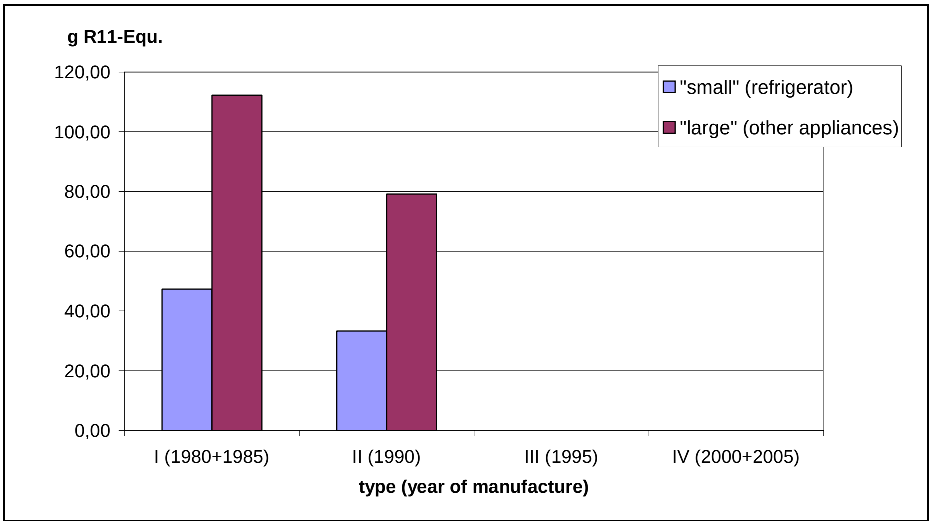

Figure 6: Ozone depletion potential (ODP) of the recycling of "small" and "large" cold appliances of different age.

Further use versus replacement of appliances in stock

For this step of the study a full range of results was produced:

- for the four cold appliance categories,
- for the four environmental indicators and the costs,
- for the three replacement variations (A+ in base case, A and A++ in sensitivity analyses).

The figures show for the year 2005:

- either acquisition and use of a new appliance + recycling of the old one ("2005") or
- further use of the old appliance ("1980", "1985", "1990", "1995", "2000")

According to annual electricity demand a smaller or bigger slope of cumulated impact / cost of the different curves results. At the intersection of the curves, the cumulated impacts of production and use of the new appliance and recycling of the old one ("2005") is equal to the cumulated impacts of the mere use of the old appliance ("1980", "1985", "1990", "1995", "2000").

Results of the base case

Cross-comparing the results between the refrigerators, fridge-freezers and upright freezers, the environmental payback periods are quite similar. In case of chest freezers the periods are higher than those of the other three categories. The following figures show some results considering fridge-freezers as example.

The payback period for the primary energy demand (CED) is very low for nearly all appliance categories (i.e. between less than one and five years), all appliances in stock to be replaced and all efficiency classes of the new appliance (see e.g. figure 7). The payback periods of the global warming potential (GWP) are higher than those regarding the CED (see e.g. figures 8 and 9). This increase mainly results from the release of refrigerants and foaming agents contained in older appliances. The results of the ozone depletion potential (ODP, not depicted) are not meaningful as these results only represent the very high impacts through recycling. There is no difference in ODP during the use phase. The methodological issue of allocation is strongly relevant here. Regarding the total environmental burden, the payback-periods are between those of the CED and the GWP (see figures 10 and 11).

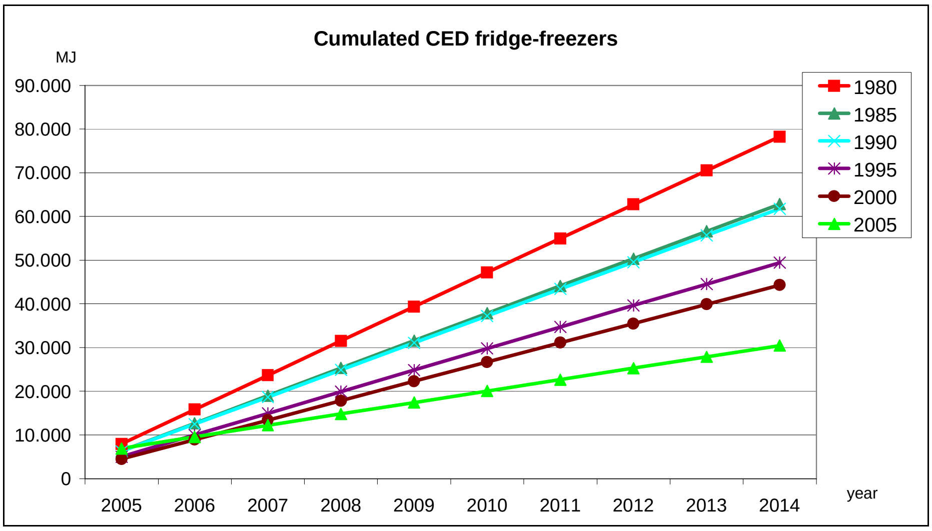

Figure 7: Cumulated primary energy demand (CED) of all regarded alternatives from 2005 until 2014, fridge-freezers (base case)

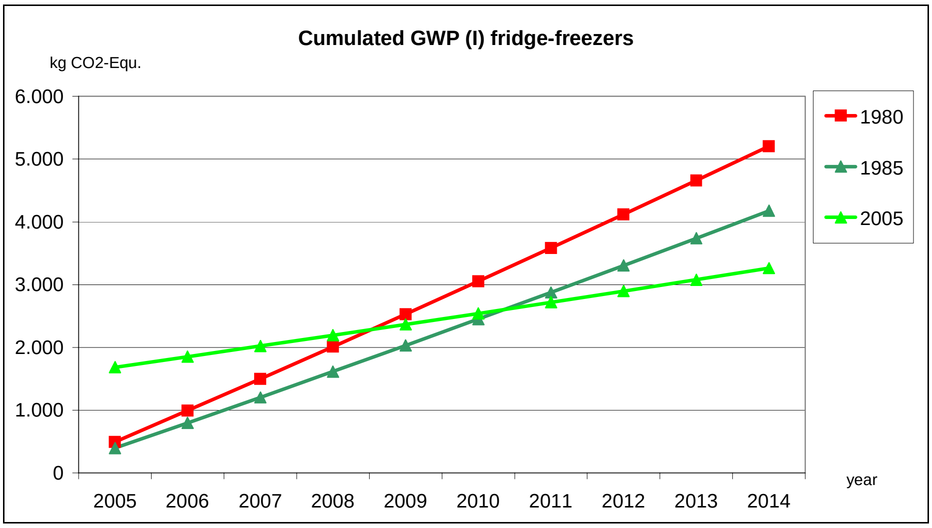

Figure 8: Cumulated global warming potential (GWP) of the regarded alternatives (2005 replaces 1980- or 1985-appliance) from 2005 until 2014, fridge-freezers (base case)

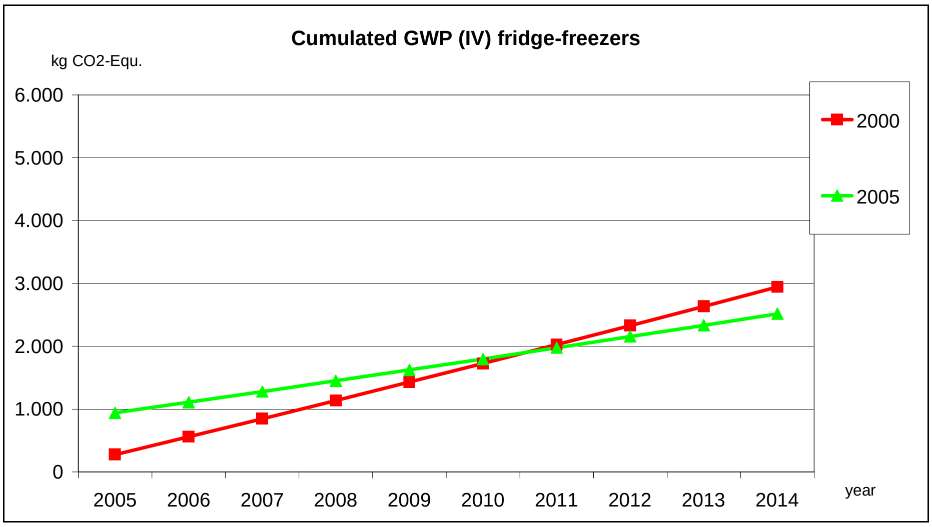

Figure 9: Cumulated global warming potential (GWP) of the regarded alternatives (2005 replaces 2000-appliance) from 2005 until 2014, fridge-freezers (base case)

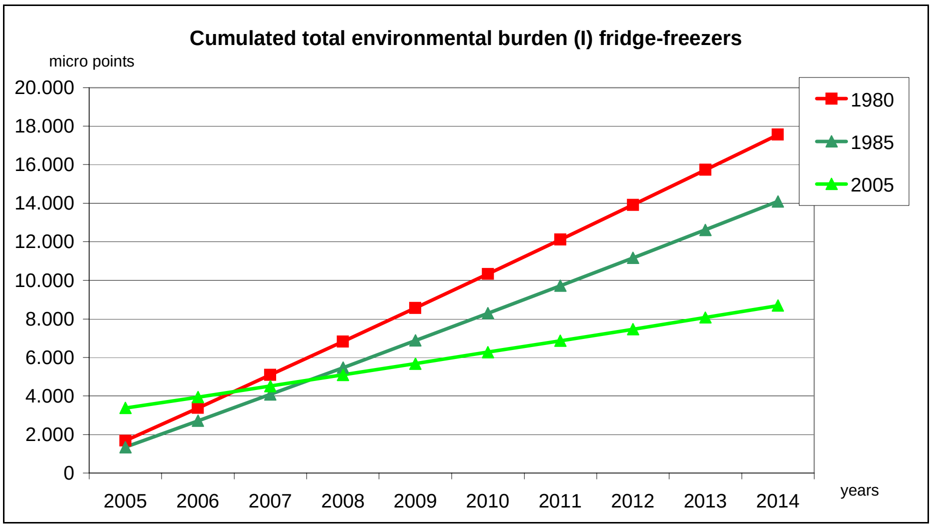

Figure 10: Cumulated total environmental burden of the regarded alternatives (2005 replaces 1980- or 1985-appliance) from 2005 until 2014, fridge-freezers (base case)

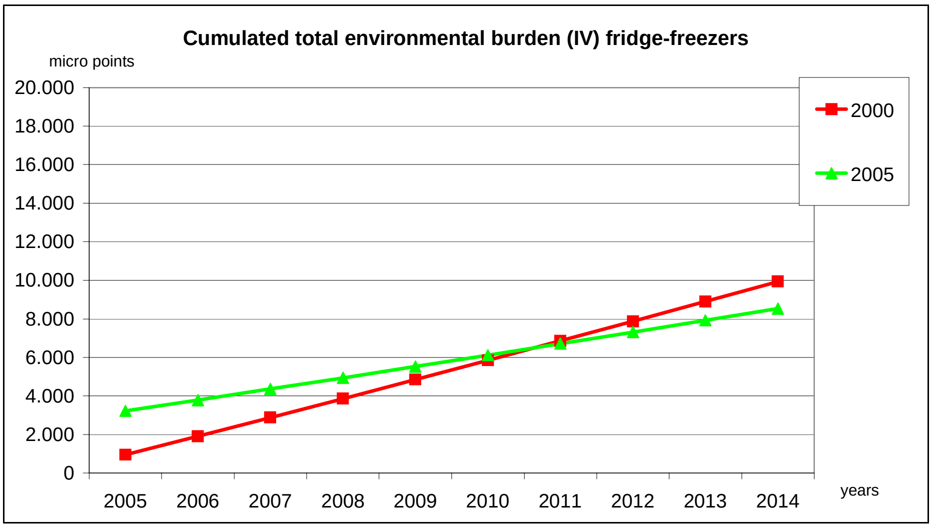

Figure 11: Cumulated total environmental burden of the regarded alternatives (2005 replaces 2000-appliance) from 2005 until 2014, fridge-freezers (base case)

The cost payback periods are higher than the environmental payback periods (see e.g. figure 12). However due to the variability of the purchase prices and the uncertainty of the dependency of the costs on energy efficiency class, the results of the costs are more uncertain than those of the environmental impacts.

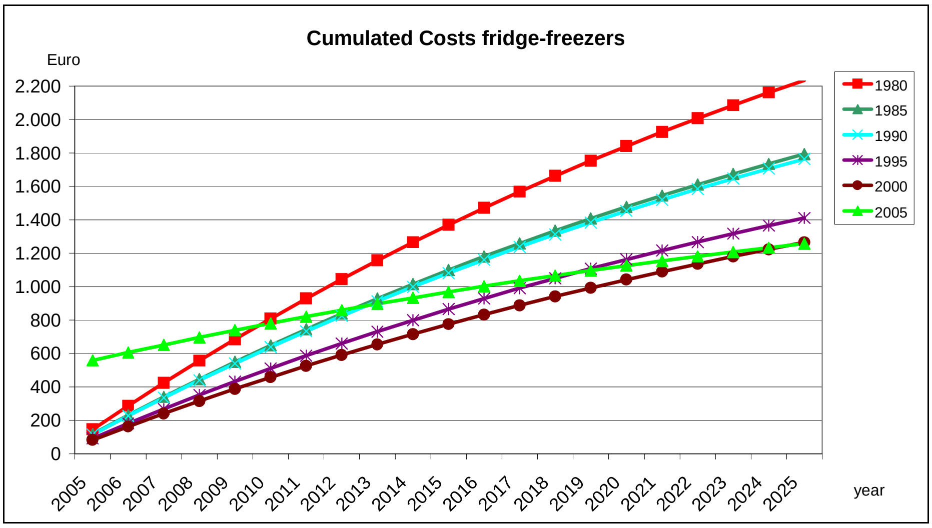

Figure 12: Cumulated life cycle costs of all regarded alternatives from 2005 until 2014, fridge-freezers (base case)

Results of the sensitivity analyses

Especially when comparing the payback periods of the primary energy demand (CED) and the global warming potential (GWP), it can be seen that the results quite strongly depend on the energy efficiency class of the new appliance. The better the energy efficiency class of the new appliance is, the shorter is the payback period (see e.g. figures 13 and 14).

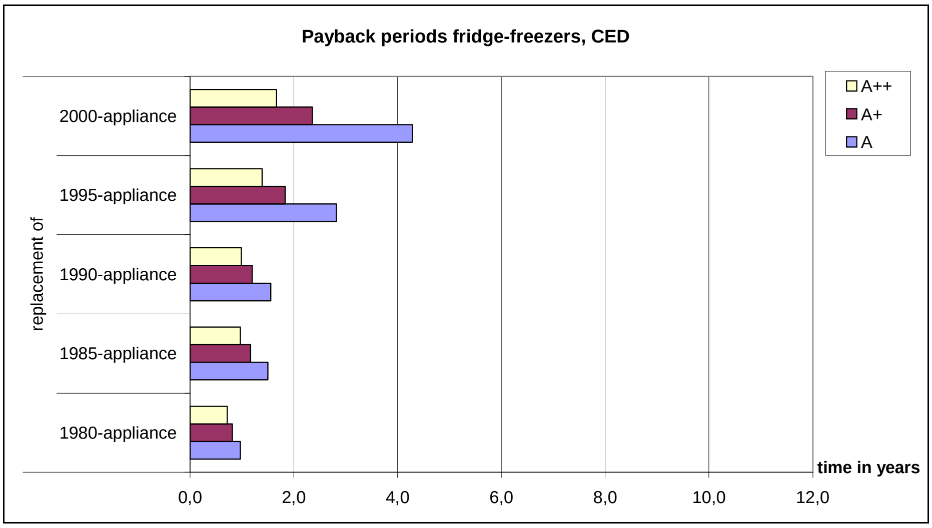

Figure 13: Payback periods of the primary energy demand (CED) with respect to the energy efficiency class of the new appliance, example fridge-freezers.

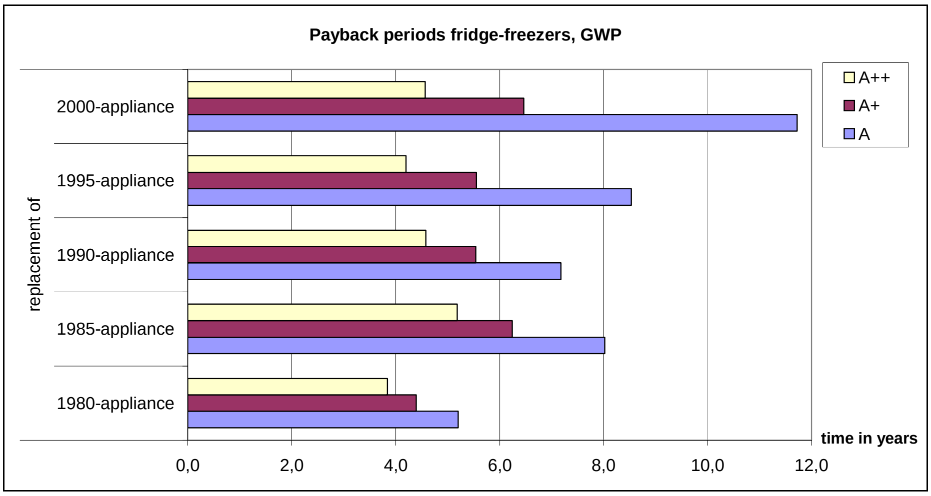

Figure 14: Payback periods of the global warming potential (GWP) with respect to the energy efficiency class of the new appliance, example fridge-freezers

Conclusions

The question if it is "worth" to further use an existing cold appliance or to substitute it and use a new model cannot be answered absolutely. The answer depends on the individual evaluation of the time span, which is acceptable for the payback period. If a payback period of up to 5 years is defined as acceptable, the replacement of cold appliances with a new one is justified in the cases shown in table 1 (regarding the total environmental burden).

Table 1: Year of manufacture of appliance with (environmental) payback periods of up to 5 years

	Refrigerators	**Fridge-freezers**	**Upright freezers**	**Chest freezers**
Energy efficiency class of new appliance				
A++	2000 and before	2000 and before	2000 and before	1980 and before
A+	1995 and before	1995 and before	2000 and before	1980 and before
A	1995 and before	1990 and before	1995 and before	1985 and before

Regarding the cost payback periods, only the replacement of upright freezers of 1980 with an 'A'- or 'A+'-model is justified. However this result has to be handled with care as the cost data is afflicted with a quite high degree of variability and uncertainty.

The results show, that an accelerated replacement of cold appliances in stock does make sense in most cases. However the following aspects should be considered:

- The energy efficiency of the new appliance should be as high as possible – at least an 'A+'-labelling is recommended.
- The take back and proper recycling of the old appliance has to be ensured: on the one hand to prevent the further use in addition to the acquisition of the new appliance, on the other hand to prevent the incorporated refrigerants and foaming agents to be released into the atmosphere.

References

[1] http://www.destatis.de/basis/d/evs/budtab63.php, last updated on 15 October 2004
[2] GfK Panel Services Consumer Research GmbH; Useful Life in Years of previous appliance (Refrigerators and Deep Freezers). MDA Presentation Consumer Panel D; Year 2003
[3] Fleet average electricity consumption of different cold appliance categories. Information received from Bosch/Siemens/Hausgeräte 2005.

[4] R. Stamminger (Co-ordinator and Editor) and Kemna, R.; CECED Report on Energy Consumption of Domestic Appliances in European Households Results of a stock model calculation including scenarios for future developments.

[5] Gabel. M.; Heinrich, H.; Kreis, H.; Meyer, A.; Welpotte, H.-D.; Wenning, U.; Entsorgung von Haushalt-Kältegeräten in Deutschland. Eine Infornation des Fachverbandes Elektro-Haushalt-Großgeräte im ZVEI. Stand: Dezember 1998.

[6] Möller, M.; Bunke, D.; Gensch, C.-O.; Quack, D.; Vogt, P.; EcoGrade 2.0 – Methodology Description. Freiburg 2005.

Promote the Early Replacement of Old, Energy-Inefficient Household Appliances

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BSH Bosch und Siemens Hausgeräte GmbH

In the first part of the contribution I will show you the achievements which we as an industry have realised so far. The second part will deal with the vast potential for further savings which could be realised if all actors in the market join in stimulating and transforming the demand for energy-efficient household appliances.

Introduction

Over the past 10 years, European home appliance manufacturers have invested some €10 billion, into, mainly, energy efficiency[1]. The results are impressive. In its Green Paper on energy efficiency, the European Commission has benchmarked our sector "world leader as a result of best technology developed in accordance with minimum standards, and a serious labelling programme" [Source: European Commission, Green Paper on Energy Efficiency or "Doing More with Less", Brussels, 10 June 2005, COM(2005) 265 Final, page 24].

CECED is grateful for this positive feedback because Europe is indeed performing well if we look at the product supply side, which is the offer of very energy efficient appliances on the shop floor. Our concern is that the diffusion of this technology in the households is rather slow because most consumers still tend to use their appliances until they finally break down (e.g. the average lifetime of household appliances in Germany today is nearly 14 years) which results in a huge stock of old appliances with really outdated consumption values.

We need a shift in political focus towards market transformation. If household appliances have to deliver additional, significant energy savings, the demand for both overall more energy-efficient appliances and the most energy efficient appliances must now become the driving force.

Achievements of the home appliance industry

European home appliance makers have always been strongly committed to the development of energy efficient appliances. Investments aimed mainly at energy saving started after the first oil crisis in the early 1970s, leading to a concerted, industry-wide effort to improve energy efficiency in the last decade.

If we focus on refrigerators and washing machines (as the appliance categories with the highest electricity consumption - covering according to the Green paper one third of the residential sector's electrical energy demand) the savings are as follows:

Washing machines

Let us start with a look at an individual machine: Today an average new washing machine, uses 44% less energy (0.95 kWh/ washing cycle compared with 1.70 kWh/ washing cycle) and 62% less water (49 l/ washing cycle compared with 129 l/ washing cycle) than a 1985 one. Compared to 1970 the improvements are even more impressive.

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[1] CECED elaboration of data provided for by Prometeia. Most of the investments were on environmental issues (energy efficiency, gases) and performances related to energy improvement.

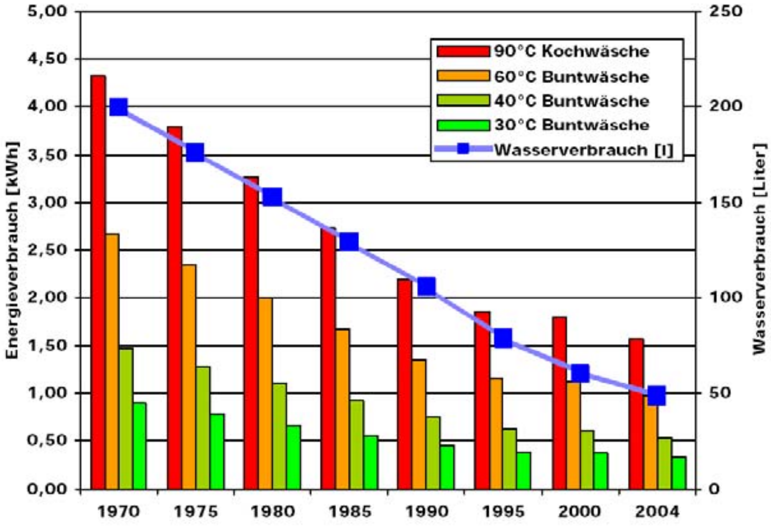

Figure 1: Consumption values of washing machines 1970 – 2004 (Germany);
source: Prof. Dr. Rainer Stamminger, Beitrag der Waschmaschine zum Nachhaltigen Waschen;
http://www.haushaltstechnik.unibonn.de/waschtag/presse.html (Vortrag der Uni Bonn)

The result for consumers is a cost reduction (from lower energy and water consumption) amounting to 60%, i.e. €0.30 cycle today versus €0.73 cycle in 1985, for an average washing machine at 175 cycles/year - accompanied by higher performance (e.g. higher spin speed)[2].

Refrigerators

Since the mid-1990s, CECED has monitored the average consumption of all models of refrigerators brought to the market (fleet consumption) by it's member companies: compared to the year 1993 the actual consumption of refrigerators today was brought down to 60.3% (2004). Our target is to reach an average energy efficiency index of 57 by 2006 [3].

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[2] The lower consumption values are irrespective of wash performance.

[3] An assessment of whether or not the target of EEI 57 was reached will be performed in 2007.

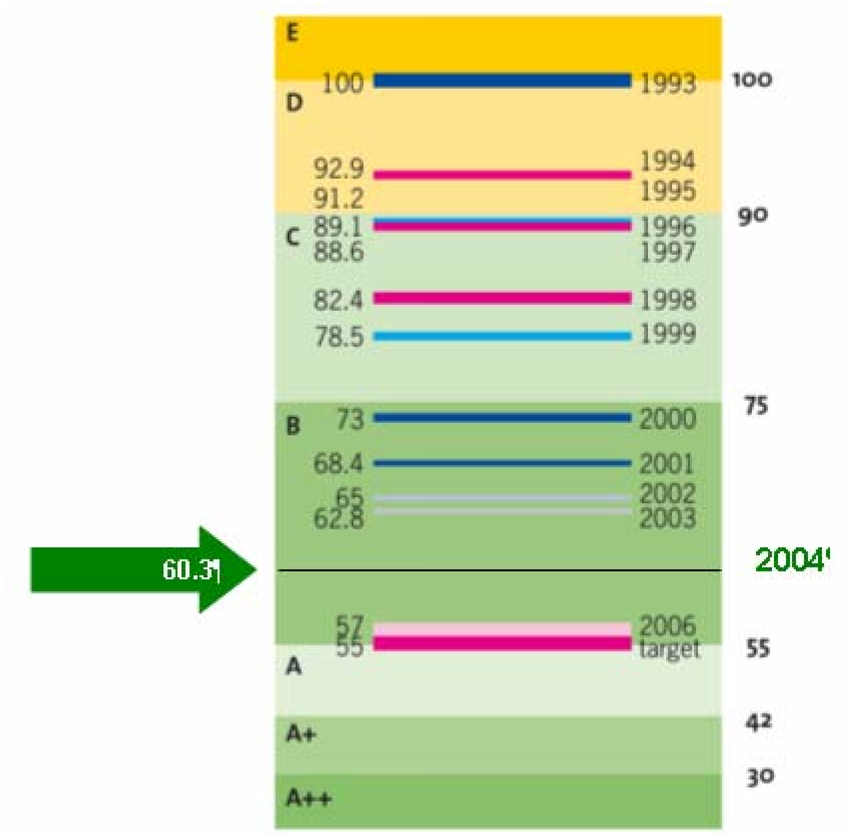


Figure 2: Fleet consumption of refrigerators 1993 – 2006; source: CECED

All this means that a 12 year old refrigerator uses nearly 60% more energy than an average current model and three times as much an A++ model.
As in washing machines the reduction of energy consumption was accompanied by an increase in performance of the refrigerator, especially the phase out of CFCs and HFCs, frost-free technology etc.
This significant reduction of the fleet consumption in refrigeration is a first proof that the European appliance industry was not only successful in developing energy-efficient appliances but also in selling them to the consumers.

In sum

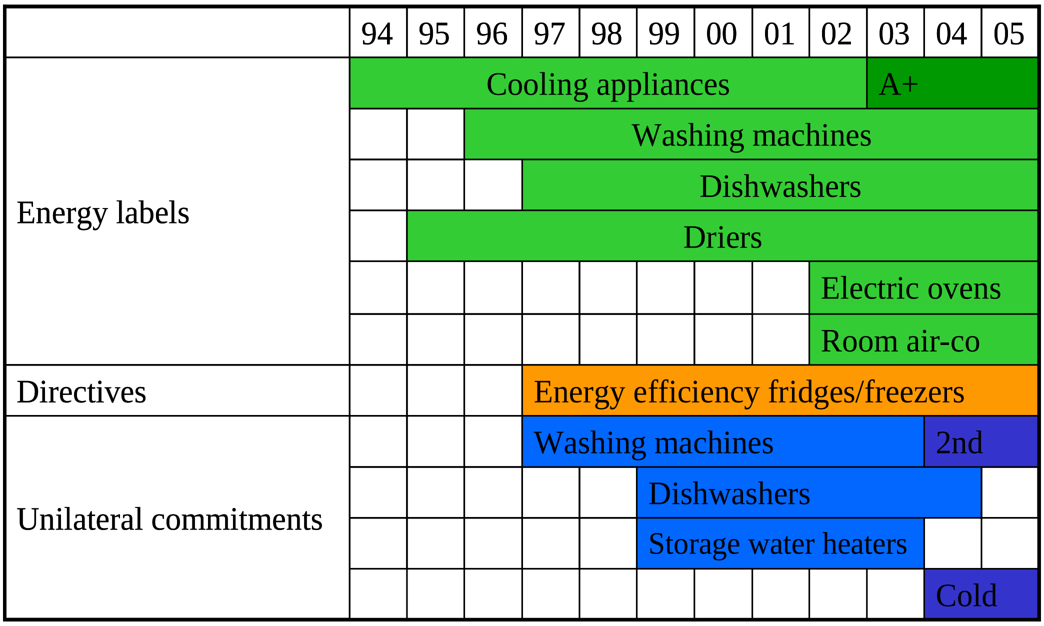
In the last decades the European appliance industry has invested a significant amount of money and effort in energy-efficiency. If we focus on the last ten years only these investments resulted in reductions of energy consumption between 25 % and 36 % (according to the different product categories).
As we continuously have been working on the improvement of the energy efficiency we have now reached a state at which some product categories (like washing machines and dishwashers) with respect to further improvements have come close to their technological limits. Or – as in the categories “refrigerators” and “freezers” – further technical improvements are possible but are not necessarily cost-effective.

Labelling and voluntary agreements

Labelling

Innovation and enhanced performances are relevant only when they get out of the laboratories into the real world. But once the products are in the shops, the power of the market becomes the driving force to create change only if consumers are sufficiently well informed to select the most environmentally sound products.
Labelling and standardisation of product information can allow for the comparison of energy efficiency of models before purchase, increases consumer awareness and encourages more rational choices.

Starting in the 2nd half of the 1990s, household appliances were the first industry to be covered by a labelling scheme. Today all relevant categories of major appliances in the EU bear the energy-label. So the labelling system is now firmly established throughout Europe - making energy efficiency a prominent factor in manufacturer's competition for the consumer's choice.



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<tr><td></td><td></td><td colspan="10">Washing machines</td></tr>
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Figure 3: Directives and measures in the European household appliance industry; source: CECED

Unilateral commitments

The European appliance industry is strongly committed to saving energy and resources. Already as early as 1997 CECED member manufacturers were amongst the first to agree on voluntary agreements committing themselves to the measurable reduction of energy consumption by household appliances.

To achieve the demanding objectives set by these voluntary agreements, the manufacturers became skilled at integrating environmental and energy efficiency parameters into design and marketing of appliances. Such an approach bans the worst energy-consuming products from the market while, nonetheless, it presents the consumer with a deeply diversified offer.

Market transformation by manufacturers

Besides developing energy-efficient appliances we have worked with good success in bringing them to the European markets.

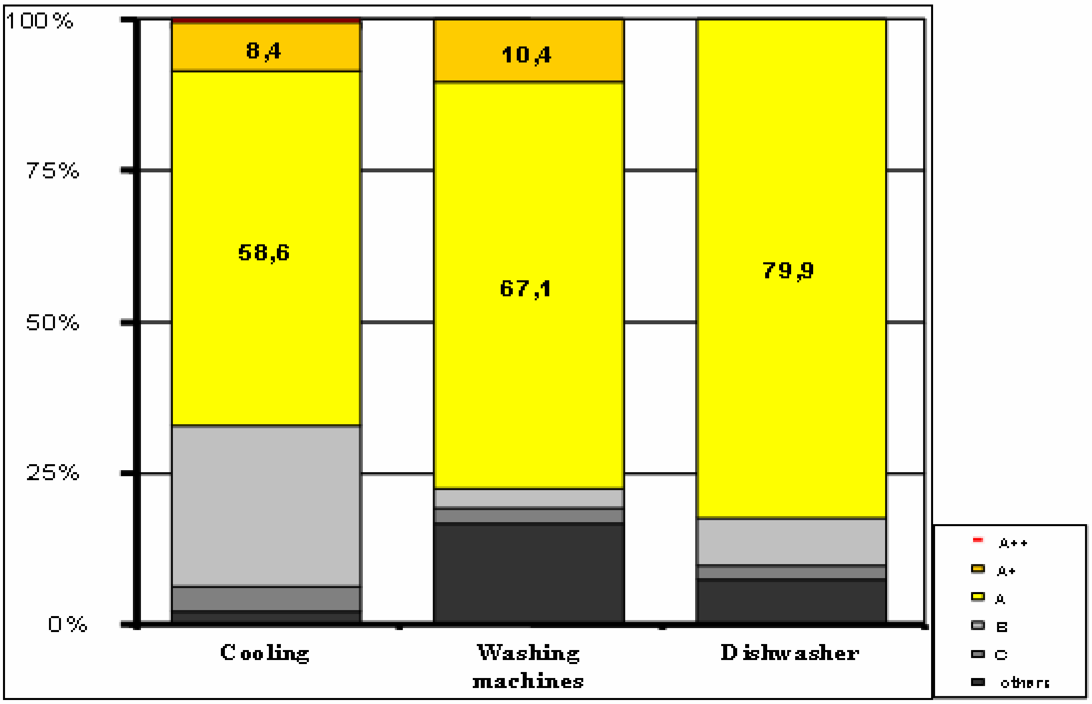

Figure 4: Market share of Energy label classes [4]**;**
source: GfK, FEB05-SEP05, AT, BE, DE, ES, FI, FR, GB, GR, IT, NL, PT, SE

Today more than two third of all refrigerators, more than three quarters of all washing machines and nearly 80 percent of all dishwashers sold on the consumers bear an energy label of A (or better).
By this the efforts of the manufacturers together with retailers, utilities, consumer councils etc. have already led to impressive savings and improvements:
In 1995, total electricity consumption by appliances installed in European households amounted to 264 TWh, generated in power plants that discharged into the atmosphere about 130 million tons of CO2[5]. It will be reduced to 230 TWh in 2005, i.e. an impressive reduction by 12%[6]. We estimate that much more than 17 million tonnes CO2 have been saved, which correspond to the CO2 generated by approximately 9 new thermo-electric generation plants of 500 MW each. Or, if you want, taking 5.1 million cars off the European road.

Potential

The market figures not only show the achievements we have reached so far - at the same time they show that there is still room for improvement. Because even if in Western Europe today 67% of the refrigerators sold are class A or better still one third of the consumers decide to buy less energy-efficient appliances. Therefore the first policy of market transformation must be "better replacement" - i.e. convincing consumers in any case to buy the most energy efficient model available in order to secure low energy consumption during the whole active lifetime.
But the really important source for huge and immediate improvements in energy efficiency is the vast stock of appliances with outdated consumption values. Based on GfK-figures we estimate that today there are some 188 million appliances in EU-25 homes that are older than 10 years. This stock of 188 million appliances is three times as much as the annual volume of the EU-25 household appliance market. If you remember the dramatic reduction in energy consumption which we have achieved in that period, then you can image what huge potential for saving remains unexploited in European homes. So the second policy that needs to be implemented are a set of measures to increase "accelerated replacement" - i.e. replacing machines with outdated consumption values before the end of their technical lifetime in order to reduce the impact on the environment.

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[4] Only for refrigerators and freezers have authorities accepted to introduce A+ and A++ as new energy classes. For cloth washers, A+ is commercially referred to in terms of best energy performance.

[5] CECED unilateral commitments.

[6] CECED unilateral commitments.

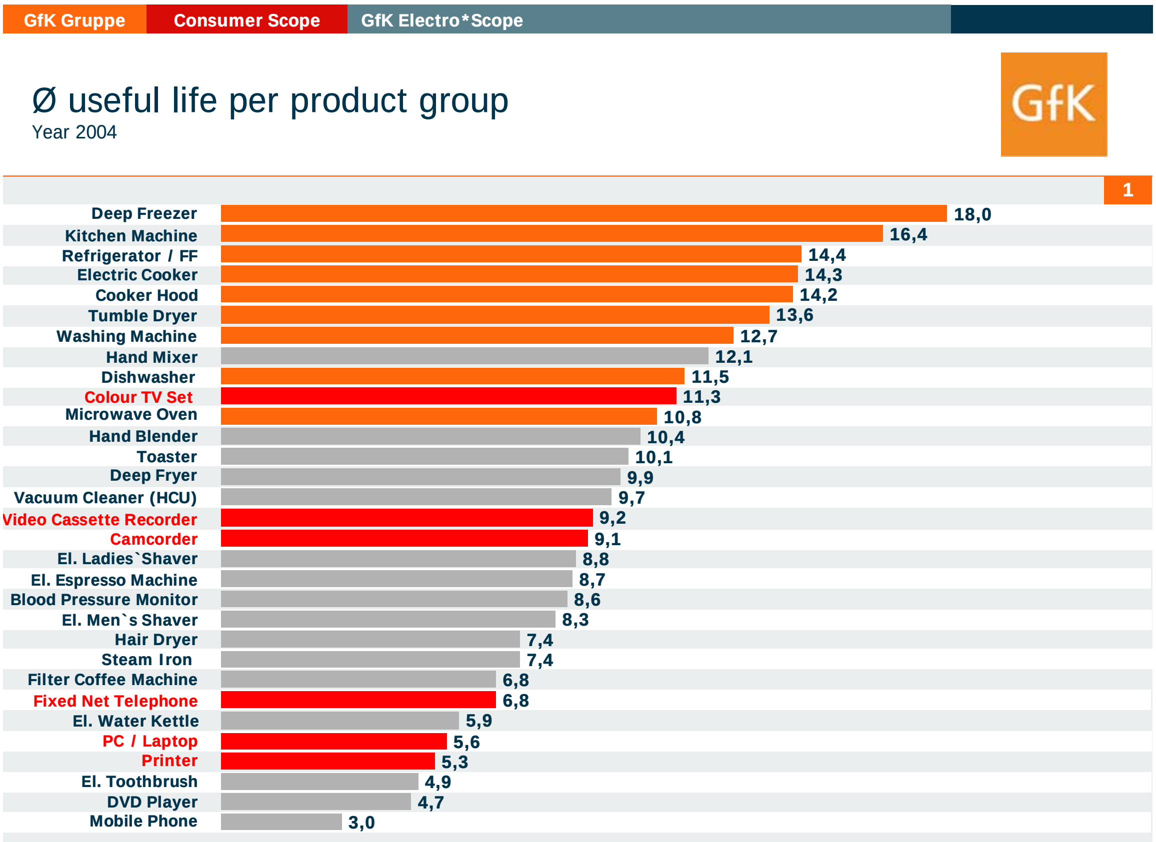

Figure 5: Average lifetime of durables in German homes; source: GfK

Figure 5 shows for the German market that compared to other durables household appliances have by far the longest average lifetime - especially cooling appliances, which consume at least one quarter of residential electricity demand, are used on average for 15 years.

Country	**stock [in million]**	**> 10 years [in million]**
Germany	152,9	48,2
France	88,4	25,7
Italy	69,8	25,4
UK	93,0	20,3
Spain	41,6	11,3
Poland	26,4	6,9
Netherlands	28,3	6,8
Sweden	18,4	6,7
Austria	14,6	4,7
Belgium	*15,9*	*4,7*
Greece	*13,7*	*4,0*
Portugal	*13,2*	*3,9*
Hungary	9,2	3,7
Czech Rep.	10,4	3,6
Denmark	*9,2*	*2,7*
Finland	*8,6*	*2,5*
Slovakia	4,6	1,8
Ireland	*4,5*	*1,3*
Latvia	*2,9*	*0,9*
Lithuania	*2,1*	*0,7*
Slovenia	*1,5*	*0,5*
Estonia	*1,2*	*0,4*
Luxembourg	*0,6*	*0,2*
Cyprus	*0,5*	*0,2*
Malta	*0,3*	*0,1*
EU-25	**633,8**	**187,8**

**Figure 6: Stock figures for the EU-25 countries;
source: CECED estimation based on GfK figures**

If we look closer into the stock figures we can also see that large numbers of old household appliances with outdated consumption values is by no means a problem of the new countries in the EU. Quite the contrary: in the old developed markets we find significant numbers of energy-thirsty appliances which offer a huge potential for energy savings.

To analyse the impact of the replacement of currently operational appliances - which is connected with the production and distribution of new ones and recycling of the replaced ones -, CECED commissioned two studies (on cooling and washing appliances) with the well known Öko-Institut in Freiburg, Germany [the result of these studies will be shown in detail by Ina Rüdenauer from Öko-Institut in her presentation named "Accelerated replacement of refrigerators and freezers - does it make sense?"].

Öko-Institut’s research clearly shows that for washing machines (and comparable for refrigerators/ freezers) older than 10 to 12 years accelerated replacement results in major savings with regard to the cumulative energy demand (CED), the global warming potential (GWP) and even with regard to the “Total environmental burden” – which Öko-Institut defines as the indicator aggregating different indicators using the EcoGrade weighing method, also developed by Öko-Institut. With regard to energy consumption - our topic today - the result is quite promising: after only four years the replacement of washing machines of more than 10 years age leads to a lower cumulative energy consumption than the continued use of the old one – even when explicitly taking into account the energy used for the production and distribution of the new machine.

But, at the same time, the studies also show that although there are clear benefits for the environment and society the replacement is often not economically attractive for consumers due to rather long payback times.

Conclusions

As real energy savings can only be achieved if energy-efficient technology is being used the CECED members are convinced that increasing the demand for highly energy-efficient appliances must now become the driving force to realise significant savings.

How can this be done?

As the situation in the different EU-market is quite different we believe that different political options for market transformation could lead to success:

- Funds or financial enablers are the starting point for any discussion about "hard" measures – as opposed to "soft" measures such as public awareness campaigns.

- Also tradable white certificates (TWC) schemes provide incentives for energy companies to invest in energy efficiency measures. In member states that have already set up a TWC scheme, one idea could also be to provide for additional discounts financed from a fixed fund for replacement of appliances older than a certain number of years. As the money would be available for a restricted group of consumers who replace their appliances, it would provide incentives for genuine early replacement.

- Finally tax credits granted from authorities to producers of super efficient appliances might provide significant oxygen to manufacturing industry directly. In America, the 2005 Energy Policy Act provides tax measures for producers.

We as an industry have worked hard for over 30 years to develop highly energy-efficient appliances – which at the same time represent some of the best technology available worldwide.
Now all market participants must join their efforts to support a wide diffusion of this technology through better replacement and accelerated replacement.
A significant market transformation will give us a realistic chance of realising the vast energy saving potential from 188 million outdated large appliances in EU 25 homes. It could be started immediately: because the huge savings offered from accelerated replacement can be realised simply by speeding up the diffusion of energy-efficient products already developed and available on the EU markets.

Policy Innovation

Multiple Solutions to a Complex Problem: Effective Strategies for Increasing Energy Efficiency in the Multi-Family Sector

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Abstract

The multi-family housing sector is an untapped resource in many regions of the nation, and there exist unique barriers to achieving its energy-efficiency potential. This paper will offer a unique in-depth analysis of three different approaches that are being used in one region and provide an opportunity to compare and contrast alternate methods. The paper will assist program planners and policymakers in understanding the obstacles to delivering energy efficiency to the multi-family sector. Likewise, the paper will offer recommendations for how best to design and evaluate multi-family programs across the country.

The objectives of this paper are to:

- Identify barriers to reaching multi-family properties and delivering energy-efficiency programs to them;
- Describe three different approaches being used to reach this segment;
- Discuss the benefits and drawbacks associated with each of the approaches; and
- Present recommendations regarding effective strategies for reaching this sector.

The basis of this paper will be the results from recent evaluations of multi-family programs, including an innovative program that assists public housing authorities change their utility allowance to account for and encourage energy-efficient improvements; a targeted, small-scale program that provides energy audits, education and training, and equipment rebates to affordable housing properties; and a large-scale, comprehensive program that offers prescriptive energy-efficient equipment rebates to multi-family properties through multiple delivery channels.

Introduction

The State of California is among the leaders in the United States for the promotion of energy efficiency. It has allocated significant resources to many different residential energy-efficiency programs that provide financial incentives and education to encourage the installation of energy-efficient measures. Within these diverse residential programs, the multi-family housing market in general, and the affordable multi-family housing market in particular, remain relatively underserved in terms of program participation as well as dollars allocated. One reason for this is that the multi-family housing market poses some unique challenges for energy-efficiency programs that do not exist in other segments of the residential marketplace.

One major problem is the split-incentive barrier, where those purchasing the energy-using equipment are different than those who are paying for the use of this equipment. Owners of multi-family properties do not have an economic incentive to invest in energy-efficient measures that will primarily benefit the tenant. Other common barriers to greater energy efficiency in the multi-family sector include difficulty identifying energy-efficiency opportunities, lack of capital, lack of maintenance staff to install energy-efficient measures, and lack of time to focus on energy-efficiency options.

In addition to this split incentive barrier, there are additional barriers in trying to introduce energy efficiency into multi-family dwellings for low-income tenants. Affordable housing is subject to complex regulations governing rent levels and the amount of subsidies that low-income tenants receive to pay their utility bills. These subsidies are often based on average area utility costs and therefore neither landlords nor tenants have any economic incentives to invest in energy efficiency. Decisions to make improvements in multi-family housing are often subject to longer budget cycles and much more complicated processes and layers of decision making than exist in non-subsidized multi-family housing.

This paper discusses three programs that have had some success targeting multi-family properties in California and identifies which elements of these programs may offer solutions that can be replicated in other regions. In the first section, we provide brief descriptions of each program. We then present findings from recent evaluations of these programs to highlight which elements were successful and which elements were not. In the final sections, we discuss lessons learned from studying the three programs and offer recommendations on how future programs can better address the relatively unique and diverse set of needs facing the multi-family housing sector.

Program Descriptions

The **Energy Action Program**[1] is a comprehensive energy-efficiency incentive program aimed at the privately- and publicly-owned, multi-family affordable housing developments. The program is implemented in the Pacific Gas and Electric (PG&E) utility service territory, which includes northern and central California. However, the program concentrates its efforts in the San Francisco Bay and Central Valley areas of California. The program includes a wide array of financial incentives and financing options that have been custom-tailored to this specific market segment. In addition to capturing energy savings, the program has two broad policy objectives:

- Enhance the equity of the State's energy-efficiency portfolio by ensuring that the affordable multi-family housing community has efficient access to resources; and
- Continue to strengthen the technical infrastructure for energy-efficiency investment in the affordable multi-family housing market through a combination of technical training, diagnostic assistance, and peer-to-peer exchange.

The Energy Action Program is a hybrid, public/private partnership involving many stakeholders in both program design and implementation. The partnership includes the following organizations, most of which are locally based: ICF Consulting, California Coalition for Rural Housing (CCRH), Center for Energy and Environment (CEE), GRID Alternatives, kW Engineering, Local Initiatives Support Corporation (LISC), Non-Profit Housing Association of Northern California (NPH), and Strategic Energy Innovations (SEI).

The program's model relies on hands-on account management, where a full-time outreach manager—called an energy resource manager—serves as the point of contact for all participating property owners and managers. The energy resource manager works with the organizations in the partnership to recruit participants and oversees the work completed through the program.

To reduce the first cost barrier to property owners and managers, the program offers prescriptive and custom rebates coupled with no-interest loans for qualifying energy-efficiency upgrades. These upgrades also result in monthly energy cost savings that enable participating properties to allocate scarce resources to other pressing needs. The Energy Action Program covers a wide range of energy-efficiency measures common to multi-family housing, including some measures that are not addressed through other programs targeting this sector (e.g., outdoor reset/cutout controls).

Program offerings also include a variety of engineering services including onsite energy audits and technical assistance. These services introduce property owners and managers to the program and provide them with valuable, customized audit reports assessing opportunities for energy-efficient upgrades in their properties. The reports include details about rebates and other financial incentives available for the recommended measures. The program's engineering services serve as a tool for engaging property owners and managers and encouraging them to apply for rebates and install the measures.

Finally the program includes a training component that engages property managers, property owners, and maintenance staff. This component of the program seeks to develop a cadre of property managers and operations and maintenance staff with the necessary skills to maintain the energy saving benefits of the measures installed through the program. The idea is to develop a sustainable, onsite infrastructure that can identify additional opportunities for energy savings once the program has ended.

The **Designed for Comfort Efficient Affordable Housing Program**[2] targets publicly- and privately-owned affordable multi-family and single-family properties.[3] Designed for Comfort is a third-party program designed and implemented by the Heschong Mahone Group, Inc. (HMG) and funded by the California Public Utilities Commission. It operates in the service territories of California's Investor-Owned Utilities (IOUs), which together account for about 80 percent of the state's residents.[4] In

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[1] The Energy Action Program is a partnership funded by the California ratepayers under the auspices of the California Public Utilities Commission (CPUC). For more information, go to www.energyactionresources.org.

2 For more information, visit http://www.designedforcomfort.com.

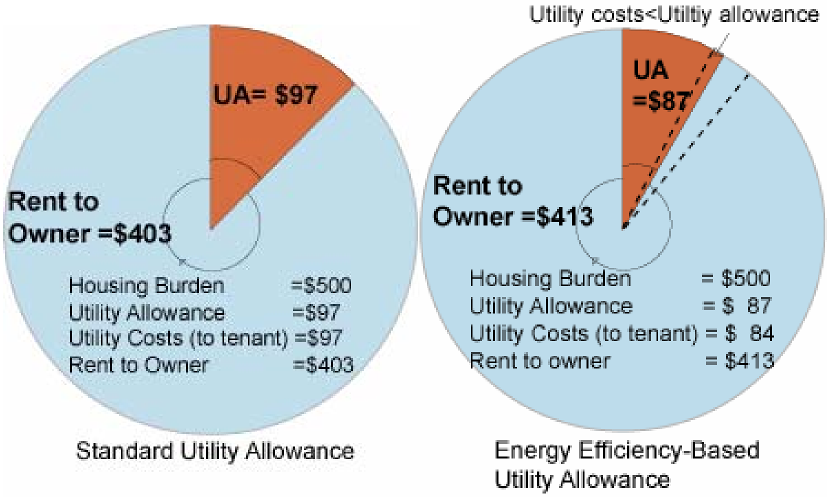
3 While the program also offers incentives to the single-family affordable housing sector, this paper focuses on the incentives available for affordable multi-family properties.

4 These utilities include Pacific Gas and Electric (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE), and Southern California Gas (SCG).

addition to reducing energy consumption and coincident peak demand, the program's goals include the following:

- To reduce regulatory barriers to energy-efficiency through structural changes in the affordable housing industry;
- To encourage long-term energy savings (electricity and natural gas) by providing financial incentives for long-lasting energy-efficient upgrades;
- To increase owner-developers' knowledge of energy efficiency through design assistance and training; and
- To provide energy-efficiency information and assistance to public housing authorities.

The program works with local public housing authorities to encourage their adoption of an Energy Efficiency-Based Utility Allowance (EEBUA). The EEBUA is an alternative to the standard utility allowance—the subsidy that low-income tenants receive for their utility bills. If their local public housing authority adopts the EEBUA, owners or developers who achieve certain levels of energy efficiency in their new or existing affordable multi-family properties can collect higher rents. These higher rents are possible because the EEBUA has reduced the tenant's utility allowance to correspond with the reduction in utility costs that have been achieved by the energy-efficiency measures installed in the property. The tenants also receive a small benefit. As the example in Figure 1 shows, the reduction in utility costs should be large enough not only to offset the increase in rent, but also leave a few more dollars each month in the tenants' pockets.



Standard Utility Allowance

Energy Efficiency-Based Utility Allowance

Source: Heschong Mahone Group

Figure 1. Example of an EEBUA

Although the EEBUA is designed to reward owners and developers of affordable multi-family properties with additional cash flow, the Designed for Comfort Program also offers additional prescriptive rebates to owners and developers whose properties meet the energy-efficiency standards set by the program. To qualify for either the EEBUA or these rebates, owner-developers must have their energy savings verified by a certified Home Energy Rating System (HERS) rater and requires analyses of baseline and proposed energy consumption performed by an energy consultant.[5] The program subsidizes these analysis and verification costs. The program's focus on engaging the energy experts further reinforces its goal of effecting long-lasting change by increasing owner-developers' knowledge of energy efficiency.

The **California Multifamily Energy-efficiency Rebate (MFEER) Program**[6] provides prescriptive rebates to multi-family property owners and managers for a wide range of retrofit energy-efficient

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[5] A HERS rating is an evaluation of the energy efficiency of a home, compared to a computer-simulated reference house (of identical size and shape as the rated home) that meets minimum requirements of the Model Energy Code (MEC). Note that a new HERS rating scale will be effective in July, 2006.

[6] The California Multifamily Energy-Efficiency Rebate Program is funded by the California ratepayers under the auspices of the California Public Utilities Commission (CPUC).

improvements. Multifamily properties with two or more units are eligible. The program also operates in the service territories of California's Investor-Owned Utilities (IOUs). Program guidelines and incentive levels are consistent across the state. The program's goals include long-term energy savings, peak demand reduction, and equity. Unlike the Energy Action and Designed for Comfort Programs, however, the MFEER Program is not targeted solely toward affordable properties.

The primary drivers of the California MFEER Program are installation contractors who are attracted by the program's prescriptive rebates. These contractors do their own prospecting for customers. Because some of the energy-efficient measures (e.g., compact fluorescent lamps) have relatively low equipment and installation costs, in some cases program rebates are sufficient for contractors not to charge for their services. For more expensive measures—such as central boilers—the incentives only cover a portion of the incremental costs. In addition to installing the energy-efficient measures, the contractors also usually fill out the rebate application forms on the customer's behalf.

These activities of the installation contractors are effective at mitigating many of the barriers to greater energy efficiency that multi-family property owners/managers face. These barriers include the split incentive barrier, difficulty identifying energy-efficiency opportunities, lack of capital, lack of maintenance staff to install energy-efficient measures, and lack of time to focus on energy-efficiency options. The contractors have been so successful at finding multi-family property owners that program rebates are often used up a few months after they become available. However, there are some disadvantages to this reliance on installation contractors, as explained later in this paper.

In addition to relying on installation contractors to deliver the program, the program also conducts marketing and outreach to the California multi-family property sector. These efforts include making presentations before apartment associations, paying for advertisements in multi-family trade publications, and sending direct mailings to attract contractors—such as insulation or boiler contractors—that are currently underrepresented in the program. The program further increases its visibility by collaborating with other statewide and national energy-efficiency programs, such as the California Residential Appliance Recycling Program and the national ENERGY STAR® initiative.

Program Evaluation, Monitoring, And Verification

The economic and institutional barriers within the multi-family housing market pose challenges to energy-efficiency program implementation. Energy Action, Designed for Comfort, and the California Multi-Family Energy Efficiency Rebate Program approach the multi-family housing market from different program design perspectives. However, while each developed sophisticated approaches to overcoming these challenges, none of the programs succeeded in eliminating the obstacles entirely.

To understand where each program was successful, where it fell short, and why, KEMA, under the sponsorship of the California Public Utility Commission, has undertaken comprehensive evaluation, monitoring, and verification efforts for all three programs. The remainder of this section discusses how each program addressed the challenges posed by this market, starting with the split incentive issue, and provides some measure of the programs' varying levels of success.

Program Challenges

Energy Action. The Energy Action Program was designed to help affordable housing properties overcome a number of barriers to implementing energy efficiency. These include lack of time, staff turnover, lengthy budget cycles, bureaucratic impediments, and perhaps most importantly, lack of capital. However, overcoming these barriers has been difficult. For example, the program has been unable to find a way to address the long budgetary lead times associated with subsidized housing. Many of the eligible properties are subject to budgetary cycles during which multiple levels of bureaucracy must approve changes, which requires budgetary cycles frequently spanning two or more years. While the Energy Action Program lengthened its initial rebate reservation and application period to accommodate the properties' longer budget cycles, the period still is not long enough to allow some properties to participate.

The program also offers rebates and no-interest financing to help overcome lack of capital and split incentive barriers. In some cases rebate levels have been set to cover the whole cost of the energy-efficient measure, not just its incremental cost over a standard efficiency alternative. This higher incentive is paid to avoid the bureaucratic barrier of having to get signoffs from multiple parties for even the smallest expenditures.

Yet these financial incentives offered by the program have had mixed success. The program's no-interest loans were designed to reduce the long-term burden of financing more expensive energy-efficiency measures. However, few properties have used these loans. One representative of an

Energy Action partner organization suggested that this may be due to property board members' and financiers' reluctance to have typically cash-strapped affordable housing properties take on additional debt.

The Energy Action Program also tries to train operations and maintenance staff in the hope that these staff will make improvements to their properties in the long-term. Yet this has proven very challenging. One problem is that low-income multi-family housing properties are generally understaffed and management and maintenance staff have multiple competing demands for their time. Another serious problem is high staff turnover. For these reasons, along with the administrative burden of conducting this training, the Energy Action Program staff decided to discontinue this training toward the end of the 2004–2005 program period and concentrate its efforts on recruiting properties into the rebate process.

Designed for Comfort. The Designed for Comfort Program approaches the split incentive dilemma from both a policy perspective and an economic perspective. On the policy side, the program develops an alternative to the standard utility allowance called the Energy Efficiency-Based Utility Allowance (EEBUA). The EEBUA allows affordable housing owners and developers to collect additional rent income while also reducing their own utility costs. The allowance also provides tenants with a reduction in their utility costs that more than makes up for the small increase in rent. On the economic side, the program offers financial incentives that provide affordable housing owners and developers with additional encouragement to make energy-efficient improvements.

To be successful the Designed for Comfort Program must persuade Public Housing Authorities (PHAs) to adopt the EEBUA. This has proven challenging. PHAs have been slow or unwilling to adopt the EEBUA for a number of reasons including:

- **Lack of an explicit HUD endorsement.** Many PHAs want to ensure that the influential U.S. Department of Housing and Urban Development (HUD) endorses any policies concerning utility allowances that they adopt. The Designed for Comfort Program sought, but did not initially get an explicit endorsement from HUD, and as a result many PHAs have been reluctant to adopt the EEBUA.
- **Failure to see the benefits.** The primary beneficiaries of the EEBUA are the affordable housing owners and developers. While some PHAs are very interested in seeing their owners and developers benefit in this way, others regard it as a lower priority when compared to other concerns they must address.
- **Funding cuts.** Cuts in Federal funding for affordable housing subsidies had two effects on the adoption of the EEBUA. First many PHA officials had to devote their attention to lobbying against the cuts when they were first proposed and this left them less time to focus on the EEBUA. Second when the funding cuts went through, many PHAs had to lay off staff, which made adoption and implementation of the EEBUA more difficult.

Yet another complication to program implementation is that each PHA has its own special needs and as a result the program marketing approach had to be customized for each. In addition, PHAs often have several levels of management without any clear hierarchy governing decision-making for a program like the EEBUA. Further, finding appropriate contacts at the PHAs and explaining the utility allowances and the EEBUA concept was time consuming.

To try to combat these problems, the Designed for Comfort Program has spent a lot of resources to provide the PHA with the necessary "hand-holding." The program has created customized EEBUAs for each PHA they have tried to recruit, provided the PHAs with tailor-made presentations so they can sell the EEBUA concept to their boards of director, and even offered to administer the EEBUA for PHAs with staffs of limited size. Yet despite these great efforts, PHA adoption of the EEBUA has been slow.

All these delays in PHA approval eventually forced the Heschong-Mahone Group to alter the original program design. Initially the program policy was only to give prescriptive rebates to affordable housing owners and developers who were located in the jurisdiction of a PHA that had adopted the EEBUA. These rebates were considered as a reward for those who had adopted and implemented the EEBUA. However, as the EEBUA adoption process dragged on, the program became concerned that it might not be able to achieve its energy savings goals in time. Therefore, HMG decided to allow qualifying affordable housing owners and developers to receive the incentives even if their jurisdictional PHA had not adopted the EEBUA. Although the program met most of its energy savings goals, most of the savings were achieved in areas where the EEBUA had not been adopted.

California Multifamily Energy-Efficiency Rebate Program. The Multifamily Energy-Efficiency Rebate Program addresses the split incentive barrier by providing incentive packages that are designed to be large enough so the property owners and tenants have to invest little or no capital to realize savings.

The primary driver of the program is a highly motivated group of installation contractors who are attracted to the program's prescriptive rebates. As noted, the program funds for financial incentives are often used up a few months after becoming available. This has forced the program to adopt rationing and reservation mechanisms to lengthen the period that the financial incentives are available.

Although these installation contractors have been very successful at identifying energy-efficiency opportunities in multi-family properties, there have been some drawbacks to this method of program delivery. The program has found it difficult to encourage diversity in the energy-efficiency measures that are installed. To be able to offer the energy-efficient measures to property managers/owners at little or no cost, many contractors rely on installers that do not have sophisticated technical skills. Therefore they prefer to promote energy-efficient measures that are relatively quick and easy to install—such as compact fluorescent lamps and programmable thermostats. The program has found it more difficult to attract contractors that install central boilers or more sophisticated lighting systems. Furthermore many property managers have expressed dissatisfaction with the quality of some of these "quick and dirty" installations.

The program has also had some difficulty recruiting large property management firms. Developing relationships with these companies is important not only because they have large property portfolios but also because they frequently acquire new properties. However, installation contractors who participate in the program have found it hard to obtain energy-efficiency projects with these large property management firms. Layers of bureaucracy make it difficult for contractors to locate the key decision-maker within these firms. These larger management companies also often have their own maintenance crews and are wary of using outside contractors.

On the other end of the spectrum, the program has also found it difficult to reach small multi-family properties. Smaller multi-family properties are naturally unattractive to the installation contractors that drive the program. Such smaller properties often do not have enough apartment units to offset contractor costs for marketing, administration, and travel. The program has been most successful in reaching properties in the mid-range of the size spectrum (100–250 units).

Program Successes

The Energy Action Program deals with the issue of reaching larger property management firms through a portfolio-level approach in which program staff establish contact with higher-level management in the management firms rather than directly contacting staff at the properties managed by these firms. In many cases, contact is established by the energy resource manager. This manager is a representative from a well-respected non-profit organization, the Local Initiatives Support Coalition (LISC), who is able to build relationships with the management firms and access many properties through one point of contact. Trust is a major barrier in working with low-income multi-family properties, and property representatives trust LISC because of their familiarity with the organization and/or their impression of LISC as an unbiased entity. After establishing initial contact with the properties, the outreach manager then acts as their advocate throughout the program process.

Because Energy Action was not solely a resource acquisition program, the energy resource manager's role is essential to the program's success. As an unbiased third-party, this manager may have more influence with affordable property managers than contractors who are perceived as just trying to "sell something." The energy resource manager and other program staff are instrumental in guiding property managers through the complicated process of obtaining engineering services, training, and rebates. Program partners report that without this "hand-holding," far fewer properties would ultimately make energy-efficient improvements.[7]

The Energy Action Program has also had success offering no-cost measure installations during the 2004–2005 program period. These no cost measures allow some properties to participate in the program that otherwise would not be able to do so. They also allow other properties to install energy-efficient measures much more quickly than they would have if they had to pay for the improvements themselves. Although the Multi-Family Energy-Efficiency Rebate Program also offers no-costs

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[7] It's important to note, however, that despite the time and efforts of the resource manager and other program staff, a much higher proportion of properties were still unable to make the recommended improvements because of the other barriers described herein.

measures, the Energy Action Program's energy resource manager and other staff can provide some oversight of the contractors to insure higher quality installations.

The Designed for Comfort Program has been able to achieve its program goals, both in the number of public housing authorities adopting the EEBUA and the amount of energy savings acquired. However, as discussed above, this was achieved through significant changes in the program design. Recently the program was able to get a more explicit endorsement of the EEBUA concept from the U.S. Department of Housing and Urban Development (HUD). This should accelerate the EEBUA's adoption going forward. Finally the program has also had some success in its goal of increasing the awareness of energy efficiency among affordable housing owners and developers. A key catalyst of this has been the program's requirement that these owners and developers use Home Energy Rating System (HERS) inspectors and other types of energy consultants. Positive experiences with these energy experts has led the owners and developers to regard them as a valuable resource that they can use on other energy-efficiency projects, even those outside the program.

The MFEER Program has been very successful in acquiring energy savings in the multi-family sector. The program has consistently been able to exceed its annual energy savings goals and demand for the program's rebates far exceed supply. Furthermore the program has been able to achieve this will relatively low program marketing costs. This success is largely due to a group of installation contractors who have marketed the program aggressively. These contractors have combined the program's prescriptive rebates with their own low-cost installation practices so that multi-family property owners/managers often pay little or no out-of-pocket costs for their energy-efficiency improvements.

Lessons Learned

A review of all three programs yields valuable lessons, including the following:

The most cost-effective way to acquire multi-family energy savings is to totally subsidize the cost of the energy-efficient measures. All three of the programs found that prescriptive rebates that totally or substantially covered the cost of the energy-efficient measures were the quickest and easiest ways to acquire energy savings in the multi-family sector. The opportunity to reduce their energy costs and improve their properties using little or no out-of-pocket costs has great appeal for owners and managers of multi-family properties. The rebates directly target the split incentive and lack of capital barriers. In addition, the rebates are crucial in attracting installation contractors who can help overcome other multi-family owner/manager barriers such as difficulty identifying energy-efficiency opportunities and lack of maintenance staff to install energy-efficient measures. Finally, for affordable multi-family housing in particular, rebates that fully cover equipment and installation costs can avoid the bureaucratic barrier of having to get signoffs from multiple parties for even the smallest expenditures.

However, using total-subsidy rebates can cause problems with quality control and measure diversity. For rebates to provide total cost subsidies, the energy-efficiency measures must have relatively low equipment and installation costs. This explains why compact fluorescent lamps and programmable thermostats accounted for a large proportion of the measures installed by the Multifamily Energy-Efficiency Rebate and Energy Action programs. The need to keep costs to a minimum can lead to "quick and dirty" installations and poor quality equipment.

Yet the California programs also suggest possible strategies for mitigating these problems. To promote measure diversity, in 2006 SDG&E, one of the utilities participating in the Multi-family Energy-Efficiency Rebate Program, will offer a bonus incentive for energy-efficiency projects that use three or more different measure types. To discourage poor quality installations, the Multi-Family Energy-Efficiency Rebate Program has taken a number of actions. These include more frequent inspections of rebated projects, conducting post-installation customer satisfaction surveys, providing property managers/owners with manuals that help guide them in selecting contractors, requiring contractors to provide contact and warranty information for addressing post-installation problems, quickly responding to customer complaints and making contractors remedy the situation, and even gaining the authority to exclude noncompliant contractors from the program. However, it is important to note that while these actions reduced the prevalence of quality problems, these problems still exist. The energy resource manager used by the Energy Action Program can help police contractors on behalf of multi-family property owners and managers. Because this monitoring can be quite costly, contractors should be pre-screened and held to terms and conditions that ensure quality installations.

Frequent staff turnover can make energy-efficiency education in the multi-family sector problematic. However, introducing multi-family property owners and developers to the benefits of energy-efficiency consultants has some promise. Toward the end of its implementation period, the Energy Action Program dropped its training of multi-family operations and maintenance staff to focus on recruiting properties into the rebate process. Energy Action's training efforts were greatly hindered by high staff turnover and a possible lack of knowledge transfer among staff. The training was also expensive to administer, as it required in-depth technical information and technical experts to conduct the training seminars.

The evaluation of the Designed for Comfort Program, however, found that there might be more promise in the education of owners and developers of multi-family properties about the benefits of energy efficiency. There appeared to be lower turnover in this group of market actors. Furthermore, since these owners/developers are frequently acquiring and building new multi-family properties, or retrofitting existing ones, the education of these market actors should have broader and longer-term benefits. It is important to point out, however, that for this energy-efficiency education to have practical results, multi-family property owners and developers must know that there are experts available that can easily recommend energy-efficiency strategies for their properties. This is why there was great value in the Designed for Comfort Program showing developers and owners how useful that HERS raters and other energy efficiency can be. Many of the developers said that they had not used such experts before but were excited about using them in the future.

Systemic solutions, like Energy-Efficiency-Based Utility Allowances, have great theoretical promise, but require great time and patience to implement. The Designed for Comfort Program's Energy-Efficiency-Based Utility Allowance (EEBUA) is a very elegant and innovative way to attack the disincentives to energy efficiency that result from standard utility allowances. However, the program discovered that it was very difficult to get Public Housing Authorities to adopt the EEBUA, despite considerable 'hand-holding' on the part of the program. Hopefully HUD's recent explicit endorsement of the EEBUA concept will encourage PHA adoption in the future.

Affordable multi-family property owners/managers need program assistance in negotiating complex institutional barriers. Complex regulations, long budget cycles, and multiple layers of decision-making are all barriers that affordable multi-family property owners/managers face in addition to the conventional multi-family barriers (split incentives, difficulty identifying measures, etc.). Both the Energy Action Program and the Designed for Comfort Program found that it was important (albeit expensive) to provide a lot of 'handholding' to help these owners/managers negotiate this complex maze so that energy-efficiency improvements could be funded.

Cost-effectiveness should not be the only measure of success for programs targeting the low-income multi-family housing sector. Because of the unique financial and staffing challenges posed by this sector, a custom set of program evaluation rules may be necessary to ensure equal access to energy-efficiency program resources by low-income multi-family property managers. An equity-based approach to evaluating programs targeting this market sector should be considered.

Partnerships with respected and trustworthy housing organizations are highly beneficial, if not essential, to successful program implementation. Because of the trust issues within the low-income multi-family sector in particular, association with (or endorsement by) an established, familiar, and respected organization like HUD or LISC can only strengthen a program's potential for success within this market sector.

Programs must have long lifetimes to achieve energy savings in this market. The long budgetary cycles, high staff turnover, and intense financial pressures on multi-family property owners necessitate lengthy program periods. As evidenced by the Energy Action Program, even a two-year program period may not give the properties enough time to include energy-efficient upgrades in an upcoming budgetary cycle.

Recommendations

Results of these three program evaluations have demonstrated that although the affordable multi-family housing market sector may be difficult to serve, it is possible to achieve energy savings through thoughtful program design and implementation. Based on our findings, we believe the most successful programs will incorporate the following elements:

- Total-cost rebates for energy-efficient measures;
- Quality-control procedures to reduce the incidence of poor quality installations in rebate projects; these procedures might include:
  - Pre-screening participating contractors;
  - Random post-inspections of rebated projects;
  - Random satisfaction surveys of participating property managers/owners; and
  - Gaining authority to exclude noncompliant contractors from the program.
- Partnership with (and/or endorsement from) respected non-profit affordable housing organizations to lend credibility and guide participants through the program process;
- Adequate program resources so that complex institutional barriers can be understood and then mitigated through administrative assistance provided by the program;
- Subsidized technical assistance (e.g., from energy consultants);
- Goals that effectively balance equity and cost-effectiveness; and
- An adequate (lengthy) program period.

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Product Policy in China

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Abstract

China is rapidly becoming the largest producer and consumer of domestic energy-consuming products, with potentially significant implications for China's economy and environment. To tackle the growing pressure on resources and the environment, the Chinese premier stated at the 2006 National People's Congress that a main target for the national economy was to increase energy intensity by 20% by 2010. This commitment should be a key driver for improving energy efficiency throughout the economy including the energy efficiency of appliances and lighting.

Product policy can play a significant role in improving the energy efficiency of domestic products thereby reducing their environmental impacts and raising the quality of life, both in China and the rest of the world.

China has started to introduce energy efficiency policies for domestic products, introducing energy efficiency standards and labels for air conditioners, refrigeration appliances, washing machines, colour televisions, compact fluorescent lamps, etc. These are the first steps towards an integrated market transformation policy approach.

A UK government-funded project (Defra's Market Transformation Programme and the Foreign and Commonwealth Office) is working with the China National Institute of Standardization (CNIS) and the China Standard Certification Center (CSC) to share experience on the development of product policy and develop a road map with recommendations for a market transformation programme in China. Mandated by China's National Development and Reform Commission, the project, the aim is to allow better prioritisation and integration of product policies, and through this facilitate better coordination with international initiatives. There are a series of global initiatives underway where harmonising policy is essential.

This paper will provide a brief overview of the standards and labels already introduced in China. This will be followed by a description of a joint China-UK project to develop a market transformation approach.

Introduction

China is rapidly becoming the largest producer and consumer of domestic energy-consuming products, with potentially significant implications for China's economy and environment. To tackle the growing pressure on resources and the environment, the Chinese premier stated at the 2006 National People's Congress that a main target for the national economy was to increase energy intensity by 20% by 2010. This commitment should be a key driver for improving energy efficiency throughout the economy including the energy efficiency of appliances and lighting.

The last 15 years, or so, has seen the increasing use around the world of market transformation policy tools to improve the efficiency of products being sold on the market: there is international agreement that such policy can bring forward better products at relatively low marginal costs to society, with significant benefits.

China has recently begun a programme of standards and mandatory labels for domestic lights and appliances, following on from a programme of voluntary endorsement labelling of lights and appliances.

Table 1: Existing product policy

Product	**Endorsement labels**	**Comparative labels**	**MEPS**
Refrigerator	Yes	Yes	Yes
Air conditioners	Yes	Yes	Yes
CFLs	Yes	No	Yes
Washing machines		In preparation	Yes
Residential micro-wave ovens	Yes		
Rice Cooker	Yes		
Electric water Heater	Yes		
Color TV	Yes		
DVD	Yes		
Electro-magnetic oven	Yes		
Ballasts for fluorescent tubes, double-capped fluorescent lamps, high-pressure sodium lamps, ballasts for high-pressure sodium lamps, metal halide lamps, ballasts for metal halide lamps	Yes		

Institutions

The government department tasked with improving China's energy efficiency is the Department of Environment and Resource Conservation (DERC) of the National Development and Reform Commission (NDRC). The key institutes involved in improving the efficiency of appliances are the Institute of Environment and Resource Conservation (IERC) of the China National Institute of Standards (CNIS) and the China Standard Certification Center (CSC, former CECP). CNIS report to the Ministry responsible for standards in China (AQSIQ) but both CNIS and CSC work very closely with DERC. China's test laboratories develop testing protocols at CNIS' instruction. Where labels already exist (certification labels from CSC and comparative labels from IERC) their thresholds are based on the developed testing protocols.

AQSIQ is the General Administration of Quality Supervision, Inspection and Quarantine. It is in charge of quality, measurement, import & export of products/sanitation/propagation inspection, certification, accreditation and standardization.

NDRC, the National Development and Reform Commission, implements China's sustainable development strategy, studies and formulates plans for resource conservation, participates in the formulation of ecological improvement plans, puts forward policies of resource conservation and utilization and coordinates environmental protection.

CNIS, the China National Institute of Standardization, is in charge of research on standardization, and the development and management of national standards.

CSC, the China Standard Certification Center, is a department of CNIS. Founded in1998 by NDRC & AQSIQ, it is a not-for-profit independent third-party certification body, with responsibilities for China's labeling programme. These labels identify energy-efficient, water efficient, environment-friendly and CCC (China Compulsory Certification) products. In addition CSC carries out research work to support policy-making.

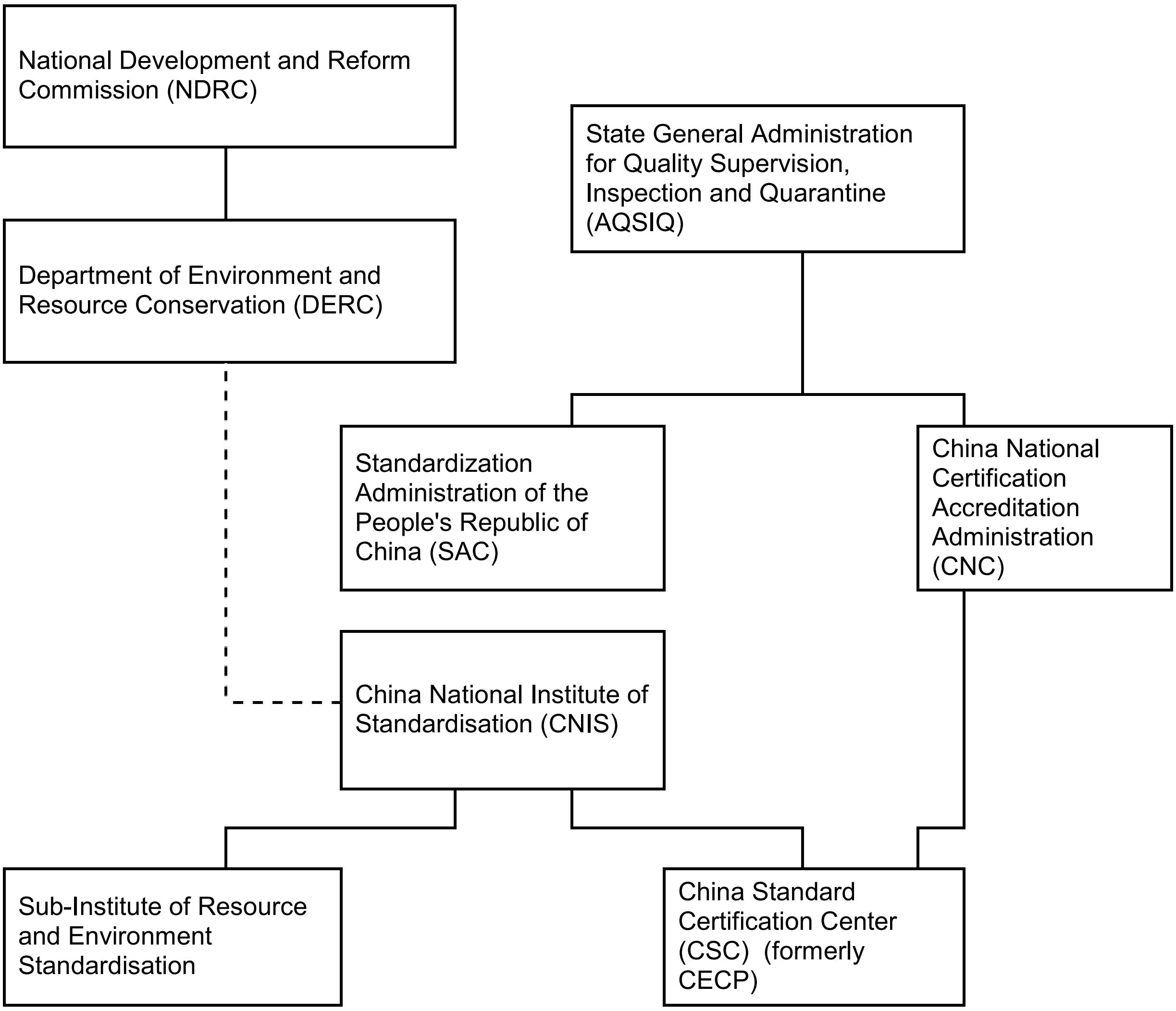


Figure 1: Organisation of product policy in China

There already exists a policy structure within China for undertaking integrated product policy, mainly at the mandate of NDRC: product policies, both voluntary and mandatory, have already been enacted in China. However, there are opportunities for closer integration with other policies, to develop techniques for the prioritization of policies and examine opportunities to harmonise where appropriate with other global initiatives.
This paper will provide a brief overview of the standards and labels already introduced in China. This will be followed by a description of joint China-UK project to develop a market transformation approach.

Existing Product Policy in China - voluntary

Product-specific policy begun in China with a voluntary labeling and certification programme run by CSC. The programme was formally launched in 1998 and today it covers 40 product categories with participation from more than 300 manufacturers, including HP, Dell, Epson, Panosonic, Haier, LG.

Table 2: Voluntary labelling scheme

Product area	Product categories
Home Appliances	Refrigerators, air conditioners, electric water heaters, residential micro-wave ovens, rice cookers, washing machine, etc
Lighting Products	Ballasts for fluorescent tubes, double-capped fluorescent lamps, CFLs, high-pressure sodium lamps and the associating ballasts, metal halide lamps and the associated ballasts, etc.
Industry Products	Air compressors, electric motors, line traps for AC power system, electric power fitting, power control devices, etc.
Standby power Products	Color TVs, DVD/VCD, printers，copiers, fax machines, computers and displays, etc.
Building materials	Sealed insulating glass unit, polystyrene, etc.

Source: http://www.cecp.org.cn/englishhtml/index.asp

Each product that qualifies for the certificate can display the Energy Conservation Certification label.

Figure 2: Energy conservation certification label

Eight of these categories are listed in “The List of Energy Efficient Products for Government Procurement”, including colour TV, refrigerator, air-conditioner, CFL, double-capped fluorescent lamps, computer, printer, toilet, water taps.

An expanded list is currently under approval and includes monitor, fax machine, and external power supplier will be listed in the new government procurement list, and there will be 91 models of colour television, 417 models of computer, 213 models of printer, 43 models of copier, 14 models of fax machine, 26 models of external power supplier and 297 models of monitor will be listed.

Existing Product Policy in China - mandatory

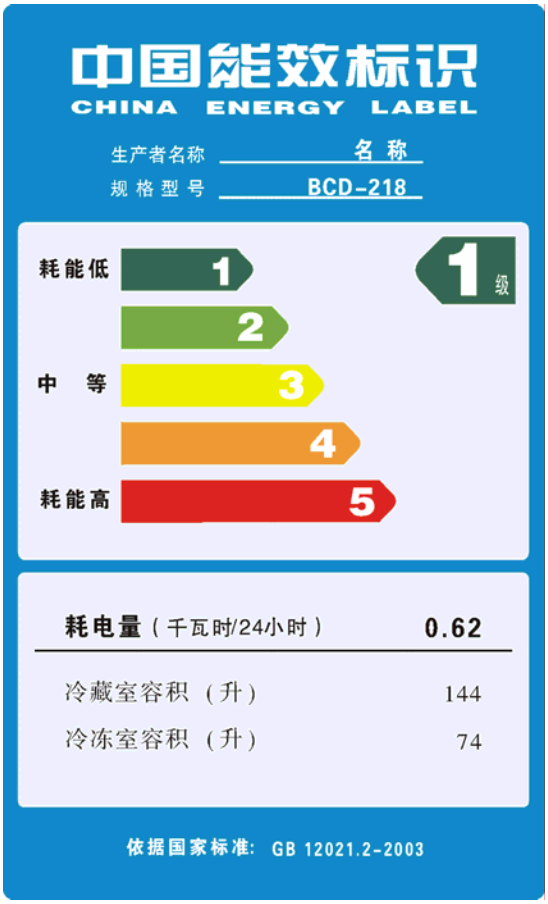
China has begun to introduce mandatory energy efficiency comparison labels and efficiency performance standards. They have been introduced at the same time. The following appliances have received some policy attention:

- Refrigeration
- Air-conditioners
- Fluorescent lamps
- Washing machines - proposed

Each of these products is briefly explained in turn.

Refrigeration appliances

Research, prior to the Chinese energy labeling being introduced, showed that Chinese householders preferred the number-based rating system (numbered one through to five, similar to other parts of the world, such as Australia), displayed in a format similar to the EU-based A-G labeling scheme [2]. The label for refrigeration appliances is shown in Figure 2 below.



中国能效标识

CHINA ENERGY LABEL

生产者名称 名 称

规 格 型 号 BCD-218

耗电量（千瓦时/24小时） 0.62

冷藏室容积（升） 144

冷冻室容积（升） 74

依据国家标准：GB 12021.2-2003

Figure 3: Energy label for refrigeration appliances

The underlying information and performance levels for refrigeration appliances' labels is similar to the EU A-G labeling scheme – thus an A-rated (B, C, etc) refrigerator in the EU would be awarded a grade 1 (2, 3, etc) in China. Grade 5 is the minimum performance standards allowed on the market. This harmonization of approaches is useful for government since it can benchmark performance across the world (which is useful for setting future MEPs, rebate levels, etc).

Air conditioners

There is an existing standard on on-time energy consumption for air conditioners: GB12021.3-2004 'Power Consumption Restriction Value and Energy Efficiency Grades of Room Air-conditioners' which limits the restriction of input power energy efficiency ratio for room air conditioners (cc≤4500) to be 2.60 W/W (which equals the input power consumption of 1731 W). This regulation came into force in 2005. [3]

The energy efficiency ratio of room air conditioners (cc≤4500) are evaluated up to 5 grades, which are shown below:

Table 3: Label performance levels for air conditioner

Grade	**5**	**4**	**3**	**2**	**1**
Energy Efficiency Ratio (W/W)	2.6	2.8	3.0	3.2	3.4
Power Consumption Restriction Value (W)	1,731	1,607	1,500	1,406	1,324

A restriction value at the level of grade 2 will come into force in 2009.

Fluorescent lamps

Limited values of energy efficiency and rating criteria of self-ballasted fluorescent lamps for general lighting service (GB19044-2003) has been issued in 2003, and came into force on September 1, 2003 [5]. The Standard is applicable to self-ballasted fluorescent lamps for general lighting services used in household or similar circumstances, working under rated power of 200V, 50Hz AC frequency, with screw cap or bayonet caps that integrate start control and stable ignition parts, with rated wattage of 60W and below. It is not applicable to self-ballasted fluorescent lamps with lampshades. The energy efficiency rating criteria are shown in Table 4.

Table 4: Energy Efficiency Grades of Self-ballasted Fluorescent Lamps

Range of Rated Power (W)	Initial Luminous Efficacy (lm/W)					
	Energy Efficiency Grade (Tone: RR,RZ)a)			Energy Efficiency Grade (Tone: RL,RB,RN,RD)a)		
	1	2	3	1	2	3
5~8	54	46	36	58	50	40
9~14	62	54	44	66	58	48
15~24	69	61	51	73	65	55
25~60	75	67	57	78	70	60

GB19044-2003 is based on GB 16844, and GB/T17263-1998, and keeps the same range of rated power, testing methods, and inspection rules with those two standards [6]. The article about limited values of energy efficiency for self-ballasted fluorescent lamps is mandatory. Energy efficiency grades and evaluating values of energy conservation are also recommended in the standard. The minimum values of the energy efficiency for self-ballasted fluorescent lamps shall be the grade 3 in the energy efficiency grades in Table 1 while the evaluating values of energy efficiency shall be the grade 2 in Table 1.

The rated luminous flux and efficacy are established in GB/T17263-1998 (Table 5).

Table 5: Rated Luminous Flux and Efficacy of Self-ballasted Fluorescent Lamps

Range of Rated Power (W)	Rated Luminous Flux (lm)	Minimum Allowed Initial Luminous Flux (90% of Rated Luminous Flux) (lm)	Rated Luminous Efficacy (lm/W)	Minimum Allowed Luminous Efficacy (lm/W)
5~8	213	192	30.4	27.4
9~14	493	444	43.5	39.2
15~24	962	866	53.3	48.0
25~60	1734	1561	57.5	51.8

Televisions

There is an existing standard on on-time energy consumption for colour television sets: GB12021.7-1989 'Power consumption restriction value of colour and B/W TV receivers and its testing method" which limits the input power consumption of colour (37cm – 56cm) and B/W (31cm – 47cm) televisions set to between 55 – 75W. This regulation came into force in 1990. This is only covering smaller television and is not effective for the increasing numbers of large screen size televisions.

The standard *Limited values of energy efficiency and evaluating values of energy conservation for color television broadcasting receivers* (GB 12021.7-2005) replaced GB12021.7-1989. It came into force on March 1, 2006 [8]. Limited values of energy efficiency, evaluating values of energy conservation, energy efficiency index (EEI) have been specified in it (Table 6).

Table 6: Limited Values of Energy Efficiency, Evaluating Values of Energy Conservation for Color Television

	Stand-by mode (W)	EEI*	Note
Limited values of energy efficiency	9	1.5	Effective on March 1, 2006
Evaluating values of energy conservation	3	1.1	Effective on March 1, 2006
Target limited values	5	1.0	Effective on March 1, 2009
Target evaluating values	1	0.75	Effective on March 1, 2009

*: Only for CRT colour TVs.

Washing machines

China is moving from traditional top-loading (impeller) washing machines to automatic front-loading machines. There is a proposed labelling and efficiency standard scheme in place: GB12021.4-2004 'Power consumption restriction value and energy efficiency grades of Washing Machine'. The performance levels for these are provided in Table 7.

Table 7: Label performance levels for washing machines

GRADE	Impeller (vertical axis – top loader)			Tumble box (horizontal axis – front loader)		
	Energy consumption (kWh/cycle/kg)	Water consumption (l/cycle/kg)	Lotion rate	Energy consumption (kWh/cycle/kg)	Water consumption (l/cycle/kg)	Lotion rate
1	≤ 0.012	≤ 20		≤ 0.19	≤ 12	≥ 1.03
2	≤ 0.017	≤ 24	≥ 0.80	≤ 0.23	≤ 14	≥ 0.94
3	≤ 0.022	≤ 28		≤ 0.27	≤ 16	
4	≤ 0.027	≤ 32	≥ 0.70	≤ 0.31	≤ 18	≥ 0.70
5	≤ 0.032	≤ 36		≤ 0.35	≤ 20	

Market transformation in China project

A UK government-funded project (Defra's Market Transformation Programme and the Foreign and Commonwealth Office) is working with the China National Institute of Standardization (CNIS) and the China Standard Certification Center (CSC) to share experience on the development of product policy and develop a road map with recommendations for a market transformation programme in China. Mandated by China's National Development and Reform Commission, the project, the aim is to allow better prioritisation and integration of product policies, and through this facilitate better coordination with international initiatives. There are a series of global initiatives underway where harmonising policy is essential.

The project will focus on energy-using products, including domestic refrigerators, room air conditioners, set-top boxes, compact fluorescent lamps (CFLs), colour TVs, rice cookers, washing machines and microwave ovens.

The key project tasks are:

- Desk research
- Workshop.
- Gap analysis.
- Knowledge sharing.
- Road map.

Desk research

For each of the main energy-using products in the domestic sector, the project has created stock models, to identify projected electricity consumption and potential savings. These have been complemented by overview papers and proposed action plans.

Set-top boxes example

China has a policy to move the country to digital TV by 2015: the energy and environmental impacts are considerable. The initial analysis of the project has highlighted that over 20TWh of additional electricity will be needed for simple digital to analogue converters alone (based on current usage patterns). Additional services could make this figure much higher.

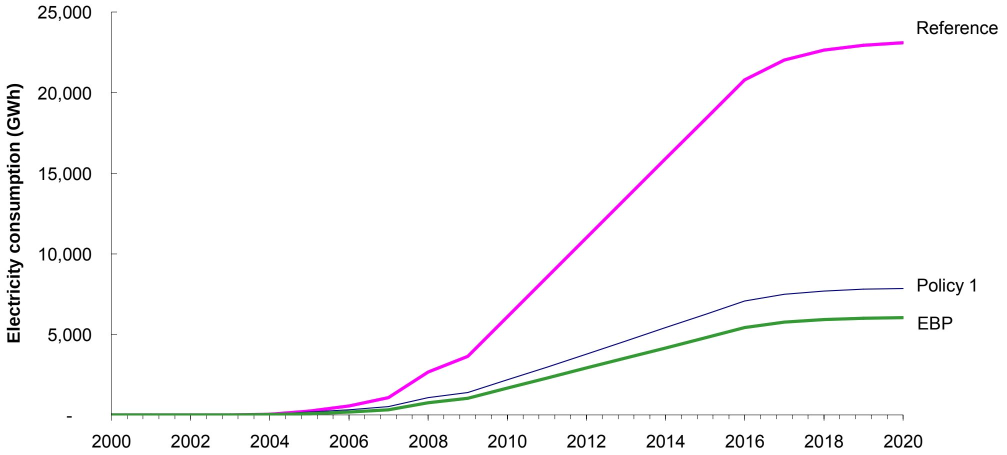


Figure 4: Project electricity consumption by set-top boxes

A set of actions has been identified which would mitigate the expected increase in consumption by set-top boxes. For the case of set-top boxes, the potential mitigations effects are substantial.

Workshop

Interim results of the desk research and energy projections were presented at a workshop involving relevant Chinese and UK organizations in Beijing in March 2006. This included presentations on a comprehensive market transformation approach: the workshop sought to gather feedback from delegates on the relevance and applicability of such an approach to China. Those present included product policy experts as well as representatives of Chinese and UK government departments.

In general the approach was welcomed. In particular, it was felt that clearly stating assumptions and data sources would facilitate the process of policy development, as areas of agreement or disagreement could be identified more easily and sources of better information identified. Delegate also supported the idea of publicizing all findings and of encouraging relevant stakeholders to actively participate in the process, as this would help ensure building consensus at an early stage. The transparent nature of presenting the evidence, allowed the relevant importance of issues to be

In addition, the project is evaluating the potential for a transparent programme to allow more stakeholders to be involved to ensure robust product policy is implemented.

Gap analysis

A gap analysis is being prepared which will be a review of current gaps in knowledge, policy appraisal and institutional development. It is has already identified some data gaps, proposal for additional policies required for some products. This includes the use of cost-benefit analysis to allow programmes to be appraised and prioritised. These will be based on bottom-up models to estimate the benefits of various programmes. The gap analysis will lead to into the identification of necessary activities to improve the knowledge base to inform the development of a schedule of activities at government and implementing agency level. This gap analysis and subsequent roadmap will propose a way to develop product policy: both in terms of prioritizing product policy and which type of institutional support is needed.

Knowledge sharing

A training workshop for technical staff provides the opportunity to develop skills in applying the market transformation approach and examine the usefulness of the proposed approach. IERC and CSC staff have worked directly with MTP in the UK on the development of product scenarios and proposed action plans for China. A UK study tour for senior government official offers first hand experience of how the market transformation approach is applied in the UK and other countries (EEDAL conference in June 2006).

International harmonisation

Through communication internationally there will be better understanding of solutions to issues. Furthermore, there are a series of global initiatives underway where harmonization of policy instruments is being considered. Mainly, to examine the opportunities to make use of consistent testing methodologies and seek to harmonise performance levels, even if countries use different policy tools. Such harmonization is likely to deliver better quality products and at lower costs to manufacturers and ultimately consumers. For example for refrigeration appliances, there is already a strong understanding of the programmes and issues and harmonization of testing protocols and performance levels. This is less clear for the consumer electronic products, both in China and globally. Therefore there is the perceived need for co-operation on set-top boxes and televisions in the near term.

Road map

The road map will summarise the results of this project and present a schedule of activities for all products covered by this project. This road map will outlines the aims, objectives, costs and benefits of market transformation programme of work. It will suggest appropriate tools to employ, methods of communication and stakeholder engagement techniques, mainly within China, but also with relevant international communities engaged in similar activities. Finally, it will propose management structures to facilitate such processes. A road map to be delivered during 2006 will lay out the way forward.

This project will finish its final report in September 2006: all reporting will be given on the following two websites:

http://www.energylabel.gov.cn/index.asp [9]

http://www.mtprog.com [1]

We are inviting Chinese and international contacts to help the project identify future areas of collaboration.

Summary and conclusions

China's policy makers understand the benefits of market transformation product policy and have already embarked on a programme of mandatory energy labeling and minimum energy efficiency performance standards, in addition to the voluntary labelling schemes.

The MTP in China project is examining the options for institutional activities to maintain an evidence base and tools to help priorities and develop future policy. The project has already developed underlying stock models and proposed actions plans for several products. These have been laid open to scrutiny at a public workshop and will be developed further as a transparent approach. A gap analysis is being prepared which will lead to a proposed roadmap for further activity.

Developing a managed product-policy approach within the Chinese government, will facilitate harmonisation and likely convergence of performance levels at a global level, allowing more efficient products at a lower cost to be brought onto the market. This will be of benefit for the peoples of China, the rest of the world, and the environment.

References

[1] MTP in China, http://www.mtprog.com/MTPSupportedProjects.aspx, accessed May 2006

[2] Energy Foundation, http://www.efchina.org, accessed May 2006

[3] GB12021.3-2004 'Power Consumption Restriction Value and Energy Efficiency Grades of Room Air-conditioners'.

[4] http://www.energylabel.gov.cn/index.asp, accessed May 2006

[5] GB19044-2003 Limited values of energy efficiency and rating criteria of self-ballasted fluorescent lamps for general lighting service

[6] GB/T17263 Self-ballasted lamps for general lighting service-Performance requirements

[7] GB12021.3-2004 'Power Consumption Restriction Value and Energy Efficiency Grades of Room Air-conditioners'

[8] GB12021.7-2005 Limited values of energy efficiency and evaluating values of energy conservation for color television broadcasting receivers

[9] http://www.energylabel.gov.cn/index.asp, accessed May 2006

Acknowledgements

The work in this paper has been funded by the UK's Market Transformation Programme and the Foreign and Commonwealth Office.

Creating a Virtuous Circle for Climate Change with Consumers, Manufacturers and Sufficiency

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Abstract

Electricity consumption per household is rising due to the increasing ownership of appliances and compounded by the growth in household numbers. The resultant higher carbon emissions are causing even more climate change, at a time when the evidence points to the need for greater and faster reductions in greenhouse gases.

Policies and perspectives need to encourage a change in this situation and ensure that higher standards of energy service are combined with declining household energy consumption. Some of this can be achieved by lower energy use per appliance, as a result of European regulation and manufacturer trends. This alone will not achieve the required energy reduction, there is also the need to consider whether we have sufficient appliances. Three approaches are considered: energy labels on all energy-using appliances sold; products can only be brought to market that have a proven benefit for the environment; personal carbon allowances. This will include the role of European policy, for instance the introduction of labels that are based on energy consumption (kWh) rather than energy efficiency (kWh/unit of service).

For consumers, the objective of policy would be to encourage personal responsibility so that the number of energy-using pieces of equipment per household does not just continue to rise. This trend is aided by the decline in household size, both in terms of people and floor area. For manufacturers, the effects will be for the focus to switch to downsizing and to a greater awareness that innovation must benefit the environment.

Context

Per household, energy demand is either flat or growing in many European countries. This is despite substantial policy interventions over the last 30 years and the achievement of a high standard of living for the majority of citizens. The greatest increases are occurring with electricity use, particularly in lights and appliances (including for cooking). This growth is often occurring in countries where compliance with the Kyoto Protocol is proving challenging, so new initiatives are needed that could come into effect and be influential by 2008.

To avoid dangerous climate change – as agreed at Rio de Janeiro in 1992 – the scale of carbon dioxide emissions reductions may need to be 80-90% lower by 2050 [1]. Already, many of the countries in the EU have targets that require major reductions by 2050, for instance the 75% target in France [2] and the 60% commitment in the UK [3].

Table 1: Long-term carbon reduction targets, EU member states

Country	**CO_2 reduction targets**
Czech Republic	30% per capita by 2020 (vs 2000) 25% in aggregate
France	1.8tCO_2 per capita by 2050 (75%)
Germany	45-60% by 2050 (vs 1990) [40% by 2020 if EU is 35%]
Netherlands	40% by 2030 60% by 2050
Poland	40% by 2020 (vs 1988)
Sweden	50% by 2050, all GHG
UK	60% by 2050

Sources: [4], amended by the author

As an example of the growth in household electricity demand, the UK residential sector showed a 6% increase in consumption in the third quarter of 2005 (July, August, September) over the same period in 2004. For a year-on-year change this is substantial and worrying. There has been a general upward trend, since at least 1990, for electricity consumption per household (Figure 1). 1996 may have been an anomaly, as a result of confusion over customer numbers with liberalisation, so it might be best to think of 1995-8 as a smoothed increasing line. Gas usage per gas-owning household is strongly correlated with external temperature, and little else. The improvements in insulation and reduced heat loss have, it would appear, been offset by some combination of higher internal temperatures and additional hot water use (both are provided by gas-fired systems in the majority of UK homes).

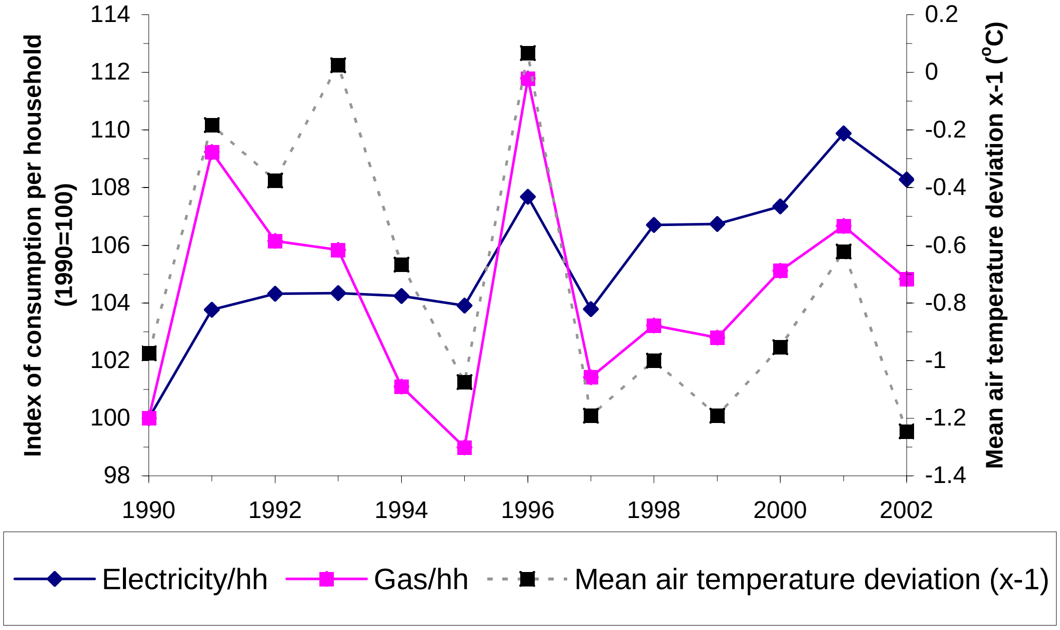

Figure 1: UK household electricity and gas consumption and external temperatures

An example of the factors that influence the growth in electricity consumption comes from the purchase and use of larger and larger TVs, particularly inefficient plasma TVs. In simple terms, the larger the TV, the more power hungry it is. However, any purchasers of large screen TVs that chose to buy the liquid crystal display (LCD) technology could be drawing under half the electricity of a (smaller) cathode ray tube and less than a fifth of a plasma TV [4, 5]. Thus, the new level of consumer service – large screens – imposes a a considerable energy penalty, but the greatest increase in demand comes from the new, but unnecessary, technology of plasma TVs.

Another example of unhelpful recent developments is patio heaters, which are as powerful as many of the boilers used to heat homes (Table 2). In total, 630,000 patio heaters have been sold to the UK domestic sector to date. Based on the above assumptions the annual energy consumption is 0.67TWh, with equivalent emissions of 0.14 $MtCO_2$.

Table 2: Estimated consumption/emissions per patio heater per year

Average power of patio heater, (S)	8.90	kW
Days per year in use (D)	30	days
Hours per day in use (H)	4	hours
Energy used per year (E = S x D x H)	1,068	kWh
CO_2 emissions per year (= E * 0.214)	229	Kg CO_2

Source: LCF team

There are two important lessons from these examples:

- The individual purchasers have no idea that they are making a decision with such considerable energy implications. There are no energy consumption labels and, in all probability, the staff in retail outlets are either ignorant, for instance of the relative impacts of plasma and LCD, or they choose not to discuss the information with the customer;
- The regulators need to move from a reactive approach to policy – only acting when a problem emerges – to a pro-active approach so that manufacturers do not put such power-hungry devices as the plasma TV and patio heater on the market.

New policies are needed so that manufacturers are required to innovate in a way that reduces, rather than increases, emissions, that consumers have appropriate information at the point of purchase and to encourage householders to recognize the need to take responsibility for their impact on the environment.

New directions for energy labels

Before discussing these options, there is one generic development that would be beneficial. The EU Energy Label is an energy efficiency label, in terms of the A-G rating. The actual consumption is given on several labelled products, in kWh of electricity use per annum. However, most consumers are encouraged to respond to the A-G scale and this is all that is available on some products, for instance light bulbs. This is a relative measure (eg kWh per litre of cold space or per wash cycle) that is then used to rank the appliance in terms of the range on the market, to give the A-G categories. The result has been that many manufacturers have increased the size of the products that are sold, as this makes it easier to get into a good energy efficiency category. For instance, most washing machines are now 5-6kg drums, whereas they were typically 4.5kg drums before the label was introduced. The average household size is dropping throughout Europe, so there is unlikely to be a consumer pull for bigger drums. The same trend can be observed with refrigeration equipment, where large American-style two-door machines are increasingly being sold in the UK and Europe. Other nations emphasise the total likely consumption per appliance on their energy labels (perhaps excluding any measure of energy efficiency), encouraging consumers to select smaller appliances. The decrease in energy efficiency that has been achieved through the growth in larger fridge-freezers and higher energy consumption is shown in Figure 2 for models sold on the UK market.

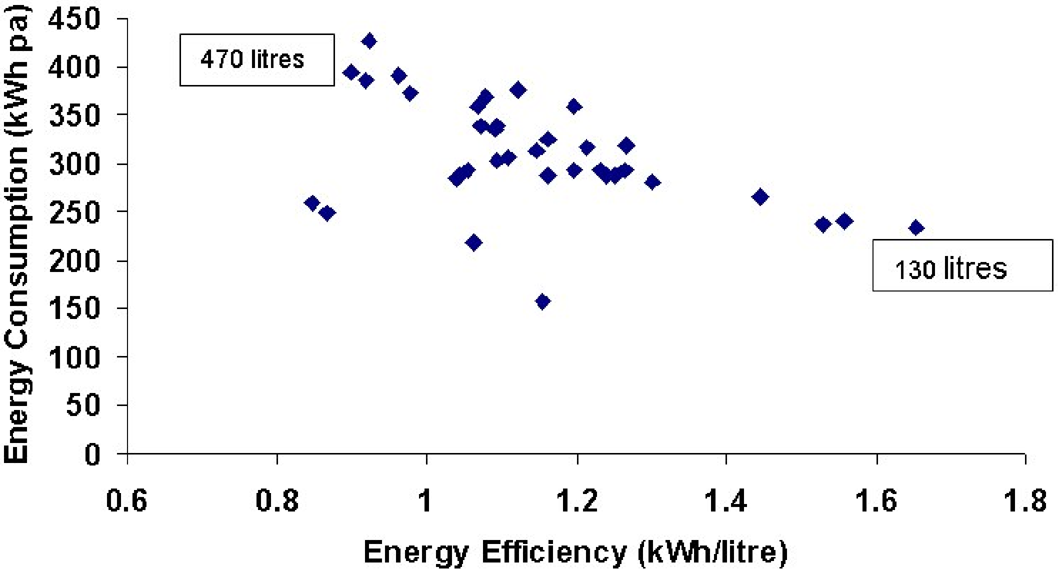

Figure 2: Energy consumption and fridge-freezers, by size, UK 2004
Source: A Peacock, 40% house presentation

The European Commission is drafting a new labelling directive and it would be entirely appropriate it this is based on absolute consumption of electricity or gas, not the amount used per unit of service. This would make it clear to customers the extra consumption that is associated with larger equipment, whereas it is obscured somewhat with the present energy efficiency label.

Currently, there are three logical components to reducing the unnecessary growth in energy consumption, which may need to be combined in practice.

Energy labels for everything

The simplest solution would be to make sure that every piece of energy-using equipment has its energy consumption clearly labelled and that it cannot be brought to market without this label. Some of this information is already on the appliance somewhere, as the maximum demand (in Watts) has to be identified under existing regulations. The difficulty at present is that consumers do not consider this information when making a purchase, it is not clearly drawn to their attention by retail staff and the data are often hidden deep down in the manufacturer's manual.

In addition, the power demand does not easily translate into an annual consumption figure and the maximum power demand is never achieved in most pieces of equipment. For instance, with a refrigerator, the maximum demand monitored in a machine is during the occasional periods of warming, when the panels are heated to ensure the ice melts. This could be for a period of less than one hour per fortnight.

To implement these energy labels with sufficient accuracy, would require the test procedure for new appliances to be developed much more quickly than at present. At present, the procedure involves the manufacturers and can take easily five years to establish. This is one reason why rapidly-developing technologies, for instance audio-visual, are difficult to label: the technology is changing more rapidly than the test procedure could be developed. Hence, the present system will always leave the consumers in ignorance on many new products.

Developing faster test procedures could be undertaken by one or a small group of independent experts, in order to get the information and not hold up the marketing of a new appliance. It would probably require the manufacturers to notify the Commission of their intention to bring a new product to market – an extension of the type of process already undertaken to get certification according to electrical safety regulations [6]. In some case, simple guidance could be given. For instance, this set top box uses 30W of electricity, which means that it will consume 263kWh if left on all year (as the supplier requires).

Labelling everything will mean that consumers gradually become more energy-literate, as they see these energy labels frequently and begin to feel confident when thinking about consumption levels. For simplicity and speed, these new labels would give straight information, eg kW and kWh, rather than rank the products on the market in an A-G category. This would be necessary with brand new products, as initially they will come from just one or two manufacturers – the range is not there.

For new products, for instance plasma TVs, there would be some difficult decisions about how to quantify usage patterns, particularly across Europe and even when a TV is used in different rooms in a UK home. Whatever number is used could be defined by Brussels and would have to be the same for all technologies in a category, eg TVs or space heaters. The information on the energy label could be given as consumption over the design or guaranteed life. This would avoid the confusion caused by pre-determining set patterns of consumption, eg this washing machine is used 5 times a week, or this light bulb is switched on for 4 hours a day, but would emphasise the established lifetime.

For other new products, for instance patio heaters, the usage pattern would be more problematic, as there was nothing comparable on the market before. The label could be defined in terms of 'this appliance will use a 80kg butane canister in …hours', based on a standard likely supply source. This is comparable to the information on light bulbs, where the lifetime is given in terms of the numbers of hours of use. By making energy labels completely inclusive and covering all energy-using products, the definitions of individual categories would become clearer, for instance combining TVs and computer monitors as visual display products, as they provide dual functions.

Whatever the details of the measurement methods, the aim would be to make sure that every energy-using product has an energy label that is clear, bright and informative, for the customer. This procedure could be introduced relatively quickly and certainly by 2008. This would help consumers control their future consumption, by making more informed choices, in advance of the first Kyoto commitment period (2008-12).

Manufacturing environmentally-beneficial products only

An alternative approach to controlling the growth of profligate energy-consuming equipment and the resultant carbon dioxide emissions would be for manufacturers to have to demonstrate to government that there is an environmental benefit as a result of manufacturing a new product. This is close to the recommendation of the UK's Energy Saving Trust that energy-profligate equipment should be outlawed [7]. All equipment has to have a certificate showing that it has been approved for sale within the European Union (the CE mark) and this proposal would build on that approach: a new product has to be deemed safe for the environment (not profligate) before it can be sold to consumers. In the shops, this seal of approval would be identified by the CE mark, a kite mark or similar. Retailers would be required to ensure that all products sold in their stores had this environmentally-beneficially mark on them. Enforcement would be vital.

This approach is different from a procedure whereby the worst examples of an existing product range would be excluded (eg the G rated equipment). That is the task of minimum standards, which is a separate and important policy strand. What is being discussed here is the situation when a brand new product range is being proposed, for instance the plasma TVs or patio heaters, and the manufacturers would be required to demonstrate that this new product will be good for the environment and better than the nearest alternative. This would protect consumers and the environment from irresponsible manufacturing ideas. Manufactures would be encouraged both to continually improve the energy performance of products, but also, for example, to increase the use of recycled materials and avoid harmful chemicals. It is similar to an Environmental Impact Statement, currently required for developments, but applied to products - with the onus on the manufacturer to improve each product release. Manufacturers would need to put much more focus in the research and development process on environmental performance rather than style or gadgets and this will change the entire nature of the commercial industry ethos.

The problem is particularly acute with brand new products. The present system of energy labels is responsive, not proactive: once the product is on the market, the EU can set up a study to identify appropriate policy initiatives and how to assign the energy label categories to the spread of models. This is already too late, as shown with plasma TVs. There are no labels on them and already the estimated 3m households in the UK have bought a model are consuming 2.2GWh of unnecessary electricity, in comparison with the purchase of same size TVs with liquid crystal displays.

It would not be difficult to draw up the clear, transparent guidelines for environmental assessment and even an announcement that this approach is being considered would at least identify the future risks for manufacturers. TV screens as large as 100” are already being developed, with all the additional electricity consumption that this implies [8]. The agreement at Gleneagles in 2005, that the G8 countries would promote the 1 watt initiative is an example of a move in the right direction. The limited progress in 2006 demonstrates how governments need to be proactive to protect the environment and millions of consumers from unnecessary energy use.

The aspiration behind the requirement for environmentally-beneficial products would be to encourage innovation that is good for the environment.

Personal carbon allowances (pca)

The third proposal is for the introduction of individual carbon allowances, to encourage personal responsibility. Each adult would receive a plastic card with an equal allowance of, say, two tonnes of carbon dioxide on it. Every time electricity, gas, petrol or a flight is purchased, the appropriate quantity of carbon dioxide would be taken off the card [4, 9]. When the free allowance has been used up, the individual could still continue to purchase these goods, but they would cost more. The scheme could be described as a carbon tax, with a substantial tax-free allowance. The carbon allowance would decrease each year, in line with the Government’s international obligations. As the carbon credit card covers over half of the economy’s carbon dioxide emissions (more if aviation is included), then this policy provides the Government with considerable certainty about the country’s ability to comply with its legal obligations. The strict adherence to an equal allowance for all adults provides the least polluting households (for instance the 20% of adults that neither drive nor fly, usually people on a low income) with a surplus of carbon, that can be sold. Pcas have two strong assets, therefore: certainty and equity.

One of the major advantages of a pca is that it would require householders to learn how they are consuming energy. Initially, at least, product policy would have to support this educational process, for instance by putting the energy consumption labels on all equipment. After a period of time, people would have a much better understanding of which are the high energy-using pieces of equipment in the home. They would also be more inquisitive at the point of purchase, making sure that new appliances help, rather than hinder, the careful use of energy.

Even if pcas are to be introduced, it will take several years before the scheme is operative. And even then, only direct energy purchases would be covered, for the sake of scheme simplicity: over half of the country’s emissions have to be covered by other policies, such as the EU Emissions Trading Scheme. Therefore, what is needed is for an immediate response to signal clearly to manufacturers that protecting the environment is the task for all of us. At the same time, procedure to build up consumer literacy on energy consumption will help them as well as restricting climate change.

Conclusions

The present system of energy labels helps consumers to rank very few appliances, but is encouraging manufacturers to produce every bigger pieces of equipment. This is because the energy labels are based on the level of energy service per unit volume (or similar) and larger machines are, by definition with this scheme, more energy efficient.

Energy consumption per household continues to grow across most of Europe, despite the lower number of people per household. So, just when there should be reduced consumption per household as a result of smaller equipment, the trend is in the reverse direction, aided and abetted by the design of a policy tool, the energy label. Other factors contribute, such as increasing household wealth and the growth in per capita space, so there is an increase in the number of pieces of equipment owned per household. The net effect is a growth in energy demand. The slow introduction of mandatory minimum efficiency standards also permits this growth in demand.

In some cases, this higher levels of appliance ownership does represent an increase in the standard of living. However, the are a growing number of examples where consumers are being encouraged, by manufacturers, to purchase and use unnecessary appliances, or ones that use profligate amounts of energy.

To constrain this growth, policy needs to be more actively involved with the decisions being made by manufacturers and customers. Three options have been discussed:

- No energy-consuming product is sold without a label confirming this level of demand;
- Manufacturers cannot produce a new line without demonstrating its environmental benefits and gaining permission from the government;
- Consumers have a personal carbon allowance, which encourages personal responsibility.

There are advantages and disadvantages with all three systems. The first two proposals focus on product standards and the third on behaviour by householders. The ideal combination, in preparation for greater personal responsibility by consumers, would be to start with aspects of all three: manufacturers will produce new products and range that are confirmed by government as having environmental benefits; each product will carry an energy label before it is placed on the market, and policies to encourage consumer energy literacy will all proceed together. Then, policy would prevent today's householders unwittingly causing unnecessary carbon dioxide emissions to the detriment of the environment.

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Acknowledgements

The opinions in this paper are based on extensive research by the Lower Carbon Futures team, at the Environmental Change Institute of Oxford University, particularly for the *40% house* report. It is their efforts that have exposed the problems that this paper is aiming to address. Particular thanks go to Stephen Berry, Australian Greenhouse Office and Mark Hinnells of ECI for useful comments and insights.

Saving Water Saves Energy

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Abstract

Hot water use in households, for showers and baths as well as for washing clothes and dishes, is a major driver of household energy consumption. Other household uses of water (such as irrigating landscaping) require additional energy in other sectors to transport and treat the water before use, and to treat wastewater. In California, 19 percent of total electricity for all sectors combined and 32 percent of natural gas consumption is related to water. There is a critical interdependence between energy and water systems: thermal power plants require cooling water, and water pumping and treatment require energy.

Energy efficiency can be increased by a number of means, including more-efficient appliances (e.g., clothes washers or dishwashers that use less total water and less heated water), water-conserving plumbing fixtures and fittings (e.g., showerheads, faucets, toilets) and changes in consumer behavior (e.g., lower temperature set points for storage water heaters, shorter showers). Water- and energy-conserving activities can help offset the stress imposed on limited water (and energy) supplies from increasing population in some areas, particularly in drought years, or increased consumption (e.g., some new shower systems) as a result of increased wealth.

This paper explores the connections between household water use and energy, and suggests options for increased efficiencies in both individual technologies and systems. Studies indicate that urban water use can be reduced cost-effectively by up to 30 percent with commercially available products. The energy savings associated with water savings may represent a large additional—and largely untapped—cost-effective opportunity.

Water Withdrawal and Consumption

Unlike energy, water can be reused. That is, after water is used for one purpose, it may be returned to a water source (such as a river or lake) and then taken again for another use. Removing water from a water source is known as “withdrawal.” Withdrawn water may be consumed or returned. “Consumed” water—e.g., water evaporated in cooling towers or evapotranspired from plants—is not immediately available in liquid phase to be used again. Figure 1 shows the uses for which fresh water is withdrawn and consumed in the United States; domestic (household) uses account for 8 percent of withdrawals and 5 percent of consumption. Withdrawals are dominated by cooling water for thermoelectric power plants and by irrigation for agriculture. (These do not include hydropower or environmental water such as in-stream flows, wild and scenic flows, required outflows, and managed wetlands water use.)

Water consumption is dominated by agricultural applications (82 percent), followed by residential and industrial uses (5 percent each). Commercial applications account for another 1 percent. Increasing system efficiencies in industrial and commercial facilities and increasing end-use efficiencies in all applications have the potential to reduce water consumption, which in turn reduces energy consumption. In addition, water—with appropriate attention to quality—can be recycled or reused.

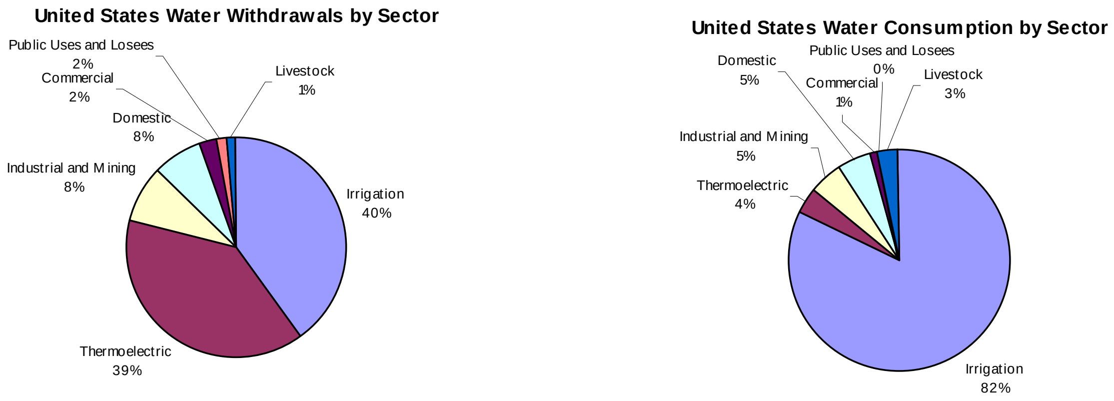

Figure 1: Water Withdrawal and Consumption by Sector, United States, 2000. [1]

The demand for water, and related energy demands, can be reduced through more efficient processes, adoption of water- and energy-efficient technologies, and changes in behavior toward sustainable practices.

Water Consumption in Households

The average household in the United States directly consumes 74 gallons (280 liters) of water per person per day. [2] Major indoor end uses include toilets, clothes washers, showers, faucets, and leaks. Outdoor uses—e.g., irrigating the landscape—account for even more water, but are not discussed further here.

Figure 2a shows a pie chart of household water consumption by end use in the United States. [2] Figure 2b shows household natural gas consumption by end use and Figure 2c shows household electricity consumption by end use. [3]

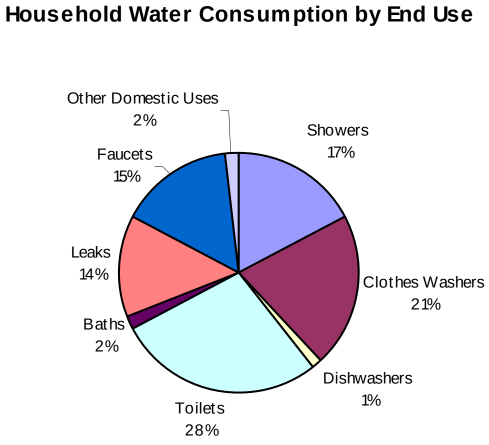

Figure 2a: Household Water Consumption by End Use, United States. [2]

Figures 2b and 2c: Household Site Energy Consumption by End Use for Natural Gas and Electricity. [3]

As these figures show, a significant share of household energy consumption is associated with water. Water heating comprises 9 percent of household electricity consumption and 24 percent of household consumption of natural gas in the United States. The heated water is used by appliances such as clothes washers and dishwashers, as well as for showers and baths.

In addition to the water directly consumed in households, energy consumption in households increases the need for water in the energy sector. Since households are responsible for 35 percent of U.S. electricity consumption, they account for about 14 percent of freshwater withdrawals for thermoelectric cooling, in addition to the 8 percent of withdrawals consumed for household water uses, for a total of 22 percent of freshwater withdrawals. Therefore, there is potential for reducing the stress on water systems by reducing electricity consumption in households.

Efficient Technologies

In the United States, efforts to increase energy efficiency have, in parallel, increased water efficiency, most notably for clothes washers and toilets. Technologies having a range of efficiencies are commercially available. Studies in California, where significant efficiency gains already have been made, indicate that urban water consumption could be reduced by at least an additional 30 percent, using technologies that are already commercially available and cost-effective. [4]

Clothes Washers

The National Appliance Energy Conservation Act of 1987 (NAECA) established mandatory energy performance standards for clothes washers in the United States, effective in 1988. [5] Subsequent updates established progressively more stringent standards, effective in 1994, 2004, and 2007. [6] The mandatory standards are expressed as a modified energy factor (MEF) in cycles per kWh per cubic foot of tub volume. MEF includes both washer and dryer energy, to account for the spin speed of the washer. In 2004, the mandatory MEF was 1.04, while the voluntary Energy Star level was 1.42. Clothes washers commercially available in the United States have MEFs ranging from 1.04 to 2.79 and water factors ranging from 12.9 to 3.5. [7] In 2007, the mandatory MEF will be 1.26, while the voluntary Energy Star level will be 1.72, with a water factor of 8.0 gallons per cubic foot.

Figure 3 shows the relationship between increased energy efficiency and energy and water savings. [8] Most of the energy savings are achieved by reducing the amount of hot water used. Clothes washers with both a high energy efficiency and high water efficiency (low water factor) use less hot water and less total water. However, there is not a direct correlation of energy efficiency to water efficiency; some clothes washers with higher energy efficiency may have lower water efficiency (i.e., a higher water factor), saving energy by using larger quantities of cold water.

The State of California originally established energy performance standards for clothes washers, which were superseded by the national standards. In 2006, California proposed water efficiency standards for clothes washers and has petitioned the U.S. Department of Energy (DOE) to allow the state to adopt them.[9] Pending DOE's approval, the State of California adopted water efficiency standards, effective in 2007, with a maximum water factor of 8.5 gallons per cubic foot (of tub volume); effective in 2010, the maximum water factor will be 6.0 gallons per cubic foot.[10]

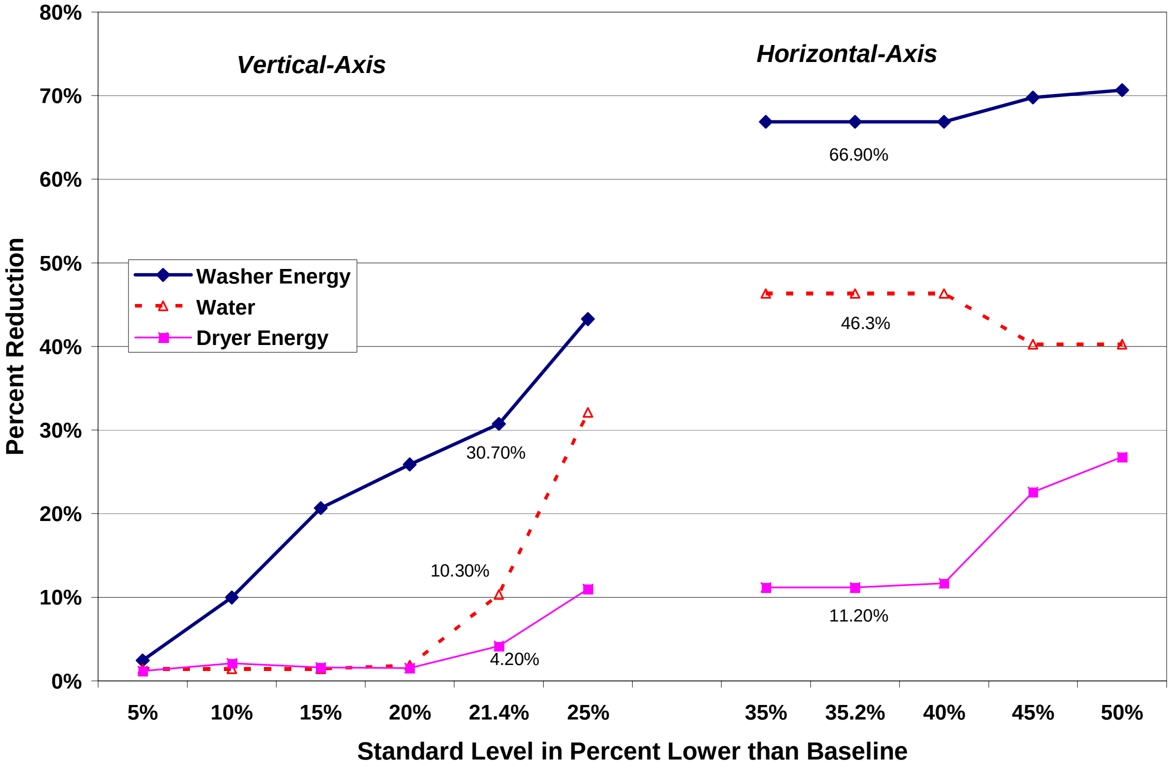

Figure 3: Energy and Water Savings for Clothes Washers for Various Changes in Modified Energy Factor [8]

Dishwashers

NAECA established mandatory energy performance standards for dishwashers, effective in 1988, for the United States.[5] Subsequent updates established more stringent standards, effective in 1994, with an energy factor (EF) of 0.62 and 0.46 cycles per kWh for compact and standard dishwashers, respectively.[11] In 2004, the voluntary Energy Star level was 0.58 cycles/kWh for standard dishwashers; no level has been established for compacts. Dishwashers commercially available in the United States have EFs ranging from 0.46 (the minimum required) to 1.11.

In 2003, the DOE test procedure for dishwashers was updated to account for soil-sensing models and changes in the number of cycles per year, and to require the measurement of standby power consumption in annual energy use or operating cost calculations. [12]

Showerheads

The Energy Policy Act of 1992 established mandatory performance standards for showerheads, faucets, water closets (toilets), and urinals, effective in 1994 for the United States. The mandatory standards require showerheads to have water flow no greater than 2.5 gallons per minute (gpm) at 80 psig. Prior to 1992, some showerheads had flow rates of 5.5 gpm.

Showerheads commercially available in the United States have flow rates ranging from 0.94 to 2.5 gpm [13] or more. California called attention to the issue of whether some current products are above the standard. Recent testing by the California Energy Commission found showerheads that had flow rates of up to 13 gpm.[14] Recent trends include installations of multiple showerheads in new construction—an estimated 3–6 percent of new households [15]—as well as in existing showers. Some of these shower systems with multiple sprays from different directions are designed to provide a therapeutic function, rather than a cleaning function, and may thus increase the duration of a shower.

Toilets

The mandatory standards established by the Energy Policy Act of 1992 require toilets (termed "water closets" in the Act) to have flow rates no greater than 1.6 gallons (6.0 liters) per flush, compared to previous designs using 3.5 gallons. Toilets commercially available in the United States have flow rates ranging from 0.8 gallons ("short flush" in dual flush models) to 1.6 gallons. The California Urban Water Conservation Council reports maximum performance testing by model to identify the best performing designs.[16]

Energy Used to Supply, Treat, and Dispose of Water

Water consumption requires large amounts of energy for three main purposes: water supply, water heating, and wastewater disposal. As an illustration, the California Energy Commission conducted a preliminary analysis of energy consumption by the water and wastewater sector and found that 19 percent of statewide electricity and 32 percent of natural gas consumption was related to water.[17] These estimates included water conveyance, treatment, distribution, and water heating (in residential, commercial, and industrial sectors); wastewater treatment, collection, and discharge; and treatment and distribution of recycled water. The amount of energy varied significantly, depending on the amount of pumping required in conveyance and the amount of treatment required as a function of water quality. Conveyance is a major component of water-related energy use in California, since two-thirds of the annual precipitation occurs in the northern portion of the state, while two-thirds of the water demand is in the southern portion. The amount of energy required to provide water to Southern California is high because the water must be transported over 1000 km via canal and pumped over the Tehachapi Mountains (a vertical lift of 610 meters).[18]

Reductions in water consumption at the end-use level directly reduce energy consumption required for supplying and heating water, and for disposing of wastewater. An important recent finding is that large energy savings are not only available but may be more cost-effective from water efficiency measures than had been identified in California's electricity savings plans. Table 1 shows a comparison of three estimates of savings in California: a) electricity savings achieved in 2004–2005; b) planned electricity savings in 2006–2008; and c) potential electricity savings from newly identified water savings opportunities. Preliminary calculations suggest that the goals that are being pursued in current electricity-savings plans could have been achieved at lower cost by saving water instead. This suggestion does not imply that the electricity savings programs are deficient, but rather that an additional, large, untapped potential for energy savings exists by saving water.

Table 1: Water Use Efficiency Potential Compared to Energy Efficiency Programs in California

	Energy Efficiency Procurement by Investor-Owned Utilities		**Water Use Efficiency Potential**
	2004-2005	**2006-2008 (projected)**	
GWh (Annualized)	2 745	6 812	6 500
Peak MW	690	1 417	850
Funding ($ Million)	$762	$1 500	$826
$/Annual KWh	$0.28	$0.22	$0.13
Cost of Electricity Saved from Water Efficiency as percent of Cost of Procurement of Electricity Efficiency (Ratio of respective $/Annual KWh)	46%	58%	100%

California Energy Commission (CEC-700-2005-011-SF), Table 4-2 [19]

Future Trends

Supplies of potable freshwater are a finite resource. Future trends in water (and related energy use) may depend on such factors as population growth and demographic trends, climate change, technological changes, and policies.

Population Growth and Demographic Shifts

Demand for potable water is expected to increase as a result of population growth. In addition, the demographic trend in the United States is toward the south and west—toward warmer regions with more restricted freshwater supplies.

Climate Change

Historical records over the last few centuries provide sufficient basis for planning for periodic droughts. Climate change has the potential to make future precipitation patterns depart from the recent historical record, and perhaps to increase the frequency and severity of droughts.

Technological Change

Since most freshwater supplies have already been identified, technologies are focused in two directions: a) more efficient use of water; and b) treatment of brackish water, seawater, or other impaired water to make it useable. For those end uses that use both energy and water, such as clothes washers, dishwashers, and showerheads, new technologies that reduce hot water consumption will save both water and energy. For those end uses that use cold water, such as toilets, increases in water efficiency will directly save water and indirectly save the energy used to supply and dispose of water.

Some proposed technological solutions to increase the supply of potable water have the potential to significantly increase energy consumption. Current methods for removing salt from brackish water or seawater increase the energy required for water supply by factors of two to five. In such situations, joint planning of both energy and water systems will be essential to avoid unintended and possibly unacceptable consequences.

In addition to attention to specific technologies, such as those used for end uses such as clothes washers, systems analyses will be needed, with particular attention to recycling or reusing water. Possibilities include dual systems and distributed treatment. A dual system would involve providing a household or business with two water systems—one for potable water and one for “gray” water for uses that do not require potable water, such as irrigation of the landscape. Depending on the scale of the technology developed, distributed treatment may involve treating wastewater at the household or neighborhood level, rather than at central municipal facilities.

Policies and Programs

Water is essential to life and health and is also, in some applications, a commodity. Establishing an economic value for water is complex, and includes long-term considerations of sustainability as well as short-term desires by some to establish markets. Laws about ownership of and rights to water are complex and vary among jurisdictions. Responsibilities for various aspects of water supply, water quality, and wastewater reside in a large number of government agencies and institutions. For example, agencies dealing with health, agriculture, and environmental issues are involved at several levels of government, from national to local. In the United States, the number of utilities is much greater for water than for electricity.

Information about water consumption by end uses is not always available. Efforts similar to those expended over the last thirty years to understand and reduce energy consumption are necessary for water. Voluntary programs to improve efficiency and reduce consumption need reliable information in order to establish goals and track progress. Incentive programs, whether tax credits to manufacturers or rebates to consumers, can in some ways be modeled after experiences in the energy sector. In some cases, as with clothes washers, considering the combined energy and water savings rather than considering each resource separately will justify greater efficiency improvements. For example, both energy and water utilities offer rebates for clothes washers, and some voluntary and mandatory standards for these products have considered both energy and water efficiency.

Conclusions

Households account for about 8 percent of freshwater withdrawals and 5 percent of water consumption in the United States. Household uses of water include bathing or showering, washing clothes or dishes, irrigating landscape, cooking, and drinking. Energy use and water use are related, since energy is required to supply potable water and to heat water for washing and other applications. Conserving water or using water more efficiently reduces energy consumption. Since freshwater withdrawals to cool thermal electricity generating plants represent about 39 percent of total withdrawals, and household electricity consumption is 35 percent of the U.S. total, about 14 percent of freshwater withdrawals can be attributed to household electricity consumption. Combining direct water uses with electricity use, households account for 22 percent of freshwater withdrawals and about 6 percent of freshwater consumption.

Opportunities for reducing water consumption include efficient technologies for clothes washers, dishwashers, toilets, and showerheads. For clothes washers, energy-efficient designs tend to reduce consumption of hot water as a primary strategy for saving energy. However, some energy-efficient clothes washers reduce energy consumption by using more cold water. Both voluntary and mandatory energy-efficiency standards can be complemented by water efficiency requirements in the form of water factors. Some studies indicate that, in California, where a number of efficiency measures are already in place, an additional 30 percent reduction in household water consumption is cost-effective and available now from commercially available products.

A preliminary estimate of the cost of energy saved from more-efficient water use indicates that a significant reservoir of energy savings may be available at a lower cost per kWh than current energy efficiency procurement programs in California.

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International Collaboration and Procurement

Lifting Markets – a Role for Public Procurement

Martin Charter, Chris Evans

UK Market Transformation Programme

Abstract

Markets are becoming greener, but could change happen faster? Currently the most effective market tools, Minimum Energy Performance Standards (MEPS), energy labelling and similar operate primarily by pushing the market i.e. by simply providing a marketing advantage to the better ones. But these measures alone are not enough to lift the market to new levels. Something extra is needed to drive innovation and pull the market up to new levels.

Demand side management dynamics exist for pulling the market e.g. Japan's 'Top Runner' programme and Australia's 'Energy Allstars'. Is there something we can learn from these and build on their success? Experience from Japan suggests the need for 'joined-up' thinking e.g. creating a greener internal market through the use of public procurement and other policy tools appears to have stimulated the development of greener products. In the US, building on the success of Energy Star, The White House and 11 federal departments signed a memorandum (2004) calling for increased use of energy and resource efficient products aimed at reduced life-cycle impacts and costs.

The European approach has been different. Much of the initial focus has been on the creation of product specifications, albeit through consultation with stakeholders including the supply chain. Examples of these include the UK's Quick Wins, Sweden's EKU and Denmark's Indkøbsvejledning.

There are clearly a number of developments that suggest public procurement can play a significant role in lifting product eco-performance and stimulating innovation. Policy makers should consider these whilst recognising that as products are traded globally, the best results are likely to be achieved if policy makers work cooperatively and internationally.

Greener public procurement

The global economic and political context has changed substanially over the last twenty years. Recognition of the concept of sustainable development - development that meets the needs of the present without compromising those of future generations - means that there is a growing recognition of need to take environmental and social policy considerations into account in public policy decisions. Links to the market started to emerge in Europe in the mid-nineties through national *environmental* product policies in some countries e.g. Sweden and latterly through discussion over Integrated Product Policy (IPP) using a smarter mix of demand and supply-side policy tools. ([1]) One of the policy tools being used by some countries e.g. Japan to *green* the market and as a strategic policy to enhance the future technology and economic competitiveness is green or *sustainable* public procurement

"Green Public Procurement is the approach by which Public Authorities integrate environmental criteria into all stages of their procurement process, thus encouraging the spread of environmental technologies and the development of environmentally sound products, by seeking and choosing outcomes and solutions that have the least possible impact on the environment throughout their whole life-cycle". ([2])

EU

Public authorities spend an estimated 16% of the EU's GDP - around €1,500 billion - on goods, services and works. At a Member State level, the overall percentage varies between 11% and 20% of GDP. This indicates the latent power that central and local government has to shift markets if it starts to demand more sustainable solutions. If government chooses to use its market leverage to buy greener technologies, goods and services this can create a very significant contribution towards sustainable development as well as achieving key environmental objectives, such as improved energy efficiency in buildings or overall reduction of greenhouse gas emissions.

In 1997, sustainable development was included in the European Union (EU) Treaty as an overarching goal and four years later EU heads of state and government launched the EU's Sustainable Development Strategy. While the Strategy does not explicitly refer to public procurement, other fora that the EU are committed to, do.

The World Summit on Sustainable Development in Johannesburg in 2002 called for ‘public procurement policies that encourage development and diffusion of environmentally sound goods and services’. …, and encouraged "relevant authorities at all levels to take sustainable development considerations into account in decision-making "([3]).

In January 2002, the Organisation of Economic Cooperation and Development (OECD) Council recommended that OECD member countries take greater account of environmental considerations in public procurement of products and services (including, but not limited to, consumables, capital goods, infrastructure, construction and public works). Many initiatives have been undertaken in OECD countries, most successfully in Japan and Denmark where green public procurement has proved to be workable and highly effective ([4]).

Between 2001 and 2003 a major research study on green public procurement in Europe - RELIEF (Environmental Relief Potential Of Urban Action On Avoidance And Detoxification Of Waste Streams Through Green Public Procurement) - was completed for the European Commission (EC) by the International Council for Local Initiatives (ICLEI). It showed that if all public authorities in the European Union (EU) switched to buying green electricity, they would save more than 60 billion tonnes of carbon dioxide (CO2), thus contributing 18% of the EU’s Kyoto target on reduced greenhouse gas (GHG) emissions for 2012; if they all switched to energy-efficient desktop computers another 830,000 tonnes of carbon dioxide (CO2) would be avoided (the public sector buys a total of 2.8 million computers each year), which would bring an additional 0.25% closer to the Kyoto goal; and if they used water-saving toilet flushes and water taps, water consumption would be reduced by 200 million litres (see Table 1). ([5])

Table 1: The Potential of Eco-Procurement [[6]]

Product*	Impact category	Environmental relief through public eco-procurement	Environmental relief through eco-procurement on the whole European market
Buses	Photochemical ozone formation (tC_2H_4-equiv.)	-3,350	-6,980
	Corresponding person equivalents* *	-134,110 (European)	-279,390
Sanitary devices	Water consumption (l)	-251,046,679	n/a
	Corresponding person equivalents* *	-3,086,387	n/a
Computers	Greenhouse gas emissions (tCO_2-equiv.)	-832,320	-8,049,385
	Corresponding person equivalents* *	-101,503 (Global)	-981,632
Food	Nutrification (tPO_4-equiv.)	-41,560	-763,295
	Corresponding person equivalents* *	-3,676,492 (European)	-67,524,295
Electricity	Greenhouse emissions (tCO_2-equiv.)	-61,350,363	-922,639,465
	Corresponding person equivalents* *	-7,481,752 (Global)	-112,517,008

* The measures needed to achieve these results are as follows: buses - all new purchases comply with EURO IV emissions standards instead of EURO III; sanitary devices - replacement of standard 9l-flush toilets, with 6/3l-flushes, and the installation of water-saving taps; computers - all new purchases fulfil better than Energy Star requirements with TFT monitors; food - 100% of meat, wheat and milk produced organically; electricity - 100% switch to renewable electricity.

* * European person equivalents describe the emission of an average European Union (EU) citizen. Global person equivalents describe the emission of an average person living anywhere in the world.

* * * A person equivalent is calculated by dividing total emissions of a substance from a given geographic area, for example Europe, by that areas population. This gives the average emission per person, which can then be compared with the reductions generated by green purchasing.

Another survey of EU Member States (before the 2004 enlargement) showed that only 19% of public authorities practised a significant amount of green procurement (which was defined for the purpose of the study as “the application of environmental criteria to more than half of their purchases”). Sweden topped the list, with 50% of all its administrations applying this high level of green purchasing, followed by Denmark (40%), Germany (30%), Austria (28%) and the United Kingdom (23%) with the EU average being 19%. Among these ‘front runners’ - the so-called “Green 7”(Austria, Denmark, Finland, Germany, Netherlands, Sweden and UK) - 40-70% of published tenders during 2004 included environmental criteria. ([7]) In 2005, a new Europe Green Public (GPP) procurement status overview also highlighted “Green-7” that are currently implementing more elements of GPP. These Green-7 exhibit some or all of the following traits:

- Strong political drivers and/or national guidelines
- National programmes: GPP has been approached as a national programme and addressed for a number of years
- Information resources: all have websites and information resources (often containing product related criteria and specifications) available for public sector staff concerning GPP
- Innovative procurement tools: 60% of questionnaire respondents from the Green-7 are using one or more of the following tools: life cycle thinking, functional specifications or contract variants compared with 45% from other countries
- Management systems: 33% of the Green-7 organisations corresponding to the questionnaire stated that they had an environmental management system which addressed GPP compared with 13% from other countries. ([8])

ICLEI completed a second survey on green public procurement in 2002. The so-called “Buy it Green” - Network of Municipal Purchasers (BIG-NET) study that indicated 5 out of the 17 products groups were of particular interest in relation to green procurement: office material (88%), IT equipment (PC, copiers, 86%), paper (81%), office furniture (73%) and cleaning products (73%). ([9])([10])

Japan

Experience from Japan suggests the need for ‘joined-up’ thinking e.g. creating a greener internal market through the use of public procurement and other policy tools will stimulate the development of greener products. Key elements of this strategy include Japan's Green Purchasing Network, the implementation of the Green Purchasing Law in 2001 and the Eco-Products exhibition that started in 1998, an annual meeting place for over 500 exhibitors and 150,000 visitors.

The Green Purchasing Law

Japan’s green purchasing is whole-society approach and appears to have a strong link to developing a new competitive advantage for Japanese industry. Strong law framework provides the backbone of Japan’s greener internal market.

There have been significant changes in environmental policy in Japan over the last decade or so. This started in the early nineties with the Action Programme to Arrest Global Warming (1990), Law for the Promotion of Utilisation of Recycled Resources (1991), the Basic Environment Law (1993), Energy Saving and Recycling Support Law (1993) and voluntary environmental efforts by corporations.

The Japanese government adopted a series of laws to address the pressing issue of waste disposal facilities being pushed to capacity in April 2000.

These laws include the Basic Law for Establishing the Recycling-based Society, the Law on Waste Disposal and Cleaning, the Law for Promoting Effective Utilization of Resources, the Law for Promotion of Sorted Collection and Recycling of Containers and Packaging, the Law for Recycling of Specified Kinds of Home Appliances, the Law on Construction Material Recycling, the Food Recycling Law, and the *Law on Promoting Green Purchasing* ([11]).

The objectives of the Green Purchasing Law are to "promote and disseminate products and services (eco-friendly goods) that contribute to reducing the negative impact on the environment and to build a society with less burden on the environment and is sustainable." To that end, the law encourages the public sector, including the government,

(1) to promote the procurement of eco-friendly goods, and to
(2) provide information on such goods. ([12])

In an effort to combat global warming, the Energy Saving Law was reviewed in 1997 and the ‘Top Runner System’ was implemented. The ‘Top Runner System’ requires manufacturers to improve the energy performance of their products each year, so that the average products of tomorrow exceed the performance of today's very best 'top runner' product. It is a system that fosters ingenuity and creativity in manufacturers. Furthermore, the government established a Green Purchasing Law in 2000 (enforced in 2001), which helped to support producers by promoting the demand for green products. ([13])([14])

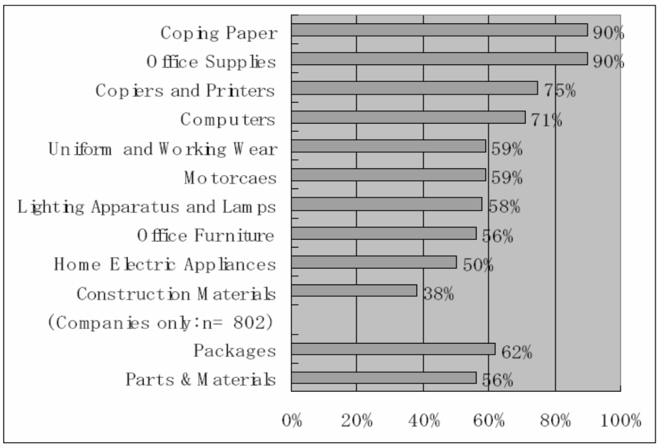
The Green Purchasing Network (GPN)

The establishment of Green Purchasing Network (GPN) was another unique feature in Japanese approach. The GPN was set up in February 1996 to promote green purchasing among consumers, businesses and governmental departments in Japan. As of April 2004, it had about 2,800 member organisations, including corporations, local governments, consumer groups, environmental NGOs, and cooperative associations. GPN promotes green purchasing ideas and best practice by holding seminars and exhibitions throughout the country, deeveloping purchasing guidelines for a range product and service categories, publishing a database on greener products, completing surveys, and providing awards and commendations for organisations that have shown remarkable performance in implementing green purchasing. ([15])

The GPN started questionnaire surveys on green purchasing in 1997 and the first report showed that there had been a limited amount of implementation of green purchasing practice. However, by 2003 the report indicated that 83 % of the institutions surveyed (members and non-members) were actively involved in green purchasing. On supply-side, 60-70% of companies reported increases in the sales of environmental preferable products for three consecutive years after 2000. Out of total sales, the percentage of green products was 51% in 2003. Those products that the GPN has been promoting, score much higher in the percentage: i.e. personal computers, copiers and printers, office furniture, and electric appliances. The GPN estimated the total sales of green products as 46 billion dollars, 9% of GDP, totalling 500 billion yen in 2003. ([16])([17]) Institutional purchasers (including public and private sectors) are practicing very high levels of green purchasing through GPN, especially in some product groups e.g. coping paper (90%), office supplies (90%), copiers and printers (75%), computers (71%), and another seven product groups are all above 50%. (see Table 2).

Table 2 ([18]):

Products Areas where Japanese Institutional Purchasers practices Green Purchasing



Findings from survey by GPN in 2002

Other findings from the GPN survey in 2002 also indicated:

- 51% of responding companies have written policies on green purchasing
- 36% of them have adopted green purchasing policies on parts and materials.
- 52% of them also consider suppliers' EMS and other environmental activities as well asaspects of purchasing products ([19])

Eco-Products exhibition

Start from 1998, the annual event “Eco-Products exhibition” provide the Japanese green products a green channel to demo their products and services.

Each year over 150,000 people from every walk of life gather at this exhibition over 3 days to exchange their views on "spreading eco-products" and "protecting the environment." More than 500 organsations and corporations, including Toyota and Panasonic, as well as lesser-known companies with leading technologies exhibit a wide range of cutting-edge products and services, ranging from latest fuel-cell equipments and electronic appliances to hybrid cars. Its aim is to accelerate the expansion of green markets by exhibiting greener products and services. ([20])

"Japan is setting a new standard for competitiveness like they did for quality."

Comment by American businessman Randy Sadewic who attended Eco Products Exhibition in2005. ([21])

US

In the US, building on the success of Energy Star, The White House and 11 federal departments signed a memorandum (2004) calling for increased use of energy and resource efficient products aimed at reducing life-cycle impacts and costs. This is just one example of a range of developments in the US, spread between activities at the state or county level e.g. Nevada County (California) Green Procurement and Sustainable Practices Policy ([22]); at the voluntary national level led by the Environmental Protection Agency e.g. Environmental Protection Agency’s (EPA) Comprehensive Procurement Guidelines ([23]) and at federal government level led by the Office of the Federal Environmental Executive (OFEE) ([24]). An example of how US federal government purchasing is being harnessed to ‘pull’ the market for office information and communication technology (ICT) equipment upwards is through the application of Executive Order 13101 “Greening the Government through Waste Prevention, Recycling and Federal Acquisition” ([25]). The US government is the world’s largest procurer of technology products and services ([26]) so is particularly well placed to introduce policies aimed at levering up performance in this sector. The upshot of Executive Order 13101 was the creation of Electronic Product Environmental Assessment Tool (EPEAT) ([27]), a programme that is introducing a rating system to evaluate office ICT products according to three tiers of environmental performance – Bronze, Silver and Gold in eight categories of product performance:

- Reduction/Elimination of Environmentally Sensitive Materials
- Materials Selection
- Design for End of Life
- Life Cycle Extension
- Energy Conservation
- End of Life Management
- Corporate Performance
- Packaging

Compared to what went before e.g. just Energy Star, this is set to create a huge step forward in levering up the overall environmental performance of office ICT. Informal feedback from EPA indicates that US suppliers have said that they will have bronze level products available when the standard becomes final and publicly available April 30th 2006 (but they will need more time to design product to meet the silver and gold levels). At this point EPA are encouraging federal and other institutional purchasers to request EPEAT Bronze registered products in their information technology (IT) contracts and will encourage purchasers to ask for products meeting the Silver or Gold level requirements in the future. EPA have requested the addition of a new clause to the Federal Acquisition Regulations which would require federal purchasers to buy EPEAT Bronze registered computer desktops, laptops, and monitors to the best extent practicable.

Europe

The European approach has been different. Much of the initial focus has been on the creation of product specifications, albeit through consultation with stakeholders including the supply chain. Examples of these include the UK's ‘quick wins’, Sweden's EKU and Denmark's Indkøbsvejledning. ([28])

As presently formulated, these product specifications provide a simple and practical means for busy and non-expert procurement staff to specify products with an environmental performance that is better than would be found at the bottom of the market. But they have disadvantages too. None cover many products

– there are just 10s of specifications but 1000s of products, there’s limited coverage outside of energy consuming products and they are more likely to impact by cutting off the bottom of the market e.g. like a Minimum Energy Performance Standards (‘MEPS’), rather than setting aspirational levels more likely to pull the market upwards.

Whilst setting market pulling aspirational levels might be seen simply as a policy decision, the practicalities of using these checklists as a market transformation tool are rather more demanding. Feedback to the UK Market Transformation Programme Procurement Team, who are responsible for the UK ‘quick wins’ specifications, is that if the specifications in these checklists are planned to be uplifted over time then the supply chain would welcome the development of the UK national checklist into a time series ideally stretching at least five years ahead. Thus, in conjunction with a policy of demanding increasingly stringent environmental specification (i.e. pulling the market upwards), the UK could send an advance signal to the supply chain of what levels its public procurement market will be demanding in, say, 5 years time e.g. a ‘forward commitment’.

Having a system that provides advance warning to the market provides three significant advantages:

- It sends a positive signal to the supply chain that there will be a market for improved products, so is an incentive to develop improved designs;
- It gives the supply chain a practical opportunity to adjust its design/manufacturing in a time/cost efficient manner;
- It provides a simple-to-use tool for identifying new markets and developing innovative solutions

There are potential parallels between this approach and that being developed out of US Executive Order 13100. The Executive Order sent an early policy signal to the ICT market that public procurement was going to have an increasing environmental focus. The EPEAT system that developed thereafter could be used to provide a practicable means for applying a time series of uplifting specifications since the US Federal Acquisition Council could decide to signal federal purchasing requirements at Bronze level in 2006 at the same time as indicating these will rise to silver level in (say) 2009 and gold level in (say) 2012.

In some European countries, local authorities constitute an important part of the public procurement market and a number of city municipalities have successfully pioneered the development of sophisticated public environmental purchasing policies, e.g.

- City of Vienna (Austria): mandatory use of environmental criteria catalogue (total value of contracts covered is €5 billion)
- City of Kolding (Denmark): 92 % of all framework agreements are ‘green’ (2005) ([29])

Some countries have subsequently developed frameworks for taking forward their green public procurement policies, while others, such as Denmark, have set up voluntary agreements between national and local government to implement such policies. One such agreement was set up in Denmark in 1998 and by the end of 2001 almost all Danish local authorities had a green public procurement policy in place. Guidelines are developed centrally, but the implementation of policies is left to the respective administrations. ([30])

Greening public procurement in the UK

The new UK Sustainable Development Strategy was launched in 7th March 2005 including a commitment to work with the EC towards an EU-level benchmark target to improve overall green public procurement performance so that by 2010 the average level is equal to the level of the current best performers.

The Sustainable Development Strategy (SDS) highlighted four priority areas:

- Sustainable Consumption and Production (SCP)
- Climate change and energy
- Protecting natural resources and environmental enhancement
- Sustainable communities

The SCP theme builds on the existing UK SCP framework with sustainable products and sustainable procurement receiving a relatively high profile in the new SDS.

In April 2005 the Environmental Audit Committee of the House of Commons examined sustainable procurement. In May 2005, a business-led Sustainable Procurement Task Force was established and is charged with drawing up a national action plan by 2006, aimed at making the UK a leader in sustainable public procurement in Europe by 2009. The taskforce led by Sir Neville Sims – Chairman of International Power plc - will report to the Chief Secretary to the Treasury in May 2006 and is exploring: a) the direct impacts of public sector procurement; and b) *how £125bn annual public sector expenditure can be used to drive innovation and create markets for more sustainable products.*

The Action Plan will provide guidance on:

- Avoidance of adverse environmental impacts arising on the government estate and in the supply-chain.
- More efficient use of public resources.
- Stimulation of the market to innovate and to produce more cost effective and sustainable options for all purchasers.
- Settting an example for business and the public and demonstrate that government and the wider public sector is serious about sustainable development. ([31])

Following the deliberations of an interdepartmental working group, government departments are expected to buy goods that meet certain 'quick win' specifications that include buying products that meet certain standards for energy efficiency, recycled content and biodegradability. Examples of ‘quick win’ specifications include personal computers (PCs) meeting current 'Energy Star' requirements.

The relevant central government department has also published a strategy for local authority public procurement, which includes a range of targets and a statement to the effect that '[e]very council should build sustainability into its procurement strategy, processes and contracts'. ([32])([33])

The Environmental Innovations Advisory Group (EIAG) chaired by Jack Frost, Director, Johnson Matthey Fuel Cells was established by Department for Environment, Food and Rural Affairs (DEFRA) and Department of Trade and Industry (DTI) to take forward the work of Environmental Innovation and Growth Team (IGT). The group is exploring strategies to use sustainable public procurement (SPP) to foster more radical ‘sustainable innovation’ amongst ‘early adopters’ e.g. the ‘Forward Commitment’ project (also see Innovation-Orientated Green Public Procurement [IOGPP]).

Policy Tool 1: Legal framework for green public purchasing

ICLEI’s “Buy it Green”—Network of Municipal Purchasers (BIG-NET) Survey (2002) showed that “political commitment” and “transparency and content of legal rules” were the two most important factors influencing green public procurement (GPP). ([34])

The international legal framework for government procurement is the Government Procurement Agreement (GPA). This is one of the multilateral agreements annexed to the World Trade Organisation (WTO) Agreement; it applies only between those WTO members that have subscribed to it. Although the GPA itself does not contain any reference to environmental protection, the Sixth Recital of the Preamble to the WTO Agreement, which also informs the annexed agreements, recognises the need to act in accordance with the principle of sustainable development and to protect and preserve the environment. Therefore it is broadly accepted that the GPA allows contracting entities to take into account environmental considerations when defining technical specifications (including process and production methods) and selection and award criteria, on condition that they are not discriminatory, and are sufficiently objective and verifiable. ([35])

A number of recent cases have highlighted opportunities for green public procurement, these include:

Court of Justice ruling on low-pollution buses in Helsinki, Finland

In 2002, a Court of Justice decision supported the Helsinki city authority's purchase of a fleet of low-pollution buses. The Court said that Helsinki was justified under EU law to take into account the emission profile of the buses as one of the criteria determining its choice. EU legislation states that authorities can choose to adopt one of two award criteria, either the 'lowest price' or the 'economically most-advantageous' tender. The latter provides the opportunity to include other criteria — such as environmental ones — and to get 'best value for money'. The Court investigated the procurement choice following the case being submitted by the competitor who would have won on a least-cost basis. It concluded that the procurement decision, which took account of nitrogen dioxide (NOx) emissions and noise levels of the buses, was fair since it followed the environmental criteria laid down in the public procurement tender. The Court noted the conditions in which these criteria can be applied. They must be 'non-discriminatory', 'connected to the subject matter of the contract', they must not give 'unrestricted freedom of choice' to the contracting authority, and they must be explicitly mentioned in the tender documents or notice. Given that the rules on how to award points for NOx emissions and noise levels were clear and the fact that all companies offering proposals could have used natural gas buses and hence obtained the additional procurement points, the final conclusion was that there was no discrimination or restriction and that the procurement decision was fair. ([36])

Court of Justice ruling on renewable energy in Austria

On 4 December 2003, the Court of Justice settled a dispute between an Austrian electricity supplier and the national authorities. It recognised the possibility for contracting authorities to consider the renewable character of the sources of the electricity to be supplied as one of the award criteria for letting a public supply contract, basing itself on the fact that renewable energy helps to protect the environment, and that such a criterion (the source of the electricity) is clearly linked to the subject matter of the contract. Despite the 45 % weighting attributed to this environmental criterion, the Court ruled that this was in principle not incompatible with EU law. ([37])

The Court of Justice rulings allowed for environmental and social criteria to be taken into account in public tenders. The new EU Directives regulating public procurement further clarifies the possibilities for public purchasers (national or local administrations, schools, hospitals, etc.) to integrate environmental considerations into the tender documents when they decide to buy goods, services or works for their day-to-day activities (Directives 2004/17/EC and 2004/18/EC) ([38])

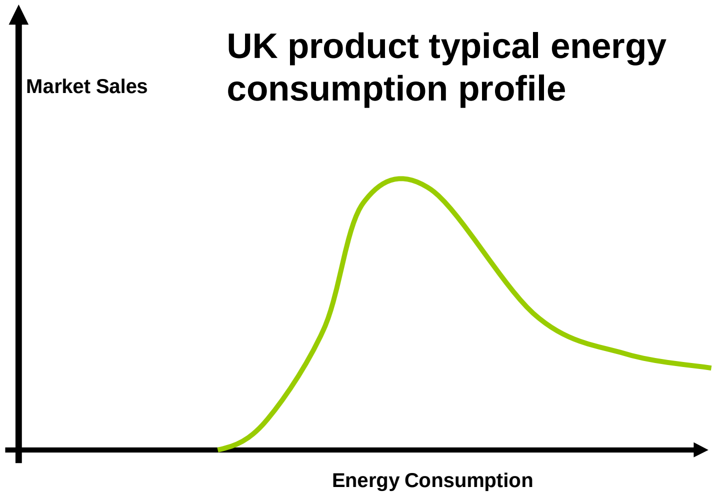
The cases above illustrate some of the circumstances that may enable GPP, but there are perhaps two emerging drivers in Europe that might accelerate things further:

- The EC's European Environmental Technologies Action Plan (ETAP): the ETAP recognises the potential of public purchasing to stimulate the market for more environmental technologies and encourage innovation.
- Integrated Product Policy (IPP): The Commission's Communication on IPP in 2003 set out a European strategy for improving the environmental impact of products. This included a call to all member states to draw up green procurement action plans by end 2006.

The next section discusses some of the issues related to market intervention through public policy

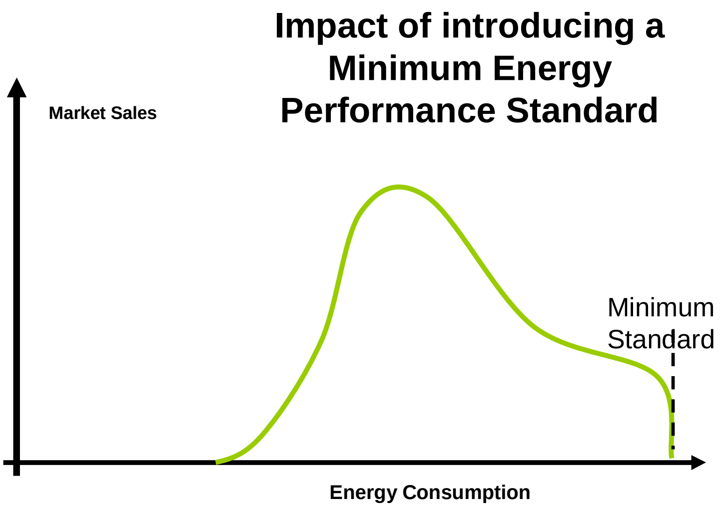
Policy Tool 2: Market intervention

Before government intervention, a typical market picture for most products looks like this:

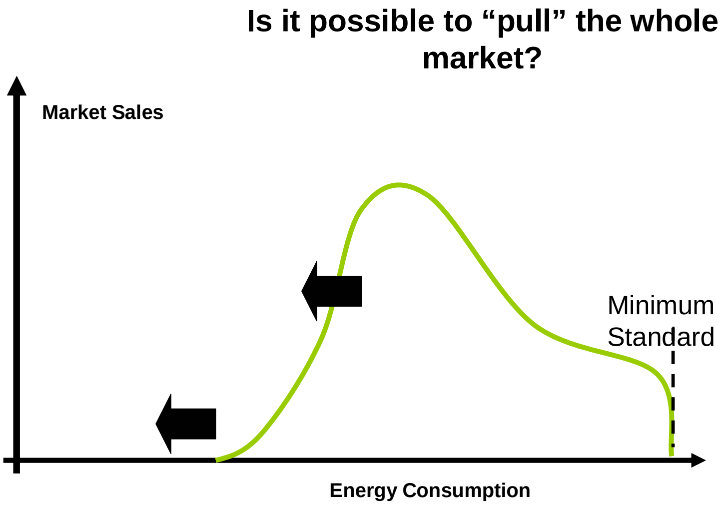


The bulk of the sales (the top of the curve in the figure above) are of products with near average performance, the better performing energy efficient products represented by the left side of the curve are in the minority and the there is a long "tail" of energy inefficient products disappearing to the right side.

Initial market intervention often comes in the form of energy labelling followed by Minimum Energy Performance Standards ('MEPS'). The impact of energy labelling can shift the peak of the curve to the left with MEPS being used to cut off the "tail" of inefficient products:



Whilst this brings an overall improvement to the market it provides no incentive to the most energy efficient part of the market to continue to improve its performance and thus "pull" the market further to the left side of the figure:



Demand side management dynamics already exist for pulling the market. These include Japan's 'Top Runner' programme ([39]) and Australia's 'Energy Allstars' ([40]). Both these programmes, and others of their type, make it easy for interested persons to identify and buy the best energy performing products in the product sectors they cover; 18 in the case of 'Top Runner', 29 in the case of 'Energy Allstars'. They also set class leading benchmark standards that inform all stakeholders - manufacturers, specifiers, regulators and market transformers.

Clearly they bring benefits and facilitate the process of pulling the market towards improvement. But can more be done? More can always be done and through incentivising innovation or creating entirely new markets the potential exists to lever the market still higher.

But, before exploring how these might be accomplished, it is necessary to explore the obstacles and barriers that may need to be overcome. The following list is based upon the experiences gathered by the UK Market Transformation Programme's Procurement team

- Buying the cheapest initial (capital) cost. The custom and practice for managing public procurement budgets is usually on a least cost basis as this is perceived to be the easiest and lowest risk route for achieving value for money. Value for money=lowest cost is a particularly important performance criterion that procurement staff are judged on. It's also the theme on which they have conducted their entire careers to date.
- Whole life cost information is not usually made available by suppliers and, even if it was, many buyers have neither the expertise nor the overall budgetary responsibility for considering it. This last issue can have a significant impact upon buyer behaviour as the purchase cost for an item may come from one budget whilst the operating cost comes from an entirely different budget. A buyer may have no incentive for purchasing a higher capital cost item that delivers a lower running cost since the subsequent savings are made on a different budget for which that buyer has no responsibility.
- Lack of buyer expertise. Public procurement in the UK is highly devolved. The majority of staff who have some purchasing responsibilities within their job are not trained procurement experts. Indeed, their main job probably has nothing to do with procurement. (It has been alleged to the author that one UK Government Ministry has 24,000 staff with purchasing responsibility.) Consequently, most buyers have not been given awareness training on environmental or sustainability matters so are unaware of the value for money benefits they may gain through seeking information on whole life costs and similar.
- Another frequently encountered example of buyer inexpertise is their frequent citing of the EU Public Procurement regulations (and FTA requirements) as a barrier preventing inclusion of environmental requirements in procurement tenders.
- Absence or low visibility of policy drivers. Although high level policy initiatives have been taken in the UK e.g. From 1 November 2003, all new central government department contracts must apply the minimum environmental standards when purchasing certain types of product, which cover aspects such as energy efficiency, recycled content and biodegradability ([41]) take up (or even knowledge of them) has been patchy. A recent review of take-up undertaken by the UK's National Audit Office([42]) concluded "…Sustainability considerations could be better mainstreamed in public procurement practices…".

Policy Tool 3: Green public purchasing (GPP) as a tool to drive innovation

The opportunity to accelerate European eco-innovations through public procurement was highlighted in the conclusions of the Spring Council of the European Ministers mid-term review on the Lisbon strategy in 2005. The Council agreed on the following conclusion as part of the mid-term review:

The European Council reiterates the important contribution of environment policy to growth and employment, and also to the quality of life, in particular through the development of eco-innovations and eco-technology as well as the sustainable management of natural resources, which lead to the creation of new outlets and new jobs. It emphasises the importance of energy efficiency as factor in competitiveness and sustainable development and welcomes the Commission's intention of producing a European initiative on energy efficiency and a Green paper in 2005. Eco-innovations and environmental technology should be strongly encouraged, particularly in energy and transport, with particular attention paid to SMEs and to promoting eco-technology in public procurement. In addition to its growth in the Internal market, this sector has considerable export potential. The European Council invites the Commission and the Member States to implement the action plan for eco-technology as a matter of urgency, including by specific actions on a time scale agreed with economic operators. The European Council reaffirms the importance of the objective of halting the loss of biological diversity between now and 2010, in particular by incorporating this requirement into other policies, given the importance of biodiversity for certain economic factors.

Innovation can be described as '"the successful exploitation of new ideas". Often it involves new technologies or technological applications….it can deliver better products and services, new, cleaner and more production processes and improved business models' ([43])

The above definition highlights the importance of commercialisation phase e.g. innovation is not just about good ideas it is also about commercialsation.

"There are two notions about innovation structure:

Innovation is a process: often, this process is divided into three stages: product development, the launching customer phase (the first demand for the product by clients who are prepared to accept certain risks associated with new products) and diffusion of products (technical reliability is determined, product establishes a mature position in the market)

Distinction must be drawn between product innovation and system innovation: this refers to the circumstance that the innovation involves institutional change as well. For instance, the purchase of environmentally benign products that require high investments but have low operational costs (e.g. energy-saving equipment) may be hampered by decision-making procedures that discourage high-investment purchases" ([44])

"Innovation-Orientated Green Public Procurement (IOGPP) also known as 'technology procurement' is a much more complicated activity than 'ordinary' green procurement which only has to look for relatively green products and services available on the market. *It requires the public purchaser, or rather the local authorities, to come up with challenging demands for products and services that are not yet widely known, and to share risks with the potential suppliers of innovative products and services*. Some quite motivating experiences with technology procurement have been reported for Sweden: Heat pump procurement resulted in an increase of performance values with 30% and a decrease in price by 30% at the same time. The used of LED's in traffic control saves up to 90% of energy. While no green LED has been available, as a result of technology procurement now all 18,000 traffic control posts in Stockholm are changed to LED." ([45])

Eco-innovation and particularly *sustainable innovation* are still relatively new topics and the practicalities of linking innovation to GPP and sustainable public procurement are even newer still.

'Sustainability-driven' Innovation means the creation of new market space, products and services or processes driven by social, environmental or sustainability issues

Source: Innovation High Ground Report, Arthur D. Little, 2004

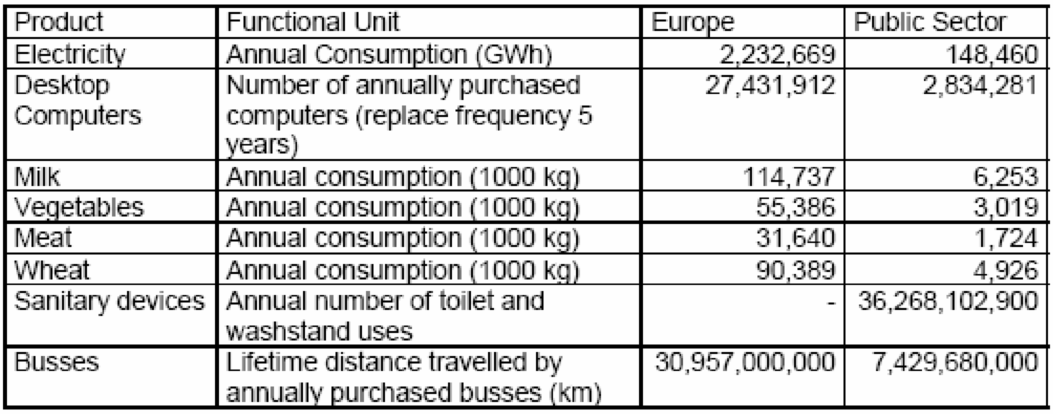
A key discussion point is how can public procurement be used to accelerate innovation beyond minor, incremental improvements in environmental or broader sustainability performance of technologies, products or services.

Public procurement can either support innovative technology, product or service developments, by creating a demand, or it can set incentives for the supplier to seek ongoing innovation or it can hinder it!

On a positive note a number of case studies have indicated that fostering innovation can be enabled by GPP. For example, at the request of a Swiss bank, a new energy-saving computer monitor was developed; low-emission buses were launched with the help of public transport tendering criteria; cities in Germany brought down prices for solar energy collectors by purchasing them for swimming pools; and contracts for heating supply to public buildings provided an incentive to continuously search for more efficient solutions.

One of the findings from the RELEF study illustrated that the application of GPP to certain product categories can create substantial changes to the total market. For example, European public procurement buys 2.8 million computers annually (which represents 12% of market), if energy efficiency is integrated into the procurement process it can have a significant impact on overall computer market resulting in CO2 savings (830,000 person equivalents)

Table 3: Units sold in the EU



Product	Functional Unit	Europe	Public Sector
Electricity	Annual Consumption (GWh)	2,232,669	148,460
Desktop Computers	Number of annually purchased computers (replace frequency 5 years)	27,431,912	2,834,281
Milk	Annual consumption (1000 kg)	114,737	6,253
Vegetables	Annual consumption (1000 kg)	55,386	3,019
Meat	Annual consumption (1000 kg)	31,640	1,724
Wheat	Annual consumption (1000 kg)	90,389	4,926
Sanitary devices	Annual number of toilet and washstand uses	-	36,268,102,900
Busses	Lifetime distance travelled by annually purchased busses (km)	30,957,000,000	7,429,680,000

Public authorities can play an important role as a ‘niche’ market for innovative, environmentally superior products and services (cf. Brander et al., 2002). However, the current public procurement rules are not really suited to the need for innovative solutions. Typically, innovations are characterised by a large amount of uncertainty and risk concerning the outcome of the process, whereas procurement Directives are more suited to situations where the customer knows exactly what he or she wants and what the specific features of the product or service are. (46)

New Drivers for Public Procurement 1: Climate Change and Greenhouse Gas (GHG) Reduction as a New Driving Force

Climate change and reduction of greenhouse gas (GHG) emissions are now increasingly important in many countries national agenda. There is a growing consideration of using public green purchasing power as a public policy tool to reduce GHG emissions e.g. London Energy White Paper and the World Mayors’ Council on Climate Change (WMCCC), C20 group of large world cities (including Paris, Tokyo, New York, Berlin, London, etc.)

“Commit to create sustainable procurement alliances and policies that accelerate the take up of climate friendly technologies” (47)

According the RELIEF study, if all public authorities were to purchase green electricity in place of conventionally generated electricity 61,350,363 tonnes CO2-equivalent would be saved each year. This figure equates to approximately 18% of EU commitments under the Kyoto Protocol to reduce CO2-equivalent emissions by 340 million tonnes.

Impact on Appliances

There are growing calls for “Action on 1 Watt-standby” as an energy-saving measure on appliances. 80 delegates from 20 countries met in Copenhagen on 8th to 10th March 2005 to discuss and find ways forward to reduce the serious problem of high standby consumption in appliances.

The overall conclusions of the conference were that:

- The standby problem is becoming increasingly serious, because more and more appliances have standby functions with much higher standby consumption than necessary and without proper power management. Typically about 10% of the electricity consumption is used for standby functions.
- There should be regulation on standby efficiency, while public procurement and voluntary agreements should pave the way for the most efficient products.
- The EU Commission should start preparing a horizontal regulatory measure for securing a standby power level of maximum 1 watt for all relevant products before 2010. Preparation should be initiated as soon as possible because the preparatory phase typically takes two to three years.
- The EU Member States and organisations in and outside the EU should strengthen cooperation on technical specifications for public procurement and voluntary agreements, and on exchange of experiences. A first step could be an on-line forum for information exchange followed by efforts to harmonise procurement specifications at stringent levels.

- The EU member states should take a more active role in initiatives for public procurement and voluntary agreements supported by the EU Commission. ([48])

Impact on buildings

Buildings are major consumers of energy contributing an estimated 40% of final energy consumption in the EC alone. EC research has indicated that by improving energy efficiency, CO2 emissions from buildings and related energy costs could be reduced by 42%. Given the significance of public procurement in Europe and that approximately 40% of the procurement budgets of local authorities are spent on buildings, promoting energy efficiency of public buildings has an important role to play in contributing to this potential.

The procurement of energy efficient materials and/or services by public bodies has the potential to become a major driving force for the market penetration of efficient products. To date, however, many obstacles to the realisation of energy efficiency still exist in this sector.

In China, 2006 marks the first year of China's 11th Five-year Plan for social and economic development. High on the agenda is finding ways to reduce energy and resource consumption rates in the construction sector. The Chinese government is now increasing efforts to improve the enforcement of laws and regulations and undertaking of technological research on energy-efficient buildings. According to official figures, approximately two billion square metres of floor area are constructed annually in China, accounting for half of floor space in the world.([49])

New Drivers for Public Procurement 2: Local Authorities and Network Approaches

Both central *and* local government can play an increasingly important role on green public purchasing power.

For example, in Japan, The Tokyo Metropolitan Government (TMG) has conducted environmentally friendly procurement according to the TMG Policy for Green Procurement Promotion, and campaigned to reduce strain on the environment arising from day-to-day work operations.

In 2002, TMG integrated the "Guide for Environmentally Friendly Goods Procurement (April 2002)" and the "Policy for Promoting Green Procurement in TMG Goods (August 1999)", to develop the TMG Policy for Green Procurement Promotion (April 2003), setting out how TMG must conduct green procurement. Every year, TMG issues the TMG Green Procurement Guide, listing specific items and requirements. The revision in 2004 added "electricity as an item subject to measures against global warming". TMG will seek the use of renewable energies for at least 5% of overall power consumption to promote the use of such energy.[50]

The State of California is the first government to regulate CO2 emissions from vehicles. In 2002, California lawmakers passed the first law in the world aimed at regulating greenhouse gas emissions from vehicles. Californians purchase 10% of all vehicles in the US, and that purchasing power has the ability to impact auto manufacturers. Using this clout is not new for the state; California's anti-smog rules forced car companies to build and sell cleaner cars.The greenhouse gas regulations aim to affect vehicle models released on the market beginning in the year 2009.

Networks among local authorities and international cooperation are also emerging in different places: e.g.:
The International Green Purchasing Network (IGPN) (http://www.igpn.org/index.html)
Buy It Green network (http://www.iclei-europe.org/index.php?id=677)
Eurocities (http://www.eurocities.org/)
"Energie-Cités: Promoting sustainable energy policy through local action"
(http://www.energie-cites.org/)
Civitas Initiative (http://www.civitas-initiative.org/civitas/home.cfm)
GPPnet Cremona (http://www.provincia.cremona.it/servizi/ambiente/gppnet/en/index.html)
Danish public procurement network
(http://www.ks.dk/english/procurement/network/)

Conclusions

There is need for a better legal framework to enable the full potential of green public procurement (GPP) at international, national and local authority levels

Central government should consider the smarter use of both pull and push policy tools to make markets greener, and GPP is one key tool within a broad policy toolbox

There is a key need to consider the GPP agenda in tandem with the product policy agenda e.g. the UK may aspire to become a key leader in GPP by 2009 but this may mean that public procurers are then forced to buy non-UK products, technologies and services because other countries have solutions with demonstrable better environmental performer at a similar or cheaper price – GPP should be used as a mechanism to 'kick start' the supply side

GPP should be expanded from certain product groups to wide range of public purchasing

GPP is frequently not concentrated on the product groups where the public authorities have the greatest financial impact: construction, energy, information technology, furniture and food.

Growing concern over climate change and reducing the GHG is pushing governments to start to excise public purchasing power in relation to low carbon, low emission products, including public transportation (e.g. fuel-cell bus in 10 EU cities), green electricity, green buildings, etc.

Opportunities for innovative solutions need to be enhanced by using public-private partnerships and bottom-up approaches, building on the experience from the Japanese approach.

There needs to be more consideration over how GPP can be used to foster eco-innovation e.g. to move beyond incremental improvements in energy and resource use in products and technologies

GPP can be used to stimulate specific niche areas especially in areas of major environmental impact e.g. building technologies, products and services

There is a need to tackle various practical obstacles to GPP amongst public procurers e.g. through better training, the development of regional and national networks to share best practice, experience and ideas, etc

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Chinese Government Procurement Policy for Energy-efficient Products

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Abstract

Harnessing government purchasing power can be capable of yielding very impressive savings, and enhance market transformation of energy-efficient products. Energy audit in Chinese government agencies shows that at least 20% energy cost can be reduced through purchasing energy-efficient products and government facilities management. Especially, with the rapid growth of procurement volume, the purchasing power, if directed towards energy efficiency technologies, could create increased demand for these products. On December 2004, the government procurement policy for energy-efficient products was launched in China. In this paper, based on barriers analysis reflected from a national-wide procurement staff survey, the authors will share experience and lessons learned in the design of government procurement policy, analyze what flaws exist for existing policy and discuss detailed key elements that is considered and forward further policy suggestions on how to improve it.

1. Introduction

Jeffrey Harris, et.l.'s research shows that the ratio of government expenditure to GDP is about 10-20% across a wide range of GDP/capita in 150 countries, from the wealthy industrialized countries to less developed countries with very low per capita income. In past 20 years, this ratio in China is about 11-15% as shown in Figure 1. Because governments have a significant market share, their purchasing power, if directed towards any technologies such as energy efficiency and environment friendly technologies, could create increased demand for these products, and enable the technology manufacturers to move towards mass production of their products. Mass production would lead to reduced manufacturing costs and reduced product prices, and would improve prospects of more widespread deployment of the technologies. Therefore, in most countries, public policies, especially government procurement policy, are utilized to transform the market and facilitate the advancement of specified technologies.

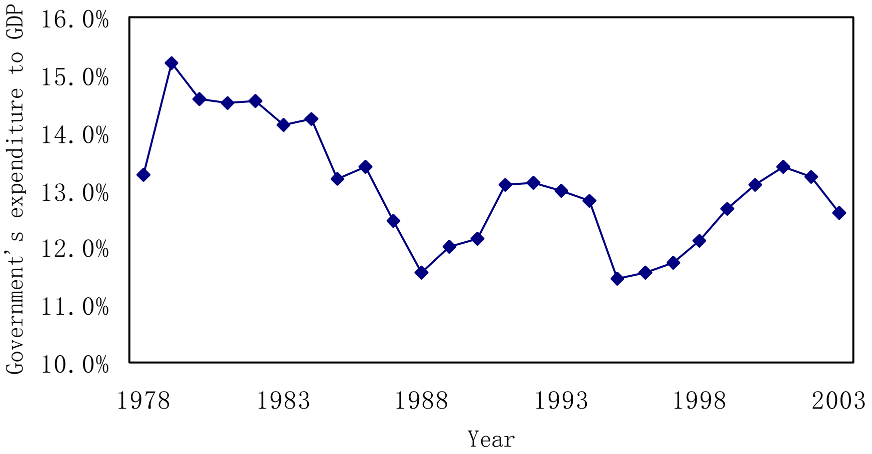

Figure 1: Ratio of Chinese government expenditure to GDP in past 20 years

Since the procurement policy was initiated in 1998 in China, it envisaged an amazing rapid growth in procurement scale. In 2004 the procurement scale reached 213.6billion RMB, nearly 68.9 times that in 1998. It is estimated that procurement scale in 2005 will be more than 250 billion RMB. The purchasing power makes a very positive impact on their market and is highlighted by Chinese government. Much effort has been put in institutional capability building in the past years.

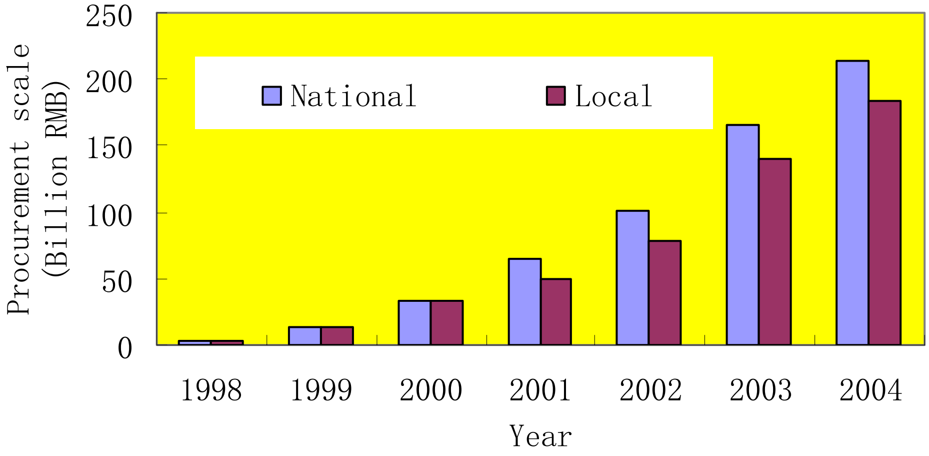

Figure 2: Chinese national and local total government procurement scale growth

2. Energy efficiency procurement policy

Procurement policies offer a means to achieve significant energy savings over time, by simply redirecting funds that will be spent anyway to purchase or replace essential equipment. Energy-efficient procurement is also one of the most potent ways for the public sector to aggregate its buying-power to stimulate broader changes in the market. The purchasing power for energy-efficient products is widely harnessed by most developed countries. A striking example of how government can help commercialize energy-efficient technologies was the 1993 Executive Order in the US, directing all federal agencies to purchase only energy-efficient computers and office equipment that qualified for the Energy Star label. Even though federal sales amounted to a mere 2-3% of the market, this policy caused an immediate jump in manufacturer participation in the Energy Star program, with most types of office equipment quickly achieving Energy Star penetration rates of 90% or more (Jeffry Harries, etc.) Another example is from a bulk purchase pilot project in UNDP/GEF China Green Lights programme. Within half a year before the bulk purchase project started in 2003, only several lighting manufacturers applied for national energy efficiency labeling programme. At the end of 2004, directed by the bulk purchasing power, more than 40 top lighting manufacturers with production capability of 60% market share passed the labeling programme.

With the rapid growth of procurement scale and increasing concern on energy efficiency and resource-saving society development, Chinese policy-makers are coming to realize that actions by government can lead the rest of the market, both through the direct buying power of government and through the example it provides for others. On December 17, 2004, China's Ministry of Finance, in tandem with the National Development and Reform Commission, announced a new policy for government energy efficiency procurement. The new policy modified the National Procurement Policy, enacted 1 January 2003, to include the preferential purchase of labeled energy efficient models of products subject to mandatory procurement. The program started in 2005 and by the end of 2006 will be rolled out to all levels of government, including central, provincial, and local. In China, the "government" sector also includes schools and hospitals, and these will be subject to the same requirements as the formal government offices at each level.

In the policy, an official "List of Energy Efficient Products for Government Procurement", or simply "Energy Efficiency List", is specified to present qualified products that all governments should be preferentially procured. The Ministry of Finance and the National Development and Reform Commission have the responsibility to develop and update the energy efficiency list. The efficiency specifications for each product are those underlying China's current energy efficiency labeling program run by the China Standard Certification Center (CSC, formerly CECP- China Certification Center for Energy Conservation Products), and qualified procurement models must have received CSC certification.

The first energy efficiency list including following 9 product categories was issued with the directive:

- Refrigerators
- Room Air Conditioners

- Double Capped Fluorescents for General Service Lighting
- Self-ballasted Fluorescents for General Service Lighting
- Televisions
- Computers
- Printers
- Toilets
- Faucets

At the end of April 2006, Chinese government is considering to expand product categories in the energy efficiency list. It is expected that more than 15 new product categories will be added into existing energy efficiency list.

3. Policy Analysis

1) An understandable Energy efficiency list

The national survey in 2004 shows that in the past government purchasers at all levels, just like other purchasers of technology, make decisions based on information such as: how effectively a technology performs in relation to the purchaser's needs, the capital and running costs, how easy it will be operated, and how good the maintenance and after-service will be once it is installed. Little attention is paid on product energy efficiency. Therefore, it is not surprising to find no energy efficiency experts in the established procurement expert roster and network. It is also proven in the procurement personnel survey that lack of energy efficiency information is the biggest barrier for most procurement personnel as shown in figure 3.

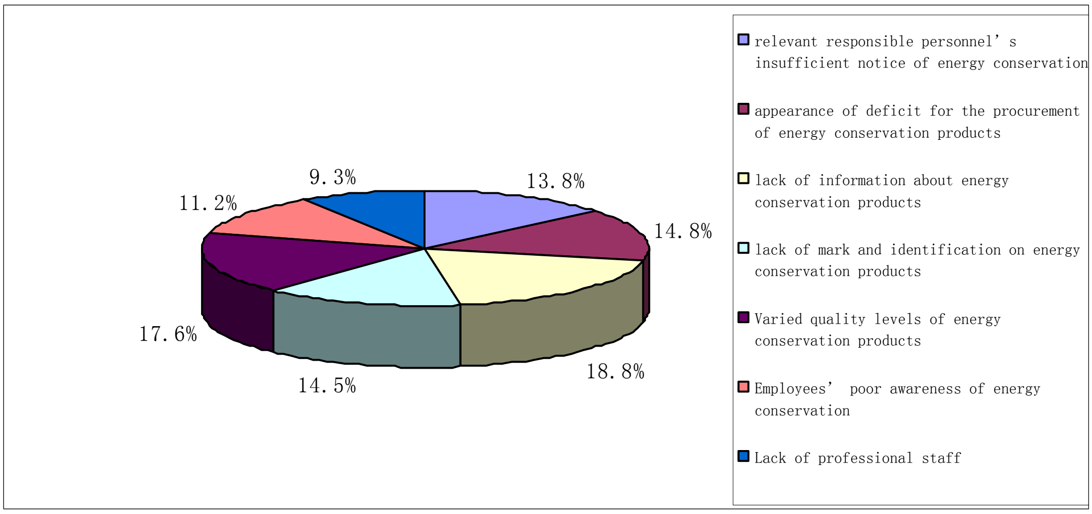

Figure 3: Barrier survey on energy efficiency procurement

To overcome the above-mentioned information barrier, an energy efficiency list is provided with the issuance of the policy. The energy efficiency list consists of key elements such as manufacturer name, product model number, CSC certificate number and effective date. The eligibility of products will automatically expire when the certificate expiration date is passed.

The advantages of the energy efficiency list could include:

- It is easy for procurement officers to identify, access and verify qualified products;
- The energy efficiency performance in the list are warranted because those product models meet stringent certification requirements;
- The energy efficiency performance, qualified product models and manufacture information could be updated with technology advancement.

There also exist disadvantages such as:

- It would be a heavy task to verify if each tendering products is included in the list, especially when the list becomes too long with more and more product categories and qualified product models are added;
- It would be a challenging issue for procurement staff to access the latest updated energy

efficiency list, especially for those having bad information infrastructure.

2）An easily discounted policy

Although Chinese government highlights the importance of energy and environment issues, a preferential purchase policy is specified because Chinese different regions are at various levels of economical and social development. It is specified in the directive that government organs at all levels, public sector non-profits units and organizations (collectively “procurers”), when using fiscal resources for procurement, should preferentially procure energy efficient products and gradually eliminate low-efficiency products. The preferential purchase decision should be made based on List of Energy Efficient Products for Government Procurement, or simply “Energy Efficiency List”.

Only general requirements such as preferential purchase are specified in the existing policy. There are no detailed items such as purchaser’s responsibilities, incentive policy on best practice, requirements on purchase chain from project planning, budgeting, to verification in view of energy efficiency, which results in an easily discounted policy, or ineffective implementation of the policy. For example, one clause in the directive is:

When procuring products [from a category] appearing on the Energy Efficiency List, priority must be given to the energy efficient products on the Energy Efficiency List, under the condition that the technology and service of the product are equal.

In the competing market, it is hard to find any two manufacturers having equal technology and service. Especially, few purchase cases with equal technology and service would happen because so many other elements such as product quality, bidding price and after-sale service will be considered. Eventually, energy efficiency will be overlooked in the bidding process.

4．Problems

As a breakthrough to integrate energy efficiency into existing procurement system, the energy efficiency procurement policy is highlighted by the society. Meanwhile, half of provincial governments issued a local directive to facilitate adoption of the policy in practical procurement activities. By December 2005, for 9 product categories within the energy efficiency list, the growth rate of manufactures and product models that meet procurement criteria is 49.5% and 51.3%

David Fridley’s research shows that for the 7 energy efficient products in the current energy efficiency list, avoided electricity consumption in year 10 of the program would reach 4.65 TWh . And on a cumulative basis, avoided electricity use in year 10 reaches 10.9 TWh, with discounted savings of ￥8.7 billion (US$1.07 billion). This is equivalent to the emission of 10 million tonnes of CO2, 31.4 million kg of SO2, and 14.2 million kg of NOx.

As one of most cost-effective market transformation and energy technology innovation tools, the energy efficiency procurement policy is highlighted by Chinese governments national-wide. However, from a survey at beginning of 2006 there exist some problems for this nascent initiative that bring bad impacts on effective implementation of the policy.

1) Little awareness

Since the policy was publicized on December 2004, Chinese governments have taken little actions to promote the policy. And few education or training courses happened. A random interview through phone call in 2005 reveals that some local procurement organizations don’t know the policy.

2) Distorted implementation

It is specified in the directive that in government procurement activities, the procurement officer must make explicit the assessment standards for product energy efficiency requirements, conditions for product qualification, and priority of energy efficiency procurement in all tender documents (including negotiation documents and price request documents).

Because it is not a unconditional mandate policy to procure energy-efficient products, in most actual procurement activities the implementation of the policy was distorted. For example,

- Lack of clear energy efficiency requirements in whole procurement activities. The survey shows that part of procurement officers who know the policy did not integrate energy efficiency requirements into existing procurement activities.

- No requirements from end-users. In most Chinese government agencies, there are no targets to reduce energy consumption. End-uses always pay little attention on energy expenditure. Another barrier is that most end-users are refused to reduce energy expenditure, which will result in the reduction of allocation because fiscal budget is calculated mainly based on past expenditures in existing fiscal system. Therefore, when submitting a procurement request of new equipments, end-users always have not energy efficiency requirements and procurers will care about energy efficiency level.
- Ignorance of energy efficiency in assessment. In some cases, the energy efficiency are specified in the Terms of Requirements but not in the assessment documents, which results in the ignorance of energy efficiency or whether the product model is in the energy efficiency list or not when assessing tenders.

3) Too much emphasis on capital cost

In existing Chinese government procurement activities, the practice of “decision according to price” is a big barrier for the implementation of government procurement for energy-efficient products, which leads to cutthroat competition between enterprises. Normally, the capital cost of high-efficiency technologies can be higher than less efficient alternatives, and with the relatively low costs of product, initial cost comparisons between the options can lead purchasers to buy low-efficiency technologies.

4) Little knowledge on energy efficiency

The survey shows that nearly all procurement officers have little knowledge on energy efficiency. As a nascent policy in China, there is no successful experience and best practice to learn. Procurement officers are uneducated on how to integrate energy efficiency in procurement activities.

5. Follow-up actions

Based on national survey and analysis of existing energy efficiency procurement policy, Chinese government are taking following actions to improve and facilitate the policy.

1）Make a more detailed policy

The Chinese governments realized problems and barriers of this nascent policy. A more detailed clear energy efficiency procurement policy communicated jointly from top to down will be developed in 2006 to enhance market through government purchasing power. This includes: 1) Detailed requirements on responsibilities and rights of organizations and individuals such as financial administrators, central procurement organs, purchasers, suppliers, 2) Detailed targets in the development of procurement budget, procurement plan, procurement program and procurement volume, 3) Detailed scheme to monitor and supervise the policy.

2）Develop toolkit for purchasers

One of targets to move forward the policy is to develop toolkit in 2006. The aim of the policy toolkit is to enable procurement officers in each public administration to implement energy-efficient purchasing without having to fear conflict with public procurement rules, and to ensure that they receive political backup and commitment to rely on for their decisions. The toolkit will be available in Website to overcome purchaser’s professional skill barriers. The toolkit will include following elements: 1) common purchase specifications and methods, a learning-by-doing exercise where procurement, officers’ practice to write call for tenders, and to evaluate; these tenders, based on the purchase specifications. 2) Development of common information material and simple “how-to” guides based on the experiences of the pilot action. 3）Development of life-cycle analysis tools to consider both capital and running costs for end-use energy consumed products.

3) Information, training and education

Adequate training of government purchasers to inform them at regular intervals about the energy-efficient products which are available, would be an effective means of ensuring that informed choices are made. Meanwhile, continued updating and information is needed, as is the availability of tools, instruments, guidelines and training for procurement officers. In the directive three websites are specified to serve as the media for announcement of the energy efficiency list. Therefore, abundant information such as best practice, guidelines and tools will be provided to make these Websites as the procurement information desks in 2006.

4）Explore international cooperation

Government procurement is a turn-key for energy efficiency market transformation and energy technology innovation. International cooperation targeting at harmonization of procurement policy in different countries will expand energy-efficient product market through removing market barriers, facilitating trade flow globalization and advancing energy-efficient technology development. With support from APEC, REEEP (Renewable Energy & Energy Efficiency Partnership) and Chinese government, CSC is developing a harmonization road-map for government procurement for energy-efficient products through market and policy research and international workshop in APEC economies. We welcome international cooperation in this regard.

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Communities of Practice: A New Approach for Co-ordinating Energy-Efficiency Standards and Labeling Programmes

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[2]***Danish Energy Management***
[3]***UK Market Transformation Program***

Abstract

An expansion of individual national requirements for energy-efficient products may lead to higher compliance costs, which in turn is likely to raise further barriers to the uptake of efficient products. This paper makes the case for a greater degree of international co-ordination amongst those involved in designing and implementing energy efficiency programs around the world, with the aim of promoting harmonisation. Additionally, it proposes a mechanism for such co-ordination: "Communities of Practice", which can serve to link together experts in different locations and nations through the sharing of e-mail, documents, and proposals for co-ordinated international action. These communities can act as a medium for exchange of information and discussion of proposals for co-ordinated international action. Their advantage over the regular exchange of e-mail is that they provide an open, transparent, and inclusive platform, and can thus result in more informed and broader input into policy and regulatory decisions. Led by Australia, two international Communities of Practice are currently being tested for two product types: compact fluorescent lamps (CFLs) and TV set top boxes.

Introduction

Until a few years ago, national or regional energy efficiency programs tended to be developed with limited interaction with similar programs in other countries or regions. Programme managers commissioned national market studies and assessed the benefit-cost implications of regulating energy-efficiency levels for equipment and appliances. Many good ideas and best practices were swapped at conferences, and in the process many excellent programs and initiatives were spawned. As might be expected, the programs that resulted tended to be well suited to the interests of local manufacturers/suppliers and customers.

Over the past few years it has become increasingly apparent that globalisation has hit the world of energy efficiency. On the one hand, a growing number of countries are designing a range of different national programs to improve the efficiency of products; while on the other there are suppliers dispatching products to markets in all corners of the globe. Not only are markets spread far and wide, but the development cycle for new products (if not new technology) is now far shorter.

The situation is most starkly apparent in the world of consumer electronics and office equipment; where it is not uncommon to see new models appearing every six months. This contrasts with the traditional product development cycles for wet goods, where models may stay in the market for five years or more.

This situation presents particular challenges for those interested in stimulating the market for more energy efficient products.

For example, how should governments meet national requirements in the context of this global marketplace, without creating barriers to trade and excessively increasing compliance costs? How do programs aimed at providing information on the performance of products to consumers remain up to date when new models are entering the market with such frequency?

This paper explores some of these challenges for governments and industry, and also raises some possible solutions, drawing heavily on the evolution of policy in Australia over recent years.

The view from Australia

The Australian Government has approximately 15 years' experience in the implementation of regulations for energy efficiency. These regulations now cover a range of domestic and commercial appliances, and they have proved to be a reliable and effective mechanism, ensuring that energy savings are achieved and sustained over a long period (NAEEEC 2005a). The case of the domestic refrigerator is a good illustration, as shown in Figure 1.

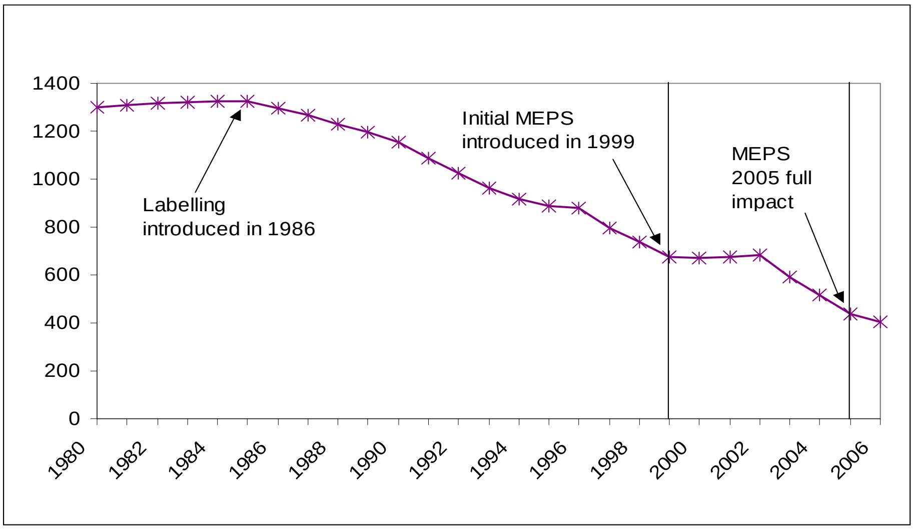

Figure 1: Graph (kWh/year) of average new family refrigerators use 60% less power in Australia than 20 years ago (Source: Australian Greenhouse Office)

Regulations in Australia have also proved to be extremely cost effective. Regulation saves the community on average $US20 for every tonne of carbon abated (NPV 10% discount) as compared with other greenhouse gas abatement projects that cost the community between $30 – $400 per tonne saved (NAEEEC 2005b).

By 2020, the cumulative impact of regulation will save more than 200 Mt and save the Australian economy around $US 4 billion (NAEEEC 2005b).

In setting regulated performance levels, the Australian government policy has evolved. Initially the Government focussed on products in the local market – identifying the range of performances exhibited and picking an appropriate threshold for the minimum energy performance level (or in the case of label, appropriate levels for each star).

This approach was fine, and indeed common elsewhere, but it begged the question – "What if technology used in Australia was less advanced than in other parts of the world?". The problem with this process was that we had no incentive to compare products in Australia with those used elsewhere.

As in many other fields, the Government took the position that there is no reason why Australia should not benefit from the best technology available, so long as it was being used successfully in a similar economy. Policy was therefore altered and the strategy for setting energy efficiency requirements became one of matching the most stringent regulated levels in force in a major trading country.

Australia currently has a policy of matching "international best regulatory practice" when developing new MEPS and labeling requirements. The Australian approach is that its MEPS levels should not be lower than any other economy – or stated another way, if a product is made in Australia, it should meet the energy and environmental criteria and be able to be sold in any market in the world (NAEEEC 2001).

This position also acknowledged that Australia, as a country with a population of 20 million and only 1% of the world's manufacturing industry, imports the majority of its consumer products. Nor are these products made for our market - generally Australia receives products which are primarily designed for Europe or Asia, which have similar electricity supply conditions. Australia has always had a limited capacity to influence product design and performance and now in a global market, that capacity has further diminished. As such a small market, there is a danger that if we set our performance requirements too high, suppliers may simply opt out of this market, which will benefit no-one. This is why a policy to match the performance of the best products in the world makes more sense for Australia at the current time.

This policy does require that considerable analysis of overseas programs is undertaken prior to the adoption of efficiency levels. In particular, attention is given to the requirements in countries which represent Australia's trading partners.

During this process, we have become increasingly aware of the diversity in test methods and energy performance requirements for a wide range of products. For example, a recent survey of mandatory and voluntary performance requirements for compact fluorescent lamps (CFLs) found that there currently exist over 22 different specifications around the world (MEA 2005).

While setting national requirements is of course the right of any sovereign nation, the existence of disparate requirements almost certainly adds to compliance costs for internationally traded products. For some manufacturers, the cost of doing business is simply too much, and some markets may be limited in the products available.

As we know, the price premium for energy efficient products is an important issue for consumers. It is sufficiently important that governments over the years have put considerable effort into reducing the barrier caused by higher capital costs, through educational programs focussing on payback periods. Where compliance costs are raising the price to consumers, this is therefore a significant issue. It would be ironic if programs designed to promote high efficiency products were in themselves adding to costs and therefore limiting the uptake of these products.

The information available at the current time does not prove the case one way or another – there is simply not enough detailed data available – however it should be recognised as a conceivable possibility and a situation to be avoided (Du Pont 2005). It is a further reason for supporting the harmonisation of test methods, and some rationisation of performance specifications.

Harmonisation is one of those terms that is ubiquitous and may be in danger of losing its meaning. To understand what harmonisation may mean in the energy efficiency world, two recent projects are described briefly.

Case Study: External Power Supplies

In 2003, Australia took the decision to begin investigating the efficiency of external power supplies, those small black boxes used to charge mobile phones and attached to almost all electronic devices nowadays. Every household in Australia has between 5 and 10 of these which remain plugged into the mains electricity supply more or less permanently (E3 2006).

Almost exactly two years ago the US Natural Resources Defence Council (NRDC) hosted a meeting on power supplies in San Francisco. It was attended by manufacturers, researchers and representatives from several energy efficiency agencies, including Australia. In addition to the potential for huge energy savings, what was apparent was that manufacturers did not mind too much what requirements were placed on them in terms of performance, so long as these were uniform across their markets.

This was a different message to the one's we'd been hearing in previous negotiations with local manufacturers of products, such as washing machines, which were not intended for export. It was our first real contact with a mass-produced internationally traded product with global sales of over 1 billion.

Importantly, it was also the first time that most agencies involved in energy efficiency were required to confront the need for a global response. Although there has been contact between different national organisations, these links have previously been sporadic, informal and dependant upon the personnel involved.

What has evolved is a coalition of interested parties which undertake a co-ordination role, including US Energy Star, the Californian Energy Commission, CECP in China, JRC in Europe and the Australian Greenhouse Office (EPS IEMP 2005).

These organisations have all overseen the development of a test method, undertaken tests in their own countries which has contributed to a large database of tested products, and participated in round-robin tests.

This large and diverse database of product performance allowed us to set realistic performance requirements based on a larger sample than any single country would usually have at their disposal.

Early on in the process it became clear that one performance requirement would not suit the needs of the various agencies involved. For example, the Energy Star program is intended to promote the best performing products, while Australia and California wanted to set a minimum performance level to remove the worst products from the marketplace.

Therefore, a system was devised which contains a limited number of performance requirements which, like rungs on a ladder, increase in stringency. The key elements of this system include:

- Countries can still select which ‘level’ to set their requirements;
- However, the number of different specifications are limited;
- Countries can elect to move requirements ‘up the ladder’ in due course, for example after 3-4 years when technology improves;
- Manufacturers have clear performance targets set for many years.

One further element to this project is the development of a special ‘marking’ system as an aid to compliance monitoring (see Figure 2). Comprising a roman numeral which corresponds to each performance level, this ‘efficiency mark’ is placed on the product nameplate, alongside safety and other compliance information (EPS IEMP 2005). It is not a label for consumers, and indeed will probably be meaningless to most people that see it.

The purpose of the ‘mark’ is to indicate to those involved in enforcement that the product has been tested according to the unified test method, and claims to meet a certain performance level. This gives regulators in any country the chance to make a first assessment of compliance, and provide a claim to check against. All of this can be done quickly without resort to test reports, which are often difficult to source and may take months to track down from the parent company.

Figure 2: Illustration of the efficiency ‘mark’ for external power supplies (EPS IEMP 2005).

Some two years after that initial meeting in 2004, there now exists a single test method used by all agencies running programs for external power supplies. Australia and New Zealand have published this as a national standard in 2005 (AS/NZS 4665.1:2005) and are committed to submitting this for adoption by the IEC as an international test method.

We also have a timetable for a variety of national and regional programs in the United States, China and Australia which are all using one of two performance specifications. The pre-existing Code of Conduct program in Europe will also become aligned in a couple of years time.

Most recently, a further six States in the US have announced that they will adopt harmonised standards, and China will also introduce a mandatory minimum energy performance standard. Europe is preparing minimum efficiency standards for external power supplies in the framework of the ecodesign directive.

The important points to note from this example are that all of this has been achieved in a relatively short period - almost exactly two years. Also, there has been a remarkable degree of co-ordination despite that lack of any formal agreements between countries. And finally, there is a framework for a system which meets the needs of manufacturers in terms of harmonised standards, without sacrificing the rights of individual nations.

It is interesting to note that along the way, we have also established something which may make it easier for other jurisdictions to join up to, as with the other US States.

Case Study: Compact Fluorescent Lamps

The second example concerns compact fluorescent lamps (CFLs) which have become something of an icon for most energy programs around the world. They represent an ideal energy efficient solution, being relatively low cost, easily retro-fitted by householders and lead to substantial energy and greenhouse savings (75% compared to the standard incandescent lamps they replace).

However, unlike many other energy efficient products, the degree to which consumers accept them is determined not so much by their energy features as by other characteristics, such as lifetime, colour and size (Artcraft 2005). As mentioned previously, there are now a plethora of programs which aim to ensure consumers confidence in CFLs thereby encouraging their purchase in increased quantities.

The success of these programs is reflected in the phenomenal growth in sales in recent years (see Fig 3), which in turn has helped to reduce the price. In many countries the value of CFL sales now exceeds the value of incandescent lamps.

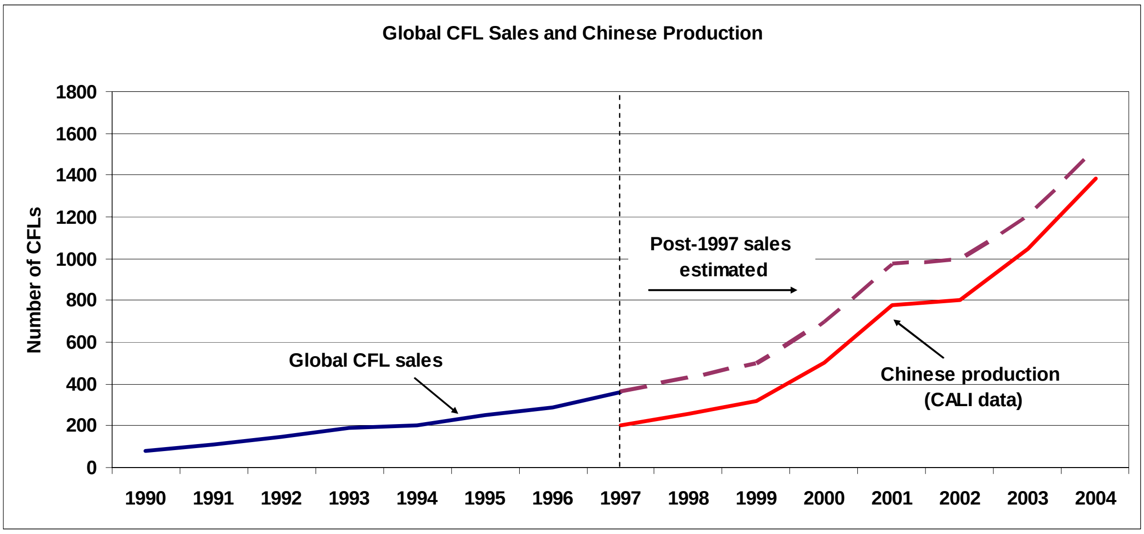

Figure 3: Estimated Global Production of Compact Fluorescent Lamps (CFL) 1990-2004 (Du Pont 2005)

The extent of the growth in international trade of CFLs, and the increasing number of national programmes have highlighted the variation in requirements of these different programs.

In order to maintain the momentum through further cost reductions while maintaining quality, the proposal to initiate a harmonisation process was put to participants at the international Right Lights 6 conference in Shanghai in May 2005. More than 80 delegates from 13 countries attended a Special Session on CFL Harmonization and the majority voiced their in-principle support for the program.

At the same time, five working groups were established, with the following specific goals over the next three-year period:

- Create a uniform *international testing method,* covering the performance features of self-ballasted CFLs;
- Identify a number of *performance specifications* for self ballasted CFLs to facilitate international comparisons of CFL performance requirements;
- Develop and initiative a program for *inter-laboratory comparison* of test results to ensure confidence in the quality and accuracy of testing of CFLs;
- Propose a set of *compliance mechanisms* for CFL testing and performance regimes; and
- Propose and promote these initiatives to the wider international lighting community.

There are several novel aspects to this ambitious project, which reflect a new paradigm for energy efficiency policy development.

The way in which this initiative is organised is neatly described by the term “community of practice”. It is an open community which invites participation from industry, governments and NGOs, using web-based tools to communicate and maintain a dialogue. The input is channelled through a number of “virtual working groups” on specific topics, such as performance specifications, test protocols, and compliance mechanisms) In this way the process, debate and decisions are transparent. (See http://www.apec-esis.org/cfl)

The other feature of this community is its focus. It is a single product initiative, dedicated to achieving a clearly articulated goals within a given timeframe. There is no intention of creating a new organisation, with a structure and a need to maintain itself beyond the lifetime of the project.

This makes it a relatively low-cost exercise. In this instance the Australian Greenhouse Office has provided some seed money, but most organisations are self-financing their participation. A small number of previously scheduled events have been identified for future meetings where further discussion and reporting on progress can take place. Again, most organisations will be funding their attendance at these events.

The Community of Practice concept is being pilot tested through the CFL web site, as well as through a similar web site being established to mediate a discussion on the regulation of set top boxes, the boxes that sit on top of television, receiving signals from providers of cable TV and other related services. The devices have large energy losses that can easily be reduced through concerted international action.

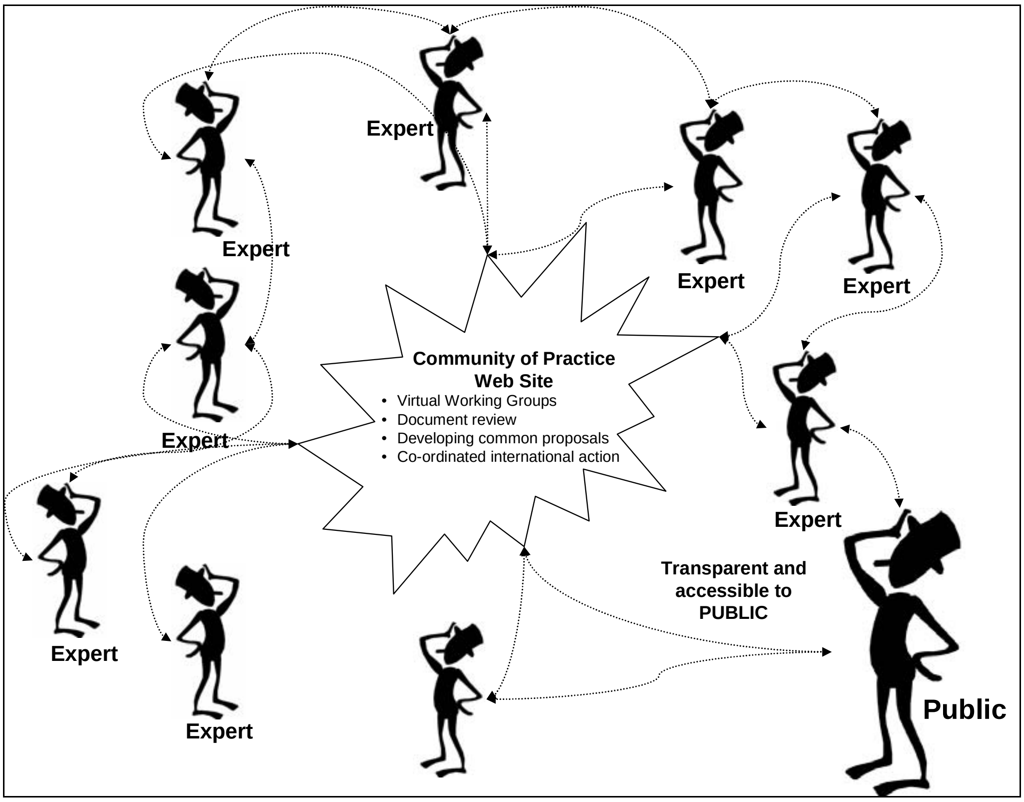

Figure 4: How a Community of Practice works.

The Community serves to link together experts in different locations and nations through the sharing of e-mail, documents, and proposals for co-ordinated international action. It acts as a medium for exchange of information and discussion of proposals for co-ordinated international action. Its advantage over the regular exchange of e-mail is that it provides an open, transparent, and inclusive platform, and can thus result in more informed and broader input into policy and regulatory decisions. Led by Australia, two international Communities of Practice are currently being tested for two product types: compact fluorescent lamps (CFLs) and TV set top boxes.

What is being attempted through these communities of practice is an appropriate multinational response to the globlisation of product markets. Communities of practice establish a means for co-ordinated policy development, but do not in themselves implement measures – this responsibility remains with the participants, such as governments or energy efficiency agencies. Ultimately these bodies retain their sovereign rights to decide on national implementation issues. However, the framework of the community of practice enables nations to readily compare performance levels of products within their country with those elsewhere (using a common test method), and to set appropriate performance requirements.

One of the potential benefits of this transparent 'community' is that countries that do not currently have programs may find it easier to be linked to this international initiative, confident that they are not taking action in isolation.

An additional important aspect concerning the sharing of information, which may bring considerable benefits, concerns verification and enforcement. All programs currently undertake forms of compliance monitoring to ensure that program requirements are met. This is a difficult task but one which is vital to the integrity of all programs and to protect the investment of program participants.

In general it is fair to say that enforcement is not given the emphasis it probably deserves, mainly because of the limited resources available. For CFLs it is proposed that the results of any verification testing undertaken by program managers should be shared with the ‘community’ through the website. This information will be extremely useful in determining which products other countries should target for verification, and will therefore go some way towards making better use of the limited resources available for verification activities.

Conclusion

This paper describes challenges caused by both the increase in globally traded products, and the growth of governmental interest in promoting greater energy efficiency levels.

In this context, an expansion of individual national requirements may lead to higher compliance costs, which in turn is likely to raise further barriers to the uptake of efficient products. This paper therefore makes the case for a greater degree of international co-ordination amongst those involved in designing and implementing energy efficiency programs around the world, with the aim of promoting harmonisation. In this context, harmonisation applies to both the test procedures and a rationalization in the number of different performance specifications.

It is suggested that ‘communities of practice’ provide a focused means of achieving this objective. Based on the examples for external power supplies and compact fluorescent lamps communities of practice can provide a mechanism to advance the harmonisation of test methods and performance specifications. The key features of these communities include:

- A means of drawing together expertise from governments, industry, NGOs, academia, etc;
- International focus on a single device, piece of equipment or appliance;
- A high degree of transparency through the use of electronic media;
- Low establishment costs, and limited on-going commitment;
- International co-ordination without sacrificing national rights;
- Higher efficiency products at lower cost to government industry and consumers.

In addition to set top boxes, it is envisaged that further communities will be established over the next two years for standby power losses, televisions and electric motors.

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Comparison of UK and Best International Energy Standards

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[2]Klinckenberg Consultants

Abstract

In February 2005 a review was undertaken for selected products of the best international energy standards (minimum energy performance, best practice, and government procurement standards) and the comparable values for the UK. The work was part of the UK Government's cross-departmental[1] Energy Efficiency Innovation Review, which examined the state of domestic, industrial and commercial energy efficiency across the UK, looking to identify areas where policy measures could be usefully implemented to enhance rates of energy efficiency.

The review was desk study based on: available reports and databases about this topic and brief evaluations of international (principally: US, Japan, Australia, Europe) standards.

The review found that while for some products, for example gas central heating boilers and washing machines, the EU/UK had the most demanding standards. However there were many other products where the EU/UK standards could be increased, with considerable associated energy savings.

A Comparison of International Standards to Inform the UK Government

The Government's cross-departmental Energy Efficiency Innovation Review has examined the state of domestic, industrial and commercial energy efficiency across the UK, looking to identify areas where policy measures could be usefully implemented to enhance rates of energy efficiency.

The Market Transformation Programme was asked to provide data and expert opinion on a number of topics, of which the original version of this review, undertaken in February 2005, was one. The report has been updated in March 2006 as an input to further Government reviews.

This paper, and the underlying report [1], provides an indicative overview of the best international energy efficiency standards for products (minimum energy performance, best practice, and government procurement standards) and the comparable values for the UK as at March 2006. The international data in the report are based on: available reports and databases about this topic; brief evaluations of international (principally: US, Japan, Australia, Europe) standards. Especially useful resources were the work of the Australian Greenhouse office, Energy Efficient Strategies in Australia, and CLASP S&L Worldwide Summary / APEC (Asia-Pacific Economic Co-operation) Energy Standards & Labeling Information Network database.

The UK data are based on information already gathered by the Market Transformation Programme (www.mtprog.com) in particular from the Performance Standards Information Base (PSIB, www.mtprog.com/psib). The PSIB provides benchmarks for the environmental performance of household appliances and traded goods and identifies existing and proposed test methodologies used to determine a product's environmental performance.

Components of the Analysis

This report describes the best available international energy efficiency standards for selected product sectors, as far as could be established within the scope of the underlying work. Due to this scope, this report may be incomplete, and some inaccuracies may exist. Nevertheless, it is believed to provide a reasonably accurate overview of the best international standards currently applied by major countries or regional trade blocks.

In order of importance, the underlying analysis focused on:

- minimum performance standards
- best practice standards
- procurement standards

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[1] Comprising representatives from Defra, Treasury, Energy Saving Trust and Carbon Trust

The product sectors covered in the analysis are:

- domestic wet appliances (washing machines, tumble dryers, dish washers)
- domestic cold appliances (refrigerators, freezers)
- gas and electric cooking (electric ovens, gas ovens, electric cookers, gas cookers)
- domestic heating (central heating boilers, gas water heaters, domestic electric storage water heaters)
- ICT (PCs, Monitors, Copiers, Printers)
- consumer electronics (TVs, VCRs, Set-top boxes, external power supplies)
- domestic lighting (ballasts, light bulbs, CFLs)
- commercial lighting (ballasts, fluorescent tubes, fluorescent tube luminaires, high-pressure sodium vapour lamps)
- commercial air conditioning (Small packaged units, Large packaged units, Split systems)
- motors and drives (3-phase motors, 1-phase motors, pumps)

It should be noted that apparently similar products can have very different characteristics in other markets, and may not be comparable internationally. This applies particularly to domestic wet appliances and heating appliances.

The overview presented here is compiled on the basis of a rather crude comparison of international standards levels; **no effort was made to assess the effects of different test standards (or test procedures),** as this would be outside of the scope of the underlying work, although these are known to influence the reported energy performance levels. For some products this fuller comparison already had been made and this information has been incorporate into this report. (Some analyses have been made on behalf of the Australian Greenhouse office, as part of their strategy to match the most ambitious minimum energy performance standards (MEPS) level in their major trade partners).

A first analysis was conducted in March and April 2005, including all product sectors listed above, but focusing mainly on minimum energy performance standards and based on the information available at that time. This analysis was repeated in March and April 2006, with more attention for best practice and procurement standards and taking into account newly released standards and new, additional information.

About the 2006 Update of the Analysis

The update included a review of the information in the first report, in light of new standards and policies being introduced, and of more information about standards and labels in more countries becoming available.

On the first issue, of new standards being introduced, it can be noted that especially the APEC-economies have been active in the introduction of new standards in recent years. Australia, Korea, and China have introduced various new standards, some at the world's most ambitious levels. The California Energy Commission has introduced various State energy standards, some for products that were previously not regulated (by MEPS) worldwide, and the USA Federal Energy Management Program has, following up on the US '1 Watt Executive Order', introduced a series of standby power requirements that are among the most ambitious in the world. Many of these initiatives originated from before March 2005, but the details about these programmes and standards could only now be identified.

The availability of more, and more detailed data, is best demonstrated by the now integrated CLASP S&L Worldwide Summary / APEC Energy Standards & Labeling Information Network database [2], which is an extended combination of the two pre-existing databases of CLASP and APEC. This new combined database has a good coverage of minimum energy performance standards and energy labels in especially the Americas and the Asia-Pacific region. A second new and useful source of information is the Power Integration Green Room standby programs overview [4]. This new information, however, does not imply that the report has a full coverage of all standards, as that would require a much more detailed analysis. It is an updated, but indicative overview of the best International Product Energy Efficiency Standards.

International Best Standards: An Overview

Almost all major energy using products in the domestic, commercial and industrial sector are subjected to standards in a country, and some products are targeted with standards in many countries. No country, however, covers all main energy-using products. The analysis clearly identified that no country has the best standards in all product sectors, and that countries with very ambitious standards in one product sector often have very weak or no standards in other sectors.

For the analysis, the best level was defined as being the most ambitious level (best energy performance). This leaves out the aspect that lower energy performance levels may be more adequate for a country in some circumstances. The objective of the analysis, however, was to establish an indication of the most ambitious levels, to inform the UK government of energy performance levels that are being achieved in other economies and are thus technically realistic with commercially marketed products.

Brief overview by trade blocks

No single country or trade union has been identified as having established the most ambitious standards for all products.

- The USA has the longest tradition in setting MEPS and has set the most MEPS worldwide (Canada usually implements USA MEPS a few years later). Additionally, the USA has developed the Energy Star programme, the widely used endorsement standard for electronics;
- Japan has the well-established Top-Runner programme, which is not a MEPS but a mandatory manufacturer sales-average energy efficiency target. The target levels are often quite ambitious, and would represent a larger mandatory change in the market than some MEPS (especially for electronics);
- Europe has only a few, some weak, MEPS; an increasing number are voluntary rather regulatory. It has relatively ambitious endorsement standards for products with high energy consumption;
- Other countries have leading standards only for specific products.

Brief overview by product segments

- Domestic wet appliances: EU negotiated agreements are generally more ambitious than US MEPS, and EU endorsement standards[2] are leading worldwide;
- Domestic cold appliances: USA MEPS are leading, and EU and Australian endorsement standards are the most ambitious;
- Gas and electric cooking: Canadian MEPS are leading for electric cooking, the Japanese Top-Runner targets are the only MEPS for gas cooking.
- Domestic heating products: British, US and New Zealand MEPS are leading, Dutch endorsement standards are the most ambitious;
- Domestic heating demand reduction (building standards): Swedish MEPS are leading.
- ICT and Consumer electronics: Japanese Top-Runner targets are the most ambitious levels worldwide, the US Federal Energy Management Program standby requirements are leading endorsement standards;
- Domestic lighting: No MEPS exist that cover more than fragments of this segment. Chinese quality standards are leading;
- Commercial lighting: Australian /New Zealand MEPS are the most ambitious; the US Federal Energy Management Program sets the most demanding procurement standard – this also functions as an endorsement standard.
- Commercial air conditioning: Commercial air conditioning: Korean, US and Taiwanese MEPS are leading, Korean and Australian endorsement standards are comparable
- Motors and drives: Australian MEPS and best practice standards are leading Mexican standards exist for less relevant products.

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[2] endorsement standards are performance specifications that are used to encourage best practice. They may be used to:

- Provide information to consumers eg via a label
- Allow a rebate or grant on qualifying products
- Set a value for procurement

Examples are the Energy Star in the US (EPA) and the Energy Saving Recommended in the UK (Energy Saving Trust), Ecolabel (EU) and the top EU energy label classes

Within Europe mandatory energy labelling of products has been introduced, particularly for domestic products. These labels have been widely used to set thresholds, both for minimum standards and for best practice/endorsements.

Selected Examples of the Best Standards Comparison

Some selected examples from the comparison of best international standards are presented here, covering all three standards types identified in the analysis.

- minimum performance standards are typically mandatory thresholds that any product on the market, in a country, must meet. Some countries, however, rely mainly on voluntary agreements to set a minimum performance level, and sometimes also on fleet average targets;
- best practice standards are typically voluntary thresholds recommended by government, public bodies or civil society parties, recommending the interested buyer of the 'best deal' regarding the energy performance of products;
- procurement standards are used by governments and other main buyers for the selection of products that they purchase for their own use. The standards level often, but not always, coincides with the best practice level.

Minimum Performance Standards for Cold & Wet Domestic Appliances

Product	Source of best standard	Best standard	UK standard	Notes on test methodologies
Cold domestic (fridges and freezers)	USA 2001 standard	Energy efficiency Index <= 0.55 (equivalent)	Energy efficiency index < 0.75 (class B)[3]	Very different but Australians have compared and found USA to be most stringent.
Washing machines	European Committee of Domestic Equipment manufacturing (CECED) voluntary commitment[4]	0.27kWh/kg (The commitment also sets a fleet average target of 0,20 kWh/kg (just below A-class border) for European manufacturers)	Same	N/A
Tumble driers (full size)	USA 1991 or Canada 1995 (very similar)	0.73kWh/kg	None	Different (ambient temperature and humidity, load content, initial moisture and final moisture – all different but expected to largely balance out. See ref 4)
Dishwashers	European Committee of Domestic Equipment manufacturing (CECED) voluntary commitment	Energy efficiency index <=0.88 (full size) (class C)	Same	N/A

Source: Comparison of UK and Best International Energy Standards as at March 2006 [1]

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[3] With the exception of chest freezers which is class C and above (EEI < 0.90).

[4] This is not a regulatory minimum performance standard.

Minimum Performance Standards for Commercial Air Conditioning

Product	Source of best standard	Best standard	UK standard	Notes on test methodologies
Split Systems (These are systems in two parts – one of which is outside. This standard applies only to systems capable of cooling a room).	USA 2004 (for smaller units, up to 3.2kW Japan's Top Runner targets for 2006-07 are more ambitious requiring EER=3.64)	EER=3.35	None	N/A
Systems for large commercial buildings (eg office blocks, department stores, hospitals)	None identified within the scope of this study – standards are embedded in building regulations	N/A	For E&W in part L of building regulations.	N/A
Packaged chillers (major single energy using component in large whole building air conditioning systems.)	Canada 2004[5]	EER > 2.8 for chillers up to 500kW	None	N/A

Source: Comparison of UK and Best International Energy Standards as at March 2006 [1]

Best Practice Standards for Consumer Electronics

Product	Source of best practice	Best practice	UK best practice	Notes on test methodologies
TVs	For standby power only, US FEMP	1W	For integrated digital TVs only – Energy Saving Recommended – maximum standby power 1.5W, maximum on power 250W	N/A
VCRs (standby power)	US FEMP	2W	None[6]	N/A
Set top boxes	None[7]	N/A	As for VCRs	N/A
External power supplies	As for set top boxes	N/A	As for VCRs	N/A

Source: Comparison of UK and Best International Energy Standards as at March 2006 [1]

Government Procurement Standards

Very few procurement standards have been identified. These are:

1. The Chinese government made an announcement in December 2004 that they were introducing standards, starting in 2005 in central government, rolling out to regional and lower level government in subsequent years. The products included some relevant to this summary

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[5] Standards in Taiwan and the US (embedded in building standard ASHRAE 90.1 1999) are very similar.

[6] Energy Saving Trust's Energy Saving Recommended is in the process of being extended into consumer products. Also, there is discussion with the EC about setting up an EC Energy Star scheme to provide a Best Practice standard but nothing has been agreed.

[7] There are US Energy Star standards for consumer electronics but these are generally less stringent than the standards under the various EC voluntary agreements listed in the minimum standards section. Also, unlike the case of ICT, Energy Star has not been widely used in the EC.

ie: air conditioners, TVs, computers and printers. However it has not been possible to identify the details at this time.

2. In the USA an executive order by President Bush specifies that all products purchased by the Government and its agencies have a maximum stand-by power consumption of 1 Watt (or similar, depending on product type) when this does not compromise some aspects of performance. This target applies to a lot of electronics products, particularly internal or external power supplies.
3. Also in the USA, Federal buyers are directed by FAR Part 23 and Executive Orders 13123 and 13221 to purchase products that are Energy Star labelled or products that are designated to be in the upper 25% of energy efficiency in their class. As these are endorsement standards these have been covered for the relevant products under Best Practice above.
4. In the UK the Quick Wins Programme provides minimum standards for central Government procurement of some products.
5. Canada recently adopted a non-binding government procurement policy, which is based on Energy Star requirements for most energy using products.

Issues with the Analysis of International Best Standards

The overview presented here is compiled on the basis of a rather crude comparison of international standards levels; **no effort was made to assess the effects of different test standards (or test procedures),** as this would be outside of the scope of the underlying work, although these are known to influence the reported energy performance levels. During the course of the analysis, an attempt was made to compare the impacts of some European and US test standards. Although a 'quick-and-dirty' comparison could be established in some cases, almost no detailed international comparison has been made of test standard impacts, and thus of the impact of these on standards levels, between the main trade blocks in the world. This severely limits the possibilities of policy makers to harmonise standards levels internationally, if desired, and should be a focal point for further action.

For some products this fuller comparison already had been made and this information has been incorporate into this report. Some analyses have been made on behalf of the Australian Greenhouse office, as part of their strategy to match the most ambitious minimum energy performance standards (MEPS) level in their major trade partners [5].

The review considered all forms of minimum performance standards: regulatory minimum energy performance standards, fleet average performance standards and voluntary agreements as well as best practice and procurement standards. These has to be included, as different trade blocks rely (mainly) on different forms of standards: voluntary agreements in Europe, the Top-Runner programme in Japan and Federal minimum performance standards in the United States. The differences did introduce an issue in the analysis, however, as the impact of the various types of standard can be very different, and a higher level for a fleet average standard may not necessarily lead to a more energy-efficient market than a slightly lower regulatory minimum performance standard.

It was more difficult to identify best practice and procurement standards and where identified, it was not always possible to get a clear definition of the standard. Although best practice and procurement standards can have an important market transformation impact, and can be considered essential in an integrated product policy, few countries have established systematic best practice or procurement policies. Further, most international overviews and databases focus mainly or entirely on regulatory minimum performance standards.

It should be noted that apparently similar products can have very different characteristics in other markets, and may not be comparable internationally. This applies particularly to domestic wet appliances, which differ significantly in type and usage in all three major trade blocks, and heating appliances, for which typical products differ even country-by-country.

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Demand Response, Metering and Home Automation

Building Demand Response Capability into Appliances: A-HELP in difficult times

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Abstract

Household air conditioner ownership and use in Australia has grown phenomenally since the late 1990s, and is projected to increase even more over the next 10 years. In some States more than half the peak demand from the household sector on extreme summer days is air conditioning load. This is stressing electricity supply infrastructure today and is projected to drive infrastructure investment in the near future.

Although some utilities are moving to time of use pricing, the great majority of air conditioner owners do not face the real costs of supply and are heavily cross-subsidised by other electricity users. Better signalling of prices is necessary but not sufficient – air conditioner owners need to be able to respond to price signals, either manually or automatically.

Many electricity utilities, especially in the USA, have developed demand response programs targeting air conditioner loads. However, these have been limited in scope because of the expense of making the last link between the utility's communication and control system and the appliance, and by reliance on proprietary technology and standards.

The Australian Household Electricity Load Management Platform (A-HELP) project, funded by the Australian Greenhouse Office, involves air conditioner suppliers, the electricity supply industry, government agencies, research groups and others, with the common aim of developing open standards and protocols for communications between electricity suppliers and individual household appliances (with or without smart meters or other intermediate controllers).

The ultimate aim is for demand management response capability to be built in to all air conditioners sold, either as a standard design feature or as an easily-installed option.

The Growth of Household Air Conditioning in Australia

Until recently, Australian households have not been high users of air conditioning. During the 1980s the penetration of refrigerative conditioners (both cooling only and reverse cycle) appeared to plateau at about 25%, while penetration in the USA climbed from about 60% to more than 70% (Figure 1).[1]

Penetration rates have historically been higher in the states of Western Australia, South Australia and Victoria, which have hot summers and cold winters, and lower in the more temperate coastal climates of New South Wales and Queensland. Evaporative coolers are also popular in the southern coastal cities, which have lower summer humidity, and in some inland centres.

Sales of refrigerative air conditioners increased dramatically after 1996, from an average of around 400,000 units per year through the early 1990s to over 1 million units in 2003 [1]. Large variations in annual sales have been common in the past, because air conditioners have been to some extent seasonal and impulse purchases, and if the early part of the summer is hot then sales for that year tend to be higher. Some of the recent sales growth was associated with a series of hot summers and also a boom in home-building activity. However, there are signs that the dynamics of the market have now changed permanently, for the following reasons:

- Rising household incomes: Australia has had 15 years of uninterrupted economic growth, enabling households to increase consumption of all services, including thermal comfort;
- Falling real air conditioner prices: as the share of products imported from China and other Asian countries has risen, the real average price of products has fallen;
- Falling real electricity prices (in most States), and the absence of price signals indicating the high marginal cost of supply during summer peak demand periods;

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[1] 'Penetration' rate is the proportion of households possessing at least one unit of that appliance, and cannot be higher than 100%. ' Saturation' rate is the average number of appliances held by owning households, and cannot be lower than 1.

- Decades of promotion of reverse cycle air conditioners by electricity utilities, as a counter to gas heating;
- Increasing noise, air pollution and perceived crime risk in inner city areas, making it less attractive to open windows and to rely on natural ventilation, even in low-rise housing;
- The increasing number of high rise apartments, many with poorly shaded and/or west-facing glazing, and less able to rely on natural ventilation and openable windows due to their layout, safety concerns or wind velocity and exposure problems;
- The increasing tendency for project home builders to install air conditioning (or to provide a 3-phase power outlet to facilitate later installation) as a marketing edge;
- The combination of declining block sizes and increasing house floor areas is reducing the scope to optimise orientation and to retain mature tree cover in new subdivisions. This increases the proportion of new houses that rely on air conditioning for summer comfort because they are poorly orientated and shaded, even if they have reasonable levels of insulation;
- Most of the highest housing growth areas are in the hinterlands of the large coastal cities, where local micro-climates are several degrees hotter than the coastal suburbs of the same cities;
- Changes in home financing, which enable homebuilders to increase their mortgages to cover expenditure on fixed equipment such as air conditioners, whether at the time of construction or later; and
- Global warming: summer average temperatures have been rising in Australia, as in many other parts of the world. After a relatively mild period in the early 1990s, the six hottest years since reliable records began in 1910 have all occurred in the last decade, with 2005 the hottest on record. [2]

Given these drivers it is little wonder that an increasing proportion of existing dwellings are acquiring air conditioning, and more new houses are being equipped with air conditioning at the time of construction. Penetration is projected to reach 60% by 2020.

Domestic air conditioning energy consumption and peak load could potentially grow even more rapidly than the number of air conditioners, because of increasing average dwelling size, the tendency to cool the entire house rather than just one or two rooms as in the past, longer hours of operation, increasing average outside temperature and more frequent days of extreme high temperature due to global warming.

Given the combination of high growth rates in ownership and increasing use per air conditioner, it is conceivable that the energy consumption and peak demand of air conditioning in the residential sector could double in the next 10 years.

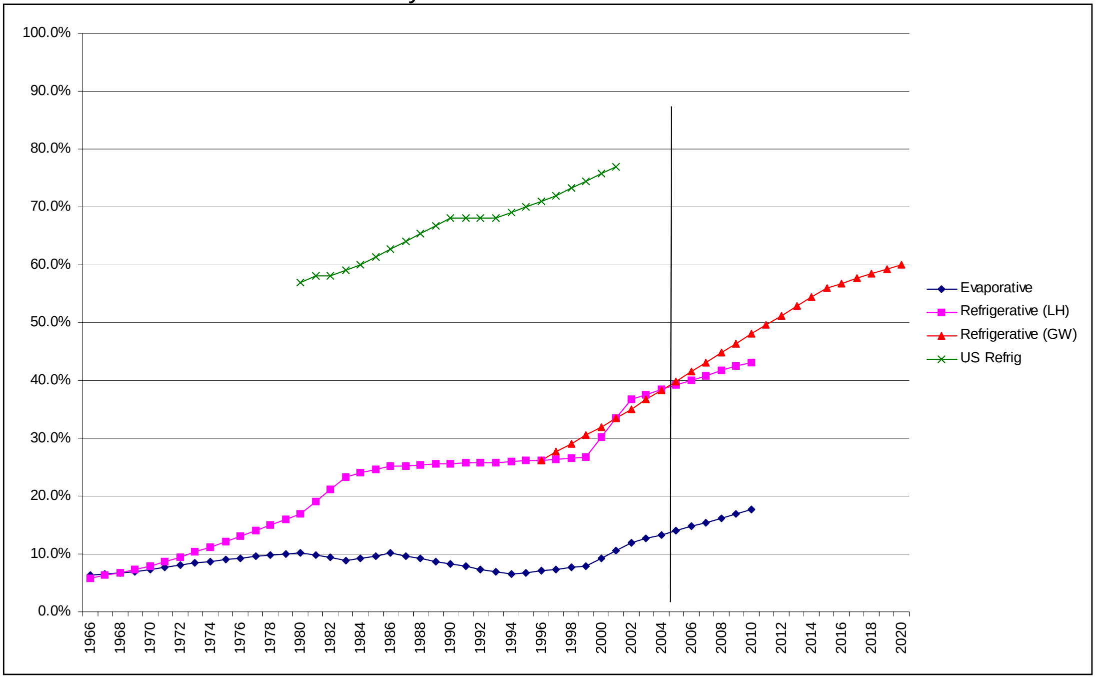

Figure 1: Percentage of households with at least one air conditioner, Australia and USA
Projections to 2010 from [1], projections to 2020 from [3]

Peak Demand

Air conditioner peak demand is one of the major factors driving capital investment in the National Electricity Market (NEM), as well as a mechanism for cross-subsidy between air conditioner users and non-users.[2] During the 1990s the state electricity systems all registered their maximum annual peak demands during winter, but all are now summer peaking. Typically about 30-40% of commercial sector demand and 40%-50% of residential sector demand on extreme summer days is now due to air conditioning, and the two loads are of similar MW magnitude.

Air conditioning load is much less of a problem in commercial buildings. The load factor of commercial air conditioning is similar to other commercial loads, whereas the load factor of residential sector air conditioning is very low – ie its share of annual energy use is far lower than its contribution to peak demand. Much of commercial sector electricity consumption is metered by time of use, so the costs of air conditioning energy and peak load can be signalled and recovered. However, there are no ready means available at present to signal or recover the costs which air conditioner-owning households place on the system.

There is a large and growing cross-subsidy from non-air conditioning households (including those with evaporative coolers) to those with refrigerative air conditioners. It is estimated that in 2004 the cross-subsidy from the 4.1 million non-air conditioner households in the NEM area to the 2.7 million air conditioner-owning households was in the range AU$300-500 million annually, or about $100 per household [3]. Apart from the equity implications, the underpricing of supply costs seriously distorts the economics of the NEM. The household air-conditioning load is in effect driving investment in both distribution and transmission infrastructure and in peaking generation plant, which is used for only a short period each year.

Policy Responses

Australian governments have become acutely aware of the peak load implications of household air conditioning through a number of well-publicised power supply difficulties during the summers of 2003-04 and 2004-05, during which some cities experienced localised blackouts on days of extreme heat (the summer of 2005-06 was relatively trouble free, since the most extreme days fell on weekends or public holidays when the business load was low).

Until recently, however, the policy response has focussed on improving building thermal performance (options 1 and 2 in Figure 2) and on increasing the energy efficiency of new air conditioners sold (option 4). While these are worthwhile measures, they have their limitations.

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[2] Australia has a National Electricity Market (NEM) covering all states except Western Australia and the Northern Territory, which are not interconnected with the main grid covering the southern and eastern States.

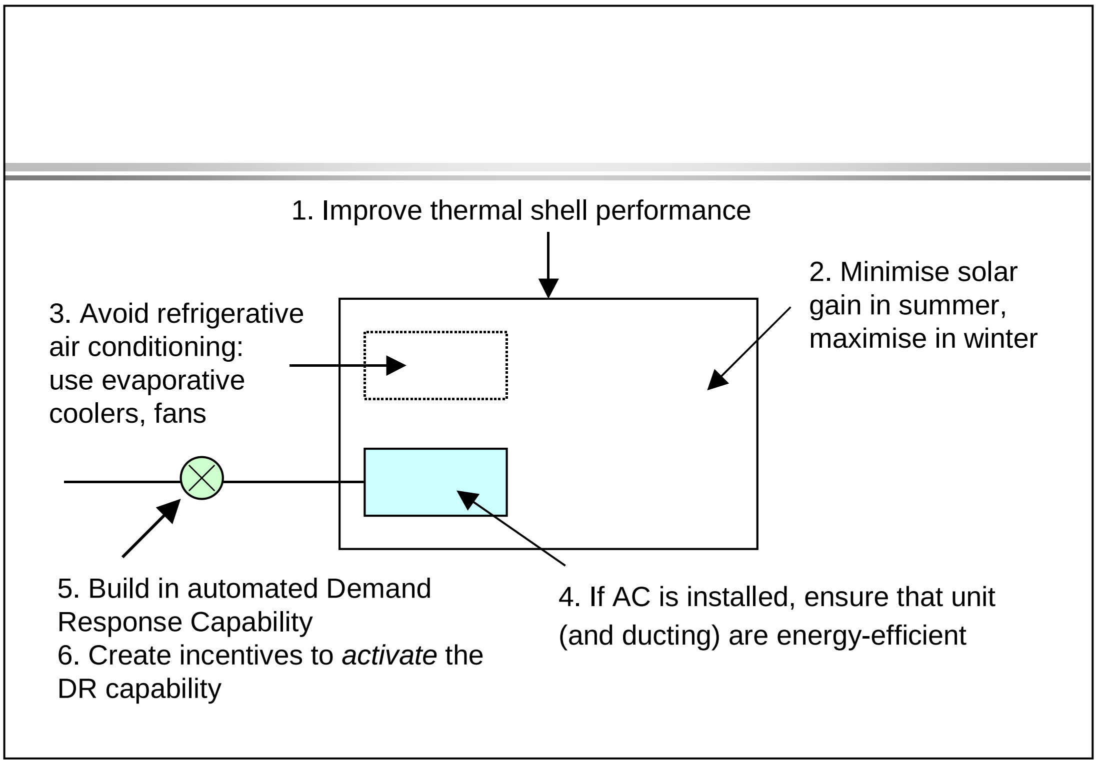

Figure 2: Policy Response Options for Containing Air Conditioner Peak Load

Building thermal performance regulations mainly target steady state heat loss or gain, and the design changes they promote are less effective in limiting the demand for intermittent cooling. Another limitation is that less than 2% of the housing stock is built new or radically refurbished each year, so the rate of improvement in thermal performance is slow. For example, an increase in the thermal performance level of the entire housing stock in the state of Victoria to ‘5 star’ standard from the present 2.2 star average (measured using the AccuRate thermal simulation model) would have reduced the peak load in the residential sector in 2002 by about 530 MW on extreme days [2]. The 5 star level was adopted as a minimum requirement for new homes built after June 2004. At the current stock replacement rate (2%) the peak load reduction from improvements in new dwelling thermal performance standards is only about 10MW per year. In 2005-06, the difference between average summer peak day and extreme day demand in Victoria was already estimated at about 860 MW (NEMMCO 2005). In other words, reliance on this policy option alone would take about 86 years to deal with the *present* level of extreme day peak demand in Victoria, let alone the projected growth.

Properly designed 5 star homes should not need air conditioning. If air conditioner installation in new homes were actively discouraged, building thermal performance standards would be a far more effective policy response to containing peak load. However, there are currently no programs aimed at avoiding the installation of air conditioning, even in houses that are designed well enough to not need it (option 3). To be effective, a program of this type would need to based on price – eg by rolling in the peak demand costs into an up-front capital charge payable at the time of air conditioner purchase. Once installed, an air conditioner will almost certainly be used, even if comfort conditions are such that the householder would normally tolerate them.

Greater energy efficiency (option 4) can work more rapidly than building standards, since about 6 to 8 times as many air conditioners are installed as homes built each year. Although air conditioner energy-efficiency has improved markedly since the introduction of energy labelling and Minimum Energy Performance Standards (MEPS), and MEPS levels are due to become significantly more stringent in 2008, the effect on peak load is limited. Most manufacturers will achieve higher efficiency by increasing cooling output rather than by reducing motor power. Where the air conditioner is used in a thermally efficient house and is well controlled, this should reduce both energy and peak demand, but if not then the motor demand will be the same, although cooling output will be higher.

The recognition that existing policies are not adequate on their own has led to the serious consideration of programs that directly target the operation of air conditioners at peak times (options 5 and 6 in Figure 2). This means the development of a demand response capability (DRC) in air conditioners, so that householders – or better still, the air conditioners themselves – can respond to price and other signals.

Time of Use Electricity Tariffs and Demand Response

Many electricity utilities, especially in the USA, have experimented with programs in which air conditioner users are invited to surrender some measure of control over the operation of their air conditioner in return for a lower electricity tariff at other times.

In general, these arrangements are an imperfect proxy for time of use pricing. Some rely on the householder to respond manually when advised of high price periods, eg by switching off or setting down appliances, including air conditioners. Others allow the utility to remotely reset the thermostat or interrupt operation altogether for short periods, usually giving the user the option to over-ride the control and accept the high price. The costs of implementing and operating these programs tends to be high, because the utility has to invest heavily in hardware and software, often from a single proprietary source. A large part of the cost is in the last link connecting the utility's control system with the appliance. The costs of recruiting and retaining customers is also high.

The costs of such programs could be reduced very significantly if:

- Time of use pricing became the norm for householders, so they became accustomed to facing the full costs of supply during peak and extreme peak periods, and conversely were offered low rates at other times;
- Response to price signals could be automated rather than manual; householders could preset their preferred response to periods of high price – eg by specifying a priority order for load curtailment – but could always over-ride their preference and accept the higher price;
- Air conditioners could be designed to operate more intelligently and flexibly, eg by pre-cooling in anticipation of pre-signalled high price periods and optimising their operation within power constraints during those periods;
- The communications and switching capability which now has to be installed by the electricity supplier were already installed in the appliance or in a standard household controller, and could be remotely accessed and activated by the electricity supplier via a set of agreed protocols.

Some of these conditions are now being met in Australia. Several large electricity distributors are planning to roll out 'smart' time of use meters, although their motivation may be more to recover the costs of supply at high price periods rather than to offer customers ways to reduce their price exposure. It will most likely be up to governments and regulators to ensure that the costs of purchasing and operating air conditioners are clearly signalled to customers, and to ensure that customers are given the option to avoid high prices rather than just to pay them. Electricity regulators are becoming increasingly interested in promoting approaches and technologies which can compete with supply in terms of availability and price, and demand response, like energy efficiency, is a direct competitor for investment in electricity supply infrastructure.

Demand response programs in Australia so far have mainly concentrated on business electricity users, who can commit to withdrawing large blocks of load during peak periods. However, the scope for aggregating demand reductions from household users is increasing as technology changes. The need to do so is also increasing: the peak load from household air conditioning is growing so rapidly in Australia that it will soon use up the buffer of load reduction available from large users.

The A-HELP Project

Australia's energy labelling and MEPS program is jointly operated by agencies of the Federal, State and Territory governments.[3] In 2004 the Australian Greenhouse Office (AGO) was requested by governments to investigate the use of the EEEP to address peak load issues in air conditioning. A study commissioned by the AGO was published in late 2004.[3]

The study suggested using the EEEP's existing influence over energy efficiency standards and other aspects of air conditioner performance to develop and promote demand response capability in air conditioners and in other household appliances. Subsequent research indicated that there are already many technical solutions to this.[6] Some capabilities are already embedded in current models, and more are being developed, either by manufacturers working in isolation or by consortia formed for this purpose in several countries.

Indeed, the problem is not technology but standardisation. There are so many different approaches, standards and protocols that product buyers, electricity suppliers and other stakeholders do not have a simple, consistent way to assess the capabilities of alternative products or compatibility with their

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[3] The program, formerly known as the National Appliance and Equipment Energy Efficiency Program (NAEEEP) was renamed the Equipment Energy Efficiency Program (EEEP) in 2005, when New Zealand formally became a partner.

own communications and control systems, proposed demand management programs and electricity pricing strategies

In early 2005 the AGO initiated the Australian Household Electricity Load-Management Platform (A-HELP) project. The aim of the project is to build a large scale, reliable and low cost demand response capability (DRC) in the household appliance stock, by standardising the main elements, *starting from the appliance end.* This will enable providers of the upstream elements of DRC systems, including metering and control gear suppliers, to take advantage of the capability at low cost.

A-HELP is not so much a single project as a framework and a point of focus for a range of projects and activities, not all managed by the AGO. In the year since A-HELP was initiated, a large number of organisations have become involved, including the principal manufacturers and importers of air conditioners and their industry association, the largest operators of electricity distribution networks and their industry association, home automation system suppliers, professional organisations, university departments and research organisations.

Many of these stakeholders have of course been aware of and working on peak load management, but have not previously been able to identify or engage with other stakeholders. After a series of informal meetings, the AGO referred the matter to the national standards-setting body, Standards Australia, which provides a forum for taking the concept further through its committee structure.

Demand Response Standards and their Application

In January 2006 Standards Australia formed a new committee (designated EL-054, Remote Demand Management of Electrical Products) and published a draft *Classification code for demand response capabilities of electrical products* to give committee participants an initial focus for discussion.[4]

The primary functional elements defining demand response capability, illustrated in Figure 3, are:

- The mode of signalling from the electricity supplier, demand response aggregator or other external agent to the customer's site (some typical options are listed in Table 1); this indicates the communications services and hardware that the external agent will need to provide or utilise;
- The additional hardware (if any) that must be present on site (options listed in Table 2);
- The level of demand response capability of the end use device (usually but not necessarily an air conditioner) (options listed in Table 3).

The fourth primary element is whether the installation is capable of one-way signalling only, so the utility has no direct verification of response, or two-way (duplex) communications.

The technical pathways for achieving these functions, including the performance requirements for different types of equipment and the rules for interfacing between them, are secondary. In fact there are many existing standards defining these already. It is not the intention to create new technical standards but to identify existing ones, to assess their consistency with the proposed functional classification and, if they are compatible, to reference them from the high-level functional standard.

Some examples of the application of the typology are as follows:

- X0 is the existing (baseline) situation – no communications, no DRC.
- Aa1.1 describes a ripple controller based system needing a receiver external to the appliance.
- Dx4.2 describes an internet based system that communicates (2-way) directly with the appliance, provided the correct modem card is installed.
- Bg3.1 describes an arrangement where a 'Smart' controller receives A power-line internet signal and switches the appliance via a 'dRy' contact. If the controller initiates the event in response tO a dynamic price signal received by a smart meter, and could siGnal this response back the utility (by whatever pathway), the cOnfiguration would be Bfg3.2.

A classification method of this tyPe (if not like this is in every detail) can be useful in a numbEr of ways. Utilities can clearly specify to product suppliers the types of configurations they require, or wish to promote, to support their demand management objectives and program designs.

Appliance suppliers can indicate the level of DRC built into their products, to assist utilities, demand aggregators or product purchasers who wish to participate in DM programs,. Suppliers of signalling and mediation equipment can indicate which configuration/s their equipment supports.

The classification provides a basis for determining compliance, eg the supplier of an air-conditioner with a built-in (or optional) DRC card could state: 'This equipment (or configuration of equipment, if

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[4] At the time of writing the draft was available at http://www.saiglobal.com/shop/Script/Details.asp?DocN=MSWD06011ATCRD. The comment period closed on 17 March 2006, and EL-O54 met for the first time in May 2006. It is likely that there will be significant changes from the Draft, the main concepts from which are summarised in the present paper.

installed together) meets the requirements of Classification Ax5.2. Bx5.2 and Gx5.2 of AS/NZS Standard ZZZZ.200X, *Classification code for demand response capabilities of electrical products*.'

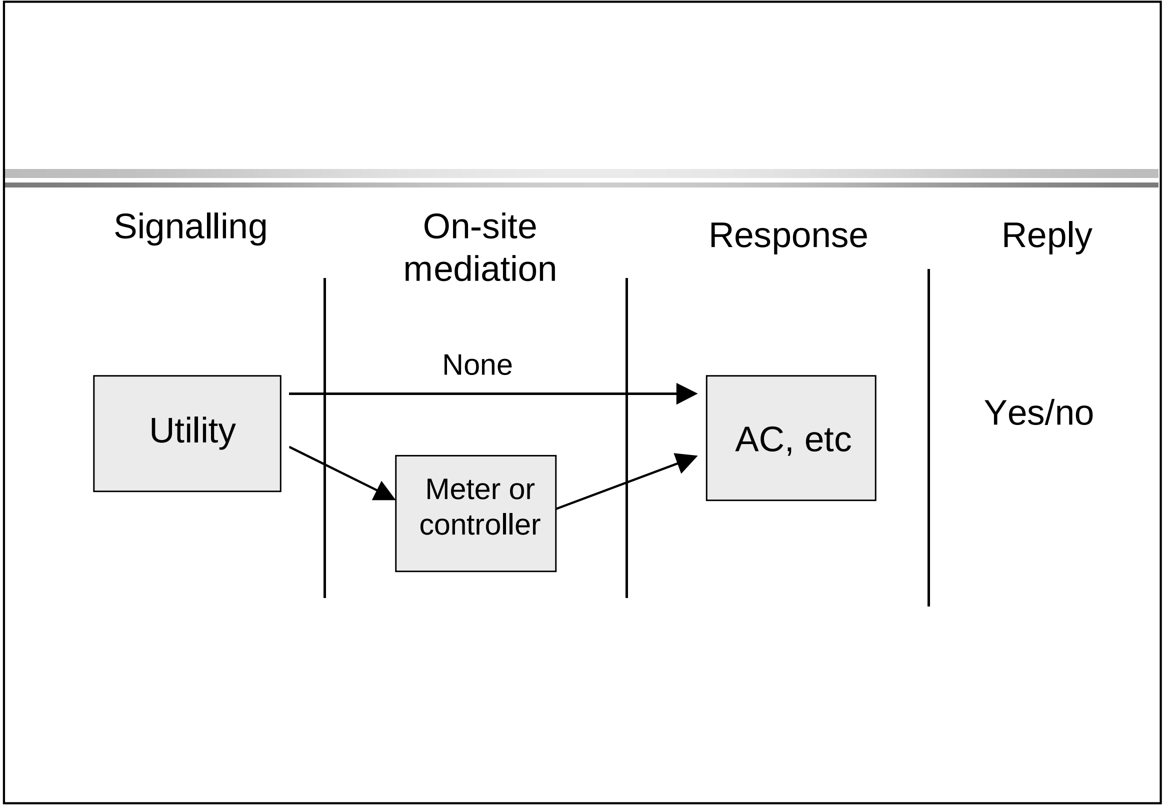

Figure 3: Proposed Standard Demand Response Capability (DRC) Classification

Table 1: Possible Standard Classification for Signalling

Type	Description
X	No means of communication, or no means of accessing it
A	Ripple control signal
B	Other powerline-carried signal (eg powerline internet) activation signal
C	Landline dialup internet
D	Landline broadband internet (copper, cable or fibre)
E	Landline other
F	Wireless internet
G	Wireless other (eg GSM, pager)
H	Other

Table 2: Possible Standard Classification for Signal Pathway and Mediation

Type	Description
x	No on-site mediation – utility signal goes straight to target appliance
a	Ripple relay receiver (hard wired – separate or built in to meter)
b	Ripple relay receiver (plug-in, for use at appliance power outlet)
c	Modem for internet
d	Wireless receiver
e	Simple interval meter (ie intelligence for price-response DRC resides elsewhere)
f	Smart interval meter (can initiate price-response DRC)
g	Multi-function 'Smart' controller
h	Other

Table 3: Possible Standard Classification for Appliance DRC

Type	Description
0	No known capability (ie either not meeting higher criteria, or not tested)
1	Can only be controlled by external power interrupt, but will restart after power resumes
2	Can be controlled by control circuit interrupt (eg compressor contactor) but no pre-existing contacts for that purpose (so needs on-site modification)
3	Equipped with external control ('dry') contacts (needs on-site cabling, but no modification of equipment itself)
4	Capable of off /on or other responses (eg settings) to external control signal/s, subject to installation setup, but no other on-site modification
5	Capable of off /on or other responses to external control signal/s, irrespective of installation setup (eg multi-function card in all units sold)

Perhaps the most powerful application of the typology will be in the interaction of the energy labelling and MEPS program and electricity utility demand management incentives. Air conditioner suppliers could choose to state whether their products were compatible with specific DRC functions, and buyers who wished to participate in their utility's DM program could identify those products and receive a rebate for purchasing them. Just as energy labelling stimulated the market for energy-efficient appliances, it can also stimulate the market for demand response.

Once there were enough products with DRC available, it would be open to governments to mandate disclosure of the level of DRC on the energy label. A suitable opportunity to do this may be at the proposed rescaling of the air conditioner energy label following the planned introduction of the more stringent MEPS for single phase air conditioners in 2008. Ultimately, meeting a minimum level of DRC could become a mandatory performance requirement, like meeting a minimum level of energy-efficiency. Any mandatory requirements would of course be subject to formal benefit-cost analysis and regulation impact assessment.

Increasing the availability and sales of DRC-compatible air conditioners would lower the costs of implementing load control programs, but would not of itself compel utilities to offer such programs or motivate consumers to participate. However, introducing DRC factors into the purchase process would facilitate other potential measures, such as requiring air conditioner buyers to install smart metering and to go on time of use tariffs. Another option would be to include a 'demand management bond' (say $500-$1,000) in the air conditioner purchase price, to be redeemable on connection to a time of use tariff or after a specified period of participation in a utility load control program.

Measures such as these may appear draconian and politically risky for governments, but they may well be less unattractive than the alternatives. They are justified on equity grounds, to reduce the cross-subsidy burden on non-air conditioner households and other electricity users, and on the grounds of increasing the security of electricity supply in a period where one of the highest risks of supply disruption is from air conditioner load. They would also have the benefit of increasing the competitiveness of demand-side responses in the national electricity market, by enabling the cost-effective aggregation and block demand bidding of air conditioner loads.

Costs and Benefits

The potential benefits of a large scale demand response capability are in some ways easier to quantify than the costs. Unpublished simulation work carried for the A-HELP project suggests that if about a quarter of the household air conditioners in the NEM area in 2004 had participated in DRC programs, the total saving to all electricity users would have been up to AU$ 1,345 million in that year alone. About 92% of this saving would have been from avoiding or reducing the operation of the highest-cost generators, and the rest from deferring network augmentation.

The simulated burden on participating air conditioner households was relatively light: not more than 0.5 hours off in every 4.5 hour period during the ten periods of highest wholesale pool prices. Whether that response were achieved by off—on switching by external agents (DRC Types 1 to 3 in Table 3), or by an average of 11% reduction in average load (Types 4 and 5 in Table 3) is immaterial to the outcome, but important to the program cost and level of customer acceptance.

The value of a demand response capability of this magnitude would be over AU$ 1,000 per annum per participating air conditioner. As the benefits would be distributed across all electricity users (including non-residential customers, households without air conditioners and air conditioner households not participating in the DRC program) the benefit accruing directly to participants would have been much lower. It would be up to regulators, electricity utilities and DRC aggregators to devise arrangements which capture the benefits and offer air conditioner households a high enough share of it so that they have an incentive to participate.

The costs of including a standardised demand response capability in every air conditioner sold cannot yet be known. However, they are certain to be significantly less than trying to add such a capability in the field after the air conditioner is installed. The capability could also be incorporated in other readily curtailable loads such as the controllers for swimming pool pumps (present in about one in ten Australian households), and possibly day rate electric water heaters. (Night rate or off-peak electric water heaters, common in Australia, are already under electricity system control. The scope for demand response in products such as clothes washers, clothes dryers or dishwashers may be limited due to safety concerns such as risk of fire or restart without warning, and the power reductions would be relatively minor).

The technology already exists to enable all the demand response capable appliances in a house (or a street, or an entire neighbourhood) to exchange information during high electricity price events, to optimise the collective response of all participants (within the constraints set by each householder), and to share the resulting cost savings.

International Implications

The great majority of air conditioners sold in Australia are imported and Australia is a relatively small market for air conditioners by world standards. The success of the A-HELP project relies heavily on the participation of global suppliers, who cannot be expected to incorporate DRC features (at however low a cost) without sufficient market demand.

Demand response and time of use electricity pricing in a less regulated utility environment are issues common to most developed economies. Developing economies face even larger problems from air conditioner load, since pricing tend to be even less cost-reflective and the supply systems operate under greater stress. The issue is probably even more pressing for economies at the beginning of the inevitable growth path in air conditioner ownership than for countries such as the USA, where air conditioner ownership and use are fairly mature.

The AGO has taken steps to engage the International Energy Agency (IEA) Demand Side Management Task (15 and 12) and the Asia-Pacific Economic Cooperation (APEC), to ensure that developments in Australia will be consistent with, and possibly become a model for, international standardisation. The AGO, with IEA support, is proposing to sponsor international workshops on the subject, possibly to be held in Europe and in Asia, over the next year.

The AGO has also proposed the inclusion of A-HELP and DRC in general in the scope of its Memoranda of Understanding with government agencies in the USA and in the Republic of Korea (the latter being the source of a large share of the air conditioners sold in Australia). It is proposed that the countries explore the scope for a common approach to direct load control. This will require discussions between government agencies, standards bodies, electricity utility interests and air conditioner manufacturer associations in the two countries.

Conclusions

Continuing growth in air conditioner use is inevitable, in Australia and elsewhere, due to a combination of greater wealth, changes in the built environment and global warming. Extreme day peak demand from household air conditioners is becoming one of the key drivers in electricity system capital investment, and one the main risks to supply system stability.

Energy-efficiency measures and programs have only a limited impact. A combination of time of use pricing and demand response is a more powerful strategy. Efforts to date have suffered from high costs and from limited application geographically. Costs can be radically lowered by standardising the hardware and software of demand response and building it in to all (or most) air conditioners sold. Even if the capability is used in only a fraction of installations, or only for part of the service life of an air conditioner (eg while the local sub-station is constrained) the costs are likely to be so low, and the benefits so high, that the strategy will probably be cost-effective.

This is the focus of the A-HELP project, which focuses on the Australian air conditioner market in the first instance. However, because the problems are common to many countries, and because air conditioners are so widely traded, the solutions must also be international.

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Dynamic Demand – Can Intelligent Cold Appliances Help Balance the Electricity Network?

Joe Short[1] and Simon Leach[2]

[1]Dynamic Demand, [2]Intertek Research & Performance Testing

Abstract

Dynamic demand has the potential to deliver several potential benefits including reduced system operation costs, improved system efficiency and hence reduced carbon emissions, and the potential to help integrate greater variable generation on the system.

This paper investigates the performance of domestic cold appliances operating under dynamic demand control (DDC). The appliances monitor the grid's AC frequency (a universally available indicator of supply-demand imbalance) and switch the appliance on or off accordingly, striking a compromise between the needs of the appliance and the grid.

This paper gives results of two tests. The first involved a demonstration dynamic demand refrigerator operating under normal conditions on the UK grid for several days. The appliance was found to operate in such a way that its likelihood of being in the "ON" state was proportional to the network frequency. In other words, it tended to use power mainly when the frequency was high, i.e. when there was excess generation on the grid, indicating that many such appliances acting together may provide valuable balancing services to the National Grid.

The second test was an independent laboratory test to assess effects of dynamic demand on normal appliance operation. Under laboratory conditions, a dynamic demand fridge-freezer and freezer were monitored to discover if the modified switching pattern adversely affected appliance operation. The performance of the tested appliances depended on the variation in grid frequency and the set sensitivity (k value) of the DDC device.

Introduction

What is dynamic demand control?

`Dynamic demand control' enables individual loads (e.g. electrical appliances) to contribute essential balancing services to the power grid. Such technologies have the potential to smooth out fluctuations in the demand, and hence reduce the need for fast-reacting back-up.

There is vast potential on the demand side to provide grid-balancing services and to reduce CO_2 emissions associated with (generally less efficient) back-up generation. In principle, any appliance that operates to a `duty cycle', such as water-heaters and refrigerators, could be used to provide a constant and reliable grid balancing service at very little cost.

The technology works by altering the timing of ON cycles so that they are less likely to coincide with periods of low AC frequency. Nominally, the UK's AC frequency is 50 Hz, but in fact it drifts continuously around this number according the balance between supply and demand at any particular time.

The AC frequency is a direct result of the speed of rotation of all the generators on the system. So a low AC frequency is an indication of slow-spinning generation caused by an excess of demand. The AC frequency is the same across the entire grid and can be easily measured from any power outlet.

One of the goals of dynamic demand is to provide a service to the grid operator similar to "frequency response" which is the current method used for ensuring that generation always meets demand despite unpredicted changes in the latter. Frequency response involves the use of partly-loaded governor-controlled generation which is able to respond in real-time to the AC frequency of the grid. Partly-loaded plant is known to be less efficient than plant running at maximum output. By responding to the frequency, dynamic demand has the potential to make significant efficiency gains by loading generators more fully and hence make savings in carbon emissions.

Policy background

Dynamic demand technology is currently being defined in legislation by an amendment to the Climate Change and Sustainable Energy Bill [i] . The definition is likely to include any controller able to alter the timing or amount of energy consumption in response to the real-time AC frequency of the power system (or any value derived from the AC frequency).

The technology is currently being promoted by the not-for-profit organisation Dynamic Demand [ii], which is attempting to create the right regulatory and institutional environment for the technology to flourish.

If dynamic demand controllers can prove suitable in appliance operation, it is hoped that widespread adoption will be encouraged by a marketing incentive.

The dynamic demand algorithm

There are many conceivable approaches to delivering dynamic demand control through appliances and there are already some companies in the UK beginning to develop different approaches. The organisation Dynamic Demand is a strictly public-interest project set up to promote the technology for its potential to reduce CO_2 and has no commercial interest in any particular approach. However, we have been demonstrating and conducting preliminary tests on one particular algorithm of operation in order to assess viability.

The dynamic demand controller in these tests works to an algorithm which adjusts the temperature switching points of the thermostat by an amount proportional to the real-time frequency excursion on the grid. As frequency falls, the thermostat switching temperatures rise. This means a particular appliance is less likely to be ON during periods of low frequency.

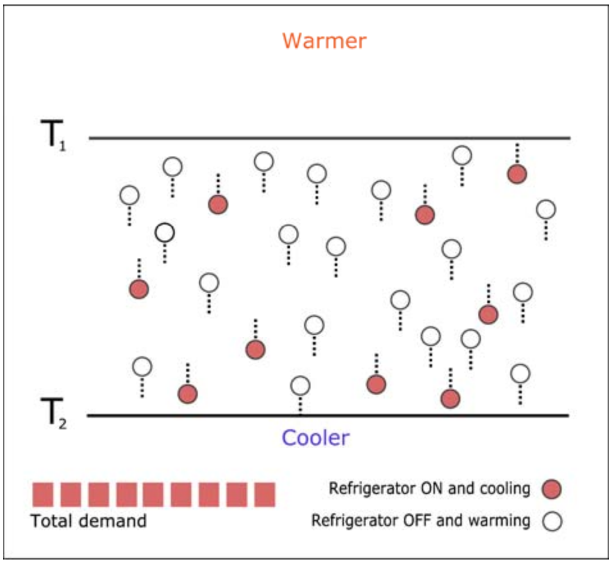
The behaviour can be summarised by the following equations.

$$T'_{high} = T_{high} - k\Delta F$$

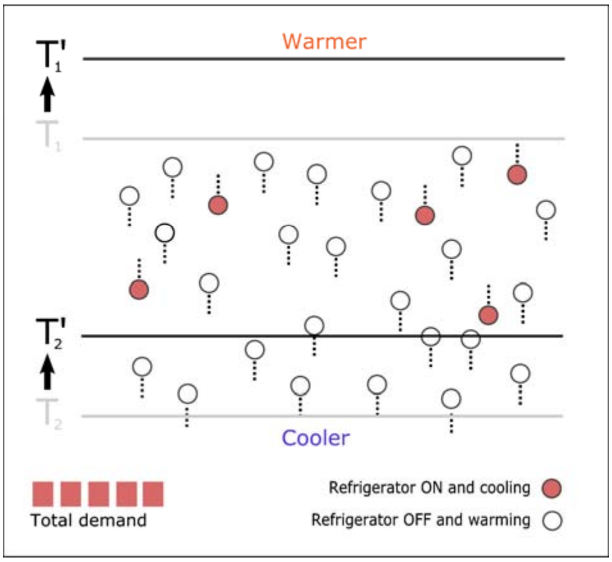
and

$$T'_{low} = T_{low} - k\Delta F$$

Where ΔF is the present frequency excursion (Hz) and k is a constant (°C/Hz) that can be changed to control the sensitivity to changes in mains frequency. The behaviour is illustrated below.



A population of appliances with different internal temperatures. Under normal operation, temperatures slowly oscillate between the two switching temperatures, T1 and T2.



The same population of appliances after a fall in system frequency. Switching temperatures have risen to T1 and T2, causing the cooler appliances to switch off early. Total demand has therefore reduced.

This algorithm, though not the only approach, seems to have four major positive aspects.

Firstly, due to differences between appliances (and between their contents and usage at any time), it can be assumed that temperatures in a population of appliances under normal conditions will be randomised. This is borne out by the fact that the aggregated demand of the refrigerators and freezers on the system today is assumed to be fairly constant, varying slightly between night and day and between summer and winter depending on ambient room temperatures. (NB: the distribution of temperatures is not in fact linear: slightly more appliances tend to be at temperatures near to T1 and T2 due to the non-linearity of how temperatures vary in time.)

Secondly, such an algorithm would not require any particular appliance to undergo two switching events in quick succession. (Some compressors are known to be unable to respond to switching events if they are too close together.) This advantage follows from the fact that once an appliance has switched (say due to its temperature falling below the bottom switching temperature, T2') it will not switch again until its temperature climbs above T1'. Even considering that T1' and T2' vary according to the grid frequency, this will be a significant amount of time later.

Thirdly, this algorithm has the advantage that, in the event of falling grid frequency (i.e. a worsening deficit of supply), the first appliances to respond by switching OFF will be the coolest ones, i.e. the ones that would soon have switched in any case had the electricity grid been in a normal state. This ensures that those appliances which participate in advantageous load-shedding are precisely those which are most suited to doing so at the time.

Fourthly, operating in this way provides a natural high-frequency response because during times of high frequency, T1' will fall causing the warmer appliances to switch ON early and increasing overall demand, soaking up some of the excess generation.

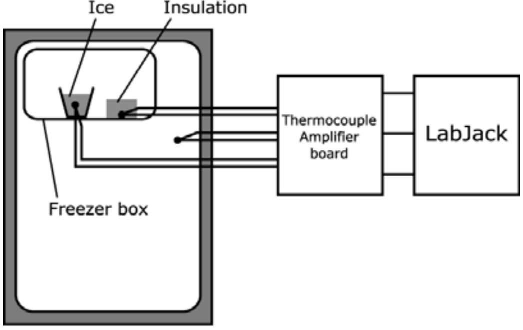
NB, Implementing dynamic demand in this way implies knowledge of the internal temperature of the appliance which raises difficulties when considering the possibility of retro-fitted. For this reason, in the exploring of the potential for this technology, we have emphasised the incorporation of the technology into new appliances. Estimates of the cost of having this capability range from 3 to 5 Euros per appliance.

Set-up for test 1 – a demonstration refrigerator

The refrigerator (a modified Zanussi under-the-counter fridge-freezer) was tested for a 30-hour period to see how it performs under dynamic demand control. The refrigerator was in a busy shared office environment (The Hub in Islington, North London) and was under normal use throughout the test.

Measuring temperature

We used a USB LabJack interface board with thermocouple amplifier board to collect and log three temperature measurements for the fridge. See below.



Set up for measuring refrigerator temperatures

Freezer Box Temperature

We placed the thermocouple in contact with the inside of the metal freezer box and then insulated it from the air space above using a foam pad.

Fridge Air Temperature

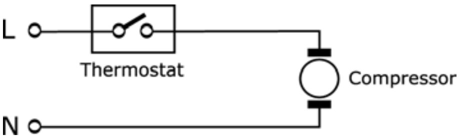
The thermocouple was suspended in the air space of the main compartment of the fridge, quite close to the fridge's built-in thermostat box.

Freezer Contents Temperature

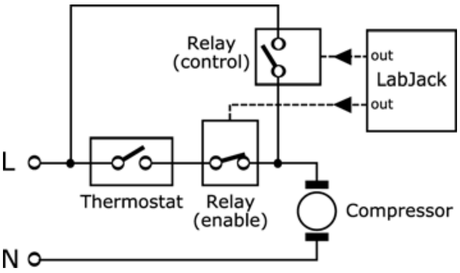
We placed the third thermocouple in a small glass of water holding approximately 0.15 litres. It was suspended in the centre of the water, which then froze. The idea was to simulate the temperature of a typical frozen food item.

Controlling the fridge

The unmodified fridge incorporated a mains-voltage thermostat which directly switched the supply to the compressor. For this experiment, we altered the wiring so that a relay switched the compressor supply instead (see below). This relay was controlled from a PC on which the dynamic demand algorithm was implemented.



Unmodified refrigerator

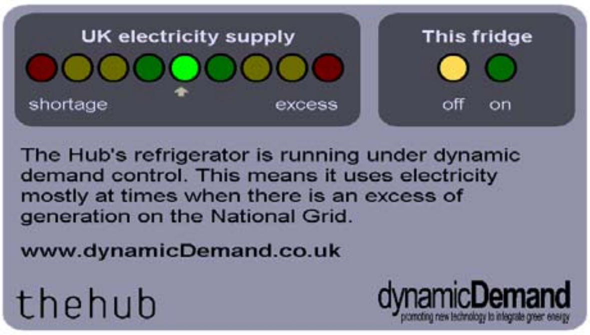


Modified refrigerator

Measuring grid frequency

We measured UK system frequency using a standard industrial transducer of the type used in power applications. The frequency was calibrated by comparing it to the National Grid website.

Further set-up details
We programmed the PC to switch the compressor ON whenever the freezer box temperature exceeded T'_{high} and OFF whenever the freezer box temperature fell below T'_{low}. The `enable' relay was kept open throughout the test. (We included this relay to ensure that in the event of a failure of the test kit, the refrigerator would return to normal thermostatic operation.)
The refrigerator was actually being used throughout the test by people working in the busy office environment where it was installed. We included an interpretation display panel shown below.



The Hub's refrigerator is running under dynamic demand control. This means it uses electricity mostly at times when there is an excess of generation on the National Grid.

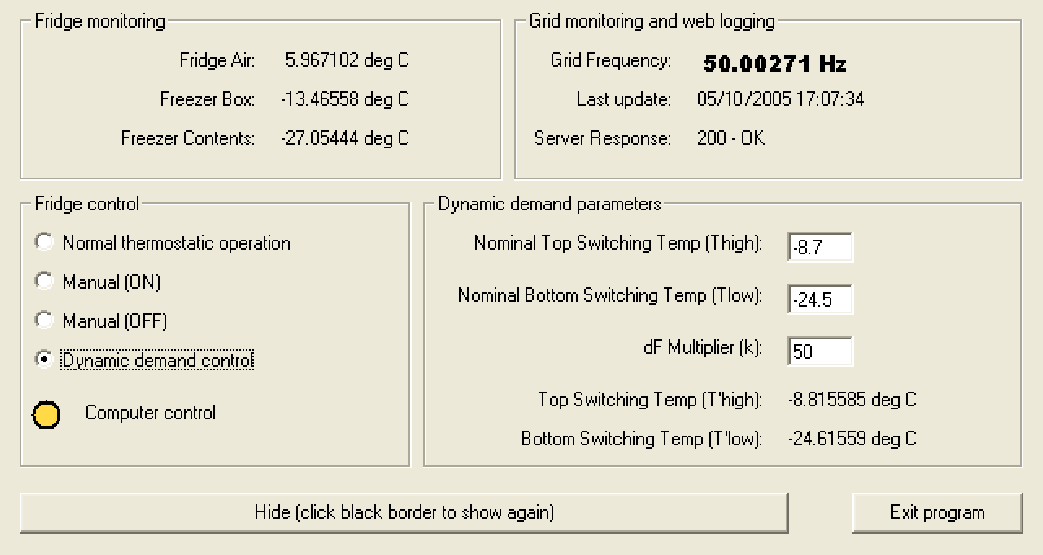
www.dynamicDemand.co.uk

thehub

dynamicDemand

An interpretation display was shown during the test run to make it clear what the refrigerator was now doing.

A technical screen showing the program in operation is shown below.



Fridge monitoring

Fridge Air: 5.967102 deg C

Freezer Box: -13.46558 deg C

Freezer Contents: -27.05444 deg C

Grid monitoring and web logging

Grid Frequency: **50.00271 Hz**

Last update: 05/10/2005 17:07:34

Server Response: 200 - OK

Fridge control

○ Normal thermostatic operation
○ Manual (ON)
○ Manual (OFF)
● Dynamic demand control

Computer control

Dynamic demand parameters

Nominal Top Switching Temp (Thigh): -8.7

Nominal Bottom Switching Temp (Tlow): -24.5

dF Multiplier (k): 50

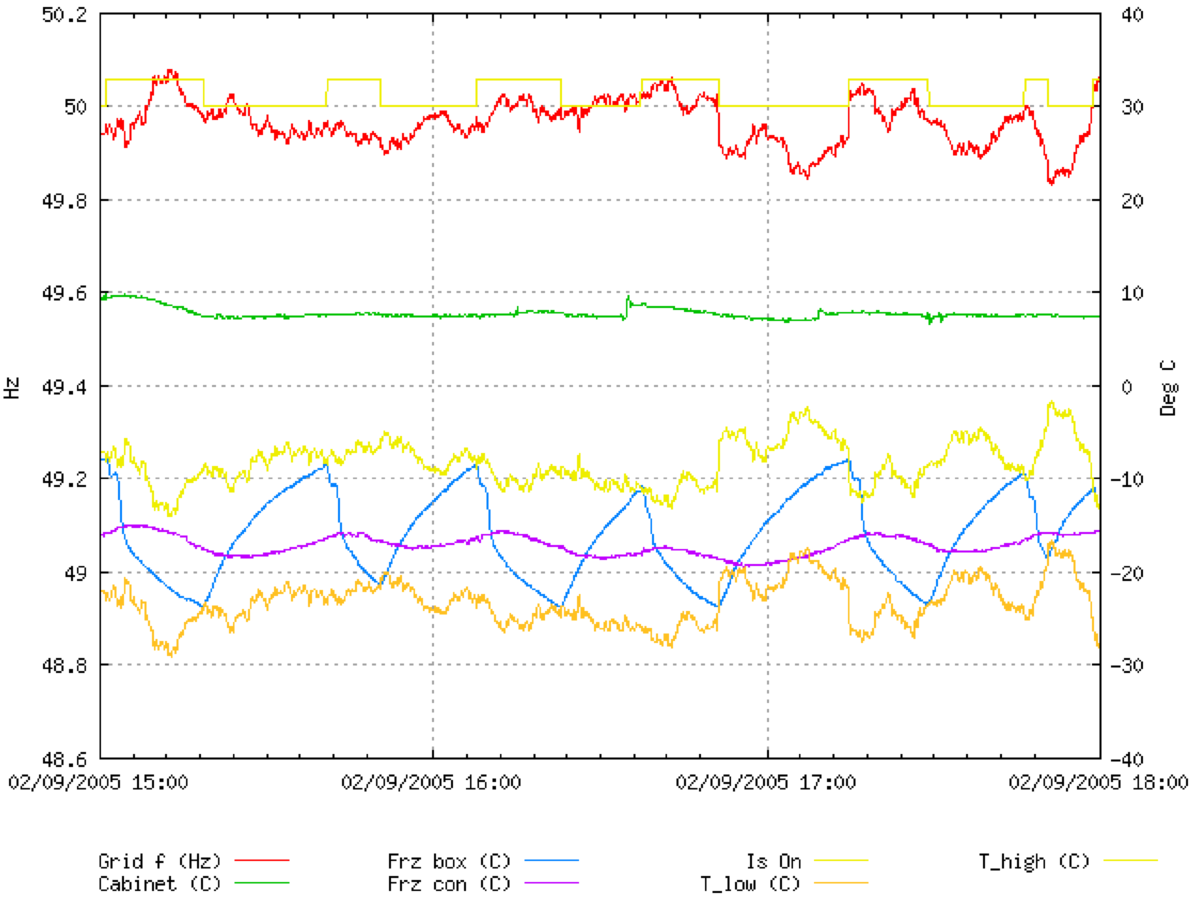
Top Switching Temp (T'high): -8.815585 deg C

Bottom Switching Temp (T'low): -24.61559 deg C

Results of test 1

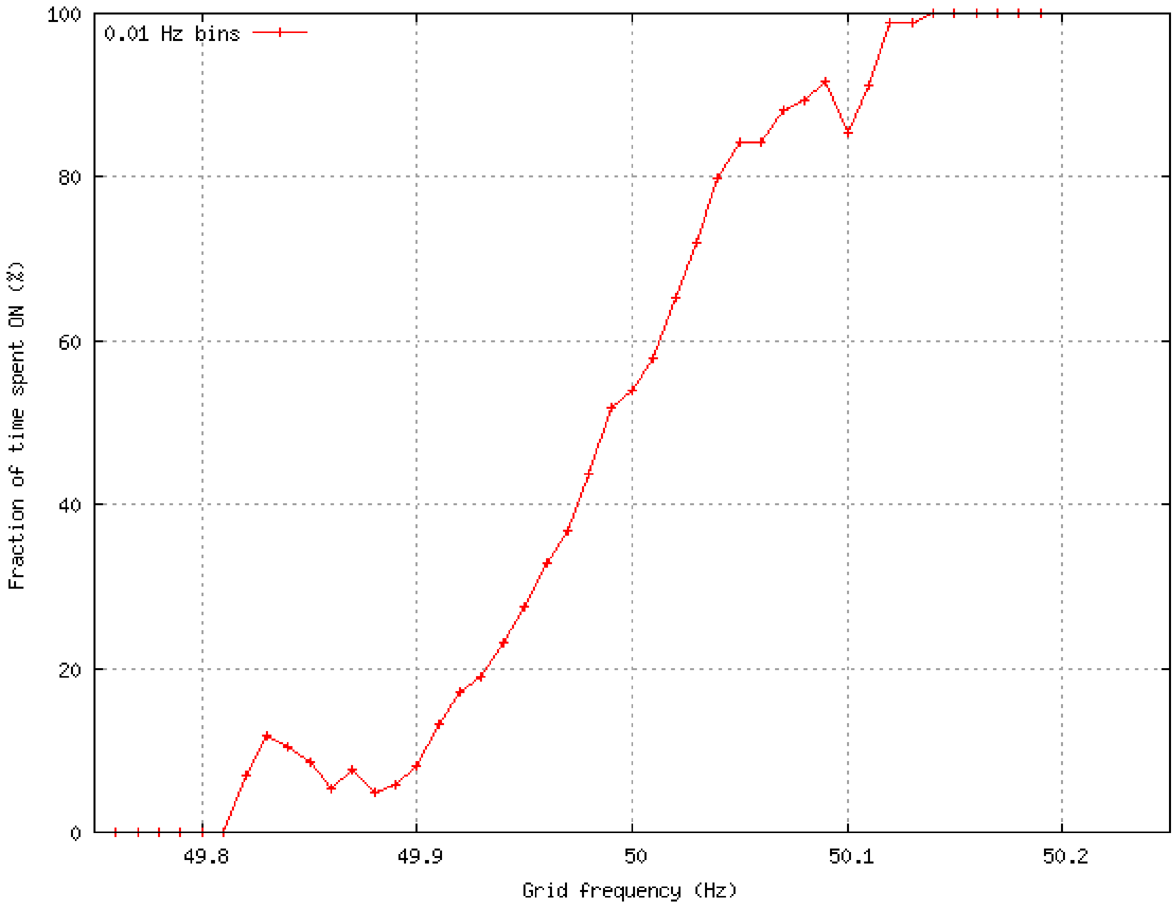
The figure below shows the internal temperatures (right-hand scale) inside the refrigerator, along with the system frequency (left-hand scale). Shown in grey are the two switching temperatures, which can be seen to vary inversely to the system frequency (shown in red).
As can be seen, the freezer box temperature (blue) "bounces" between the ceiling and floor created by the two switching temperatures. During times of low frequency, the switching temperatures were higher. This increased the likelihood that the fridge switched off earlier (or remained off for longer). Conversely, high frequencies caused the fridge to switch on early or stay on for longer.
The green line shows the cabinet air temperature. The various sudden increases are caused by the fridge door being opened. The purple line shows the temperature of food inside the freezer. This test was not designed to analyse effects on performance, which is why no comparative results are given for k=0. See results for test 2 for more information on performance impact.
Some idea of the effect of aggregating many such appliances can be seen by looking at the behaviour of this one appliance over a longer period, covering many different grid frequencies, temperatures and on/off states.

Note that given a long-term frequency excursion, it is possible that the refrigerator temperatures might stray out of the normal temperature range. This did not happen in this test due to the fact that frequency excursions tend to be very short-lived compared to the thermal timescales involved. However, in a real implementation, a narrower temperature band might be chosen to reduce this likelihood still further. Also, the original temperatures, T'_{high} and T'_{low} would probably be used to provide a safety zone beyond which the device would switch thermostatically whatever the grid frequency.



Grid frequency (left axis) and temperatures (right axis) as measured for a fridge running under dynamic demand control for a three hour period. Because the switching temperatures vary with grid frequency, the fridge tends to avoid using power during periods of low grid frequency, i.e. periods of generation deficit.

The chart below shows that the likelihood of the refrigerator being on was very dependent on the frequency of the grid. Each point on the chart represents all the times when the grid frequency was at or near a certain value (shown by the point's position on the x-axis). A point's height shows how often the fridge was on during those times. It is evident that the fridge tended to be off when the grid frequency was low.



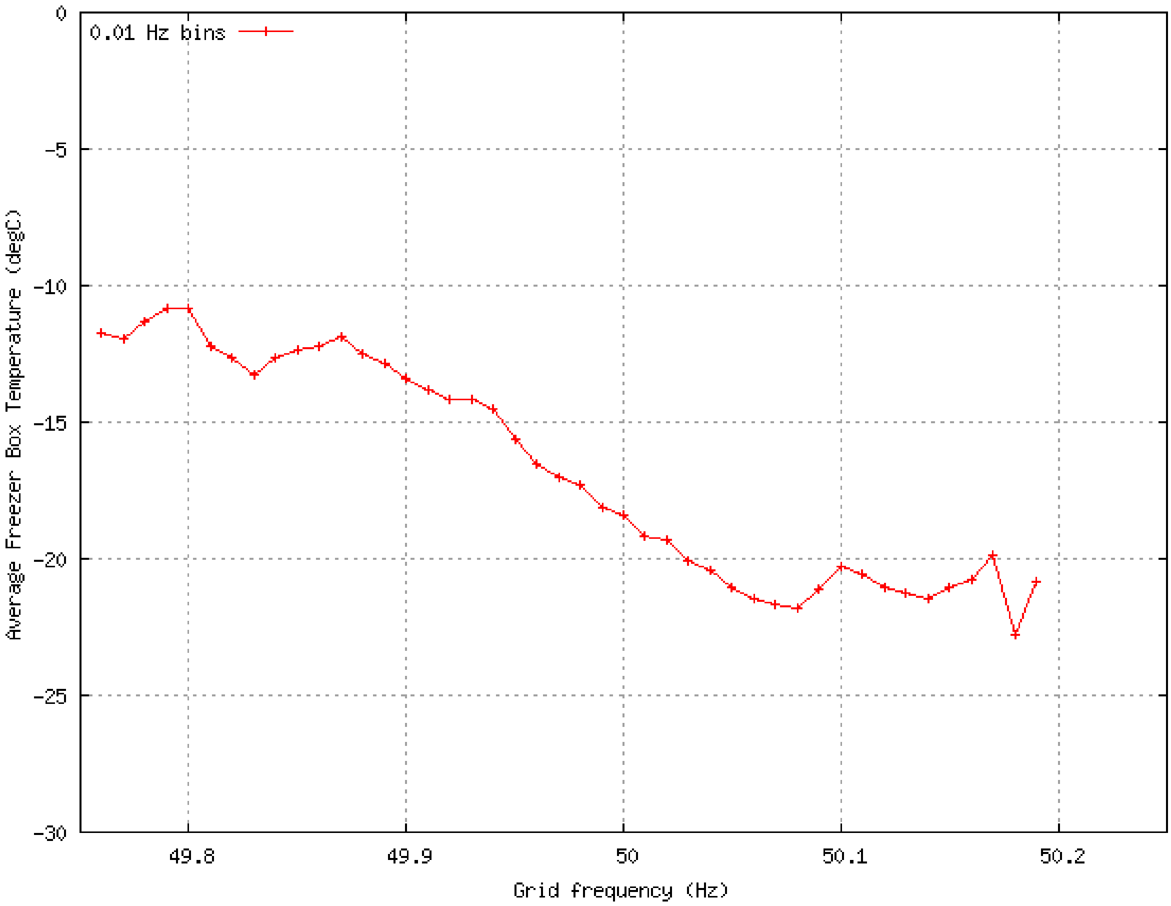
Demand-frequency dependence for a refrigerator under dynamic demand control for a 30 hour period. The chart shows that the fridge used most power during times of high grid frequency, i.e. during times of excess power on the grid.

The above graph also indicates how an aggregation of many such appliances might behave, with the left axis showing the percentage of appliances that would be on (hence the total refrigeration demand) for any particular grid frequency.

Clearly this assumes that the devices act independently of each other and do not become synchronised, or `clumped' by the continually changing frequency. (Although this assumption is backed up by a separate simulation study conducted by Dynamic Demand, we recommend that a pilot involving a large number of devices be carried out to test that it holds in practice.)

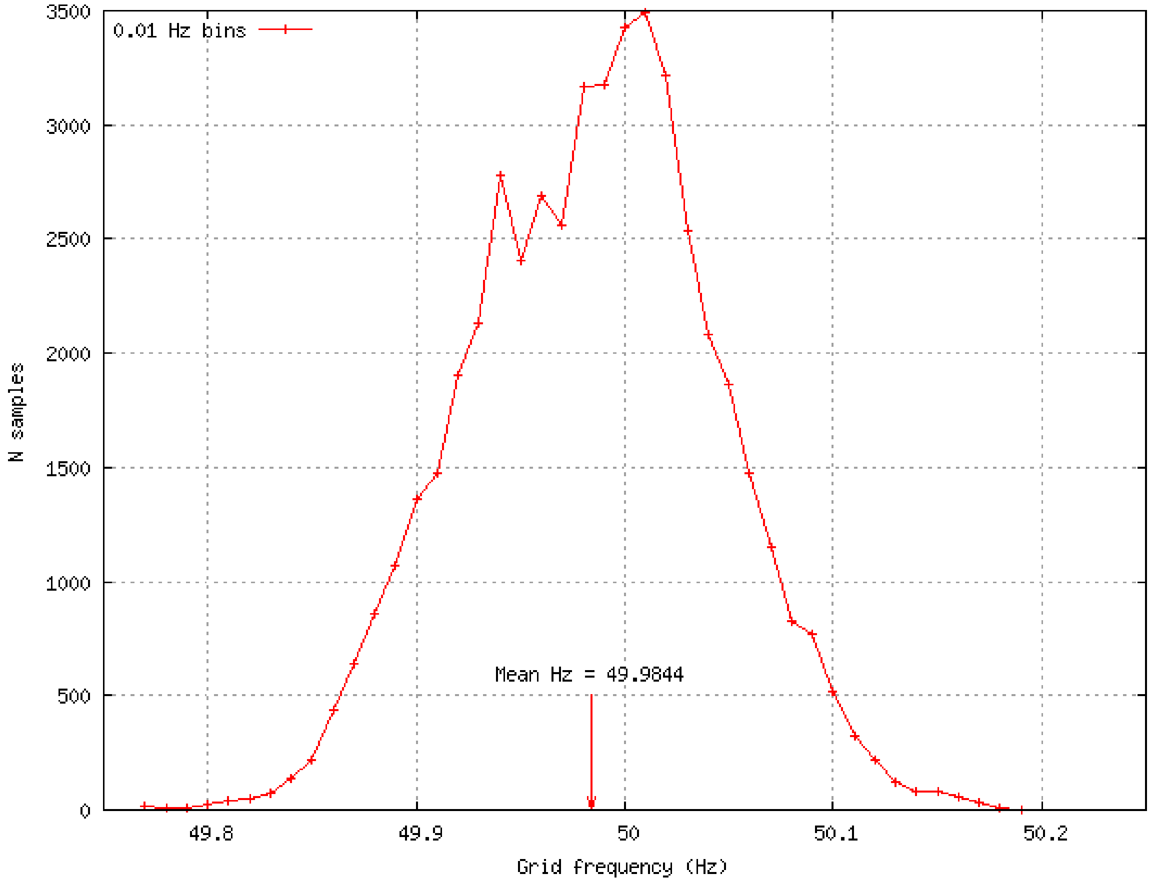
If this is the aggregate demand-frequency characteristic we can expect from a population of dynamic demand appliances, then this would imply that the characteristics of dynamic demand would resemble the characteristics of existing governor-controlled generation which generally responds, at least in the first instance, by increasing output linearly with frequency-fall.[iii]

As might be expected, there was a strong inverse relationship between freezer box temperature and grid frequency. Below can be seen that during low frequency periods, the temperature was, on average, higher than normal.



Relationship between average freezer box temperature and grid frequency. As expected, the fridge tended to be warmer when the grid is short of power.

This chart shows the distribution of grid frequencies measured throughout the test. During this period, the average (mean) frequency was found to be slightly lower than nominal. Frequency excursions below 49.85 Hz or above 50.15 Hz were extremely rare.



Distribution of grid frequency for a 30 hour period starting 31/08/2005 18:54:00. The mean frequency was slightly lower than nominal.

Conclusion from test 1: demonstration refrigerator

Test analysis showed that during low-frequency periods, i.e. during periods of power shortage on the grid, the refrigerator was more likely to be off. In fact, there was a positive near-linear relationship between the likelihood of being on and the grid frequency.

This indicates that the aggregated demand of many such devices acting together would also vary positively with frequency. This is necessary if many such devices are to be used to provide balancing services to the National Grid.

A pilot field trial using many DDC operated appliances is recommended in order to test the assumption that the temperatures and on/off states do not become synchronised over time.

Results from test 2: independent testing of performance

One fridge-freezer and one under-counter freezer, each under DDC operation were tested at the Intertek RPT laboratory on behalf of the UK Market Transformation Programme. Internal temperatures, energy consumption and mains frequency were monitored, along with on-off cycling. Each appliance was loaded with real food and standard test material (tylose) in a controlled environment set to 25° C to mimic heat ingress which might normally occur during door openings (current ISO test standard practice).

Tests were carried out initially without the DDC and then with the DDC in place of the appliance's thermostat. DDC sensitivity or k-value was initially set to zero or no sensitivity to frequency to behave like a normal thermostat. The subsequent test run were carried out with k set according to the difference in normal thermostat switching temperatures or:

$$T_{high} - T_{low}$$

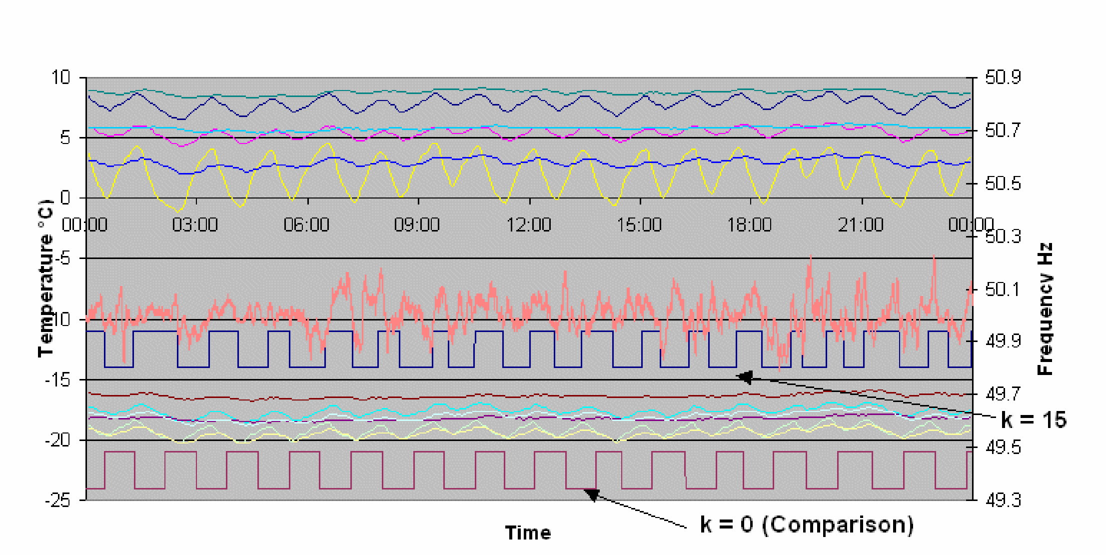
This setting was chosen in order that in a real implementation, the entire population of appliances would be forced "OFF" should frequency fall suddenly by 1Hz (an extremely unlikely event). This behaviour was chosen to mimic the “4% droop” characteristic of governor-controlled generators, whereby a fall in frequency from 51Hz to 49Hz (a fall of 4%) would cause output to increase from zero to maximum.

Further investigative test runs were carried out with k-factors in multiples of the above.

Example test results are illustrated below:

Table 1: Fridge-Freezer

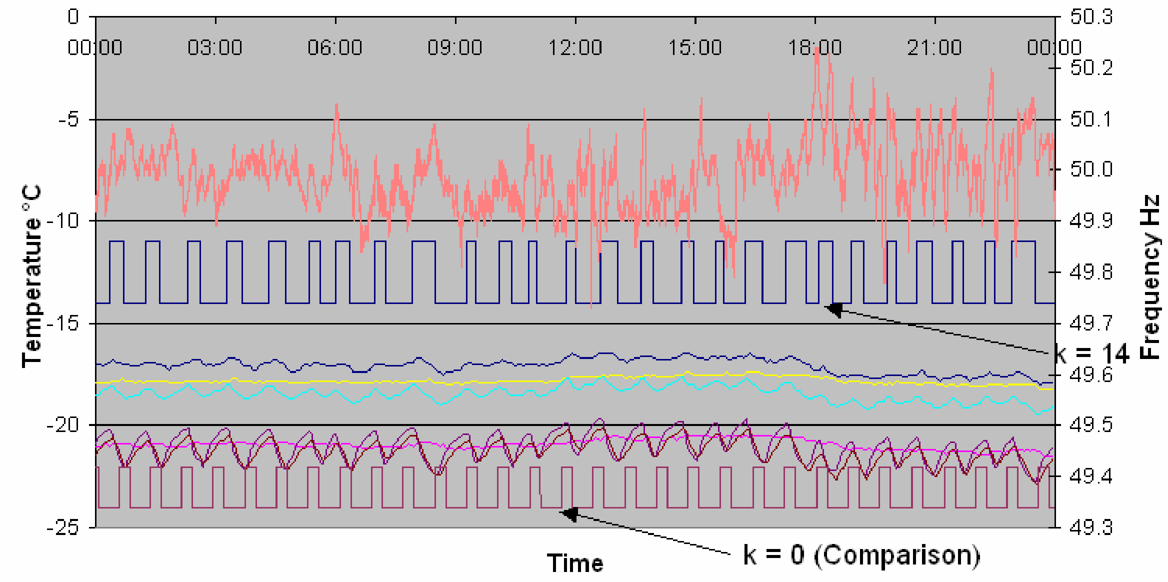
	Test Run	1	2	3	4	Max Deviation
	k factor	No DDC	k = 0	k = 30	k = 15	
Standard Thermocouples	Fg Mean ° C	5.1	4.0	5.3	5.1	+ 1.1
	Fg Max ° C	7.8	6.1	7.2	7.9	+ 1.8
Real Food	Fg Mean ° C	5.8	5.3	6.4	5.8	+ 1.1
	Fg Max ° C	8.6	8.1	9.1	8.8	+ 1.0
Standard Test Packs	Fz Max ° C	-16.5	-16.7	-15.0	-15.9	+ 1.7
	Fz Min ° C	-18.7	-19.5	-18.9	-18.6	+ 0.9
Real Food	Fz Max ° C	-17.0	-18.4	-16.2	-17.3	+ 2.2
	Fz Min ° C	-20.5	-21.1	-20.5	-20.3	+ 0.8
	Energy kWh/24h	1.03	1.10	0.984	1.04	- 0.116



Fridge-freezer k = 15 example shown below. The square waves are compressor cycling.

Table 2: Freezer

	Test Run	1	2	3	4	Max Deviation
	k factor	No DDC	k = 0	k = 7	k = 14	
Standard Test Packs	Fz Max	-17.6	-15.9	-15.9	-16.5	- 0.6
	Fz Min	-21.6	-19.9	-20.3	-21.5	- 1.6
Real Food	Fz Max	-18.5	-15.9	-17.6	-17.6	- 1.7
	Fz Min	-22.6	-19.9	-21.7	-22.9	- 3.0
	Energy kWh/24h	0.67	0.64	0.66	0.67	+ 0.03



Freezer k = 14 example shown below. The square waves are compressor cycling.

Conclusions from Test 2

DDC affected fridge temps by 1-2° C caused by "noise" on the switching temps actually increasing T*high* – T*low*.

Freezer temps: more stable under different operating conditions as expected.

Options Final Conclusions and Further Work:

These short tests attempted to mimic the same switching temps. Current further tests will try to achieve same energy consumption, by adjusting T*high*, T*low* and k as appropriate.

Appliances with fridge compartments should not be oversensitive to frequency fluctuations or DDC / thermostat control could have upper temp limit.

Fridge temps to be set to 4° C mean rather than 5° C (as per ISO 15502 Table 2).

Fridge compartments to be redesigned with thermal mass lining (eg. ice lining) and/or improved insulation eg. vacuum insulated panels.

DDC appliances essentially should be energy and temperature neutral.

Next:

DDC control of a frost free fridge-freezer currently undergoing trials at Intertek RPT (Report expected late summer 2006) since frost free appliances are an increasing portion of the domestic fridge-freezer market.

Field trial of 500 DDC cold appliances in 2007 and 2008 to be confirmed once funding is available.

Proven test results to be used in a large scale promotion of the DDC in 2008.

DDC appliances to have a financial / marketing incentive eg. "Brainy Fridge!" ESR endorsed or EEC funded or ?

Initial adoption of the DDC by some manufacturers in 2009?

Retrofit of DDC to be considered?

References

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[i] Climate Change and Sustainable Energy Bill, The Stationary Office Limited, House of Commons. See http://www.publications.parliament.uk/pa/cm200506/cmbills/017/2006017.pdf

[ii] See http://www.dynamicdemand.co.uk

[iii] The Grid System - Power and Frequency Control, National Grid Company, 1991, open Learning Materials.

Hot Water Load Control in South Africa

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Engineering Faculty, Cape Town Campus

Abstract

The paper investigates the development and use of ripple control for metering, street-lighting and hot water load control. The paper includes a study of the use of ripple control in South Africa to control domestic boilers remotely and evaluates how effective it is to implement demand side management for different tariff structures.

The algorithms used to control the hot water load are also investigated and recommendations are made to get optimum control with minimum interference and discomfort to the customer.

The paper also points out new trends, developments, present and future applications in controlling loads for the purpose of demand side management in the domestic sector. This will include the use of intelligent load control equipment with 2 way communication.

Introduction

In South Africa, like most other countries, the cost of electricity is determined to a great extent by the value of peak load during a year in relation to the average load. In order to reduce this ratio loads are analysed to determine which type of load contributes greatly to the peak demand. Figure 1 shows clearly that the domestic load is one of the loads that contributes greatly to the peak demand. This has been so for many years so South African suppliers and distributors of electricity have attempted for many years to control parts of the domestic load.

The hot water load of most South African households constitutes about 25 to 40% of the total load and the supply to water heaters can be interrupted for about an hour or two without inconveniencing the customer because of the thermal capacity of the water in the water heater. So there are many suppliers and distributors of electricity in South Africa who control the hot water load of individual customers.

The load factor (kWh produced times 100 divided by average net capacity times hours in year) of the South African supply authority, Eskom, who supplies about 97% of South Africa's electricity has increased from 52% to 69% over the last decade. So the ability to shift load away from the time of peak demand is becoming more and more important. [a]

The technology used to do this control has developed over many years and is still developing. As long ago as 1897, when electricity supply was still in its infancy, Messrs. Brown and Routin proposed to control two-rate meters by means of a contrasting type of current [1], [4]. In those days the load was mainly determined by lighting demand and was very peaky. Efforts were made to even it out by offering cheap rates at times of low demand. Other uses of electricity were promoted as a result. It is not intended to describe the development of ripple control, but a few of the early publications and first commercial ripple control systems are given in the following tables [1].

Table 1: The precursory of ripple control

Year of publication	Authors	Principle
1897	Brown & Rouin (France)	Presence or absence of a d.c. between active and earth of an a.c. network (the inverse for d.c. networks)
1901	Turpain & Renous (France)	'Hertzian waves' generated by Ruhmkorff inductor. Detection by iron-fillings detector (branley's coherer)

Table 2: The commercial ripple control systems

Year	Coding system	Coding sytem	Method of injection
1927	Cie des Compteurs (F) (Actadis)	One carrier frequency per command. Pulse duration 0.5 minute.	Sequential series injection into M.V. feeders.
1928	Durepaire-Perlat (F)	Rhythm of changing polarity impulses. 1 rhythm per command.	Injection between neutral and earth of L.V. networks.

The development of hot water load control in South Africa

In South Africa ripple control is used extensively to control domestic water heaters (or hot water cylinders or boilers or geysers) for demand side management by switching off the boilers at a large number of consumers for a short time during maximum demand periods. The first control of hot water cylinders started in Benoni in 1956 and Sasolburg in 1959. The main reason was to reduce the cost of electricity to the Municipalities, because of the electricity tariff applied by the electricity supply industry. Later the control of streetlights was added to the system. Previously it was done by timers and day/night sensors.

The conference "Domestic use of Electrical Energy" showed some of the earlier publications up until 1996 about work done in South Africa on hot water load control. From 1993 to 1996 There were at least 14 papers dealing with hot water load control and some of these papers are listed in the attached bibliography [5] to [10].

During 1997, Eskom did a large hot water load control research project [11] and [14]. The information gained from those notch tests was invaluable. More models could be developed and tested against the measured data [12], [13], [15] to [19]. The biggest gain from the notch test results is the after diversity demand information (the total demand of a group of appliances in normal use). This is explained in more detail in the following paragraph.

The controllable load of a municipality consists mainly of hot water storage cylinders (or geysers) that are collectively designated as the hot water load. An example of the total load and the uncontrollable or base load is shown in figure 1.

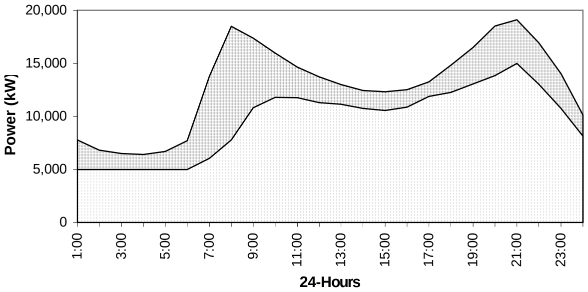

Figure 1: Total load illustrating the base load and the controllable load on top

The difference between the total load and the uncontrollable or base load in figure 1 is deemed as the controllable load (or hot water load in this case). This hot water load can be divided amongst the number of control points in order to arrive at the after-diversity demand (ADD) of the controllable hot water load as shown in figure 2.

Calculations are based on the ADD values as this allows for future load forecasting and ensures that any load that is uncontrollable at any time has no effect on the load management considerations.

The ADD graph shows that a municipality will use hot water differently during the day. The ADD graph is also unique to each municipality. Other factors, such as different consumption patterns, average element size of the hot water cylinders, outside temperature and average hot water cylinder inside temperature, will also have an influence on the graph.

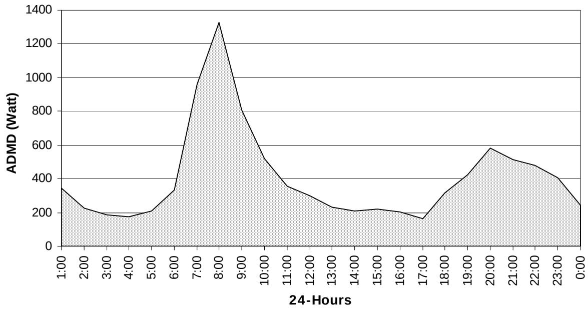

Figure 2: The ADD of the controllable load, hot water cylinders, of a municipality

This information is used to calculate the possible electricity cost saving for a municipality for a certain electricity tariff. The ADD value (per hot water cylinder) is multiplied by the number of hot water cylinders that could be controlled.

Figure 3 shows how the ADD can differ as well as what the result of a notch test looks like. The savings achieved on a R900,000 (€120 000) account per month during 2000 was in the order of R75,000 (€10 000). The tariff was a maximum demand and energy structured tariff. This was for a single customer who has many people living in university residence accommodation

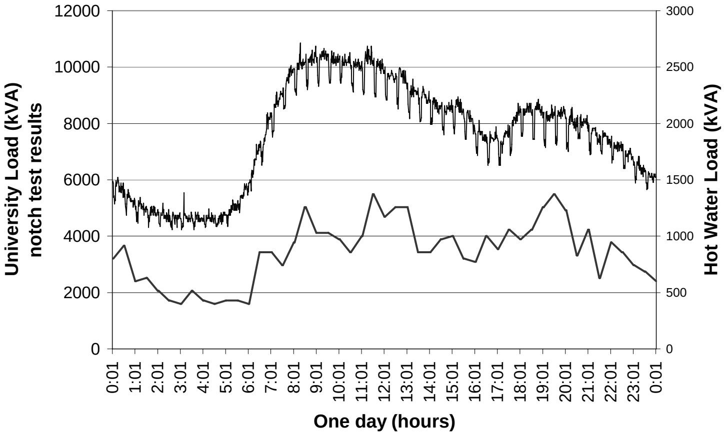

Figure 3: The notch tests and ADD of the controllable load of the University of Pretoria [21].

Using the Eskom time-of-use tariff, MegaFlex, the average saving per hot water load control switch is in the order of R 200.00 (€ 30) per year.

Current systems in South Africa

More than one hot water load control technology is used in South Africa. As previously stated, ripple control was introduced in the late 1950's. Currently ripple, radio, power line communication and combinations of radio and power line communication systems are in use. In some parts of South Africa radio technology does not work because of the demographical layout. The most common technology is ripple, but it is not necessarily financially viable for a small number of control points. Only the combined radio and power line communication technology allows for two way communication, other technologies all have only one way communication.

The highest injection voltage for ripple control is 66kV, done as a demand side management project in the Breede Valley Municipality, implemented during 2005, close to Cape Town.

Experiments have also been performed to investigate the use of free standing hot water control.[6] Fuzzy logic was used to determine the desired load pattern of hot water usage in individual households and an algorithm was developed to decrease the hot water load during peak time while minimising the possibility of users not having hot water when they wanted it. Although drift of the timing device used was considered problematic over a number of years and adjustment due to the shifting of peak periods presented a problem, the system was used very successfully in the pilot phase. Another shortcoming was the inability to respond to irregular needs due to faults in the supply chain requiring load shedding. The experience gained will prove very useful when adapting a centralised control system to suit individual customers by matching load shedding to suit the behaviour of individual customers.

Algorithms used to control the hot water load

The algorithms used to control the hot water load depend on a number of factors. Successful interventions in one municipality are not necessarily successful in other municipalities.

Normally the controlled switches will be grouped into a number of control groups, for example 20 groups. All the switches may be installed randomly. The main reason for this may be to try not to give two neighbours cold water at the same time, if the system is switching a specific group off for too long. A specific group may also be a dedicated group, for example old age homes. Those people use hot water completely different than the normal homes, so the control algorithm must take that into consideration. More examples of dedicated groupings are prisons, school hostels, hotels.

The other very important input into the control algorithm is the electricity tariff. Is the tariff a maximum demand and a single energy rate tariff, like the example of figure 3, or is it a time based energy and maximum demand tariff. The objective of the party responsible for having the control equipment installed is normally financial. So the motivation for installing the equipment is heavily influenced by the structure of the tariff. The party responsible to have the control equipment installed is normally a municipality who has to buy electricity from Eskom for resale. The structure of the tariff must be such that it motivates the municipality to improve the shape of Eskom's load curve. Another motivation for the municipality is often also to improve the shape of the load curve at any point of the network of the municipality where the municipality experiences a capacity limitation.

The reason why the maximum demand part of the tariff is so important is the recovery load. If a group is switched off for a time, then more hot water cylinders will switch on when power returns to the group than what would have been on if the power was not switched off for a time. Normally if all the switches were off for a time, the algorithm will allow the restore instruction only if the current maximum demand set point is not exceeded.

The most important point that one must remember is: Control may take place to reduce electricity cost, BUT NOT at the cost of production, in this case hot water to the customer. If a customer has cold water often, he may bypass the control in his house and the municipality will lose controllability and possible savings. Measurements have shown that during the morning and evening, when the control equipment is normally operated, approximately one third of the water heaters are switched on. Expressed in another way the average load is approximately 1 kW while the average water heater element is between 2,5 and 3 kW

The use of hot water load control to increase generation capacity

South Africa's peak demand has risen from 22 000 MW in 1990 to an expected 38The peak demand in South Africa is now very near the operating capacity of the total generating plant in the country, so South Africa is embarking on a substantial programme to increase the generating capacity. Installation of Hot water control is now planned as an alternative, cost effective way to increase generating capacity. We can also look at hot water control with another perspective. South Africa is in the process of increasing its generating capacity. Some of the options are:

- Coal power stations producing more green house gasses at a cost of R 9 000 (€1 200) per kW
- Gas fired power stations at about R 3 500 (€ 450) per kW
- Controlled Hot water cylinders at about R 2 500 (€ 350) per kW

The number of hot water cylinders in South Africa has risen from about 2 million in 1991 [20] to about 3 million now. Of these about 600 000 were controlled around the turn of the century, this gave a 360 MW saving in generating capacity [19]. Presently about 675 000 hot water cylinders are controlled. The notch tests described above show that the load which can be shed is about 1 kW per hot water cylinder during the morning peak and about 0.6 kW during the evening peak, so installing hot water load control can be compared to building a power station. The values above show that the installation of hot water load control is a cost-effective way of increasing generating capacity. Presently South African domestic customers do not have the option of a time of use customers, so the customer is not given a share of resulting savings. This has the effect that customers sometimes bypass the control equipment. Plans are in place to introduce time of use tariffs for domestic customers so that the customer can have his share of the savings. This will also counteract bypassing the control equipment.

New trends

South Africa is now experimenting with control systems having two way communication. The biggest challenge here is to obtain a cost effective technology, this applies to capital cost as well as operational cost. This technology provides the following very useful information:

- get notification of tampering,
- get hot water cylinder on / off state without doing notch tests,
- get the hot water cylinder temperature, and
- get the energy consumption of the hot water cylinder.

All these advantages will also help to make the control algorithm more customer friendly and save cost.

A need that can be ascribed to the customer is to have the hot water cylinder outlet water temperature fed back to the control switch. The switch must then have the additional intelligence, NOT to switch the hot water cylinder off, if the outlet temperature is below a certain set point. This can 'guarantee' that the customer will not have cold water.

Other controllable loads

The cost of the initial system and the load it can control determines the return on investment. The hot water cylinder is one of the largest consumers of electricity for the domestic customer, an average load of about 2.5 kW. Once the system is operational, more loads can be added. Examples are street lights, under-floor space heating and potable water pumps. These loads can then also be controlled to reduce the electrical load at peak times, thus reducing the generating capacity.
South Africa's climate is warm in summer. In the developed residential sector, a large number of houses have swimming pools. The swimming pool pump is currently under investigation to be included as a controllable load, even though the average load is only in the order of 0.75kW.

Conclusions

Hot water load control, if done properly, should be invisible to the customer. The supplier of electricity can save money, but it should never be to the discomfort of the customer.
The experience gained in South Africa with the control of hot water load over many years has put South Africa in an excellent position to use the hot water load for load shedding, without discomforting customers. The supplier and user of electricity can both benefit from cost savings that will result from this initiative. The current hot water load control systems in South Africa, can form part of the additional generating capacity that is now badly needed in South Africa as the country develops. This development is necessary in developing countries because poverty needs to be eradicated and electricity is a commodity that is a strong catalyst to improve living standards.

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Load Demand Pricing - Case Studies in Residential Buildings

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Abstract

Since the liberalisation of the Swedish electricity market in 1996, the competition between utilities has increased, and the generation capacity has gradually been adjusted to suit the demand. Consequently, the earlier excessive electricity production capacity has been reduced. However, if the gap between the generation capacity and demand will be too narrow, this may result in notable power shortages in the electricity market. In order to achieve lower load demand, to avoid load peaks and to reduce electricity cost, a Swedish electrical utility - Skånska Energi Nät AB (SENAB), is planning to include a load demand component in its electricity tariff to make customers more aware of their energy consumption pattern and (possible) load demand problems. This study investigates the impact of the new tariff from the viewpoint of the utility as well as its customers, compared to the existing tariff. The project was carried out by the Efficient Energy Use in Buildings Research Group at the Department of Energy Sciences, Lund University.

The results of the investigation show that if a load demand component were to be introduced into SENAB's network tariff, primarily customers with a 16-ampere fuse would incur higher network charges whereas customers with a higher fuse level would incur lower charges. With the existing network tariff, customers with high fuse levels pay relatively high standing charges in relation to their exploitation of the grid and as such they are subsidising customers with lower fuse levels. The study also shows that it is important that the new load demand pricing strategy (tariff) is communicated to customers in a comprehensive manner, so that they understand it and furthermore realise that they can save money by changing their energy consumption patterns without lowering their standard of living or comfort.

Introduction

Sweden has a relatively high electricity consumption per-capita, about 17 000 kWh per inhabitant annually, more than twice as high as the European Union average. In the year 2005, Sweden was in fourth place in the world, in terms of electricity consumption, after Norway, Iceland and Canada. The high electricity consumption in Sweden is due to electricity-intensive industries and the high demand for space heating caused by the cold climate. Over the past thirty years, the electricity consumption in Sweden has increased at the rate of almost 3 % annually [1].

The Swedish electricity market was reformed in 1996 and then again in 1999 for household users. As a result of the electricity market reforms, consumers may now choose their electricity supplier and all trading must be competitive. However, the grid operator can not be chosen by the consumer, and is still regulated. A corporation that pursues network operations may not pursue trading in or generation of electricity. Therefore, there must be a clear distinction between generation of and trading in electricity and network operations.

Electricity consumption varies between different hours of the day, between days of the week and between seasons of the year. The highest power demand occurs only during a few hours when the outdoor temperature drops. In recent years, the power demand has reached new peak levels but due to predominantly economic and political reasons the load reserves have dwindled. The reliability of supply criteria that determined the required peak load generation capacity before the market reform was abandoned in conjunction with the liberalisation. The problem of load capacity has become more and more obvious during the last years. According to the law (in force until March 2008) the Swedish national grid operator is obliged to ensure reliability of electricity supply by purchasing reserve capacity.

One possible solution to the load problem may be the introduction of a new pricing strategy with a load demand component, which means that consumers pay for load demand instead of electricity consumption only. In this way, the customers would be more aware of their energy consumption pattern and may be incited to lower the load demand, which could help the utility to avoid high load peaks.

The objective of this study was to investigate how such a tariff would affect one of the Swedish electricity utilities and its more than 16 000 electricity customers.

Electricity price at user level

The total electricity price charged to the Swedish customers consists today typically of three parts: electricity fee, network fee and taxes.

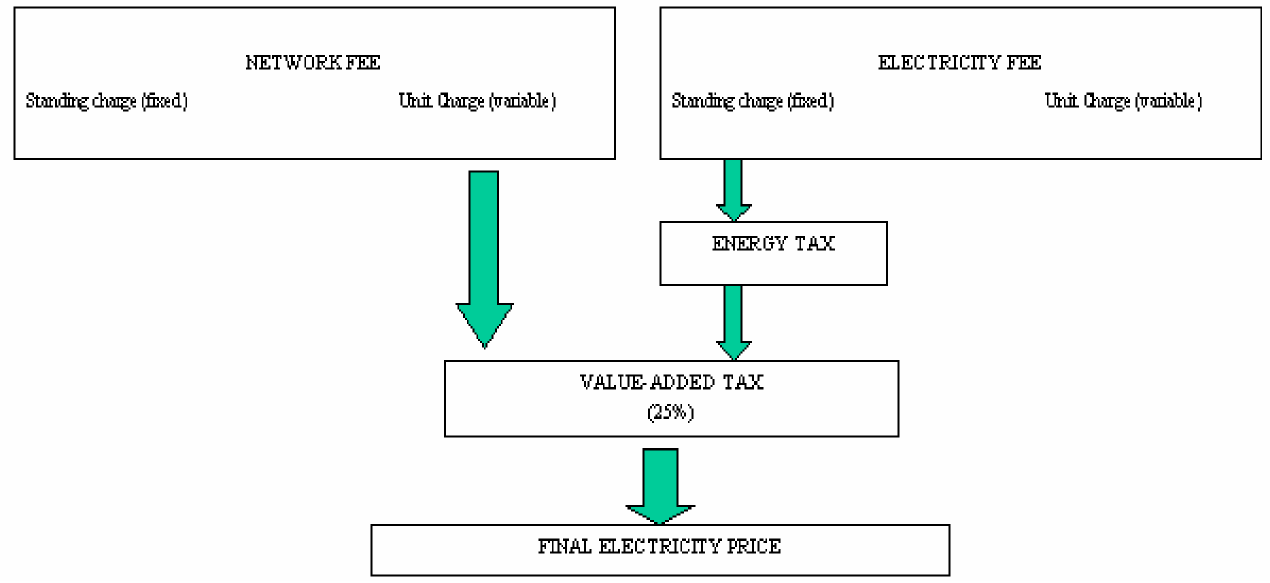

Figure 1: Residential electricity price structure [4].

The only part of the electricity bill that the customers themselves are able to influence is the electricity fee. All customers have the opportunity to switch their electricity supplier or renegotiate their existing contract, and, in this way, get a lower price.

The second part of the total electricity price, the network fee, is paid to the network owner in the area. The network owner provides the physical transmission of electricity from the generation plants to the end-user. Customers cannot choose their network provider so the network fee must be reasonable and non-discriminatory. Network tariffs are supervised and published by the Swedish Energy Agency.

The third part of the electricity charge is taxes. In Sweden, like in all the other Nordic countries, the consumption of electricity is taxed. Swedish customers have to pay two different types of taxes, an energy tax and a value added tax (VAT). The energy tax for domestic customers depends on the region. Industries pay no taxes at all at user level. The VAT is applied to the total price of electricity, including the energy tax.

About 40 % of the total electricity price to a domestic customer is the price of electrical energy, 20 % is the share of the network tariff and taxes account for 40 % [2].

Residential electricity customers can often receive two bills: one from the electricity supplier and another one from the electricity grid company in the area. Both bills divide the fees into variable (depending on the amount of electricity used) and standing subscription fees (see Figure 1). The variable fee on the network bill is the charge for transmission and network services. The fixed part is based on the main fuse used in the household and includes also governmental charges (as green certificates etc) [3].

Previous experience from load demand tariffs

The main purpose of implementing a load demand component into electricity pricing is to draw the customer's attention to load demand (kW) rather than energy demand (kWh). In this way, customers will hopefully become more conscious of their energy consumption pattern and possible load demand problems.

As of January 1st 2001, Sollentuna Energi became the first Swedish energy utility to have incorporated a load component into their grid tariff. Their experience is therefore of great interest when other utilities are investigating the possibility of implementing load based electricity pricing strategies.

Sollentuna Energi's load charge depends on the customer's average load value of three daily 1-hour load peaks during one month. This means that through achieving more even electricity use pattern, customers can lower their network bill. The utility introduced the new tariff in a broad campaign explaining "load demand" terms and giving many advices about different ways to lower load demand in residential buildings, with and without electrical heating.

Sollentuna Energi's new tariff showed that customers living in flats with a 16 ampere fuse level had paid, with the old tariff, a lower grid fee than other customers. Some customers in flats had a surprisingly high load demand and relatively large electricity use. Generally speaking, customers living in flats with a 16 ampere fuse level incurred small increase in their grid fee while customers with higher fuse levels (25 – 63 ampere) got a significant price reduction [5]. According to the evaluation made by the utility itself it was possible to lower load demand about 5 % thanks to this new load based tariff.

The experience from Sollentuna Energi also shows the importance of customers' understanding the difference between "power/load" and "energy" terms. In a study made on 1020 of Sollentuna Energi's customers in October 2002 [6], 78 % preferred the old tariff (where customers only paid for their electricity consumption) to the new one. Some argued that it was bothersome to have one more thing to think about concerning the electricity bills. Others argued that the new tariff created higher and unfair electricity costs.

Case study - Skånska Energi Nät AB

Skånska Energi AB (SEAB) is an electric utility that operates in the southern-most county of Sweden, Scania, supplying electricity to about 17 000 customers. The vast majority of these customers, about 75%, are residential customers, but there are also schools, agricultural properties and industrial companies in the customer base [7]. SEAB is divided into a retail company - Skånska Energi Marknad AB (SEMAB) and a grid company which owns the grid in the area - Skånska Energi Nät AB (SENAB).

SENAB is buying electricity from the high voltage grid owner within this area - E.On. The contract states the highest hourly load demand, so called subscribed load, which was at the time of this investigation 78 MW. If this level is exceeded, the utility pays fine per each kW, depending on the terms of the contract with E.On. Over the past 5 years, the subscribed load capacity has been exceeded twice (by 2 MW) - once on the morning of January 21st, 2004 and once on New Years Eve, 2001. The morning peak on January 21st, 2004 cost the company about half a million SEK (54 000 EUR). In order to avoid penalty charges from the supplier and to reduce load demand, and in the long term decrease the subscribed load level, SENAB is interested in incorporating a load component into the grid tariff. In 1998, SEAB invested in an advanced remote metering/billing system, CustCom. This system, which is based on 1-hour measurements for all customers, makes it possible for the utility to introduce such a tariff.

A specialised Internet module makes it possible for SEAB's customers to enter a website and to monitor their electricity use statistics (in kWh/h) whenever they wish, which may help them to verify their network bill and to give more attention to their electricity use and load peaks.

Load demand tariff simulations

With a view to analyse how a grid tariff with a load demand charge could affect the utility and its customers, a new pricing strategy (tariff) was constructed and price simulations, with varying load tariff component values, were carried out [9].

The simulations were conducted as cost comparisons between the cost that the customers would have with the new load demand tariff and the cost that they have currently, with the existing tariff.

The structure of the load demand tariff can be seen in Equation (1).

$$\Phi = P_{av}\ a + s \qquad (1)$$

P_{av} [kW] denotes the average value of the customer's three highest hourly load peaks from three separate days during each month. **a** [SEK/kW] is a constant load price that takes two different values - one from April to October and another from November to March. **s** [SEK] is the fuse level fee of the network tariff (standing charge). Taxes and governmental fees are excluded from the analysed pricing.

The structure of the existing tariff can be seen in Equation (2).

$$\Phi = 0{,}149\ E + S \qquad (2)$$

E [kWh] is the electricity consumption during one month. 0,149 [SEK/kWh] is the energy unit price of the network and **S** [SEK] is the standing charge of the network tariff. Taxes and governmental fees are not included.

The price simulations were run for all of SENAB's customers with fuse levels between 16A and 200A. Customers were divided into groups depending on their fuse level. Customers with a 16-ampere fuse were separated into tree subgroups: customers living in flats 16L, electric heated houses 16V and houses with other heat source 16A.

In all four simulations, the condition that SENAB's total revenue would be close to zero, seen over the whole year, was applied. Component **a** was adjusted in order to achieve this.

In order to get a distinct difference between low and high demand periods, the component **a** in the load demand tariff was almost doubled during the high demand period November - March, compared to the low demand period April - October.

Simulation results

In the first price simulation the following premises were given: (1 SEK = 0.11 EUR)

s = **S**/2
a = 73 SEK/kW November-March
a = 35.5 SEK/kW April-October.

Figure 2 shows the difference in SENAB's income (load demand tariff – existing tariff) for each fuse group. Figure 3 shows the average cost increase for customers in each fuse group, when using the new load tariff compared to the existing tariff.

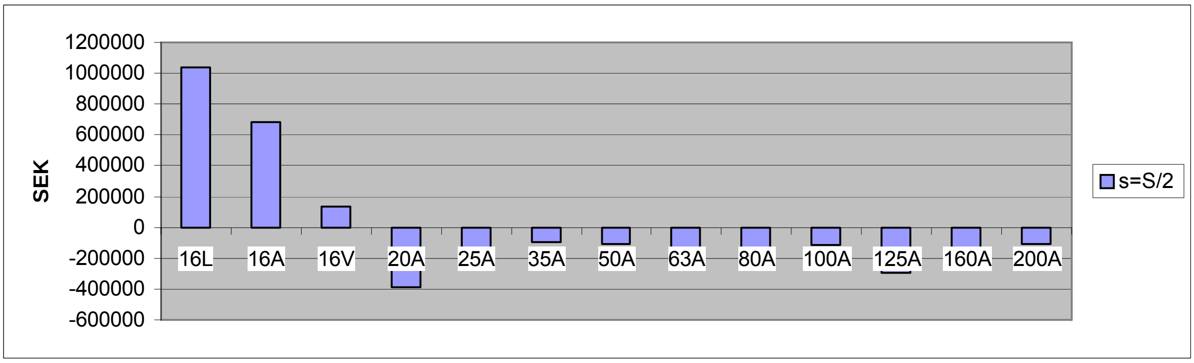

Figure 2: Difference in SENAB's income for each fuse level group (load tariff – existing tariff).
a = 73 SEK/kW November-March, a = 35.5 SEK/kW April-October, s = S/2.

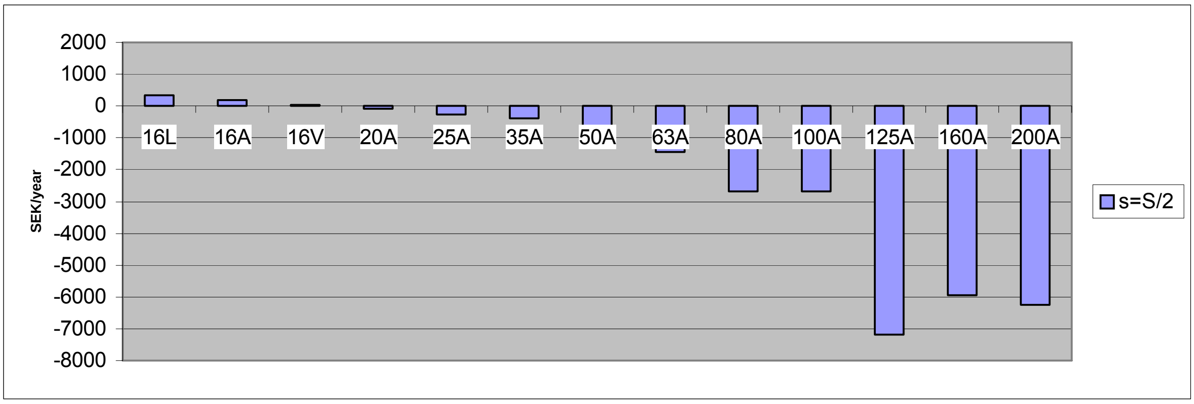

Figure 3: The average cost increase for customers in each fuse group with the new load tariff compared to the existing tariff.
a = 73 SEK/kW November-March, a = 35.5 SEK/kW April-October, s = S/2. (1 SEK = 0.11 EUR)

Negative values in Figure 3 imply that the average customer would be charged less with the new load tariff. The results show that customers with low fuse levels would generally be charged more, whereas customers with higher fuse levels would be charged less.

The second price simulation was preformed for **s** = **S**/3, **a** = 80 SEK/kW November-March, and **a** = 39.5 SEK/kW April-October. The findings from the second simulation were similar to that of the first one. 16L, 16A and 16V customers would incur higher charges with the load tariff, whereas the other groups would be charged less (see Figure 4 and 5).

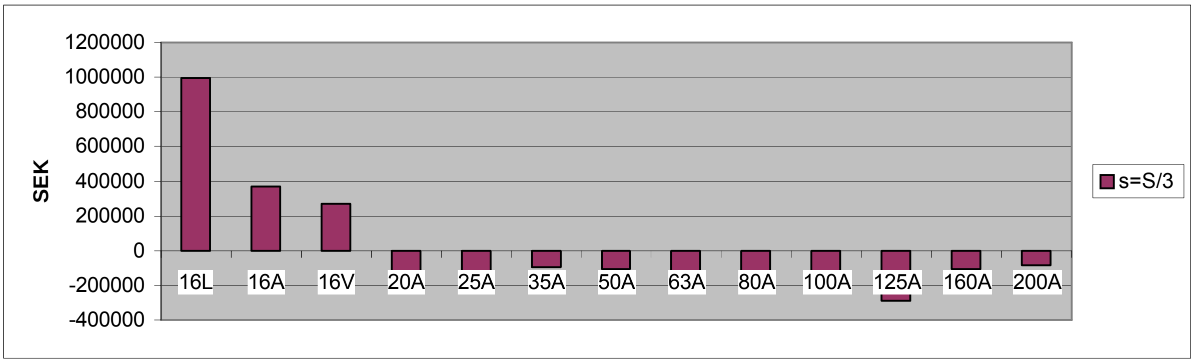

Figure 4: Difference in SENAB's income for each fuse level group (load tariff – existing tariff).
a = 80 SEK/kW November-March, a = 39,5 SEK/kW April-October, s = S/3. (1 SEK = 0.11 EUR)

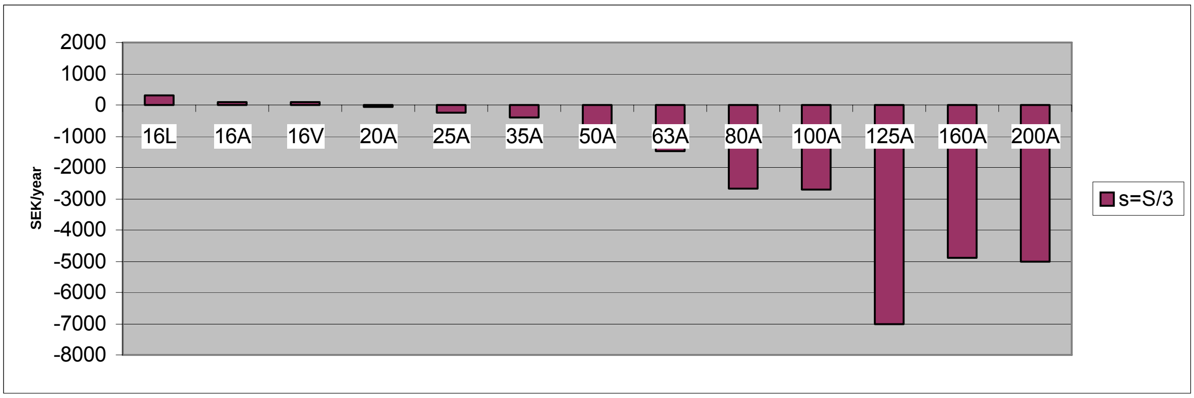

Figure 5: The average cost increase for customers in each fuse group with the new load tariff compared to the existing tariff.
a = 80 SEK/kW November-March, a = 39,5 SEK/kW April-October, s = S/3. (1 SEK = 0.11 EUR)

In order to compare how a tariff based only on a load demand component would turn out, **s** was set to zero (**s** = 0) in the third simulation. **a** = 95 SEK/kW November-March, **a** = 46.6 SEK/kW April-October. In this case, 16A customers would be charged less with the load tariff and 20A-group would be charged more, thus achieving the opposite result to the previous two cases. The other fuse groups however were still following the trend achieved in the first two simulations (higher charges for 16L and 16V and lower charges for the others groups). The results can be seen in Figure 6 and 7.

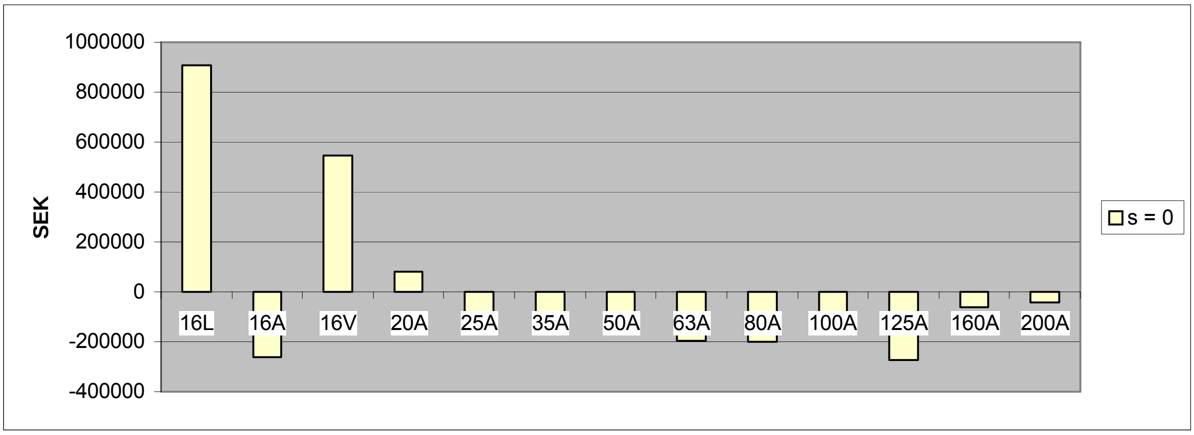

Figure 6: Difference in SENAB's income for each fuse level group (load tariff – existing tariff).
a = 95 SEK/kW November-March, a = 46,6 SEK/kW April-October, s = 0. (1 SEK = 0.11 EUR)

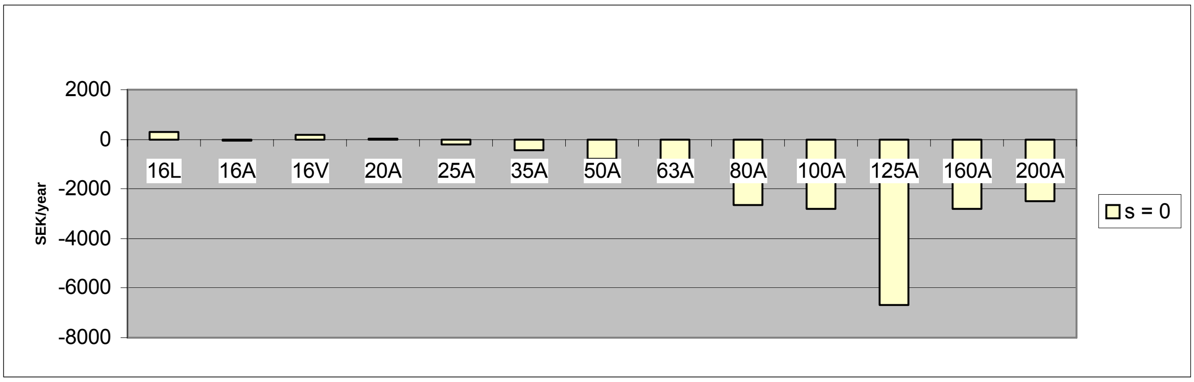

Figure 7: The average cost increase for customers in each fuse group with the new load tariff compared to the existing tariff.
a = 95 SEK/kW November-March, a = 46.6 SEK/kW April-October, s = 0. (1 SEK = 0.11 EUR)

In the fourth and final simulation, the aim was for SENAB's total revenue change, for each fuse level group, to be as close to zero as possible. In this case, **s** was the component that was adjusted. **a** was given the value of 70 SEK/kW from November to March and 35 SEK/kW during April-October. Table 1 shows the existing fuse fee and predicted fee for the new load tariff, if the goal was the one mentioned above. Customers with higher fuse levels would in general incur a higher fuse fee compared to customers with low fuse level. This means that with the existing tariff, customers with a higher fuse level pay a relatively high standing charge in relation to their load demand. It is worth noting that 125A customers would get a higher standing charge with the load tariff. This confirms the conclusion that with the existing tariff, higher fuse level customers are subsidising customers with lower fuse levels.

Table 1: Comparison between existing tariff's and load tariff's fuse fee

Fuse level (Ampere)	Existing tariff's fuse fee SEK/year (without VAT)	Load tariff's fuse fee SEK/year (without VAT)	Ratio: load tariff / existing tariff (%)
16L	696	50	7,2 %
16A	1462	606	41,5 %
16V	1800	966	53,7 %
20A	2238	1333	59,6 %
25A	2792	1820	65,2 %
35A	3861	2500	64,8 %
50A	5438	3804	70 %
63A	6758	5162	76,4 %
80A	8568	7415	86,5 %
100A	10700	8567	80,1 %
125A	13344	14570	109,2%
160A	17072	15670	91,8 %
200A	21007	18000	85,7 %

Conclusions and recommendations

Conclusions from this study and recommendations that can be relevant for energy utilities when planning load based pricing, have been gathered under some selected headings:

Existing tariff with load component

The main purpose of including load demand components into the network tariff is to achieve a lower load demand and avoid load peaks. The analysis has shown that:

- Load based tariff adjusts pricing between fuse groups,
- Totally, load based tariff together with remote meter reading is profitable for utilities,
- The difference between "energy" and "power" must be explained in a comprehensive manner,

- To reach tariff’s goals, it is very important that customers understand the structure of load tariff and its aim,
- Customers have to understand that they can save money by changing their energy consumption patterns without the deterioration of comfort or standard of living,
- According to the utility’s own evaluation, it was possible to lower load demand about 5 % thanks to the new load based tariff.

Tariff simulations
The results of this study show that:

- If a load demand component were to be introduced into SENAB’s network tariff, primarily customers with a 16-ampere fuse would incur higher network charges compared to customers with higher fuse levels, who would be charged less.
- With the existing network tariff, based on electricity use, customers with high fuse levels pay today relatively high standing charges in relation to their exploitation of the grid.
- Several households would lower their fuse level (and the costs),
- It is not clear what would the introduction of load based tariff mean for total load demand level within the simulated area.

Some important issues when introducing load based tariff

Electricity pricing should reflect real marginal costs of electricity production and the utilities’ costs. Load based price could achieve higher price elasticity and thus limit the needs for expensive peak load production. Many utilities have already invested in modern Automatic Meter Reading systems (AMR) which facilitate implementation of load based tariffs. Customers are in such a case both an exposed target and a vital potential - in many situations they really want to “help” society, and even “their” utility, to avoid problems and shortages. Therefore, promotion of a new tariff with load based price signal requires a solid and carefully prepared information campaign. It is of great importance for the result that the purpose of such a tariff is clearly introduced to the customers from the very beginning. The difference between “load demand” and “energy use” is not easy to understand and keep after for the majority of customers. They need help to gain a better insight into how their electricity costs will depend on their habits and usage of appliances and installations at home.

Load tariff structure
Load demand tariff should, as any tariff, be simple end easy to understand. The structure and price levels are of decisive importance when trying to influence and change the patterns of energy use. The tariff can always be adjusted afterwards but a comprehensive knowledge about consequences for both customers and utility will help to avoid unnecessary sources of irritation and complaints.
Construction of a new tariff should start with an analysis of load characteristics for a grid company in question - load curves for different customer groups, load factors and superposition factors as well as load aggregation on selected levels in the grid should be investigated.
It is also essential to update the customer register regarding heating system, load guards etc. The new tariff should be tested on some limited groups of customers.
A conceivable solution for a utility, when implementing a new load demand tariff, could also be to offer its customers installation of diverse electronic devices (displays, load guards, soft heating systems) helping them to “keep an eye” on load demand. Together with the new tariff, these investments should be paid back in a relatively short time, helping at the same time to lower load demand in the grid- a win-win solution for both partners.

Customer feed-back
Several investigations and studies have indicated that a continuous feed-back to energy customers is of great significance while different energy related measures and changes are in progress. Possibility to compare the results “before” and “after” or “own” with “others” can intensify and establish more long lasting behavioural changes. Introduction of load demand tariff should therefore be supported by continuous customer focused information. Market segmentation could give a hint how different customer groups should be reached and influenced, depending on their energy related behaviour, lifestyle, information sources and frame of reference.

Extra values

Introduction of load demand tariff needs, or is made possible by, a remote meter system (AMR) with hourly readings. This means that this new tariff should be seen as a part of a development of products and services connected to the AMR system. A number of applications can for example improve customer service and save needs of administration. Extra value-added services related to billing, energy statistics, monitoring, energy guidance, grid optimisation etc, can create new possibilities and values for the company and its customers.

Acknowledgements

This work was financed by the ELAN programme - a joint research programme on electricity utilisation and behaviour in a deregulated market. The ELAN programme is financed by the Swedish Energy Agency, the Swedish research council Formas and Swedish utilities through Elforsk.

The simulations described in this paper were performed by MSc Mattias von Knorring. The author would also like to express his gratitude to the staff at the electric utility Skånska Energi AB who made this research project possible.

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Smart Metering for Households: Cost and Benefits for the Netherlands

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Abstract

It is taken for granted that a smart metering infrastructure is beneficial for small electricity and gas customers (households), energy and distribution companies and society as a whole. However, business cases done by individual companies only in special situations, e.g. Italy, show a positive outcome of smart metering. In other countries, e.g. Sweden, regulation was put in place to introduce smart metering.

This paper describes the results of a societal cost benefit analysis, demonstrating that the Netherlands society would profit from installing a smart metering infrastructure. The largest benefits are energy savings for consumers, reduced costs because of more transparency in the market and less costs for handling complaints at the energy suppliers. The largest costs are costs of the smart meters and infrastructure and the cost for the (monthly) feedback to consumers. The study also included a sensitivity analysis. Furthermore, the results show why smart metering does not take off automatically, even if it provides benefits to the consumer.

Attention is paid to the role of standardisation, the process of the cost benefit analysis, the consultation of stakeholders and other qualitative aspects, including the place of smart metering within the EU energy services directive. Recommendations are provided regarding the role of the government to introduce smart metering to all households in the Netherlands.

Introduction; background and set-up of the study

Based on an earlier study on demand response by small-scale custormers in the Netherlands [1] establishing a smart metering infrastructure was considered to ba a basic requirement for implementing demand response. Furthermore, from (consumer) behaviour theory it is known that feedback on energy consumption can result in energy savings [2]; however, the theory provides no clue about the actual costs and benefits of large-scale implementation of feedback systems. Also the EU directive on energy services acknowledges the role of smart metering with respect to energy savings and says in Article 13 (Metering and informative billing of energy consumption):

“1. Member States shall ensure that, in so far it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricty, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer’s actual energy consumption and that provide information on the actual time of use.”

Insight into the (societal) costs and benefits of large-scale implementation of a smart metering infrastructure is crucial when deciding on (mandatory) implementation as a policy instrument. Also large-scale implementation is not possible without standardisation. Results of cost-benefit studies from other EU countries, e.g. Italy or Sweden [3], are only partially useful for the Netherlands because of differences in consumption and market situation. Therefore in the Netherlands a study was carried out with the following aims:

1. To clarify if and how a (European) standard for smart metering devices (gas/electricity) can play a role in accelerating the implementation of smart metering devices at small-scale customers.
2. To acquire clarity about the costs and benefits of large-scale implementation of smart meters at small-scale customers.
3. To involve players in the energy market so that they will be both well informed and able to help shape the potential process of implementation.

These objectives were further detailed in the three main parts of the study, as listed in the following sections.

Investigation on the role of standardisation in (accelerating) the implementation of smart meters

The purpose of the investigation carried out by NNI[1] was to answer the following questions:

- Is developing a standard for smart electricity and/or gas meters an appropriate strategy for accelerating innovation among market players and thereby stimulating the introduction of smart meters into the Dutch market?
- How do the players in this sector view the issue of standard development and how is this topic handled within the current standard committees?
- Will market players handle the developing of standards themselves or are there causes for the Dutch government to play a role? If so, what type of role?
- Which players should be involved in standard development? And how is this process perceived on the whole?

In order to answer these questions NNI took a number of actions, including an information day with workshops for stakeholders and 12 in-depth interviews with market parties.

Cost-benefit analysis of smart metering infrastructure at small-scale customers

The purpose of the cost-benefit analysis was to weight the *costs* of large-scale introduction of smart metering infrastructure (electricity and gas) at small-scale customers in the Netherlands against the *impacts and benefits*. Impacts and benefits for example could affect the security of supply, market operation (simplification of administrative processes, increased choices, increased transparency), environmental awareness, energy conservation and efficient energy provisions as a whole. The cost-benefit analysis was carried out by KEMA.

Involving the market players

In addition to the cost-benefit analysis, it was important to attain insight into the *process* necessary for a large-scale introduction of a new metering infrastructure. This concerned questions such as: who assumes which role, where are the responsibilities and interests, who takes initiative, how are the costs and benefits divided among the various players, etc.

Involving players from the energy market is necessary so that from the start they will be both well informed and able to help shape the process of potential implementation of smart meters at small-scale customers.

Results of investigation on standardisation [4]

Developing standards is a necessary condition for implementing a smart metering infrastructure. However, it is not a sufficient condition in the sense that standardisation is the primary activating force for this innovation. In addition to market organisation and regulation, standardisation is a type of support needed for the required innovation on the part of the market players, predominately with regard to guaranteeing interchangeability of devices and data.

The views and positions of players in the sector with regard to standard development are dependent on their market position and relationship in the chain. Grid administrators that have to maintain their operations and reliability at minimal costs view the development of standards as a necessary market instrument, characterised by Dutch and/or European consensus of market players, enabling – among other things – the realisation of upsizing and interchangeability. Grid administrators would like to assume an active role and provide input in the needed development of standards.

The other players, such as the metering companies, suppliers and meter manufacturers prefer to observe further, steer or follow developments. Depending on the position of the meter and the market organisation with regard to meter responsibility, it may well be possible that the companies responsible for metering will also want to assume a more participating role and to provide more input.

The interest of meter manufacturers is channelled from the requirement of grid administrators and metering companies to achieve interchangeability of devices and data. Players that want to develop new options for their buyers (such as on-line and real-time applications) want to utilise their market edge in order to focus on subsequent innovations.

Development of standards is not automatically adopted by all the players in the market. Government will have to play the role of a regulator and thereby facilitate the required development of standards. In order to motivate the players (the chain of service providers) a clear indication will have to be given to prevent the energy distribution infrastructure from ending at the connection register, but rather to expand it to metering data, data collection, data retrieval and communication, including the meter

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[1] NNI: Dutch Standardisation Institute

code. This means that government indicates the required (minimum) functionalities for this purpose, while the market players complete this with realising these functionalities.

There is no unequivocal conclusion to be drawn about how these agreements should come about, as long as they do emerge. The preference is for an adjustment in the regulation (metering codes) or a European/Dutch standard. Whether or not the parties prefer standards is usually dependent on their knowledge about standardisation. Manufacturers, TSOs and metering companies indicate in general that they would want to tackle standardisation without the adjustment in the metering codes, while the other parties would first prefer a clear regulation.

Grid administrator, companies responsible for metering, suppliers and meter manufacturers will have to become involved in standard development. In general, the process of developing standards is seen as follows:

- Determining a standardisation project
- Putting together participants/authors and observers
- Establishing a draft and presenting it for comments
- Processing the comments and presenting it to a vote with regard to publication
- Declaring the implementation of the project.

Results of cost-benefit analysis [5]

Set-up and basic assumptions

Definition of situation zero (base case) and situation one

The cost-benefit analysis makes a distinction between the 'situation zero' and 'situation one' (also see figure 1).

- ***Situation zero*** is the current situation in which – barring a few exceptions – small-scale customers (in the Netherlands in essence consisting of 6.7 million households) do not have a smart meter and are not connected to a smart metering infrastructure. The legal framework (gas and electricity acts), activities of government and market players remain as they are. The market dynamics (what market parties are planning to do) are not considered in this case.
- ***Situation one*** is the situation in which all small-scale customers are connected to a smart metering infrastructure by means of smart meters for gas and electricity, in any case, and these households receive minimal a monthly feedback about their actual consumption.

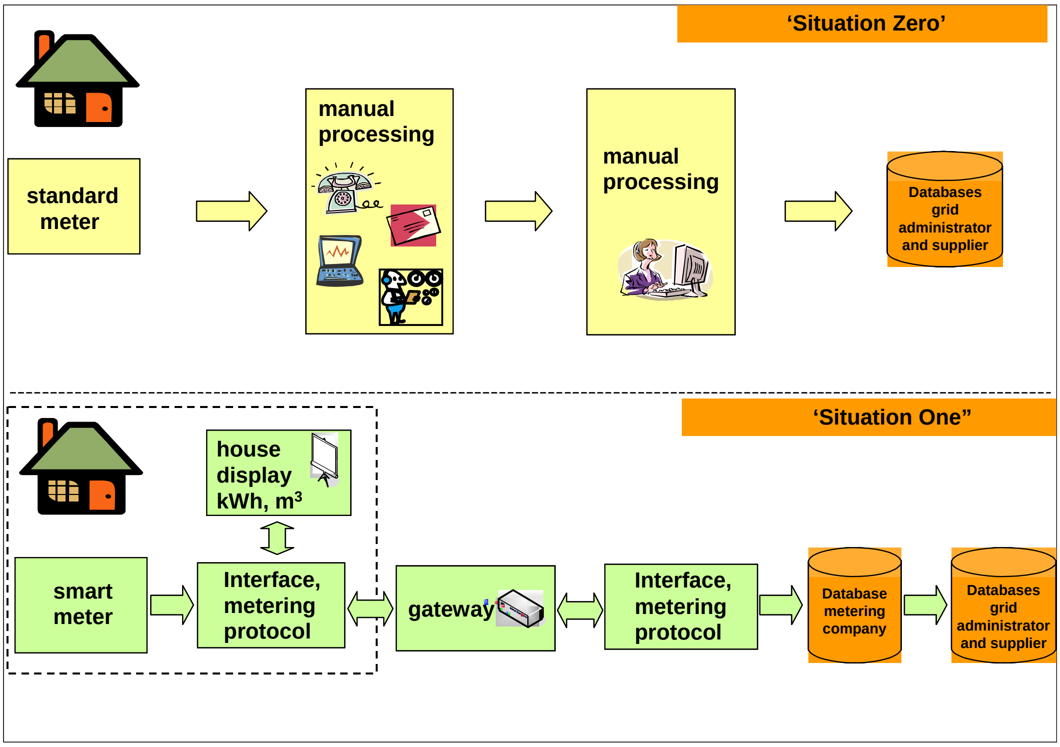

Figure 1: Situation Zero and Situation One

The transition phase from ‘situation zero’ to ‘situation one’ will be realised by the market players. They will ensure that meters and smart metering infrastructure will have an ‘open’ structure so that consumers can change suppliers easily without any problems.

The option to describe ‘situation one’ as the situation in which *all* small-scale customers are connected to a smart metering infrastructure is dictated by the fact that certain benefits can be achieved only if all small-scale customers are connected (i.e., benefits of scale). Not only is the choice for situation one vital for the results of the cost-benefit analysis, but equally important is the choice of situation zero. An overly negative zero situation provides a rosy picture while an overly positive zero situation give a pessimistic one. Situation zero is not automatically equal to ‘doing nothing’ or ‘existing policy’. The choice for a zero situation as described above is a conscious choice based on the following reasoning. Alternatives for situation zero (such as the fact that market players already have concrete plans for installing smart meters) do not materialise sufficiently without a clear framework by the government[2]. In this context, smart meters are not the only factors that play a role, but mainly the metering infrastructure. Replacing all dumb meters with smart meters does not deliver the targeted aims of energy conservation, market operation and security of supply. Every governmental intervention, for example, adapting legal regulations to create a clear framework, requires a foundation; at the present moment the cost-benefit analysis is what provides the foundation whether government takes action or not.

The consequences of the above is that even if the results of the cost-benefit analysis are positive, this does not decisively answer the issue, for example, of what type of infrastructure needs to be installed and how this should be organised. The costs of employing governmental instruments that could possibly be needed to achieve ‘situation one’ are also not included in the cost-benefit analysis. In conclusion, we want to stress that this is a differential study. Only the cost-benefit that differ from ‘situation zero’ are examined.

Societal character of the study

Furthermore, the study considers the situation throughout the Netherlands. This societal cost-benefit analysis is therefore not comparable to a survey by an individual market player that includes in it’s business case, for example, impacts such as bonding of existing customers and acquisition of new customers by implementing smart meters. For an individual group, the profits for these types of internal impacts can make the difference between an attractive or a non-attractive project. Companies often employ profits as a simple manner for accounting the costs of the organisation to separate products, processes and projects. For society, profits as a whole are only a conveyance that should make no difference in terms of social appeal. From a societal point of view, the number of customers is anyway fixed and this does not affect the cost-benefit analysis.

What is a smart meter?

A smart meter is a meter that determines and stores in real-time or near real-time energy consumption, provides the possibility to read consumption both locally and remotely and – with regard to electricity – can also be utilised remotely to limit the consumption by the consumer or to switch it off (figure 2).

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[2] This assumption is based on the research of demand response among small-scale consumers [1], the research of the NNI [4], and discussions with market players.

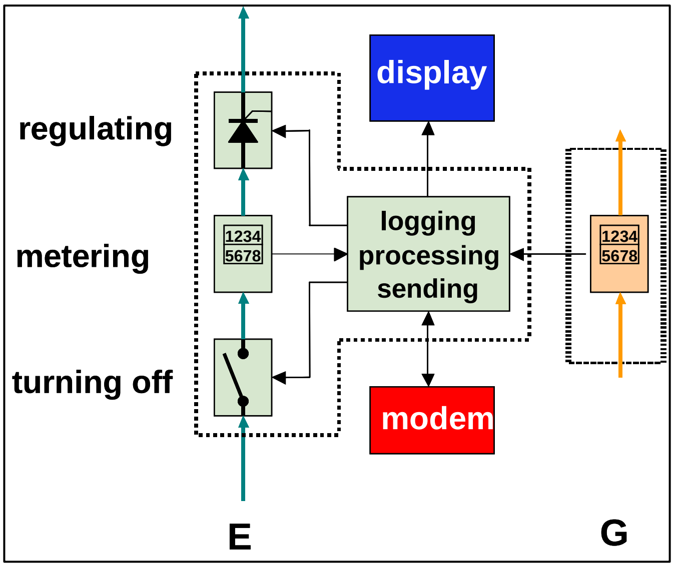

Figure 2: **Diagram of the smart meter and its functions**

The study dealt with electricity and gas meters, whereas the same unit is used for data communication. As figure 2 indicates, there is a difference between electricity (E) and gas (G) meters: with regard to safety aspects, a gas meter does not have a control and switching off function. Furthermore, the calculating capacity of the electricity meter is used for logging and processing gas consumption. The meter has a display on the device itself with an instantaneous reading of the consumption, as required in the Measurement Instrument Directive. In any case, the smart meter uses bi-directional communication and has a switch-off and switch-back function.

A basic assumption is that the *price* of smart meters will be determined by the European market. The scope of the Dutch market (in other words, the demand for smart meters) will be too limited to lead to a substantial drop of prices of smart meters. Therefore, the financial model does not include the relation between price and the number of smart meters that will be installed.

It is assumed that the *data communication infrastructure* has sufficient capacity and is available at marginal costs. Quantifying technologies are PowerLine Communications (PLC, via the existing electricity grid), communication via wireless modem (GSM or GPRS) and Internet via ADSL modem (existing Internet connections). Furthermore, it is assumed that the metering data without transaction costs will be available to the relevant market parties.

Legislation and regulations

Legislation and regulations are continuously being developed, both in the Netherlands and in the European Union. In this project the assumption is that legislation (gas and electricity acts) will not change significantly during the transition from ‘situation zero’ to ‘situation one’ and that government regulations and activities of market players will remain comparable to the current situation. At the present time there is a free meter market for small-scale customers, in other words, consumers can select their own metering company. This project therefore assumes that the free meter market remains in ‘situation one’. Should this change, then only the cost division between the mutual players change in the results of the financial model, not the total costs.

Results of the cost-benefit analysis

Scenarios

Scenarios are connected with important choices such as the rate of implementing smart meters, implementing smart meters only for electricity or for gas and electricity, choosing the type of data infrastructure (PLC, GSM or Internet), choosing the financial parameters (running period and interest percentage), how the impacts of market dominance are taken into account and how the impacts of the return (taxes and net rates) are taken into account.

The ‘reference alternative’ contains choices that lead to ‘situation one’ and in which all cost-benefit entries are represented in a reasonable manner (see Table 1 for the basic assumptions of the reference alternative).

Table 1 : Basic assumptions of the reference alternative

	Scenario value
Transition speed	10 years
Type of meters	Gas and electricity
Type of data infrastructure	40% PLC, 40% Internet and 20% GSM (expert estimate)
Financial parameters	Period of 30 years at 7% negotiable interest
Market dominance	No market dominance impacts, efficiency benefits are completely returned to the consumer
Return	Loss of tax proceeds and net income is not recuperated from the consumer.

After calculating the results of the reference alternative, a sensitivity analysis was carried out in order to further examine the impacts of the uncertainties. Whereas in the scenarios fundamental choices for implementing smart meters are examined, in the uncertainties a variety of common generic parameters were examined. The impacts of the uncertainties in these generic parameters emerge in the sensitivity analysis by varying them in the reference alternative.

Results of the reference alternative and sensitivity analysis

The net cash value of the entire project amounts favourably to € 1.2 billion. It should be mentioned once more that this societal cost-benefit analysis is not comparable with a survey by an individual market player. This study investigates the situation for Dutch society and looks only at the cost and benefits that differ from a zero situation.

From figure 3 it emerges that in the reference alternative the entries of energy conservation by households, the more efficient business processes in companies, and the competition, which results from easier switching, result in significant benefits. Purchasing and installing smart meters, the metering infrastructure and the monthly invoicing are the largest cost entries.

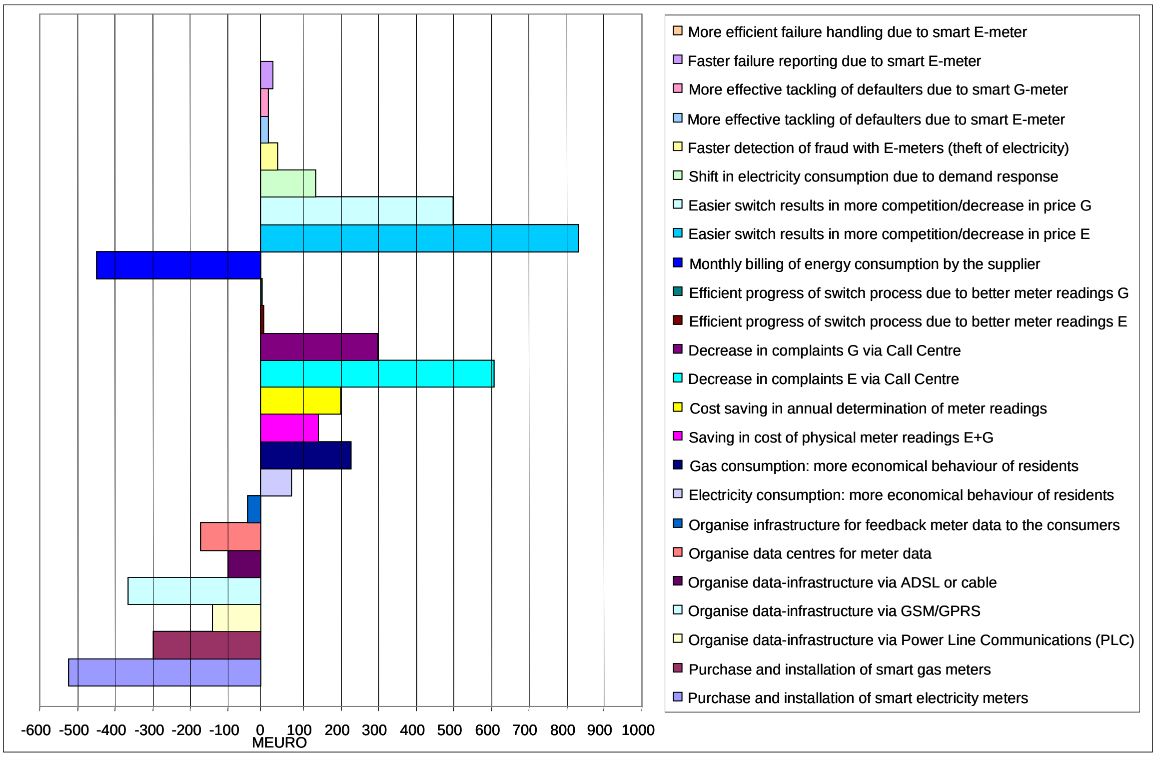

Figure 3: Overview of contribution per cost-benefit entry (reference alternative)

The division among the players is shown in Figure 4. Households in particular profit from implementing smart meters in the Netherlands. In the reference alternative, the costs are borne by the other market players.

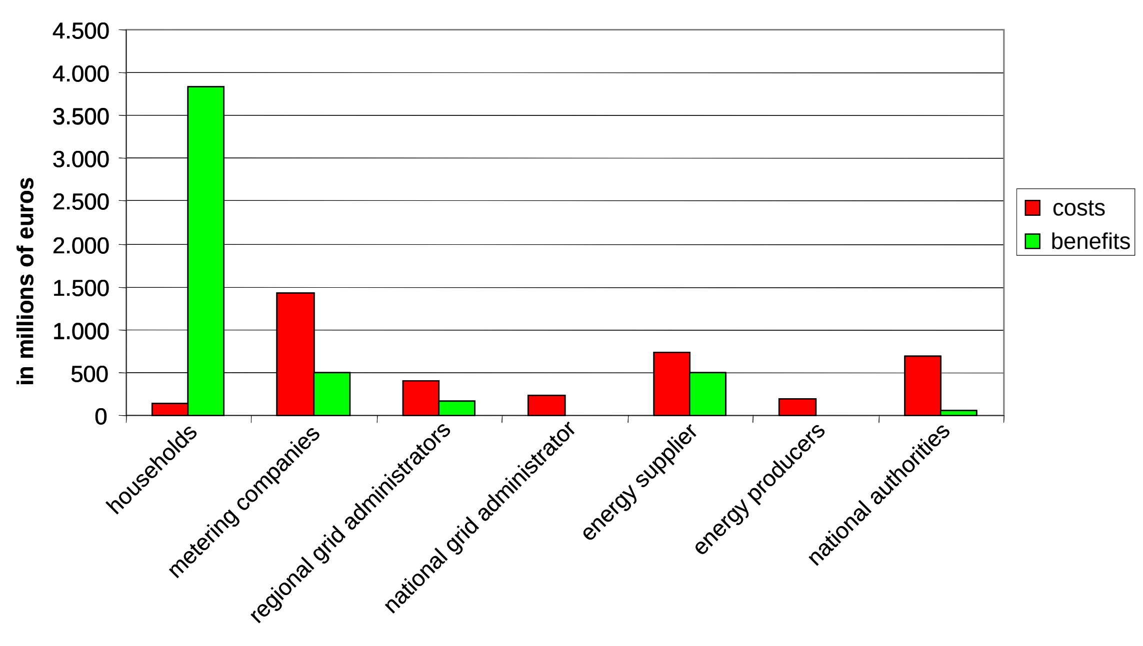

Figure 4: **Overview of costs and benefits per player (reference alternative)**

Which factors are the most uncertain or have the greatest impact on the financial result emerges from the sensitivity analysis (see Figure 5). Should a number of these factors be estimated differently (according to the left value in the figure), then the net cash value of the project might become negative.

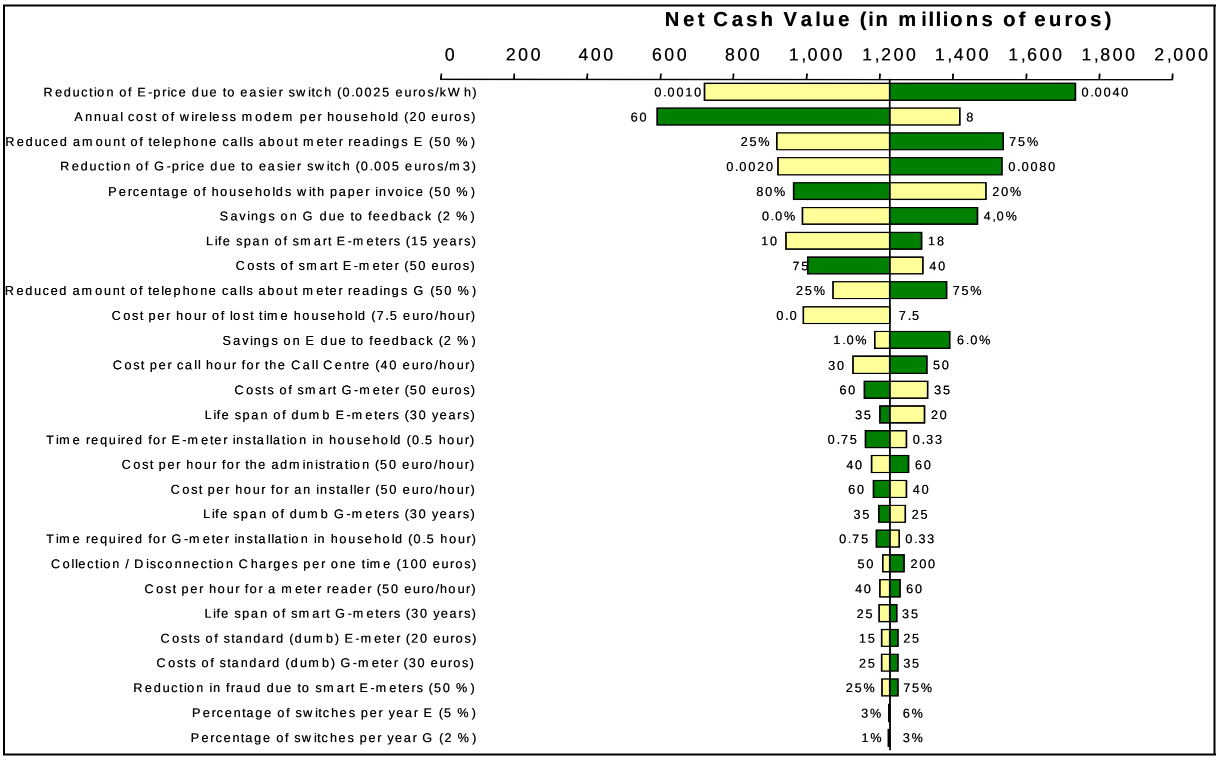

Figure 5: **Results of the sensitivity analysis (reference alternative)**

The study further examined the sensitivity per player for a number of important variables, such as energy conservation in households, the decrease of energy prices as a result of easier switching, and the reduction of the number of telephone calls. In terms of benefits, households are the most sensitive: variation is approximately € 6 billion (from € 1.5 billion to € 7.5 billion). For energy suppliers variation is approximately € 0.4 billion and for metering companies € 0.2 billion. In term of costs, the energy suppliers are the most sensitive: the variation is approximately € 2 billion. The variation for government is approximately € 1 billion and for regional grid administrators it is € 0.5 billion.

Results of other scenarios

By using scenarios, a number of variants in the net cash value of implementing smart meters can be calculated in the financial model. Table 2 sums up a number of variants that have an impact on the Net Cash Value. The results of the reference alternative have a grey background.

Table 2: The impact of variants on the Net Cash Value (NCV)

Variant		**NCV (in M €)**
Transition speed	5 years	1,400
	10 years	1,200
	20 years	1,000
	30 years	800
Type of meter	Only 100% electricity meters	400
	5% of electricity meters and gas meters	50
Type of data infrastructure	40% PLC, 20% GSM, 40% Internet	1,200
	100% PLC, 0% GSM, 0% Internet	1,500
	0% PLC, 100% GSM, 0% Internet	0
	0% PLC, 0% GSM, 100% Internet	1,600
Less systematic roll out	Transition speed of 15 years, installation period of 1 hour, cost of adjustment per household € 3	900

The basic assumption for the reference alternative is a large-scale, systematic roll out. With a less systematic roll out, for example if the meter is installed only after a consumer request, the Net Cash Value drops to € 900 million. In that case, the assumption is a longer transition period, higher installation costs and higher costs of adjustment per household.

Results of involving the market players

Introduction; overview of the market players

Figure 6 provides an overview of the relevant market players in the Netherlands.

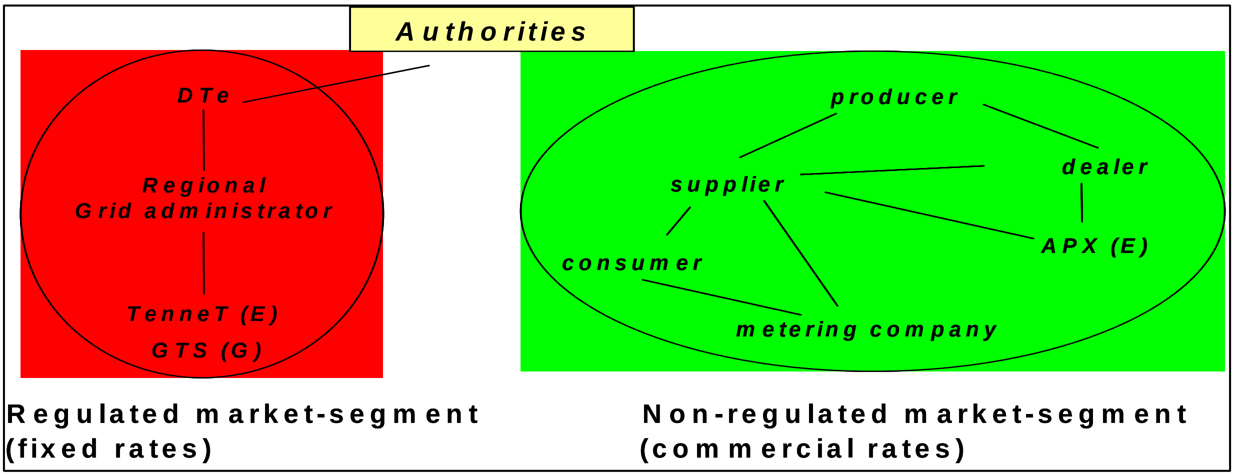

Figure 6: Overview of the market players (current situation); source [3]

All the concerned market players view the discussion about implementing smart metering infrastructure for small-scale customers in light of the regulated/non-regulated meter market, the unbundling discussion, and the total rearrangement of the liberalised energy market. These parties perceive that smart metering infrastructure offers the current market certain efficiency benefits and furthermore, future innovations in the area of energy services and Home Automation and market development of decentralised energy production

The market players very much appreciated the fact that the government makes the effort to invest in carrying out (or enable) a cost-benefit analysis. Major players were genuinely willing to participate in this study. These parties have ideas and sometimes have concrete plans for implementing smart meters.

Obstacles to the large-scale implementation of smart meters

Market players mentioned the following obstacles to the large-scale implementation of smart meters and infrastructure for small-size customers.

Regulated or non-regulated meter market

For the time being, obscurity about the future of the meter market blocks the implementation of smart metering infrastructure. Major players are biding their time.

The fact that households do not purchase new/smart meters demonstrates that somewhere there is something wrong in the way the current free market operates. According to one player, this is further substantiated by the fact that current metering companies do not merge into one or more stronger companies, but rather remain close to their mother companies.

Development in the supporting data infrastructure

An additional obstacle is the fact that the supporting data infrastructure is still largely on the move. While one player has opted for the PLC technique, other players prefer Internet and GSM or in combination with PLC. PLC requires a needs a high degree of coverage and consequently, demands that agreements are made between the area of operations of the grid administrators.

Ownership issues

A number of parties have indicated that it is important to re-establish who will be the future owner of the meter. This will prevent a situation in which a meter will have to be changed when changing a supplier. In view of the new market model that will be created, property rights of the metering data will also need to be reviewed.

Standardisation of meters

The parties agree about the need to determine the basic functionality of the smart meter. The initial specifications are described in Table 3. Standardisation will go through the existing standardisation committees.

Table 3 Basic functionalities of the smart meter, initial specifications

Basic functionalities of the smart meter
Counter (kWh) Log consumption per period (minimum per quarter) Outages (recordings of disturbance/failure) Internal clock Bi-directional transmission/communication: • Remote reading (standard data format) • Remote switching off and switching back Return delivery of electricity (e.g. produced by PV) Standard data outlet

Since a meter has a standard outlet and the data is in a standard format, it is easy to link other devices to the meter. These could use the meter data to transmit information to residents, drive household equipment, etc.

The role of government (as seen by market players)

The market players see a clear role for government in removing the obstacles. By and large they are of the opinion that the government’s role is to create a level playing field for improving market operations as well as for promoting a base for innovations in the energy services. The role of government is chiefly seen as a regulating and promoting role.

A *regulating role* entails determining the framework in which smart metering infrastructures could be built and deciding whether or not to regulate the meter market. This will clarify where the regulated public tasks lie and where the non-regulated commercial tasks lie. The regulating role is also expected in terms of determining the basic functionalities of the smart meter, perhaps guidelines concerning the supporting data infrastructure, and the aforementioned ownership issues.

To conclude, it was stated that if government would adopt a guideline (similar to the situation in Sweden) that small customers should receive invoices regularly (and possibly based on actual consumption), it could accelerate developments in the area of smart meters.

Furthermore, according to the market players, government can also *act as a promoter* by contributing to pilot projects and exchange of knowledge, for example in the area of feedback of consumer data to households. According to these parties – if the government would apply subsidies for smart meters – the implementation process would accelerate, but this is not a required pre-condition.

It could be useful for government to provide public information (as a neutral sender), alongside specific communication from suppliers to their customers. These undertakings would have to emerge from a wider vision of government on energy consumption, energy conservation and sustainable energy.

Conclusions and recommendations

Framework for conclusions

In general, a smart metering infrastructure can contribute favourably to demand response, security of supply, market operation, energy conservation, environment awareness, and efficiency of energy provisions in general [4]. Based on this the following framework for potential roles for the government was formulated for the process involved in implementing a smart metering infrastructure:

Table 4: Framework for conclusions

		Obstacles viewed by market players	
		Large	*Small*
Cost-benefit analysis	*Positive result*	1. Steps by government	2. Steps by the market
	Negative result	3. No steps	4. ?

This framework assumes four possibilities with regard to steps that would be or would not be taken:

1. Cost-benefit analysis is positive and market players perceive large obstacles: steps by the government are required.
2. Cost-benefit analysis is positive and market players hardly perceive any obstacles (or only small ones): steps will be taken by the market players themselves.
3. Cost-benefit analysis is negative and market players perceive large obstacles: government and market players take no steps because implementing smart infrastructure is not attractive.
4. Cost-benefit analysis is negative and market players hardly perceive any obstacles (or only small ones): status quo, until the cost-benefit analysis becomes positive (i.e., by changing the parameters).

The conclusion of this investigation is that the cost-benefit analysis is positive, but the obstacles perceived by market players are that great that a large-scale implementation will not get off the ground by itself. Certain market players will probably take some initiatives to implement small-scale smart metering infrastructure. In order to accelerate the desired large-scale implementation (100%) of smart metering infrastructure – which in terms of costs and benefits is the most optimal one – steps are required by the government.

Further analysis of the cost-benefit analysis

Although the result of the cost-benefit analysis is positive, we anticipate that the perceived obstacles in the market are that great that smart metering infrastructure will not be realised in the short-term in all households in the Netherlands. The reason for this is a combination of the points below.

First of all, what clearly emerges from the cost-benefit analysis is the problem of ‘split incentive’. The balance of the costs and benefits of a smart metering infrastructure is only positive for households: the benefits (€ 3.8 billion) exceed the costs abundantly (€ 0.14 billion). For all the other parties the costs exceed the benefits; this applies especially to the metering companies: they have to invest € 1.0 billion more than they earn back. In combination with the unclear direction (for the time being) of the meter market, this explains why the metering companies are not taking any steps.

However, households are also not taking any steps. Although the return for all 6.7 million households over the duration of the project is significant, the return *per* household *per* year is so low that we do not expect that households would spontaneously buy smart meters by themselves.

In the most favourable case, energy suppliers will take steps to get a smart metering infrastructure off the ground on a limited scale, even without government support. Suppliers will offer smart meters i.e., to enhance their own image. However, there are disadvantages to this: in order to recuperate the investment[3] the customer will most likely be tied to the supplier for a longer period of time or will have

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[3] The cost of installation and infrastructure at individual installation are (at least) 25% higher compared to these cost used in the cost-benefit analysis, which are based on large-scale and systematic rollout.

to pay a penalty in case of changing suppliers prematurely. The consequences of changing suppliers after the minimal contract term are also obscure: Does the new supplier have to use the old meter or will it be replaced? A long-term contract and the obscurity regarding use of the meter in case of changing suppliers hampers the option of changing supplier. This means reduced market operation on the energy market.

The expectation is that in this manner, smart meters will never reach all households in the Netherlands. Furthermore, a significant role is also played by another aspect, which did not emerge in this investigation, but did come up in the group interviews of consumers in the demand response survey [1]: The consumer above all does not want any ‘fuss’. Many consumers already find the liberalised energy market a great deal of fuss, let alone having to select a special meter.

In conclusion, we hereby state that steps by government are required for removing the obstacles mentioned by the market players (see Section 5.1.3) and for the purpose of launching a large-scale, systematic roll-out of a smart metering infrastructure for small-scale customers (the most optimal one in terms of costs versus benefits) with equal opportunities for all players.

Consequences for the implementation of Article 13 of the Energy Services Directive

The main objective of the Energy Services directive is the realisation of additional energy conservation in the member states and the development of a market for energy services. One of the pre-conditions, stated in article 13 of the directive for realising the objectives of the directive, is the requirement for meters and settlements. Article 13, paragraph 1 states that Member States must ensure that end users are provided with (smart) meters that show the exact actual consumption and indicate the time of consumption, for as far as this is technically possible, financially reasonable and proportional to the potential saving. Article 13, paragraph 2 states that Member States must ensure that energy billing is based on actual consumption and that, depending on the amount of decreased energy used, the frequency of settlement must be such that consumers are in a position to regulate their own consumption.

There is no automatic obligation to implement smart metering infrastructure at small consumers ensuing from either one of these two articles. After all, both articles make the topic dependent on proportional saving (paragraph 1) and decreased amount of energy (paragraph 2). Both paragraphs in article 13 are closely related. If the assumption is that a decreased amount of energy justifies a more frequent settlement in which the end consumer can regulate consumption, then the frequency should be at least 4 times per year and preferably every month. According to the first sentence in article 13, each settlement must be based on the actual consumption. This is economically feasible only with a smart metering infrastructure. Given that a smart metering infrastructure is technically feasible, compliance with the condition of paragraph 1 is hereby obtained and consequently, Member States have to ensure that end users are provisioned with smart meters.

Recommendations to the government

From the cost-benefit analysis it is clear that a fast, systematic, large-scale implementation of a smart metering infrastructure at small-scale customers delivers the optimal result in terms of costs versus benefits. From discussions with market players it is clear that some measure of regulation of the market will be necessary in any case, to prevent undesirable impacts in the steps towards the implementing a smart metering infrastructure.

All this combined with the ‘split-incentive’ issue in implementing a smart metering infrastructure, a low return per household per year, and taking into account that the consumer wants it ‘as simple as possible’ and is not interested in meters, our recommendations to the government are as follows:

- Oblige suppliers to invoice regularly (at least 4 times per year) based on actual consumption and to provide on-line inspection of the consumption data. In the current situation (manual reading of meters), this means a substantial increase of costs for reading the meters by the metering companies. Various market players have indicated that such an obligation constitutes a sufficient reason to shift to a large-scale implementing of a smart metering infrastructure. This is similar to the obligation used in Sweden to implement a smart metering infrastructure. Furthermore, this obligation awaits the Energy Services Directive. In principle, this obligation already ensures that implementing of a smart metering infrastructure is cost-effective for the metering companies. The experience in Sweden, however, demonstrates that based on such obligations, installed meters can also differ in functionality and are far from being future proof. Therefore, the following point is also vital.
- Prescribe the basic functionalities of a smart metering infrastructure (see Table 5 for the initial specifications). This functionality also makes the meter suitable for demand response functions. The data communication infrastructure (PLC, ADSL, GSM etc.) is *not* prescribed.

Table 5 Basic functionalities of smart metering infrastructure, initial specifications

Counter and display (kWh, m3)
Log consumption (gas, electricity) and return delivery (electricity) per period (minimum per quarter)
Outages (failure to supply)
Internal clock
Standard data outlet
Bi-directional transmission/communication (standard data format and protocols): Remote reading and remote switching off and switching back (only for electricity)

- Prescribe the implementation period (the period of time by which all households in the Netherlands should be connected to a smart metering infrastructure): between minimum 5 years and maximum 10 years. Ensure that the obligation of small-scale customers to have their meters replaced in clearly established.
  From the cost-benefit analysis it follows that the shorter the implementation period, the higher the returns. On the one hand, implementation should be done carefully with using sufficient installation capacity, for example. Prescribing the implementation timeframe creates equal market opportunities and contributes to clarity and peace in the market.
- Review via the Office of Energy Regulation (DTe) the establishment of the fixed charges for households from the perspective of the cost-benefit analysis data on the split-incentive issue. This could perhaps bring about a more equally divided allocation of costs and benefits.

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What’s on the Top? Household Load Patterns and Peak Load Problems

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Abstract

Most energy behaviour studies on households focus on the questions *how* and *why* we use energy and what can be done to lower energy consumption. Very few studies raise the question of *when* energy is used or examine the underlying explanations to load patterns. Due to economic and technical problems with electricity peak load, it is important to gain knowledge about how the load patterns of households contribute to power peaks, and to what extent households would accept a shifting of the load at certain critical periods.

This paper emphasizes these questions through a case study of ten households with electric space heating in southern Sweden. In these ten households, electricity use for heating, domestic hot water and appliances were measured as three partial loads with five minutes resolution. Energy diaries were kept by the household members. The combination of these two sets of data made it possible to see what appliances were used and what activities were carried out during peaks.

The highest power peaks in the households were based on electricity use for appliances, such as saunas, washing machines, dishwashers, and ovens. Coincidental use of large appliances, for example sauna and shower, gave the very highest peaks. Interviews indicated that there was acceptance among the households concerning a shift in the use of certain appliances at certain periods. However, all households did not have the same possibility to do this, due to their specific conditions and time restrictions.

Introduction

This paper emphasizes how every day life influences electricity load patterns in households. The examples given in this paper originate from a Swedish case study of ten households with electric space heating. The results of the study are to some extent country specific, but as there are many similarities in the way society and infrastructure are built in many countries (especially modern western countries), the discussion is interesting also in the broader perspective.

Households’ time of use of electricity is something that is not very explored in behavioural energy studies. Background to the interest in this matter, in this study, is the question of demand response and peak load problems in the power system. In order to solve peak load problems some questions may be raised: What causes household peak load patterns and how can these patterns be altered?

Peak load problems and load management

Historically, peak problems have mainly been solved on the supply side, through increased electricity production, and oversized network capacity. This is called *supply side management*. Production and network capacity have to be dimensioned by the highest load peaks that occur in the system. In order to run the electricity system more efficiently, for instance by increasing the exploitation time, *demand response* can be used to influence maximum load demand and the electricity-usage patterns. Load management means enabling and motivating electricity users to decrease or shift load when needed. Load management is defined as a set of objectives designed to directly control or indirectly modify the patterns of electricity use of various customers of a utility. This is done to reduce peak demand, which in turn makes the power supply system run more efficiently [1].

Different peak load problems

Electricity must be produced at the same time as it is used. This necessitates flexibility in the electricity production and electricity networks. Problems with insufficient electricity production can arise either when there is a sudden (and sometimes unforeseen) demand that exceeds the production capacity or when there are operational problems with some power plant. The start-up of reserve power capacity is related to high costs. The reserve power often consists of gas turbines or oil condense power that have significantly higher variable production costs than hydropower or nuclear power. In Sweden, the costs are up to 10 to 15 times higher [2].

Another peak load problem refers to narrow sectors in the electricity grid, so-called bottlenecks, where the demand sometimes exceeds the transmission capacity. Bottlenecks can cause deficiency of electricity on one side and surplus on the other side. The bottlenecks are either temporary or structural. The temporary ones appear more seldom and can be the results of maintenance, technical problems or specific market conditions. Structural bottlenecks are a result of how the power system is built, and where the producers and users are located in the system [3]. Physically, a bottleneck can only be dealt with if electricity producers in a surplus area adjust their production to the actual demand, and producers in a deficiency area increase their production. Correspondingly, the users can lower their electricity demand in the area of electricity deficiency, and increase the demand in a surplus area [3]. The possibility to import electricity from other countries is limited by the maximum transmission capacity between countries.

Peak load problems are often discussed at a national level, although many actors have different incentives to solve peak load problems at the local or regional level. Peak load problems at the national level occur rather seldom, whereas economic problems occur much more often for the local actors, that is the electricity retail companies or the local electricity utilities (at least in the Swedish case). In Sweden, local utilities pay a load tariff to the regional network owner. When subscribed load level is exceeded, large penalties are charged, especially during weekdays when industries are fully running.

Load management

The benefits from using load management can be technical, economic, environmental and social. Table 1 shows a list by Abaravicius of different interests in using load management measures [4].

Table 1. Summary of interests in load management at customer and utility sides

	Customer	**Utility**		**Producer**	**Grid operator**	**Society**
		Retail company	**Network company**			
Technical	Avoiding fuse problems		Avoided network capacity problems	Maximum use of base (and cheapest) production units Avoided production capacity addition	Stable operation of power system on national level	Stable operation of power system on national level
Economic	Lower electricity costs Lower network costs due to lower fuse level	Lower risk when purchasing power on spot market	Lower demand subscription fees. Avoided investments in the network	Lower production costs	Stable operation on lowest costs Avoided/postponed investments in the network	Economically sustainable electricity supply. Maximum reliance on local production
Environmental	Avoiding peak power plants nearby living area	Fulfilling goals established by environmental certification programs	Fulfilling goals established by environmental certification programs.	Avoided use of peak units (e.g. diesel or gas turbines) – which result in high emissions	Avoided new network construction	Least possible environmental effects
Social	Service compatible with the social activities					Power accessibility and equal conditions for all members of the society

Electricity use and load demand from a behavioural perspective

Although one may blame changes of weather conditions for many peak load problems, the use of electricity is caused by human actions and needs. Electricity is consumed because we use it to fulfil different functions. In the household, the energy helps us to create a warm and light indoor environment, to keep ourselves and the house tidy and clean, to satisfy our hunger and thirst, to get entertainment and information, and other practical functions that helps us in our daily lives [5]. “To use energy” is therefore never the main purpose when we buy electricity from the utility, but to use the functions that the electricity can serve. The product (or service) of electricity is not seen for what it is, but rather for what it can do.

In developed countries the use of energy is incorporated into almost every activity that people involve in. We turn on a light to be able to read a book. If we are hungry and take something to eat, we use energy for storing the food, for cooking the food and for washing the dishes afterwards. To keep instant track of how much energy we use is an almost impossible task, since most of our routines are carried out without much reflection. Even if we would reflect upon all our daily activities, the volume (and price) of the used energy would still be hard to control. Without installing specific meters and displays on our appliances, we do not see how much energy we use until afterwards, when the energy bill comes. And at that point, too long time has passed between the activities and the feedback, which makes it hard to recall our act in detail.

Certain energy-using functions are more obvious and observable to the user than others. These functions either require the user’s attention or are more visible than other functions. In one study where people were asked what they could do to save energy in their home, the most frequent answer was that they turn off the lights when leaving a room. Although turning off the lights is one good example of what one can do to save energy, the energy saved from turning off the lights is much less than, for example, lowering the indoor temperature with one degree Celsius, something which was a rather rare answer in the study. [6]. One explanation of the energy- saving alternative given by the respondents could be that turning off the lights is a visible action that is therefore an action easier to have in mind than lowering the indoor temperature when none is at home.

Everyday life in a context

Daily peaks in the electricity system arise from institutional influence on our use of time. Schools and working places often have similar time schedules. This means that many people have to get ready for school or work at almost the same time and perform certain activities, such as taking a morning shower, making coffee and toast for breakfast or other, often culturally conditioned behaviour, at the same time.

In the field of human geography, our daily life is discussed from the concepts of restrictions, projects and activities [7]. People adjust their daily lives to different restrictions that affect the freedom of action. There are different kinds of restrictions:

1. **Restrictions from authorities and means of control.** These restrictions are created by organisations whose legitimacy and authority are prescribed by laws and regulations. Examples of this can be schooling, timetables for transport, access to childcare system and work hours.
2. **Restrictions through interaction between members in the household or immediate family.** The restrictions are built on promises and obligations that are maintained and constantly reconsidered in the daily life.
3. **Restrictions due to deficient capacity**, for example tangible assets, knowledge, physical, economic and technical resources.

Physical restrictions of our bodies greatly influence our daily lives and when we use electricity in our homes. When we sleep for example, we do not carry out electricity using activities that need our direct attention. Indirect electricity use, where a system runs the equipment or the appliances can, on the other hand, be used any time.

Flows of *activities* occur in our daily lives either by choice or by the influence of different restrictions. Certain activities are carried out almost without any consideration. Many activities are included in different *projects* and others can be included in several projects at the same time. For example, the activity of “riding the bike to work” can be part of the project of “transporting yourself to work”, the project “to maintain a healthy body” and/or the project of “saving the environment.”

One common way to categorise the electricity use in households is to divide it into electricity use for space heating, for hot water preparation and for lighting / appliances. I will use this categorisation to pinpoint how these functions differ in regards to our behaviour.

Heading

The need for heating is influenced by different factors:

- External factors: Climate zone, weather and temperature
- Physical factors of the house: House size, construction and insulation
- Internal factors of the individuals living in the house: Comfort needs and preferences, which in turn are influenced by for example health, body activity level and convenience

Heating is one example of a function that often is automated and run by a technical system, especially electrically heated systems. The more automated the function is, the less involvement is needed from the user. As long as everything runs smoothly, the user does not have to do anything. To be able to control the function, the user has to have knowledge about the system and access to the controls. Lacking this knowledge or access, the user has no ability to control the system and this can be a real problem if one wants to achieve energy savings or a better indoor comfort. Without device that shows momentary load demand for heating, it is not easy to know how much load is on at a certain time. The heating system might be put on an adjusted temperature level, for example at 21° C, and if the system runs smoothly it will regulate the radiators automatically without any interference of any human action.

Thermal comfort for an individual is defined, according to ISO 7730, as “that condition of mind which expresses satisfaction with the thermal environment” [8]. The experience of the thermal comfort is personal and there is no perfect level that suits all. In households with more than one person, the indoor climate can be a reason for conflicts and compromises. Some studies show that women are more sensitive to low indoor temperature level. Energy-efficient behaviour such as lowering the temperature level then strikes harder on women than on men [9].

Heating is a great source to the energy consumption in Swedish households. In one study from 1991, the energy for space heating together with energy used for ventilation stood for 60 % of the total energy use in a house and the domestic hot water for 9 %. The houses in the study were all built after 1965 and the households consisted of families with children in different ages [10]. But much has happened with energy efficiency for heating in detached houses the last decades. A recent study shows that energy use for heating nearly goes halves in a new detached house in Sweden compared with older houses. In the most energy efficient houses on the market the energy demand for heating can be down to 80 % lower [11]. Hence, the energy use as well as the load demand for heating can differ very much between old and new houses. The load demand for heating varies with the conditions of climate, wind and time of the year, which means that the load demand increases in the heating season. In countries with warmer climate than Sweden, this can be compared with the need for cooling.

Domestic hot water

The use of hot water refers to routines of cleanliness like taking a bath, taking a shower or washing our hands. Or it can refer to activities like washing the dishes, either by hand or with a dishwasher that uses preheated water, or doing the laundry with a washing machine that uses preheated water. When using domestic appliances, the water use is hidden for the user.

One could say that the use of hot water is a more direct form of energy use than space heating since it often is related to human activities. The user can get some indication of the energy usage by looking at the volume of water streaming from the tap. But even if we can see the volume of the hot water used, there is still no information of how much electricity the water heater needs to prepare the hot water.

Domestic electricity use

The domestic electricity use has continuously increased in the last decades. The slope has flattened the last decade, but there is still an up going trend. In 1970, a Swedish household in a detached house used about 4000 kWh per year for domestic electricity use. Today the electricity use is close to 6000 kWh per year [12].

The electricity use per capita is systematically higher in multifamily houses, than in detached houses. This is due to the minimal level of standard of a normal home, which means that some electrical equipment and electricity use will be the same whether the household contains one member or more. Since the households systematically are bigger in detached houses than in apartments in multi-family houses, the domestic electricity use is yet higher in detached houses. There is a trend towards a greater share of households with only one household member. Number of dwellings in the country is a key factor for further development of domestic electricity use, but we cannot know if the trend will continue. There is a limit of how small a household can be and the present tendencies, for example immigration, birth rate and living expenses, can change the circumstances [13].

Our holding of electric appliances has dramatically increased in the last decades. This is one reason why domestic electricity use has increased steadily during the years. Technical development of energy efficiency for many large appliances has however counteracted the increase of energy use. Refrigerators and freezers, as well as washing machines and tumble dryers are today much more energy efficient than ten, twenty or thirty years ago. The answer to the increase of domestic electricity use may then to a certain extent be explained by the introduction of new electricity appliances in our homes, such as computers, printers, TV, VCR, CD-players and battery chargers. Many of these appliances use stand-by power for preserving the setting of clocks and programs.

For some appliances, the energy use is highly affected by the usage patterns in the household, whereas others run autonomously. Lighting is one example where the users greatly influence when a lamp is in or off, whereas the use of freezers and refrigerators are more influenced by a thermostat (although habits like how often one open the door or how often one defrost also influence the energy use to some extent). The share of electricity use for different appliances or activities was investigated by the Swedish Energy Agency in one study from 1998 [14], see Figure 1.

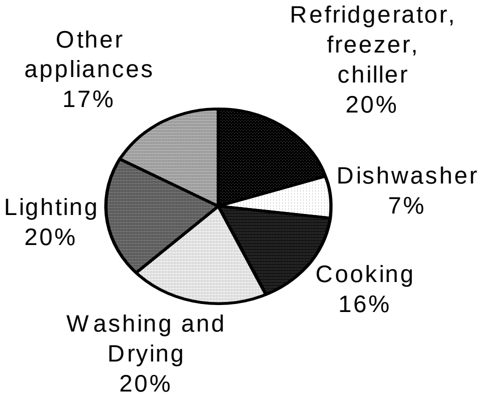

Figure 1: Share of electricity demand for different appliances in Swedish households.

Study of household electricity use and load patterns

To be able to study how people use electricity in a time perspective, that is, to look at their "peak behaviour", a case study was carried out with ten households in southern Sweden. The purpose of the study was to investigate what activities and what appliances in the household that contribute mostly to high peak load. A combination of methods; frequent electricity metering and energy diaries were used in this study. Follow-up meetings were carried out with the households after the diary period were the two kinds of data were discussed.

Selection of households

The ten households that were selected for this study, were all the customers of Skånska Energi AB, a Swedish utility located in a town called Södra Sandby in the south of Sweden. The selection of the households was not just made for this particular study, but also for load management experiments. Hence the selection was more focused on technical criteria of, for example, their heating systems, than on demographical factors, such as household composition and age. Household composition and heating system are stated below:

K1 (House 1): Composition: Married couple in their 50's with a grown up son, still living at home. Both are working. Heating system: Electric boiler, wood stove and water heater of 200 litres.

K2: Composition: Married couple in their 60's, the wife works and the husband is a pensioner. Heating system: Electric boiler with integrated water heater of 120 litres. Air to air heat pump.

K3: Composition: Widower, pensioner in his 70's. Heating system: Electric boiler and water heater of 200 litres.

K4: Composition: Married couple, pensioners in their 80's. Heating system: Electric boiler with integrated water heater of 120 litres.

K5: Composition: Married couple in their 50's, both working. Heating system: Electric resistive with oil filled radiators, fire place and water heater of 300 litres.

K6: Composition: Married couple in their 60's, both working. Heating system: Electric resistive, mostly with oil filled radiator and floor heating 8m2 and water heater of 300 litres.
K7: Composition: Married couple about 55 years, both working, one grown up son still living at home. Heating system: Electric resistive and water heater of 300 litres.
K8: Married couple about 55 years, both working but the husband was on the sick-list during the study. One grown up son still living at home. Heating system: Electric resistive and water heater of 300 litres.
K9: Younger cohabit couple in their 30's, with a baby. The man worked and the woman was on maternal leave. Heating system: Electric resistive and water heater 200 litres.
K10: Cohabit couple in their 40's. The man was working and the woman was unemployed. Two teenage kids were living in the house every fortnight. Heating system: Electric resistive with oil filled radiators and water heater of 200 litres.
The houses were all electrically heated, but some had water borne systems and some have electric resistive radiators. Seven of the houses were detached and three (K6, K7 and K8) were semidetached. K5 was the biggest house (150 m2 and basement 150 m2). K1, K2, K3 and K4 were somewhat smaller (145 –186 m2) and the smallest were K6, K7, K8, K9 and K10 (between 95 and 118 m2). The number of household members varied from 1 to four persons.

Metering
Two extra electricity meters were installed in each household which made it possible to measure electricity load for space heating, hot water preparation and total load separately. The domestic electricity load was then calculated as the difference between the total load and the load for heating and hot water. During the diary period the three partial loads were measured with five minutes resolution.

Energy diaries
Diaries have been used in other types of studies to decide where and when events and processes occur. The interplay between time and space has been the focus in time budget surveys where activities and the use of time in populations have been investigated. To be able to investigate habits and usage patterns in our every day lives, a real time perspective must be taken on [7]. Figure 2 shows the differences between a real-time perspective and an added time perspective. In an added time perspective, the information about how many times a specific activity is carried out disappears and so does the context in which the activities are carried out.

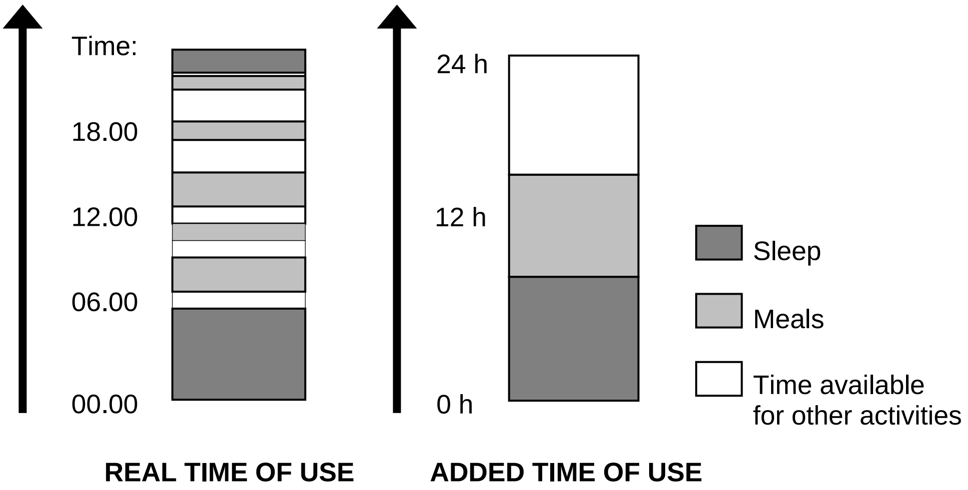

Figure 2: Different time perspectives

Let us assume that we have an added energy use instead of an added time use. The added energy use then corresponds to, for example, the yearly energy usage in a household. The yearly energy use does not say anything about *when* the energy has been used or for what, nor if the energy has been used evenly over the year. For this purpose energy diaries together with frequent electricity metering have been used in this study.
All members in the ten households noted every energy related activity they performed in their personal energy diaries (except for the baby in K9) for four days in January 2004. The households

themselves chose diary period. They had to choose four successive days in January, including one weekend. The diaries were made of prepared diary sheets. Each sheet consisted of a table with five categories; Time, Activity 1 (What I am doing), Activity 2 (If I am doing something else at the same time), Energy appliances used and Comments. One or two days after the diary period, household and researcher met and discussed the outcome of the energy diaries and compared the notes to the load curves for total, heating, hot water and domestic electricity use. Activities and appliances could then be linked to the load pattern in the diagrams. Some electricity load that did not have any corresponding notes of energy use in the diaries was found. For instance, the electricity use from floor heating was detected on the load curves in one household.
The households were also interviewed about their possibilities and acceptance of shifting the use of certain appliances and electricity use at certain periods, if they would have to pay for load demand on the electricity bill in the future.

Results

Combining the methods of frequent metering for three partial loads with notes from the energy diaries has made it possible to do different analyses of energy and load behaviour in the households. More results from this study are reported in a separate report [15].

Heating

As heating is an autonomous function in the ten households, there were not very many notes on this in the diaries. Lighting a fire and lowering the heating during the night were two examples of behaviours that were noted that referred to heating. Lighting a fire in the stove or fireplace, however, did not show on the load curves. This might be explained by the fact that the households who noted this activity had outdoor sensors so that differences in indoor temperature were not compensated for. Household K1 and K4 lowered the temperature on the electric boiler before going to bed, and then raised the temperature again in the morning. This behaviour resulted in an energy saving of approximately 9 kWh for K1 (1kW* 9 hours) and 7 kWh (0,84* 8 hours) for K4 per day during the diary period. Although this behaviour results in significant energy savings, it can also give rise to a recovery load. For K4 this was not evident, but for K1 it gave rise to a recovery load of 2,6 kW witch was approximately 1 kW higher than the stabilized load level.
Different heating systems behave quite differently. In Figure 3 the heat load curves from three households are put in the same diagram.

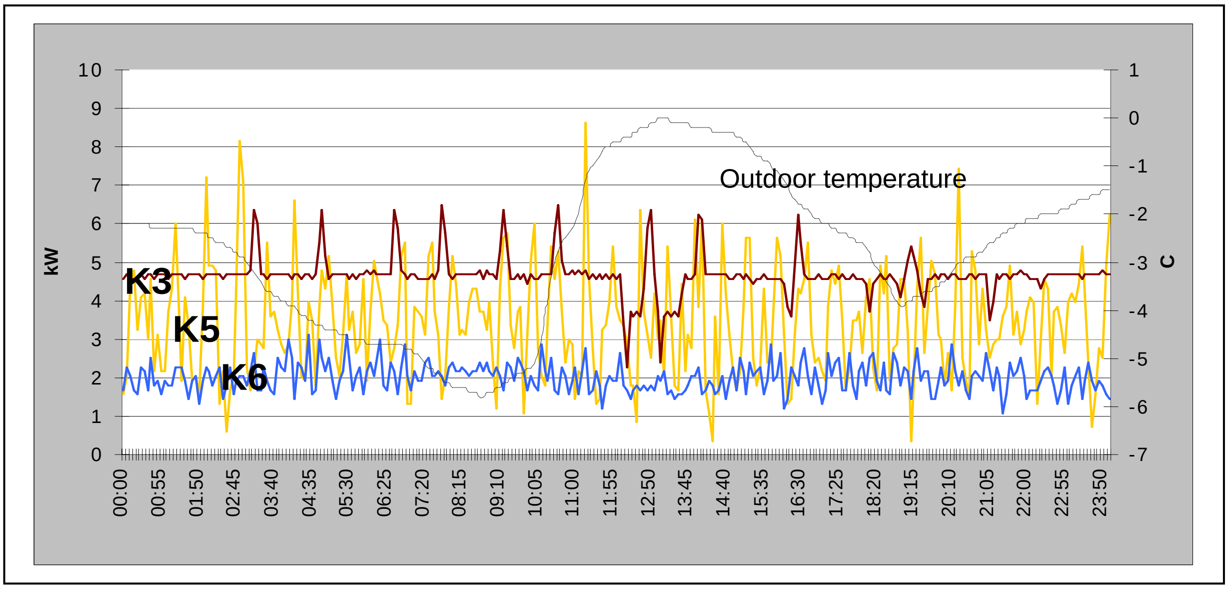

Figure 3: Heat load in three different houses for one day in January 2004.

Principally two factors seamed to conduce to the differences in the shapes of the load curves, namely the size of the houses - or more specifically: the heated area in the houses, and the kind of heating system and automatic control. The prerequisites for the houses were as follows:

- House K3, which had the highest load for heating in general of all the houses, had a living space of 180 m^2. The heating system was an electric boiler with an outdoor sensor, and the internal system was waterborne.
- House K5 was a house of 300 m^2 (150 m^2 was heated basement). The heating system was electric resistive heating with thermostats on the radiators.
- House K6 was a semidetached house of 118 m^2. The heating system was electric resistive heating with oil filled radiators and “soft heating” system with outdoor sensor.

House K3 had an electric boiler and the heating demand for this day seamed to be in accordance to one of the boilers stage of load level considering the even load shape. Shorter periods where yet another load step is activated are clearly showed in the diagram. The houses K5 and K6 had electric radiators and the load patterns from this equipment oscillated much more. House K6 had, in contrast to K5, a “soft heating” system and, moreover, a large share of oil filled radiators. The fluctuations between the peaks and the valleys of the load curve were apparently lower for K6 than for K5. This was probably due to the soft heating system.

Hot water use

Taking a hot bath, a shower or washing the dishes were the three activities that gave rise to a large use of electricity for hot water preparation in the ten households. Other types of hot water use that were reported in the diaries, for example getting hands washed, shaving or washing the floor, did show on the load curves, but did not give rise to any larger electricity use.

Both load level and electricity use were influenced by:

- The equipment: The dimension and the load level of the water heater, the adjustment of the thermostat and the insulation of the water heater matters
- The user activities and the habits related to the different activities (for how long one takes shower, how much water one use when filling the bathtub or washing the dishes etc)

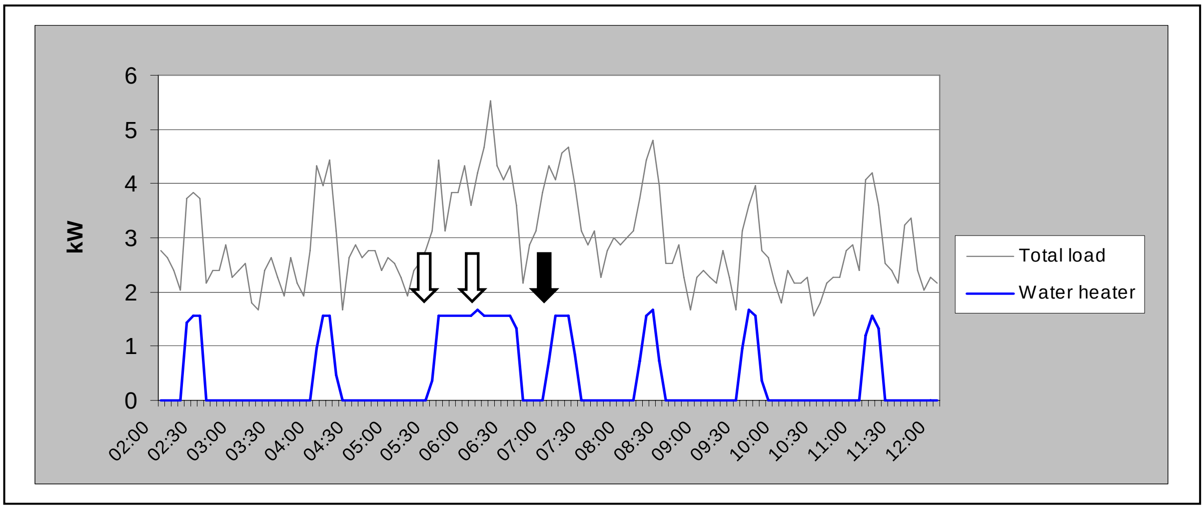

Figure 4: Use of electric water heater, Saturday 16 Jan, 2004 (House K6).

Figure 4 shows electricity use for hot water preparation in one household (house K6) in one weekday morning. Only three peaks in the diagram were due to hot water tapping. At about 05:20 the man took a shower and at 05:42 the woman did the same, which gave rise to an electricity peak that lasted in one hour and twenty minutes. At 06:56 the couple washed the dishes from breakfast. As one can see, the peaks reached the same load level every time – about 1600 W. The other peaks shown in Figure 4 referred to heat losses and came from reheating the water heater.

The sizes of the water heaters in the households varied from 200 – 300 litres with a maximum load level of 3 kW. In K6, K7 and K8 there were two load steps on the water heaters. In the study it was showed that the size of the water tank could influence the habits of hot water use. For example, the households were aware that they could run out of hot water if several persons were taking showers in a turn. In some households this did lead to an order of priority, where the ones who shower the longest had to wait until last of all. Another strategy in some other households was to regulate the time of use so that some members took their showers in the morning and some in the evening.

Domestic electricity use

Domestic electricity is used for an abundance of different functions in our homes: lighting, motor power, pump power and heating of all sorts of equipments. The electric power helps us to heat oven and hobs so that we can cook, to heat the iron so that we can get rid of creases in textiles, to heat water to wash clothes in the washing machine or to wash the dishes in the dishwasher.

In the diaries the household members have noted what electric appliances have been used during the diary period. All ten households used TV set, kitchen range, lights and shower during the period. Washing machine, coffee maker, vacuum cleaner, oven, microwave oven, hair dryer and computer were also examples of appliances frequently used in the households. All the households had got freezers and refrigerators, but few noted this kind of appliances since these are not so much linked to daily activities. As a matter of curiosity, some of the more uncommon appliances noted by the households could be named: air humidifier, electric coffee mill, electric squeezer, fryer and amateur radio station.

A large part of the domestic electricity is influenced by personal activities. But there are also a “base load” that primarily consists of the use of electricity from freezers, refrigerators and stand-by power. The electricity load from this base load varied from 250 W to 1250 W in the households. This means an electricity use of about 6 to 30 kWh per day (which means from about 2190 kWh to 10950 kWh per year). Behaviours like overhauling the stand-by power usage in the house or replacement of old freezers or refrigerators can really save a lot of electricity and money and decrease the total power load in the household!

Analysis of highest peak load from domestic electricity use

One analysis was made about what activities and appliances it were that contributed to the highest power peaks in the households (during the diary period). Each household’s ten highest peaks from domestic electricity use measured by five minutes were compared with the notes from the diaries. Following appliances or activities gave the highest load: Saunas (5-6 kW), washing machines (2-3,6 kW), ovens, car heaters and engine heaters (fully 3 kW), electric fires (1,5-2 kW).

Two households have got saunas installed in their houses and have been taking a sauna during the diary period. Heating the sauna gave rise to the highest load peaks of all, about 5 – 6 kW. Considering the fact that saunas can be on for several hours, plus the fact that taking a sauna mostly is combined with taking a shower (1,6 - 3 kW for the households in the study), electricity customers should be made aware of the load pattern from saunas if they are going to be charged for load demand in the future.

Washing machines gave rise to some of the highest peak loads in eight of the ten households. Washing machines were frequently used in the households and some households used them almost every day during the diary period. A normal washing programme takes between 45 and 80 minutes, and the load demand is typically higher in the beginning of the programme when the water is heated. Drying cupboards and tumble dryers gave rise to almost as high peaks as washing machines. These appliances are often used successively or at the same time, which together give yet higher load.

The usage of ovens resulted in high peak load for seven of the households. Combined with other cooking activities high coincidence loads were reached.

Electric heaters, such as car heaters, engine heaters and floor heaters had a relatively high load demand. Since the function of these appliances often is autonomous, especially when using a timer or thermostat, there is a risk that the households don’t pay attention to the electricity use from this kind of equipment.

Composition of the highest electricity peaks

Looking at the very highest electricity peak (from the four-day diary period) in each of the ten households, an attempt has been done to divide the peak into electricity use from different appliances. Since there were data about the three separate loads (total, hot water and heating) but not for each appliance, the load curves have been compared with diary notes and the electricity use from noted appliances have been approximated. The analysis is not exact, but it gives some idea of the appliances relative contributions to household peak load. See Figure 5.

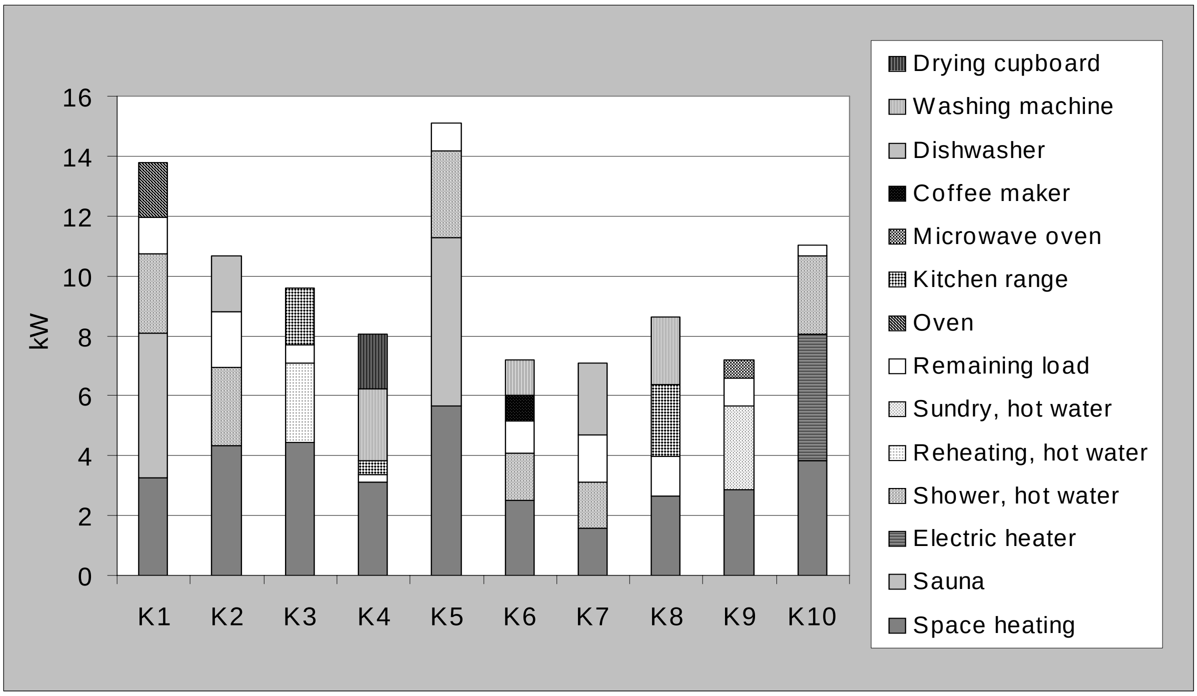

Figure 5: Composition of 10 household's highest peak load

The heating load could be seen as a base load in wintertime for all of the households. The load for heating in this diagram didn't reach the highest electricity peaks for heating in the study, but nevertheless it stands for one fourth to one third of the total peak. In eight of the households some part of the peak relates to electricity use from the water heater. In six of the cases the shower has been used. A large part of the peaks consists of load from domestic electricity use. In K1 and K5, the sauna was used and in the other households activities such as cooking, taking care of the laundry or using the dishwasher were carried out. The field in the staples named "remaining load" was based on electricity use from refrigerators, freezers, lights and stand-by power.

The households were interviewed about what changes of electricity use they thought they would adapt to, if the electricity utility made them pay for load demand (either by a time-of-use tariff or a tariff with a load component). Activities such as washing and drying linen and turning on the dishwasher were the ones that all of the households came up with immediately. This kind of activities is basically run by machines and doesn't require so much attention. The supplementary work when the machines have stopped still has to be done though, and this work would be postponed. The two households with saunas installed in their homes, said that they were flexible when to use the sauna. If the low tariff periods were not too late in the evening (or too early in the morning) they could wait until the electricity price was lower.

Cooking was one activity that the households did not want to shift in time. They wanted to be able to cook whenever they were hungry or felt for it. The use of hot water could eventually be adjusted to times with the lower tariff. Just a few of the households talked about technical solutions like, for instance, installing an accumulation tank for hot water storage which makes it possible to turn off the water heater in high tariff periods.

This analysis was made from the data of the households' highest peak during the diary period, which means that only the appliances that were used during this specific electricity peak is shown in the diagram. Other activities such as ironing, vacuum cleaning or hair drying (all about 1 kW) would also have showed in the diagram if these activities had been performed during the period.

Now, let us make an intellectual experiment. Let us remove the load from the activities that the households say they are willing to move from the diagram in Figure 5. What are the potential load savings? If we remove the load that comes from drying cupboards, washing machines, dishwashers and saunas; the load from the electric heaters in K10, since this load easily could be moved to low tariff times, and the hot water use that coincides with taking a sauna, the households would reach load savings between 0 and 57 % (mean value: 31 %) There would be no savings in K3 or K9, moderate savings of K2, K6, K7 and K8 and large savings in K1, K4, K5 and K10.

A story of one afternoon...

A mother and two kids come home to the family house. They have just left work, school and the day-care centre for the day. It's November and already dark and cold outside. They long to come in to the heat and the light inside. The kids are wining of tiredness. They are hungry and tired after a long day. Now the dinner must be served quickly before the youngest kid falls asleep in front of the TV set. The older kid has had his fun jumping in puddles during the break in school. His coat is all muddy, and he himself has mud in his hair. The coat has to go in the washing machine and the kid in the bathtub. Dinner is not prepared. The minced meat is in the freezer and must be thawed in the microwave oven. Pasta Bolognese is on today's dinner menu. Yesterday's dirty dishes from dinner and breakfast are piled on the kitchen sink. There are no clean glasses left, so the dishwasher has run one batch. The dishes are rinsed with hot water – there are stains of ketchup and egg and they won't disappear unless they are rinsed first – then the dishwasher is switched on. The electric kettle is turned on for the spaghetti water, and at the same time the older kid is shouting for help to get up from the bathtub. This kid has still shampoo in his hair and his mother takes the shower and helps him rinse his hair. When the kid is ready, cooking is continued in the kitchen. The minced meat is now thawed up and the water in the electric kettle has boiled and is poured into a big pot. Two hobs are switched on, one for the spaghetti water and one for the mincemeat sauce. The electric kettle gets filled once more; the spaghetti needs more water to boil in. Onion, garlic and celeriac are peeled and one tin of tomato paste is opened with the electric tin opener. The clock is striking six and the kids runs up and turn on the children's programme...

Let us end the story of this family a cold November afternoon. During one hour, the family manage to turn on several electric appliances: washing machine, dishwasher, two hobs, electric kettle (twice), electric tin opener, TV set and hot water for rinsing the dishes and bathing. For the total energy use in the house this period, add the use of energy for heating, lighting, refrigerator, freezer and stand-by power from different appliances.

If one would ask the mother in the story if she thinks that the energy used during this hour in the afternoon is unnecessary, the answer would most likely be *no*. All the activities have been essential to fulfil different needs in the household: to be warm, to get food, to keep the persons, the house and the clothes clean for next day. Is there any load that could be shifted to other times? Well, maybe. The kids are hungry and tired and the cooking has to be quick. With better planning, the minced meat could have been thawed over night in the refrigerator. Then, the use of the microwave oven could have been avoided. Cold food could have been served, but maybe there is a decision to serve hot meals in the evening in order to make sure the kids eat at least one cooked meal every day. This could be part of the project "family spirit" or "healthy bodies". The wash up of the coat could maybe be postponed. But the coat is going to be used the next day and it has to get dried. The washing of the dishes maybe could have waited, but there were no clean glasses and some were needed for the dinner. Besides, no one in the family manage to put the dishes in place if it gets too late.

The family experience time as a deficient capacity (or resource). Different restrictions in the society are influencing the family's freedom of actions; school hours, work schedules, timetables etc., are shaping the family members lives. When the family gets home, there are obligations: to do the dishes, prepare the food, take care of the laundry and the homework – things that have to be done here and now. Physiological factors like hunger or need for sleep make themselves reminded. The stomach is rumbling at five. The kids are tired and hungry and the experience shows that cooking has to be quick, or else the kids fall asleep without eating. After the kids are put to bed, the parents might be too tired to do any more housework.

Concluding discussion

The deregulated electricity market in Sweden, as well as in other countries, has increased the interest in demand response, which means that the electricity users should share the costs of peak load, and they should adapt to new behaviours that considers peak load problems.

Some problems come up when talking about demand response. One problem is that our use of electricity or energy often is hidden for us. This is because we do not know how much energy different appliances and equipment need. We simply do not think in terms of energy use, but rather in terms of activities. When carrying out different activities we use appliances and equipment and they in turn use energy. Thus, the construct of energy use is quite abstract for people. Then, if the construct of energy use is abstract, what about the construct of load, that is, energy use per time unit?

Some results in this study were showing how heating systems, water heaters and big appliances in the households contributed to the load pattern. These patterns were not easy to predict. In households with many members, the load patterns get even more complicated.

Using load management measures that means that the customer itself has to keep track of its peak load behaviour, might not be very fair to the customer (the use of a tariff with a load component for instance). The customer needs help to either monitor the momentary load, or to limit the power use so that it does not exceed a certain level. This could be done with a load guard. The result of the intellectual experiment in the study showed that there could be some potential in time-of-use tariffs to influence customers to adapt to new load saving behaviours. Here, the customers need help to learn what activities and equipment it is that contributes to high power peaks and large electricity consumption, and if there are any technical solutions that could be installed to help shift load.

All households don't have the same possibilities to shift their energy use in time. The mother in the story told above, felt that time was a deficient capacity. If time is restricted, there is not so much freedom of action. Therefore, a time-of-use tariff would strike harder in some households.

The discussion of how people think of their everyday life in terms of activities (where many of the activities happens to require energy) is vital in this paper. The energy is needed to fulfil different functions or services in the household. So, should the energy companies really be selling energy, when the customers requires services like a nice indoor climate, a good hot water comfort and so on? This idea of servicization is not totally new, but the energy companies do not use it to any greater extent. This idea, however, could have many advantages. If an energy company would take over the heating service in a detached house for example, the customer would pay for heat with a certain comfort level, but not for the energy use. Thus, the company could optimise the system from whatever factors it liked; energy use, energy costs, system sustainability, environmental concern or to remedy peak load problems. There are, of course, some objections to the idea. For instance, there might be some legal questions of ownership. Who owns the equipment and what happens if the house is sold? Or there might be some trouble with integrity if the company has to have access to the heating system.

Looking at the composition of the highest peaks in the households, it became evident that domestic electricity use contributed to a large part of the peaks. Big appliances, such as washing machines, dishwashers, tumble dryers and the like has been improved of their energy performance over the years. Maybe, manufacturers of white goods in the future also will have to consider peak load performance when developing new appliances.

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Smart Metering – the Real Energy Benefits

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Abstract

Smart metering is now discussed as a real opportunity for carbon reductions in many energy markets across the world. What is the scientific basis for this enthusiasm?
Smart metering can be defined as delivering more data to consumers and energy companies than can be delivered by standard metering and billing systems. This probably covers the main perceived benefit but there are many other potential uses of smarter metering systems, including the integration of household renewables, and demand response mechanisms. This paper explores how smarter metering can provide the key to the efficient use of energy in buildings.

Why the interest?

The primary reason for the high level of interest in smart metering is the requirements brought by the 'Energy End use and Energy Services Directive, published in the European Journal in May 2006 [1]. Article 13 of this lays out a number of requirements for the accurate reflection of the customers actual energy consumption and on the time of use. It also covers a number of requirements for more regular and accurate billing.

What is smart metering?

There are as many interpretations of what smart metering is as there are organisations espousing their opinions, however, from a UK context, a set of guidelines for what smart metering is has been developed and has received reasonable acceptance. These guidelines are perhaps transferable to other energy markets, but some elements are a result of the particular market structure in the UK. Market structure has a much greater impact on the type of technical solution that can be adopted in each country, than any other types of energy efficiency measure. This needs to be taken into account all through the decision process for designing, and implementing smart metering systems.

The guidelines for smart metering systems for the UK follow the following model [2]:

- A smart metering system provides a level of service above and beyond measurement of consumption.

A smart metering system provides significant additional functionality for suppliers and end use customers. The guideline is based on a fundamental set of capabilities (A,B,C) plus a range of optional functions that a smart system could include. A smart metering system must include all fundamental functions plus at least one of these optional functions. The guideline allows for a number of technology solutions including single unit, multiple units and communications options.

The guidelines can be used to describe a wide range of smart systems which can meet a number of policy and commercial objectives.

A system for metering any residential energy or water supplies that:
A Measures consumption over representative periods to legal metrology requirements
B Stores measured data for multiple time periods
C Allows ready access to this data by consumers as well as by suppliers or their agents

and at least one of the following functions:
i. Provides analysis of the data and a local display of the data in a meaningful form to the consumer or as part of a smart housing solution.
ii. Transfers consumption data to the supplier or his agent for the purposes of accurate billing without requiring access to the home.
iii. Provides a payment facility for one or more supplies.

iv. Measures, and records information as to the continuity and quality of the supply and provides this and other data to the Distribution Network Operator for purposes of system operation, planning, and loss assessment.

v. Permits remote control (e.g. interruption and restoration) of specific consumer circuits or equipment for the purposes of agreed load management.

vi. Allows display of price signals for different time periods as part of a cost reflective tariff for the purposes of demand response.

vii. Allows for remote change of tariff, debt or other rates for utility charging without requiring access to the home.

and, where a consumer has micro generation equipment installed:

- Provides a facility to measure energy export and/or generation, where required for official purposes.

The basic set of functions A,B and C are required by any smarter metering system, as these produce the basic data that can be used by utilities or customers. Without this type of basic meter, almost all of the benefits of smart metering cannot be delivered. For example in the UK consumers often only receive accurate reads in their bills every 6-9 months. The maximum number of accurate reads in the UK can only be 4 per year even if meters were read accurately every quarter. Clearly with this infrastructure smarter metering is difficult to roll out, and many of the benefits would be lost.

The second section of the guidelines covers the additional features that could be added to the basic meter either individually or as a package. Each one would deliver benefits for either the utility and/or the consumer, in many cases to the country in general, and the environment.

Local displays

Traditionally, utility meter readings are not easily accessible for consumers, the information is displayed in KWh, often shown as a cumulative total, with no ability for the consumer to access historical, or even instantaneous information. The positions of the meters are almost always determined by where the electricity or gas supplies come into the building and are not usually accessible for building users. The result is that the majority of consumers, firstly, may have difficulty in locating their meters, and, having found them, would not easily understand the information displayed on the existing meters. This historical use of meters has reflected the market requirements – the accurate measurement of KWh, the accurate billing of this energy use, and the settlement of the energy markets for utilities as well as the technical capabilities of the first mechanical and electromechanical meters. There has been little historical need for consumers to have a ready access to their metered energy use.

The much higher political importance of climate change and security of supply in all markets in Europe and worldwide is now questioning the lack of connect between consumers and their energy use. Many believe that the most effective way to increase the customer's awareness is to provide them with in-house displays of readable, easy to comprehend energy use information. Examples of these displays have been used in various markets in the world, primarily the US and Australia, although home displays have been used in Northern Ireland with some success [3]. Many observers think that once the consumer can see the changes in their energy use instantaneously they are much more likely to act to reduce that consumption, in particular in the present and expected future higher fuel pricing environment. A recent study carried out for Logica [4] by the Future Foundation asked consumers the estimated savings that they feel they could deliver by the use of a smart meter "If you had a smart meter, by how much do you think you would reduce your energy bill?'' The results showed a range between 0 and 34% with an average of 15%.

A 15% reduction in energy use across electricity and gas would meet the UK's targets for the domestic sector. Making this potential a reality, though, is not straightforward, but evidence from world markets, with differing climatic, and market conditions indicates that energy reductions of between 5-10% fairly common. The actual energy reductions from the availability of easy to access data in customers' homes is very difficult to quantify. Significant work is still required to precisely quantify what the real benefits in this area are, and, further, on how to maintain benefits over the longer term. However this need for exact savings figures must not be allowed to hold up the deployment of effective solutions for smarter metering and customer displays.

Accurate Billing

In an era of low energy prices, accurate billing for many consumers has not been an issue high on their list of concerns. However, for a significant minority of society (3.5 million) in the UK, the ability to budget via pre payment metering systems has been a great benefit. What these consumers have had for many years is a direct link with their energy use and their billing system. These consumers have received accurate billing for many years, but the vast majority of customers have had estimated bills in the main. Additional problems in a free utility market like the UK, arise when a culture of estimated bills is combined with a customer change of supplier. Energywatch, the UK gas and electricity consumer watchdog, has catalogued the significant problems that very often occur when customers change supplier. The main problem results from the long term use of estimated bills. In summary, the standard of billing systems in the UK and some markets compared to comparable utilities such as telephony is very poor.

Smart metering systems can be used to significantly improve the billing for all consumers. This could be achieved by just mandating accurate quarterly or monthly reads, as is now the case in Sweden. The example from Sweden shows that as soon as there is a need for more regular and accurate reads automated meter reading becomes economically viable. Once automated reading is in place combined with the basic data sets available from meters, bills can be designed and presented to consumers in many different ways that allow information to be understandable so that it can be acted upon. Other information can also be included on these new bills including environmental information and the sources of electricity (nuclear, gas, renewable etc).

As well as providing richer information to go on the utility bill, smart meters can, in principle, provide a data stream directly into the house. This data can have a higher resolution than the utility billing without swamping the data processing systems of the Suppliers. Taking data directly off the meter also means that the information can be real time, much increasing its value and effectiveness. Recent developments in domestic communications provide paths for the data and destinations. For instance, the data can be transmitted via WiFi, Bluetooth, PLC, Ethernet to a standalone display, the TV or a home pc. All of these destinations allow the data to be brought somewhere convenient for the customer. Better billing can, when combined with in-house display contribute to customer awareness of energy and environment and help them to make reduction decisions. Information alone will not of course deliver energy savings, however once consumers are aware of their usage, in particular in times of increasing energy costs, many observers believe they are much more likely to reduce usage. The likelihood of this will almost certainly increase if traditional energy efficiency advice is adapted given with the knowledge that consumers are aware of their energy usage.

Load management

The term load management has been used in the UK for many years, but is probably known in other markets as demand response. The benefits of allowing consumers and /or utilities to change usage patterns as a result of variable tariffs has been demonstrated in many world markets, primarily the US and Australia. How these benefits manifest themselves varies in different markets, but a shifting of energy usage from peak periods is seen in almost all examples, and in many cases the energy usage does not increase to the same levels at other lower usage time periods. There is still a very current debate as to the extent to which demand response methods lead to carbon emission reductions, either via reduced demand or the reduction in use of high carbon intensity generation plant at peak periods. The benefits in terms of security of supply are more clear cut.

Load management can have other effects if combined with the use of smart appliances, building services and household renewables. The ability of a washing machine, for example, to only operate when there is a low carbon electricity supply available can increase the carbon abatement possibilities significantly. This is particularly the case when household renewables are available locally(?), and their output can be matched to the use of, for example, appliances such as washing machines.

To achieve any of these load management solutions the basic meters installed in the UK and elsewhere must be upgraded at least to the minimum levels in the guidelines.

Integrating household renewables

Smarter metering can play an important role in the widespread take-up of household renewables. Firstly, it is impotent that the customer for these technologies can easily see the contribution that their solar generator or wind turbine is making. This is often not provided with the renewable technology, and is remote from the overall energy usage information on the utility meters. If most homes have customer display units, it is likely that these will be combined with other display equipment, such as heating controllers, and a logical extension would be to show renewable generated data on these units as well.

In addition the electricity network needs to know what the output of household renewables are for the management of the system, to balance the settlements system, and to claim any appropriate renewable certificates. Very often these important aspects of household renewables are forgotten, but the roll out of smart metering systems can provide cost effective methods to maximise the contribution that these technologies can make.

Summary

The examples given of where smarter metering systems can assist the objectives of carbon emission reduction, better billing for utilities and customers, or integrating smart appliances and renewables are the main ways in which better metering can help Government, industry and consumer objectives. There are others concerned with the management of data in the back office operations of utility companies, and debt recovery, and revenue protection. None of these benefits can be achieved with the installed metering base in the UK, and in many other European and world markets. However the implementation of smart metering solutions to meet only one of these benefits may exclude delivery of others. Therefore there needs to be a co-ordinated approach to the development of policies for smart metering in different world markets.

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Sustainability of Dutch Home Automation Projects, Evaluation and Recommendations.

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ECN, Energy in the Built Environment

Abstract

In the Netherlands, in the years 2002 to 2004 a national programme has been implemented by NIDO and ECN to evaluate the sustainability of the application of Home Automation for independently living elderly people.

Evaluation of 12 projects in the Netherlands, Belgium and Germany showed that:

- There are good prospects for improving independence and quality of life for the elderly by using home automation applications. A prerequisite is that the users are well involved in the design process. However, this is not current practice.
- In theory, there are good opportunities for combining social and healthcare applications with applications that improve thermal comfort and energy efficiency. In practice this is not applied, for a variety of reasons.
- Energy consumption of the equipment itself is usually unknown. Suppliers and consultants estimate it as being low. In two known cases the energy consumption has been measured. In these cases the energy consumption was significant: 10 to 40 % of the normal annual electricity consumption of the households concerned. With increased attention to low-power ICT-appliances this percentage is expected to be decreasing.
- Current applications are still too expensive and difficult to organise and maintain.

Simulation studies performed by ECN showed that home automation could be a good tool for supporting energy savings, especially for a target group of high income customers that are not themselves very much oriented towards energy efficient behaviour and that are living in larger and older buildings.

Recommendations are formulated for effective and sustainable application of home automation. If these recommendations are implemented, there are good opportunities for successful and sustainable application of home automation to assist elderly people living independently.

Dutch national programme for sustainable Home Automation applications

In the Netherlands in the years 2002 to 2004 a national programme was implemented by NIDO and ECN for sustainable Home Automation applications[1] [1]. NIDO was a Dutch government initiative for promoting sustainable practices across society[2]. Programme management of the NIDO programme for sustainable Home Automation was performed by ECN (Energy research Centre of the Netherlands). ECN also was delivering the technical expertise concerning energy efficiency of home automation applications.

The aim of the programme was to evaluate the sustainability of the application of Home Automation for independently living elderly people. This is an attractive market in view of the increasing number of elderly people in the Netherlands and across Europe in the coming decades. Home Automation applications can support elderly people to live independently and at the same time relieve the work load of care services, if provision is made, that the applications are properly installed and operated and the services are well organised. The focus of the programme was on how these social and financial benefits could be combined with environmental benefits, like energy and carbon savings.

For this purpose, activities were organised like project evaluations, desk research, a conference, workshops, several publications and a website [1]. To give more attention to the residents - the users of the home automation applications - joint workshops were organised with both professionals and elderly people. In total, over 100 organisations active in the field of housing, care and home automation participated in the programme.

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[1] The name of the programme is 'In eigen omgeving oud worden' (Ageing in one's own surroundings)

[2] The full name of NIDO is 'Nationaal Initiatief Duurzame Ontwikkeling' (Dutch National Initiative for Sustainable Development.) It operated from 2000 to 2004. From 2005 the activities of NIDO were taken over by the Competence Centre for Transitions [2]

ECN research on Home Automation and Energy Efficiency

Over the last seven years ECN has conducted several projects in the field of Home Automation and Energy Efficiency. These projects ranged from designing ICT architectures, developing business models to implementing laboratory tests and performing field experiments [3,4].

ECN has 4 research dwellings. One of these is equipped as an ICT research dwelling (see figure 1). In this ICT research dwelling ECN has conducted tests with energy efficient ventilation controlled by a home automation system [5]. The other three research dwellings are used for performing tests with building integration of comfort installations.

Figure 1: Research dwellings at ECN. At the right, the ICT research dwelling.

Evaluating sustainable Home Automation applications in the Netherlands

12 projects in the Netherlands, Belgium and Germany were evaluated, including:

- **Development of service flats across Flanders (Belgium)**: In the period of 1998 to 2003 Service Flats Invest NV, Antwerp (Belgium) built 700 low cost service flats in several towns in Belgium. Typical for these projects is cost reduction. This was achieved through the combination of a standardized building concept and large contracts with suppliers. Some home automation functions are included in the concept. Attention has been paid to design and ease of use. However, a disadvantage of this project was that residents have limited control over the internal arrangement of their house and the settings of the home automation system. [6]
- **Renovation project Lidwinahof, Best (Netherlands)**: In 2002 housing association Domein renovated 49 apartments for elderly people. In this renovation project home automation applications were installed for safety and security, care and comfort. Typical for this project was an extensive survey among the residents, both before and after the renovation. [7]
- **Demonstration project Moerwijk, The Hague (Netherlands)**: From 2001 to 2004 a home automation installation was designed and installed in a test apartment by expertise and consultancy centre ILSE (Independent Living for SEniors). Typical for this project was a heavy involvement of elderly people from the target group as well as care professionals, both in the design phase and in the demonstration and evaluation phase. [8, 9]

Evaluation of these projects showed that:

- There are good prospects for improving independence and quality of life for the elderly by using home automation applications. A prerequisite is that the users are well involved in the design process. However, currently in the Netherlands this is not common practice.
- In theory there are good opportunities for combining social and healthcare applications with applications that improve thermal comfort and energy efficiency. In practice this is not applied, for a variety of reasons.

- Energy consumption of the equipment itself is usually unknown. Suppliers and consultants estimate it as being low. In two known cases the energy consumption has been measured. In these cases the energy consumption was significant: 10 to 40 % of the normal annual electricity consumption of the households concerned.
- In the Netherlands home automation was (and is) still in the phase of pilot projects.
- Current applications are still too expensive and difficult to organise and maintain.
- The Dutch healthcare sector is organised with a lot of (financial) regulations. These regulations do not reward the benefits of home automation applications.[3]
- A long term policy for providing services is crucial for the long term success of suppliers of (houses with) home automation applications. A basis for this long term policy should be the future demand for housing and residential services of elderly people and other target groups. Important aspects of the long term policy are a definition of the service package provided by the own organisation and a long term cooperation with external partners in delivering residential services.

Improving Independence and Quality of Life for the Elderly

An important lesson from the programme is that for a successful supply of home automation applications it is important that the future users can choose their applications themselves ('demand-controlled supply'). Although this goes without saying for most home appliances, in the market for home automation in the Netherlands this is not evident so far. As a result, there are more negative examples to illustrate the importance of this, than there are positive examples.

The following examples illustrate the kind of problems that can arise when home automation applications are developed without proper interaction with the future residents:

- Automated corridor lighting (when there is movement in the corridor and the natural light level is below a certain threshold the lamp automatically turns on): As the resident didn't want the lamp to be lighted all the time, he turned the light off permanently.
- Automated door alarm (when the door is opened for longer than 5 minutes an alarm sound is given, to warn the resident that he has not properly locked the door): In practice, residents liked to stand in the doorway talking to their neighbours. This gave rise to alerts as well...

Positive examples to show the value of demand-controlled supply are scarce. Three Dutch examples are the following projects:

- Demonstration project Moerwijk (Expertise and Consultancy Centre ILSE, The Hague)
- Domotel (Expertise and Consultancy Centre ILSE, The Hague) [10]
- Project Berkenstede (Housing corporation De Key, Amsterdam)

These projects show that it is feasible to involve elderly people in the design of home automation appliances. It does require a lot of attention and time in the development phase of the project, but doing this eventually leads to a greater user satisfaction and to a more effective use of resources.

A final confirmation of the importance of a demand controlled supply approach comes from the renovation project Lidwinahof, Best. In this pilot project - as a test - a lot of functionalities were provided, without any choice for the residents. In practice half of the residents had their system partially or completely turned off within a year after installation. [7]

However, the same project Lidwinahof, in the city of Best, shows that home automation applications can help to improve the independence and quality of life of elderly. In the project survey many of the inhabitants confirmed that they expect to live independently longer because of the home automation appliances[4]. In general the people were satisfied with the home automation applications. People were more positive about safety and healthcare functions (like the burglary alert and the care phone) than about functions they regarded as luxury functions (like images from a front door camera on their TV screen and automatic lighting control.)

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[3] As an example, consider a case in which a healthcare alarm system reduces the number of hours spent by care professionals. This would be good for the overall efficiency of the care process. However, in such a case an organization for home care gets a reduction in income equivalent to the reduction of the number of hours spent. This means the organization is punished, instead of rewarded, for increasing the efficiency of the care process.

[4] 88% of the respondents gave a positive answer to that question (equal to 63% of residents).

Combining Social and Healthcare with Energy Efficiency Applications

For the target group of elderly people the main applications of a home automation system are social and healthcare applications. If these functions are installed, it is possible to add energy efficiency functions to the system.

Opportunities for energy efficiency applications

A whole range of energy efficiency applications is possible in home automation systems. On one hand one can think of energy efficient lighting, heating, ventilation and cooling control. On the other hand experiments have been done with applications that stimulate energy efficiency measures through user feedback on energy consumption. In addition, control applications are conceivable that focus on optimising indoor climate, like solar shading control to prevent overheating and weather dependant indoor climate control.

A special type of application is automated residential demand response. Demand response is defined as "a tariff or program established to motivate changes in electricity use by end-use customers in response to changes in the price of electricity over time, or to give incentive payments designed to induce lower electricity use at times of high market prices or when grid reliability is jeopardized." [11] Directly, this does not lower the electricity consumption. However, it can be used to compensate imbalance between electricity demand and supply. In this way demand response can foster large scale integration of intermittent renewable energy sources. Indirectly, application of demand response has been shown to contribute to reduction of the electricity consumption as well.[5] [12]

In practice these applications for energy efficiency, demand response and indoor climate control should be combined into one, comprehensive, energy efficient indoor climate control system. Of course it is very advantageous to use a home automation system not only for energy efficiency applications, but to use one system for several other applications simultaneously. In any case one should take care that the energy savings of the energy efficiency applications are not cancelled by the energy consumption of the home automation system itself.

Estimating the energy efficiency increase due to home automation applications

An estimation of the energy efficiency increase that can be achieved when adding energy efficiency applications to an *existing* home automation system for healthcare and social services has been calculated with the dynamic building simulation package TRNSYS. As a reference case a typical Dutch apartment from the beginning of the 1980s inhabited by 2 elderly people was taken. Three behaviour patterns were defined: an energy efficient behaviour pattern, an average behaviour pattern and a wasting behaviour pattern. Calculations were made for two types of energy efficiency applications added to the existing home automation system. The first type was a relatively simple one, based on current technology, with the following services: shutting down space heating, ventilation and lighting during absence of the inhabitants. The second type was an advanced type of energy efficiency application that also includes weather prediction based control. The results of these calculations are shown in table 1, 2 and 3 below. [13]

Table 1: Calculated energy consumption per household in reference case.

Behaviour pattern	**Natural gas use [m^3/year]**	**Electricity use [kWh/year]**
Energy efficient	925	2532
Average	1099	2576
Energy wasting	1500	2620

Source: [13]

The numbers given for natural gas and electricity are totals for the household (domestic hot water and household appliances are included).

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[5] One way to understand this is that delaying electricity consumption in the end can lead to canceling it. Another way to understand it is that as the marginal price of electricity increases at peak moments, consumers will have a bigger incentive to disconnect lower value appliances.

Table 2: Calculated energy savings by current technology energy efficiency applications.

Behaviour pattern	**Natural gas savings [m^3/year]**	**Electricity savings [kWh/year]**
Energy efficient	33	20
Average	44	63
Energy Wasting	105	107

Source: [13]

Table 3: Calculated energy savings by advanced energy efficiency applications.

Behaviour pattern	**Natural gas savings [m^3/year]**	**Electricity savings [kWh/year]**
Energy efficient	35	-16
Average	67	28
Energy wasting	166	72

Source: [13]

The following conclusions can be drawn from the simulation results for a 2-person household in an apartment:

- The less energy efficient the behaviour pattern, the higher the potential savings of energy efficiency applications.
- Advanced energy efficiency applications including weather prediction based control can not only provide better indoor climate but also have a higher energy savings potential.

When interpreting these figures it should be noted that the energy savings that can be accomplished in reality will depend to a large extent upon the following factors:

- The number of inhabitants and their behaviour patterns, including the amount of time they are present at home[6]
- The size and quality of the house involved.[7]

In general there are more opportunities for energy savings in larger and older buildings with high-income customers that are not themselves very much oriented towards energy efficient behaviour. Especially for this target group, home automation could be a good tool for supporting energy savings, provided the home automation system does succeed in combining additional comfort with energy savings.

Energy Efficiency of Equipment

Energy consumption of home automation systems

A trivial prerequisite for sustainable application of home automation is a very low energy consumption of the home automation system itself. However, in the current practice of home automation in the Netherlands the energy consumption of the equipment itself is usually unknown. When asked, suppliers and consultants usually estimate this consumption as being low, 'nothing to worry about'. However, the suppliers and consultants do not give exact numbers of the yearly energy consumption. And buyers do not always ask for the figures.

In one known Dutch case the energy consumption was given attention: in the case of the retrofit of an apartment building for elderly people in the town of Best by housing corporation Domein. During the preparations for the project the inhabitants were asked about their preferences and informed about the plans. At that stage, the inhabitants themselves raised the question of what the electricity consumption would be. The consultant involved answered that people were not to worry as 'it is only low voltage, so the energy consumption will be negligible'. However, after completion, the energy consumption turned out to be approximately 190 kWh per year. For the households concerned this was significant, as it was an increase of their annual electricity consumption of over 10%.[7]

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[6] In the reference case in the calculation the inhabitants were present over 90% of the time. This is more than average, meaning that for average Dutch households the energy savings potential is higher than calculated here

[7] In the reference calculation the house was relatively small and of moderate building quality. This results in a below average reference gas and electricity consumption, meaning that for average Dutch households the energy savings potential is higher than calculated here.

In another case - in which no attention was paid to reduction of the energy consumption of the home automation system - the annual electricity consumption of a very extensive home automation system was found to be as high as 1300 kWh. For an average Dutch household this would mean an increase of the electricity consumption of over 35%.

Recommendations

The following recommendations can be given for improving energy efficiency of home automation systems:

- Reduce the standby electricity consumption of the equipment.
- Reduce the number of power supplies and their number of operational hours.
- Pay special attention to the electricity consumption of equipment that operates continuously, like the communication infrastructure.
- Switch off all equipment with a stand-by electricity consumption from the power supply when it is not operational. Reduction of stand-by electricity consumption can be introduced into the home automation system as an extra function - not only for home automation components, but also for domestic appliances.

Recommendations

For effective and sustainable application of home automation the following recommendations are formulated:

- Supply in a demand controlled way, offering differentiated packages;
- Involve residents from the target group in the composition of these packages;
- Give tailor-made assistance to users during design, installation and (before the) use;
- Give attention to reduction of the energy consumption of the equipment itself;
- Include applications that improve indoor climate and energy efficiency;
- Make sure to include the whole future service chain when developing offers;
- Apply standardised equipment and communication protocols to reduce costs and prevent supplier dependence.

If these recommendations are taken into account, there are good opportunities for the successful and sustainable application of home automation to assist elderly people living independently.

However, current developments in the Netherlands do not fully take into account the recommendations mentioned above. It will depend upon combined action from the industry and the research community in the next couple of years whether or not the development of home automation applications for this growing market will be succesfull and sustainable.

Acknowledgement

The author wishes to thank all programme participants for their contribution to the programme. Special thanks go to the following participants: Johan van der Leeuw from NIZW; housing corporations Domein, De Key and Vestia and expertise and consultancy centre ILSE. The author wishes to thank NIDO for financing and supporting the programme.

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Labelling and Standards

Energy Efficiency Standards and Regulations and their influence on the Local Market and the Electric Utility

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Abstract:

The electricity consumption in households in Israel in 2004 was 32% (Fig 3) of all electricity consumed in Israel. The household consumption, per capita, between 1995-2004 increased by 72% - much more than the increase in the standard of living. Introduction of more efficient appliances (due to regulations) will raise the standard of living and will decrease electricity consumption.

Statistics show that, today, more than 85% of Israeli households own air-conditioners with even a greater percentage owning refrigerators, washing machines and other appliances.

On the basis of information regarding appliances in Israel and the recent technologies, we estimate that at least 40% of the electricity consumed for the main home appliances can be saved.

Some of the appliances are flexible and relevant to peak load shifting, and through education, load shift can be done. Others such as air-conditioning and refrigerators are not flexible. Reduction in their electricity consumption will eventually decrease peak load throughout the years.

In my lecture, I will present a study we initiated to analyze the influence of efficient appliances on energy consumption and peak load in an "island grid" of electricity, prior to the new regulation and during the course of the year after. I will also, talk about the adaptation of the local market to the new regulation.

General	**Energy**
Israel is located on the eastern shore of the Mediterranean. Five neighbors surround Israel: Egypt, Lebanon, Syria, Jordan and the Palestinian Authority. Though we have peace treaties with two of these neighbors our energy systems and our electrical grids are not inter-connected. Israel is, in essence, an electricity Island. Without the West Bank and Gaza, Israel is 16,000 km^2 and together we are 20,000 km^2, two-thirds of which is uninhabited desert. Israel is home to 6.9 million citizens and 300,000 temporary residents, mainly foreign employees. Most of the population lives in a strip150km long and 16-50 km wide. That makes the population density among the highest in the world, about 1300 persons per 1 sq. km. The climate in Israel is very hot and humid (some places) in summer; the average temperature on peak demand days is around 37^0C with some places reaching 42^0C– 45^0C. The humidity is as high as 70% - 75% in some places. Israel has 1.900 million households. Israel's GDP is about $17,800 US per capita (2005). Israel has almost no natural resources and the main civilian export is hi-tech - about 35%. The public expenditure for R&D is about 4.3% of the GDP spent mainly by the private sector. This figure does not include military R&D.	In 2004 the total primary energy supply for Israel was about, 23 million T.O.E. (the amount of fuel purchased before refining and used for electricity). 94% of the primary energy was imported. 3% is renewable energy, mainly solar, used for domestic water heating and 3% locally produced NG. The net energy consumption (excluding solar energy) was 13 million T.O.E. Until 1996, electricity was generated, transmitted and distributed by a vertical monopoly (the Israeli Electric Corporation (IEC) under an exclusive concession granted it by law. While the legal monopoly no longer exists, the IEC still dominates the generation sector and is the sole transmission and distribution entity. In the summer of 2002, the general electricity tariff was revised and now distinguishes between generation, transmission and distribution tariffs. This, along with new regulations promulgated regarding Independent Power producers and Co-generation, should facilitate the establishment of small generating units, which can be sold directly to the end user.

Electricity

The total of installed capacity of electricity in Israel was at 10,176 MW in 2005 (fig 1). 49% produced by coal-fired steam turbines and 10.4 % Fuel oil, 28.9% Gas Oil mainly for CCPS and 11.6% NG. In 2004 the IEC produced 47 billion KW/h, the consumption was 43 billion Kwh. Over the last 10 years electricity consumption grew by 83%(fig 2). The highest peak load ever registered was 8,850 MW it on July 2005(fig 1). The use of solar installations saves the equivalent of 8% of the electricity production (something like 3.5 billion, KW/h). 40% of the electricity consumed in the summer is attributable to air-conditioning; more than 45% of the peak demand is attributable to air-conditioning. The total electricity consumption for domestic use in 2004 was 13.5 billion Kwh. Electricity consumption per capita in 2004 was 5,877 Kwh. Domestic electricity consumption per household was 7,126 Kwh a year.

As for the growth of electric consumption, I am not optimistic. I know that the next 10 years will not be better. Rather, unless we do something, it will be worse.

The “Electricity Sector Law” regulates electricity tariffs in Israel. Differential tariffs are well established and penalties for power factor lower than (cos fi) 92 is used to reduce reactive energy. The “Public Utility Authority” (PUA) sets all tariffs.

Tariffs have a major influence on shifting consumption from peak uses time to low uses time. When the Israeli consumers have the benefit and the flexibility, they know how and when to use it. We have many projects, such as energy storage using diesel generators, renewable energy and others that would not be economical without tariff system. However we don't have "tariff" for domestic consumption yet.
Electricity consumption for domestic use constitutes 31.5% of Israel’s total electricity consumption (fig 3). Some analysts estimate that 30% of that consumption can be saved - 80% of that by improving the efficiency of domestic appliances, mainly air-conditioners, refrigerators, stoves, water heating systems, washing machines, clothes dryers and dishe washers.

Domestic Appliances

Statistics show that the penetration of domestic appliances into Israeli households is very high. Refrigerators – 98% Washing Machines - 90%, Clothes Drier – 45%, A/C – 85%, Dish Washers – 72%, Electric hot water, heaters or solar installation with electric backup – 88% (csb – 2002)

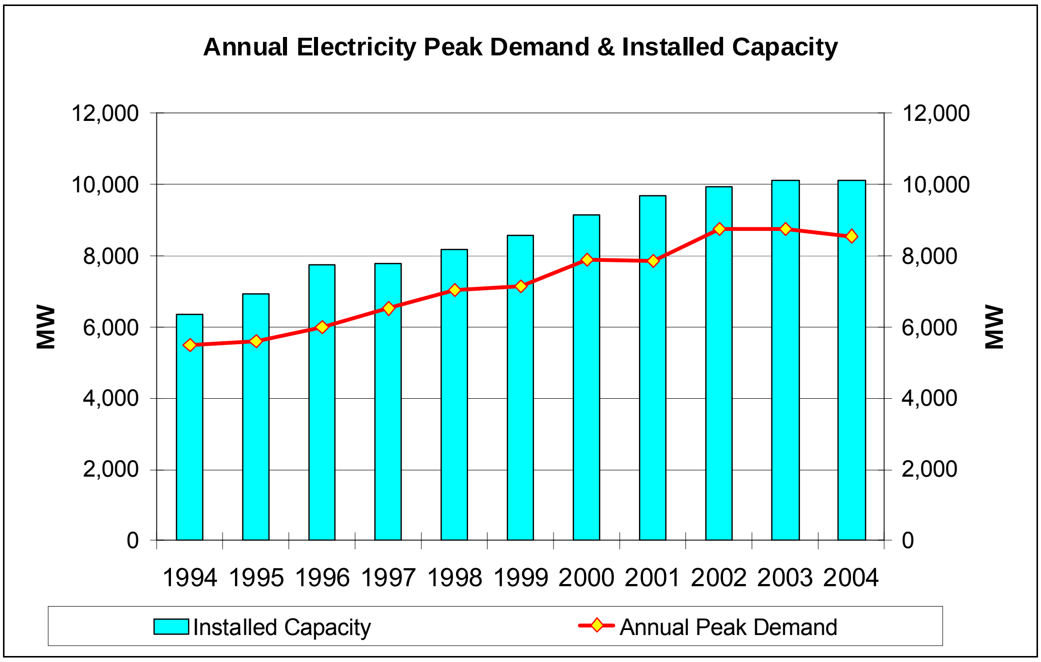


Figure 1: Annual Electricity Peak Demand

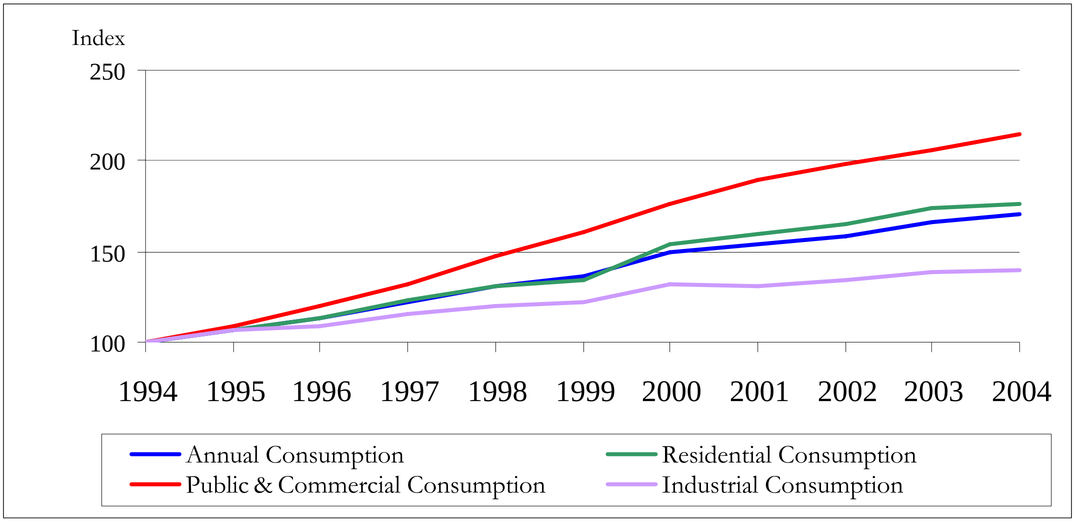


Figure 2: Growth of electricity consumption by sector, 1994-2004

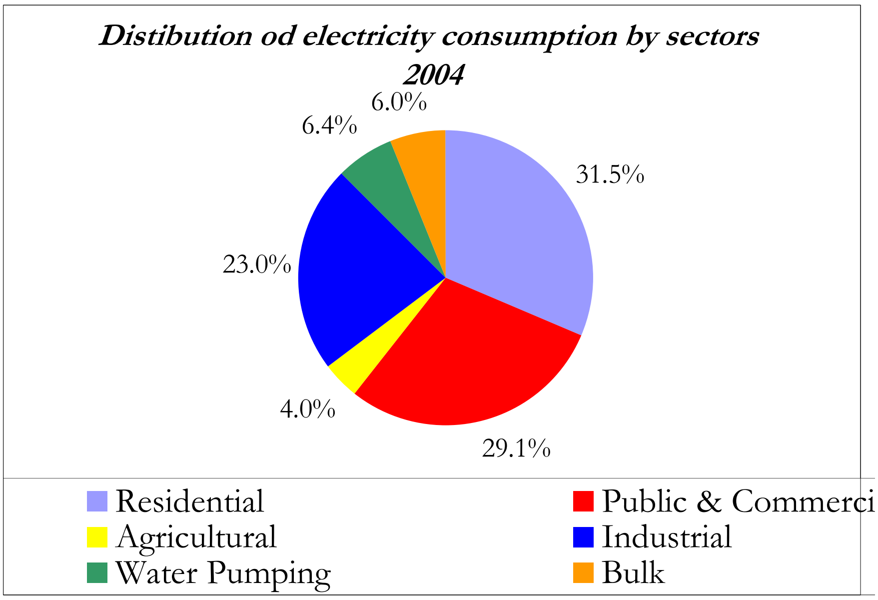


Figure 3: Distribution of Electricity consumption by sectors 2004

Israeli Regulations and Standards to Improve Energy Efficiency and Labeling.	**Standards for performance and Labeling**
Regulations - Minimum Efficiency Performance Standards, Rating and Labeling Energy Resources Regulation, (Energy Efficiency, Energy Ratings and Energy Labels for Air-conditioners), 2004. Energy Resources Regulation (Energy Efficiency and Energy Information of Cooling Appliances), 2004 Energy Resources Regulation (Energy Label for Electric Heaters) Regulations, 1993 **Other Regulations & Standards for Efficient Domestic Consumption of Energy** Installation of solar hot water systems. Thermal insulation for buildings. Energy rating for buildings – Standard Green Building – standard	1. Ballasts for Fluorescent Lamps – Energy Efficiency Requirements and Labeling. 2. Energy Efficiency of Electrical Lamps for Households Uses – Measurements Methods. 3. Electrical Dishwashers: Methods for Measuring Performance. 4. Safety of Household and Similar Electrical appliances: Particular Requirements for Washing Machines – Labeling. 5. Luminier Efficiency Ratings 6. Single -Capped Fluorescent Lamps: Safety and Performance Requirements – Labeling. 7. Particular Requirements for Stationary Cooking Ranges, Hobs, Ovens, and Similar – Labeling. (ISI – Israeli Standards Institute)

Table 1: Appliances sales in Israel, Potential of Electricity saving & potential of money saves

Local market sales of appliances, electricity consumption per appliance, consumption improvements of appliances and monetary savings (evaluation)

Appliances	**Annual sales** in (2002)	**Yearly Electricity consumption (KWH)**	**Improvement by rate %**	**Potential Saving K(KWH)**	**Potential of saving KNIS/Y**
Refrigerators	250,000	1,314	30%	98,550	39,420
Air-con	250,000	2,500	25%	156,250	62,500
Clothes washers	200,000	900	40%	72,000	28,800
Dishes washers	80,000	720	40%	23,040	9,216
Clothes dryers	80,000	225	40%	7,200	2,880
Fluorescent	1,000,000	125	20%	25,000	10,000
Stoves	100,000	216	30%	6,480	2,592
TOTAL				**388,520**	**155.408**

388,520 KWH
Distribution of electricity consumption by appliances

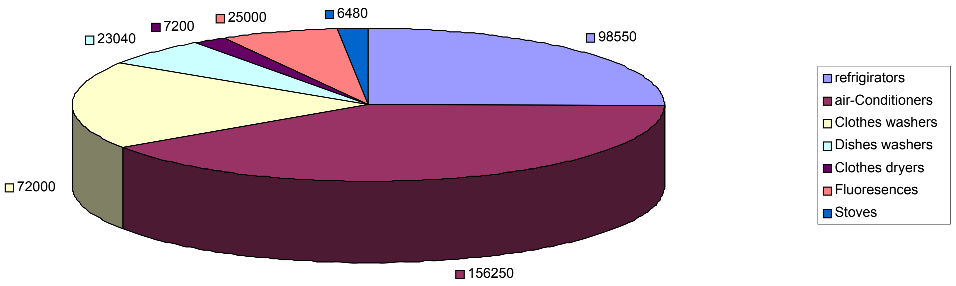
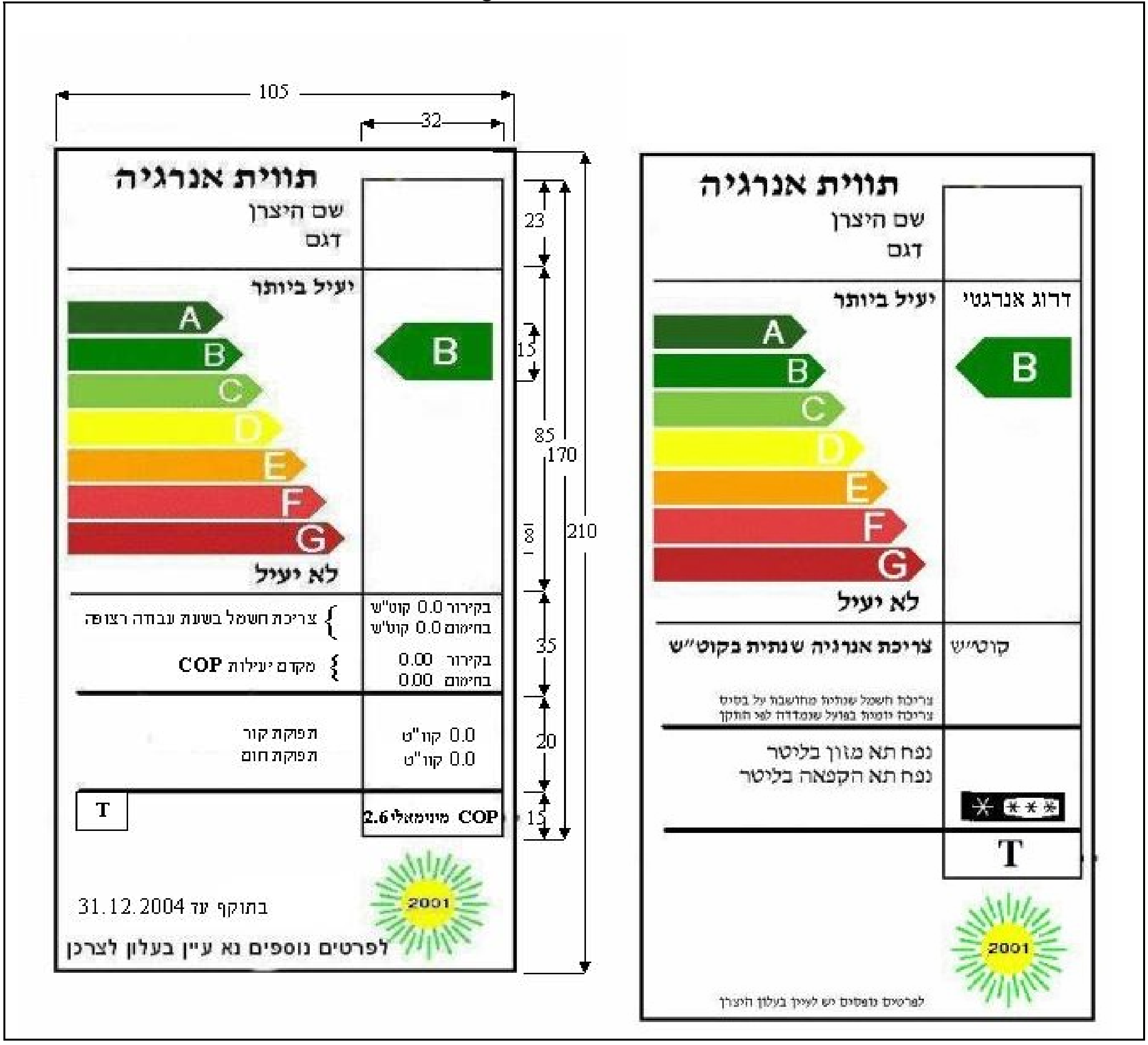


Figure 4: distribution of electricity consumption by appliances in Israel

Table 2: Israeli Labels for A/C and Frig



Improving efficiency and the influence of domestic appliances on electricity system:

The above table indicates the potential saving of electricity is approximately 400 MWH (Tab 1, fig 4). The electric consumption for domestic use in 2004 was, 13.8 GWH. This means that the potential is about 3% of the annual electric consumption for households, this number is to be added to the last years saving. We proposed regulation to decrease electricity consumption and we estimate that the total monetary saving, if all our proposals will be approved, at the first year will be about 50 million US$ (price per KWH is 0.115 US$). A/cs are the major cause for peak and they are not flexible, since a/c operates in full capacity when it is needed and when it needs it need everywhere. The real cost of a KWH at peak to the electric producer – and thereby, the saving incurred by reducing peak consumption - is much higher than that.

Since we know that the local consumer is not really mind of peaks and cost and will not look at the electricity consumption as a factor in deciding to buy an efficient appliance, we think that efficiency legislation and mandatory standards are required to achieve the goal of reducing electric consumption and peak.

We first introduced Minimum Efficiency Regulations for air conditioners in 1998 until than we use to make calorimetric tests and there was an obligation to put the result on energy label but for 12 years nothing happen the average cop was about 2 or less. At 1998 we set a minimum requirement of 2.4 and in 2000 we update it to 2.6. Between 1998 and 2002 more than 900,000 a/cs unite were sold in Israel (According to cbs).

15% improvement contributed by the end of 2002 to a save of 337.5 GWH which was worth 87,750 ton of fusil fuel and reduced CO_2 emission by 263,250 ton.

Recently we update some and introduced new minimum efficiency regulation for both a/c and refrigerators. From January 2005 they are mandatory. The minimum COP for a/c are now between 2.7 - 3 depend on the size of the air-conditioner (Tab 3). It was not easy to form those new regulations especially because we wanted to negotiate it with the local manufactures and the importers but now after it was done we see a/c with a cop of 4.2.

- All A/C that are sold in Israel have green gas.
- All A/C & frig must have Energy Label (Tab 2) and can't be imported or produced unless they have our certificates.

Cost Benefits:

For the stat (Electric company own by the state): We can think about the saving in terms of installing a new 360 MW Combined Cycle Power Station that works on Natural Gas. If it's operated 4,500 hours with a total efficiency of 86% this kind of CCPS produces 1,386 GWH. The local electric utility pays about 68 million US$ a year for a private producer for a power station that can produce this amount of electricity. A quick calculation shows that a $20 million US saving is in store and this does not require any additional investment in grid and other expenses. Dealing with efficiency can prevent installing of such a CCPS every 3 years.

Reducing Peak load – it is estimated that more efficient a/c & refrigerators will reduce peak by 0.4% annually and after 10 years it will reduce the peak by 400MW.

The cost benefit would be much higher if we could add the uncalculated externalities which, unfortunately do not yet play a role in calculation of the real cost of the electricity production.

Cost benefit for the end user: A/C - We estimate that the price of the improved appliances would likely not be much higher than the less efficient ones. In any case it is very difficult to estimate increase in price of the most efficient appliances, based purely on its efficiency. It is possible that it may cost a little more in purchasing, however, the end result of lower electric consumption and less maintenance, makes it a worthy investment. For example Min COP of small a/c (3 KW) is 3 the G type cost about 400 US$ A type a/c cost about 500 US$ the A type consume 15% Electricity lees and save 65 NIS every year The time it takes to recoup that money is about one or two years.

Frig case study - Before the regulation, the average electricity consumption of refrigerators in Israel was at 4.4 Kwh a day. Under the regulation, electricity consumption for 500-liter (adjusted volume) refrigerator should be reduced to 2.8 Kwh a day.

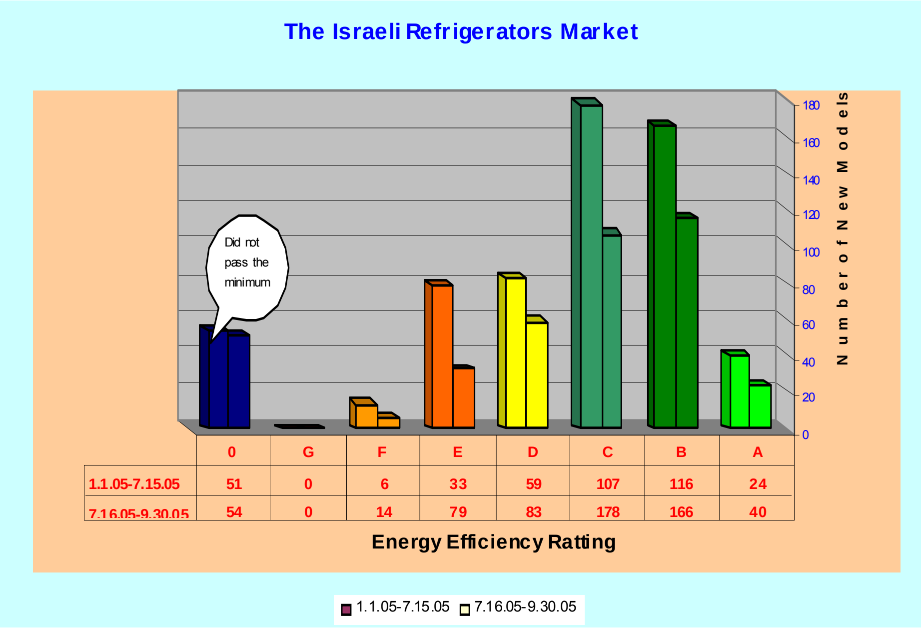
The average measured consumption for 500 liters (adjusted volume) is 1.33 Kwh a day. In the past it cost us 163.2 US$ to operate old model of 500 liter refrigerators, today a same size (adjusted) cost 53.62 US$ a year. After the refrigerators regulations become mandatory the firms refunded those who replaced their old refrigerators the incentives was around 250US$. So after less than 7 years you could pay your new refrigerator.

Table 3: minimum efficiency for A/C in Israel

Minimum COP	Type and cold Capacity KW	Period
3.00	split KW<=7	From January 1st 2005 up tp DECEMBER 31st 2007
2.8	split 18> KW>7	
2.9	Ducted KW<=7	
2.8	Ducted 12=>KW>7	
2.7	Ducted 18=>KW>12	
2.60	Window	
3.20	Split	From January 1st 2008 up to December 31st 2010
3.00	Ducted	
2.80	Window	
3.50	Split	From January 1st 2011
3.20	ducted	
3.50	Window	

First Year of Refrigerators regulations case study

Since the regulation for refrigerators and freezers become mandatory, we have certify 560 different models of cold appliances:



	0	G	F	E	D	C	B	A
1.1.05-7.15.05	51	0	6	33	59	107	116	24
7.16.05-9.30.05	54	0	14	79	83	178	166	40

As we can see 83% of all fridges that are sold in Israel have rated between A and D. The distribution curve shows that it is a normal distribution.

- 616 - Models of refrigerators and freezers were checked
- 560 - Models certified
- 54 Did not certified

Figure 5: Israeli refrigerator Market (1 January – 30 September 05)

Table 4: statistic on refrigerators

Rating	Number of Models	Portion %
A	40	7.14
B	166	29.65
C	178	31.8
D	83	14.8
E	79	14.1
F	14	2.5
G	0	0

Findings:

83.39% from the models are between A-D (Tab 4). The best sale energy consumption refrigerator + freezer NF Tropical 500 liters, in the Israeli market consume 1.33 Kwh a day, While for adjusted 500 liters the consumption is 0.75 KWH a day.

The market adjusted itself to the regulation and (fig 5) learns to live with the requirement. In most of the case since the manufacture and the importer new in advance about the future requirement they present a more efficient appliance with performance that will remain them in the market even with new requirements.

Efficiency regulation encourages the manufacture to upgrade all the models and present new technologies that influence not only on energy efficiency but on other factors as well.

Conclusions: Saving Money and Reducing CO_2

Electricity consumption without the regulation might have been 4.4*250,000=401.5 million KWH a year. Under the letter regulation, the expected electric consumption was to be 255.5 million Kwh a year, however, in fact it was only about 121.4 million Kwh a year these because the average efficiency moved from the minimum requirement of 2.8 Kwh a day to 1.33 Kwh a day.

The total saved in the first year of mandatory regulation was about 280million Kwh. Assuming that the production of 1 Kwh produce 0.75 kg CO2, this means reduction of over 210 thousand Tons of CO2 for the first year only for refrigerators. Quick calculation will show that by the end of the second year we will save 840,414,000 Kwh. This equals to 97,000,000 US$ (1 Kwh = 0.112 US$).

After the second year of operation the regulation will be updated by additional 20%. We can reach that goal especially because we see that many of the appliances are already there (all those who rated D+).

In the future we will update the regulation to increase the efficiency.

Improving efficiency of refrigerators and air conditioners and its influence on peak.

Electricity consumption for refrigerators and air conditioners is not flexible, and, therefore, load shifting off peak is not a viable solution. Reducing consumption is, however, a viable solution to reducing peak. According to statistical analysis, the contribution of the reduction in electric consumption for refrigerators is an additional 0.1% every year.

The influence of improved efficiency in air conditioners on the peak is an additional 0.3% (approximately) every year. The increased efficiency in both appliances will save additional 400 MW installed power stations (**for peak**) in a period of 10 years. Speaking on Kwh the energy efficiency measures will save much more.

The regulations are to be updated periodically, and the above calculation was carried out only for the first period of validity. In addition we estimate that this efficiency will postpone otherwise necessary investment in the transmission and distribution grids.

We also plan to carry out an end users audit for appliances, which, we believe, will give us more accurate knowledge of consumer behavior and electricity consumption in the domestic sector. It is also expected that the findings will enable us to more carefully and accurately craft regulations and programs needed to enhance efficiency in that sector.

Enforcement of Regulations regarding Appliances	
Administrative Enforcement The enforcement of the regulations is done initially when the manufacturer or importer applies for new models, then secondly, in the markets. As soon as a new model is introduced to the market the manufacturer must send a prototype to the Standards Institute of Israel to check if it complies with the Israeli standards and regulations. A checkup list is then sent by the Standards Institute to the Ministry of National Infrastructures where we calculate the COP and, if it is in accordance with the regulation, we produce a certificate and label for each new model and permit import or manufacture of that model of appliance. Without our permission (the certificate) the goods will not be released to the customer. We built a data base of all the appliances that have been approved for sale in Israel; this data base includes physical information and energy information (mainly all information that appears on the label.)	All of the appliances that comply with the regulation and information about them are publicized on our web site. Supervision We send inspectors with the data to market places across the country and they check for labels and if the information corresponds to our approval. If there is lack of compliance, we first give a warning and explain what should be done in order to comply. At a later time we return, and if the faults have not been corrected, penalties for up to US$ 5000 may be levied for each appliance that does not complying with the regulation.

References:

Israeli Book Of Regulation 2004
CBS – Central Bureau Of Statistic
ISI – Israeli Standards Institute
IEC – Israeli Electric corp. IEC statistic 2004
MNI – Ministry of National Infrastructures

Methodology for Ecodesign of Energy-using Products (EuP)

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Abstract

In the spring of 2005 the European Parliament approved the Framework Directive on the Eco-design of Energy-using Products 2005/32/EC, published 6 July 2005. It establishes a framework for the setting of Community ecodesign requirements for energy-using products (EuP) with the aim of ensuring the free movement of those products within the internal market (Art. 95). This Directive provides for the setting of requirements which the energy-using products covered by implementing measures must fulfil in order for them to be placed on the market and/or put into service. In other words, the measures under this directive are linked to the mandatory CE-marking of the EuP.

Measures may be 'generic' ecodesign requirements (Annex I) or 'specific' ecodesign requirements (Annex II). The latter means a quantified and measurable ecodesign requirement relating to a particular environmental aspect of an EuP, such as energy consumption during use, calculated for a given unit of output performance.

The design of an implementing measure is preceded by a preparatory study, that should provide the European Commission and the Consultation Forum with the necessary information regarding whether and to what extend an EuP is eligible for an implementing measure.

The methodology for this preparatory study was the subject of a study by the authors for the European Commission. This study with the title Methodology for the Ecodesign of Energy-using Products (MEEUP) describes the methods and sources to be used for the environmental impact analysis, the market analysis and the assessment of the improvement potential.

Amongst others this led to development of the 'EuP EcoReport' form for the environmental impact assessment and e.g. the use of monetary Life Cycle Costs for the assessment of energy related targets during the use phase of the product.

This lecture describes the general MEEUP methodology, some of the tools and briefly indicates the application of the methodology on some of the Product Cases.

Introduction

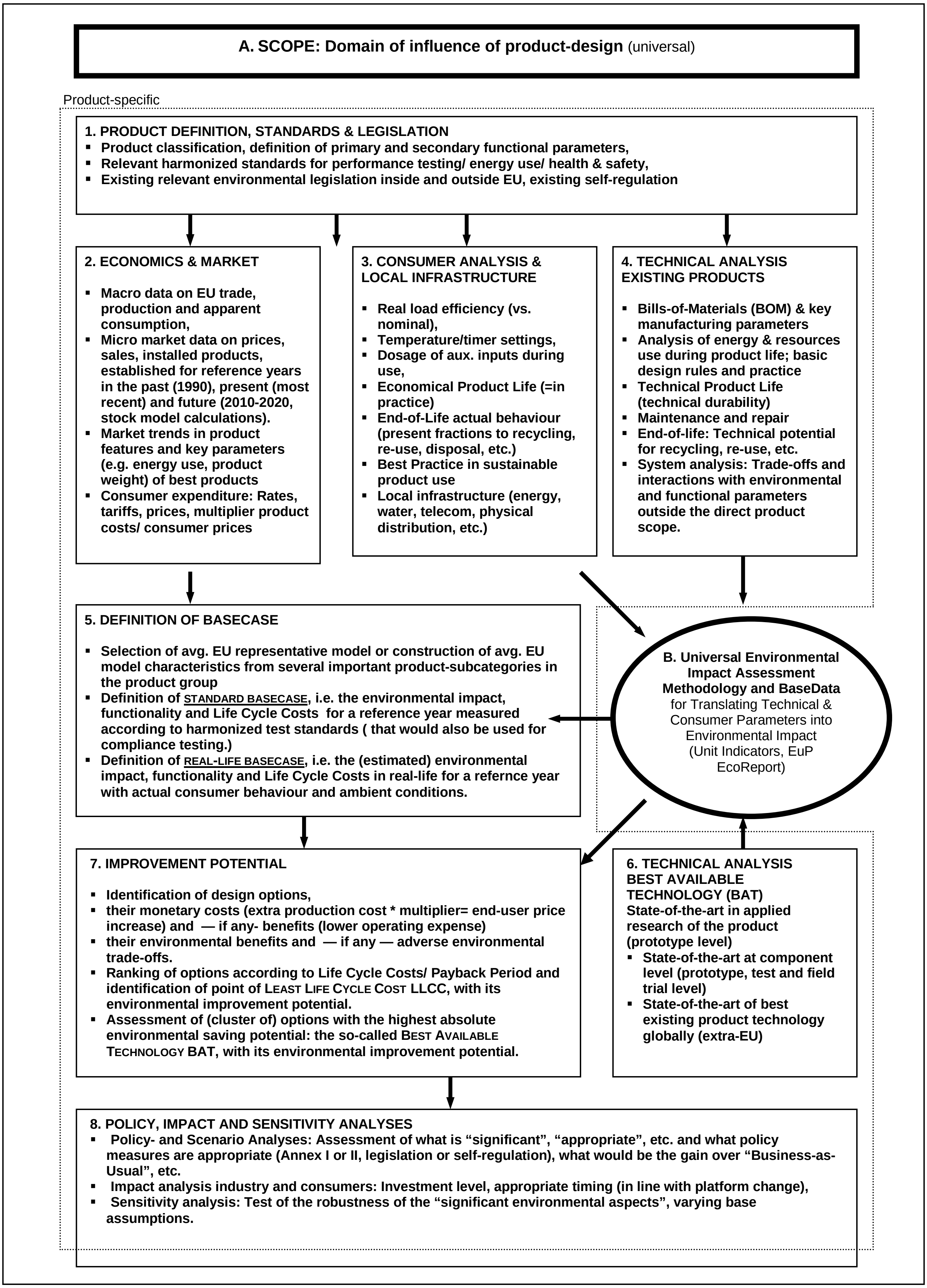
The framework directive 2005/32/EC addresses the domain of Ecodesign, as an extra dimension to the current research and product development activities. Product developers define the geometry, select the materials and the manufacturing processes and prescribe the use of the new products. As such they are a major determining factor in the environmental impact that the new products will have, if the legislator succeeds in formulating realistic, clear and accurately defined implementing measures. On the other hand it is obvious that there are limits to the sphere of influence. The product designer can choose amongst materials with different properties and environmental impacts, but the resources consumption and emissions of the individual material production processes are largely outside that sphere of influence. Also the decision where a material is purchased cannot usually be determined by product designer. The same goes for manufacturing processes, where the designer can tune the product's geometry and other properties to the technology employed, but at a certain point the specific resources efficiency and emissions are the domain of production engineers. Looking downstream, the designer can conceive how a product should be used and eventually disposed off, but the actual use may be different. This is especially important as Energy-using Products (EuP) –as opposed to many non-EuP—have by definition a relevant environmental impact in the use phase of the product.

Basic structure

The aim of the underlying Methodology study for Ecodesign of Energy-using Products (MEEUP) is to contribute to the creation of a methodology allowing to evaluate whether and to which extent various energy-using products fulfil certain criteria that make them eligible for implementing measures under the Ecodesign of EuP Directive 2005/32/EC; these criteria are specified in Article 15 and Annexes I and II of the Directive.

The study makes an analysis of the text of Article 15 of Framework Directive 2005/32/EC, identifies the parameters that require further definition and data retrieval and proposes a logical structure for these data. The logical structure, which is shown in figure 1 is proposed as a basis for preparatory studies. The structure distinguishes 8 product-specific sections:

1. Product Definition, Standards & Legislation;
2. Economics & Market;
3. Consumer Analysis & Local Infrastructure;
4. Technical Analysis Existing Products;
5. Definition of Base Case(s);
6. Technical Analysis of Best Available Technology;
7. Improvement Potential;
8. Policy, Impact and Sensitivity Analyses.



A. SCOPE: Domain of influence of product-design (universal)

Product-specific

1. PRODUCT DEFINITION, STANDARDS & LEGISLATION
- **Product classification, definition of primary and secondary functional parameters,**
- **Relevant harmonized standards for performance testing/ energy use/ health & safety,**
- **Existing relevant environmental legislation inside and outside EU, existing self-regulation**

2. ECONOMICS & MARKET
- **Macro data on EU trade, production and apparent consumption,**
- **Micro market data on prices, sales, installed products, established for reference years in the past (1990), present (most recent) and future (2010-2020, stock model calculations).**
- **Market trends in product features and key parameters (e.g. energy use, product weight) of best products**
- **Consumer expenditure: Rates, tariffs, prices, multiplier product costs/ consumer prices**

3. CONSUMER ANALYSIS & LOCAL INFRASTRUCTURE
- **Real load efficiency (vs. nominal),**
- **Temperature/timer settings,**
- **Dosage of aux. inputs during use,**
- **Economical Product Life (=in practice)**
- **End-of-Life actual behaviour (present fractions to recycling, re-use, disposal, etc.)**
- **Best Practice in sustainable product use**
- **Local infrastructure (energy, water, telecom, physical distribution, etc.)**

4. TECHNICAL ANALYSIS EXISTING PRODUCTS
- **Bills-of-Materials (BOM) & key manufacturing parameters**
- **Analysis of energy & resources use during product life; basic design rules and practice**
- **Technical Product Life (technical durability)**
- **Maintenance and repair**
- **End-of-life: Technical potential for recycling, re-use, etc.**
- **System analysis: Trade-offs and interactions with environmental and functional parameters outside the direct product scope.**

5. DEFINITION OF BASECASE
- **Selection of avg. EU representative model or construction of avg. EU model characteristics from several important product-subcategories in the product group**
- **Definition of STANDARD BASECASE, i.e. the environmental impact, functionality and Life Cycle Costs for a reference year measured according to harmonized test standards (that would also be used for compliance testing.)**
- **Definition of REAL-LIFE BASECASE, i.e. the (estimated) environmental impact, functionality and Life Cycle Costs in real-life for a refernce year with actual consumer behaviour and ambient conditions.**

B. Universal Environmental Impact Assessment Methodology and BaseData for Translating Technical & Consumer Parameters into Environmental Impact (Unit Indicators, EuP EcoReport)

7. IMPROVEMENT POTENTIAL
- **Identification of design options,**
- **their monetary costs (extra production cost * multiplier= end-user price increase) and — if any- benefits (lower operating expense)**
- **their environmental benefits and — if any — adverse environmental trade-offs.**
- **Ranking of options according to Life Cycle Costs/ Payback Period and identification of point of LEAST LIFE CYCLE COST LLCC, with its environmental improvement potential.**
- **Assessment of (cluster of) options with the highest absolute environmental saving potential: the so-called BEST AVAILABLE TECHNOLOGY BAT, with its environmental improvement potential.**

6. TECHNICAL ANALYSIS BEST AVAILABLE TECHNOLOGY (BAT)
State-of-the-art in applied research of the product (prototype level)
- **State-of-the-art at component level (prototype, test and field trial level)**
- **State-of-the-art of best existing product technology globally (extra-EU)**

8. POLICY, IMPACT AND SENSITIVITY ANALYSES
- **Policy- and Scenario Analyses: Assessment of what is "significant", "appropriate", etc. and what policy measures are appropriate (Annex I or II, legislation or self-regulation), what would be the gain over "Business-as-Usual", etc.**
- **Impact analysis industry and consumers: Investment level, appropriate timing (in line with platform change),**
- **Sensitivity analysis: Test of the robustness of the "significant environmental aspects", varying base assumptions.**

Figure 1. Structure of key parameters needed for Ecodesign of EuP directive, Art. 15.

Environmental Impact Assessment

What is referred to in fig. 1 as *“B. Universal Environmental Impact Assessment Methodology and BaseData”* is the core of the methodology assessing the environmental impact. It takes the environmental indicators given by the European Commission (see table 1) and the 2005/32/EC Directive as a basis and develops a methodology that defines the system boundaries, addresses partitioning problems, etc. and translates the underlying emissions and resources in a product’s life-cycle into these mostly aggregated indicators with appropriate weighting factors. The aggregation level as such is a given: The directive is not looking for a single-value environmental parameter to evaluate the environmental performance, not is it looking to specify all emissions of over 700 pollutants from various processes that play a role in the production, distribution use and end-of-life of Energy-using Products (EuP): It is looking for something in between: A restricted set of approximately 15 parameters that cover most if not all of the spectrum of environmental impacts.

Table 1. Proposed selection of impacts, related to the environmental priorities (Source: European Commission, Call for Tender, 2004).

	Raw material acquisition	**manufacturing**	**distribution** (incl. packaging, transport)	**use** (incl. Installation and maintenance)	**end-of-life**
Energy consumption					
primary Gross Energy Requirement in MJ					
electricity share (converted to primary)					
Water consumption					
in m³					
Material use (in kg), incl. recycling credits					
Metals (St, Al, Cu)					
Bulk polymers (PE, PP, PS, etc.)					
Technical plastics (PA, PC, etc.)					
Others (glass, electronics, etc.)					
Waste generation					
to landfill					
to incinerator					
Hazardous waste generation					
RoHS substances					
non-RoHS substances (to be specified)					
Emissions to air					
greenhouse gases					
acidifying agents					
volatile organic compounds					
ozone depleting substances					
persistent organic pollutants					
heavy metals					
fine particulate matter					
suspended particulate matter					
Emissions to water					
heavy metals					
substances affecting oxygen balance					
persistent organic pollutants					
Other product specific					

This creates the problem of how to aggregate the known 700 pollutants and resources to this restricted set of parameters. Accepted scientific principles play a role in this process and a very important consideration has been that the methodology needs to be consistent with the existing legislation. Or, to be more precise, the environmental impact assessment methodology should **follow, not precede current environmental legislation** that is developed in the context of international treaties (Kyoto, Montreal, Gothenburg, Stockholm, Århus, etc.) and transposed in appropriate EU legislation with mainly grid-based emission limit values such as the Ambient Air Quality Directives, the Water Framework Directives and others. Table 2 below gives a summary of these weighting factors.

Table 2: Summary MEEUP weighting factors

GHG emissions (air)	CO_2	CO	N_2O	CH_4	CF_4	C_2F_6	SF_6	R134a	other
weighting → CO_2 eq. GWP-100	**1**	**1.57**	**296**	**21**	**6500**	**9200**	**22200**	**1300**	**IPCC**

Acidification emissions (air)	SO_X	NO_X	N_2O	NH_3	HF	HCl	H_2S	H_2SO_4
AP weighting → SO_2 equivalent	**1**	**0.7**	**1.78**	**1.88**	**1.6**	**0.88**	**1.88**	**0.65**

Heavy Metals (air)	Cd	Hg	As	HMU	Ni	Cr	Cu	Pb	Zn	MU
HM weighting -> Ni eq.	**5**	**5**	**3.33**	**2**	**1**	**0.5**	**0.5**	**0.04**	**0.04**	**0.01**

PAHs (air)	PAHs	C6H6	CO
HM weighting -> Ni eq.	**20**	**0.004**	**0.000002**

MU= Metals Unspecified
HMU= Heavy Metals Unspecified. * =preliminary factors

Heavy Metals (water)	Hg	Cd	Ni*	As	HMU	Cu*	Pb*	Cr	Zn
HM Weighting factor → Hg/20 eq.	**20**	**7**	**7**	**3**	**3**	**2.8**	**0.5**	**0.4**	**0.2**

Eutrophication (water)	P	P_2O_5	PO_4	N	NH_4+	NO_3-	BOD	Suspended Solids	DOC	TOC	COD
EP weighting → PO_4 equivalent	**3.07**	**1.34**	**1**	**0.42**	**0.33**	**0.1**	**0.11**	**0.08**	**0.066**	**0.066**	**0.05**

EC Directives and official EU references with threshold and conversion values from which the weighting factors are derived: *IPCC* (GWP), *EC 850/2004* (POP), *2001/81/EC* (SO_x, NO_x, NH_3, VOC), *1999/30/EC* (SO_2, NO_x, PM and Pb), *2000/69/EC* (aromatics, CO), *COM(2003)423* (As, Cd, Hg, Ni, PAHs), *1999/13/EC* & 2002/3/EC (VOC), *EC 2037/2000* (ODP), *91/271/EC & 98/15/EEC* (BOD, COD, P, N, susp. Solids to water), *76/464/EEC* (Metals etc. to water).

EuP EcoReport

Once the weighting factors are attributed, it is vital to obtain the aggregated information in a format that product designers and engineers understand: per material, per production process, per energy-consuming process in the use phase, per end-of-life alternative, etc.. The study discusses the data needed, the available data sources and underpins the choice for preparatory legislative documents, such as the IPPC BREFs, and emission/resources data supplied by the materials industry. Furthermore, some specific problems relating to data retrieval for the use phase are discussed. This relates to test standards, consumer behaviour and system analysis.

Building on these foundations a data and reporting tool could be created that allows the translation of product-specific information (materials, geometry, etc.) into environmental impacts. For around 100 materials and processes a so-called **Unit Indicator table** was built, containing per unit of material (e.g. in kg) or process (e.g. in kWh/ GJ) 14 environmental indicators (and 2 auxiliary parameters) per unit material (in kg) /process (e.g. in kWh). These environmental indicators are Energy, Water (process & cooling), Waste (hazardous & non-hazardous), Global Warming Potential (GWP), Acidification Potential (AP), Volatile Organic Compounds (VOC), Persistent Organic Pollutants (POP), Heavy Metals (to air & to water) carcinogenic Policyclic Aromatic Hydrocarbons (PAH), Particulate Matter (PM) and the Eutrophication Potential of certain emissions to water (EP). Auxiliary parameters relate to electricity use and to feedstock input. Ozone Depletion Potential (ODP) is a 15tht indicator, but sufficient process data for EuP was lacking. Ambient Ozone emissions during the use phase, Materials Depletion, Land Use and Noise are also addressed, but they should be treated on an ad-hoc basis or derived from one or more of the indicators that are quantified.

Table 3: Sample of Unit Indicator Table

Material	Re-cyc	Energy			Water		Waste		Emissions: To Air							To Water	
		prim	/ electr/	fd	proc	/ cool	haz	/ non	GWP	AP	VOC	POP	HM	/ PAH	PM	HM	EP
	%	MJ	/ MJ	/ MJ	ltr	/ ltr	g	/ g	kg	g	g	ng	mg	/ mg	g	mg	mg
Plastics in kg																	
LDPE	0%	**78**	/ 13	/ 52	**3**	/ 45	**4**	/ 44	**1.90**	7	**0.49**	-	**-**	/ 0	1	**-**	27
HDPE	0%	**77**	/ 10	/ 54	**3**	/ 31	**5**	/ 38	**1.81**	6	**0.16**	-	**-**	/ 0	1	**-**	30
LLDPE	0%	**74**	/ 10	/ 47	**2**	/ 116	**3**	/ 31	**1.86**	6	**0.07**	-	**-**	/ 0	1	**-**	39
PP	0%	**73**	/ 7	/ 53	**5**	/ 40	**4**	/ 28	**1.97**	6	**0.02**	-	**-**	/ 0	1	**-**	165
PS	0%	**87**	/ 4	/ 48	**5**	/ 177	**1**	22	**2.79**	17	**0.00**	-	**-**	/ 121	2	**-**	55
EPS	0%	**84**	/ 3	/ 48	**6**	/ 176	**1**	38	**2.70**	18	**0.00**	-	**-**	/ 61	2	**-**	125
HI-PS	0%	**92**	/ 5	/ 49	**6**	/ 186	**1**	30	**2.90**	19	**0.00**	-	**-**	/ 61	2	**-**	60
PVC	0%	**57**	/ 11	/ 23	**11**	/ 62	**5**	67	**2.16**	15	**0.00**	-	**-**	/ 0	3	**3**	314

Furthermore, a reporting tool called **EuP EcoReport** was developed that facilitates the necessary calculations to translate product-specific characteristics into environmental impact indicators *per product*. The intended audience for this tool consists of policy makers, consultants and stakeholder experts involved in the preparatory stages and final decisions regarding implementing ecodesign measures; it might also be used by manufacturers for a preliminary analysis of the environmental performance resulting from the implementation of various design options. The environmental indicators are identical to the ones used in the Unit Indicator table and they enable policy makers e.g. to compare/ rank the products per environmental impact indicator also with respect of EU policy goals. As mentioned, a single value evaluation of the products across all environmental impact indicators was not desired and is not foreseen, as a robust basis for such an evaluation is lacking and policy makers should be flexible in view of changing insights and environmental policy objectives.

Apart from the environmental impact per product, the EuP EcoReport also contains tools to make an assessment of EU totals and the assessment of monetary Life Cycle Costs (LCC).

The Input Worksheet starts with a section of 200 lines reserved for the Bill-of-Materials. Descriptions of the components can be filled in manually or pasted from e.g. standard CAD-files. Product weights have to be filled in manually. For the selection of a Process of Material first a category has to be selected; both from drop-down menu's. In the BOM-section the weight per component is multiplied with the environmental Unit Indicators from Table 29. Also the product weights are summed per Category (Ferro, Non-Ferro, Bulk Plastics, etc.) and summed parameters are prepared for the manufacturing, distribution and end-of-life phases.

Table 4: Input EuP EcoReport v5 (source: VHK, 28 Nov. 2005)

Nr	Product name	Date	Author

Pos nr	**MATERIALS Extraction & Production** **Description of component**	**Weight** **in g**	**Category** **Click &select**	**Material or Process** **select Category first !**
1				
2				
3				
4				

The following section describes the (OEM) manufacturing of metals and plastics components. Most of this section uses fixed impacts on a weight basis. Specific weights per process are calculated automatically from the BOM section. The only variable that can be edited is the percentage of sheet metal scrap, i.e. the default 25% value can be changed.

Pos **nr**	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	OEM Plastics Manufacturing (fixed)	0		20
202	Foundries Fe/Cu/Zn (fixed)	0		34
203	Foundries Al/Mg (fixed)	0		35
204	Sheetmetal Manufacturing (fixed)	0		36
205	PWB Manufacturing (fixed)	0		53
206	Other materials (Manufacturing already included)	0		
207	Sheetmetal Scrap (Please adjust percentage only)	0	25%	37

The section on Final Assembly and Distribution covers all activities from OEM components to the final customer. The only design variable is volume of the final (packaged) product, but the impact also depends on what type of product is concerned. The latter is characterized by two Boolean (yes/no) variables.

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)	
208	Is it an ICT or Consumer Electronics product < 15 kg ?		YES	59	1
209	Is it an installed appliance (e.g. boiler)?		NO	60	0
				62	1
210	Volume of packaged final product in m^3	in m^3		63	0
				64	1

The two sections of the input table below describe the use phase and the end-of-life phase respectively.

Pos nr	USE PHASE Description		unit	Subtotals
211	Product Life in years	0	years	
	Electricity			
212	On-mode: Consumption per hour, cycle, setting, etc.		kWh	0
213	On-mode: No. Of hours, cycles, settings, etc. / year		#	
214	Standby-mode: Consumption per hour		kWh	0
215	Standby-mode: No. Of hours / year		#	
216	Off-mode: Consumption per hour		kWh	0
217	Off-mode: No. Of hours / year		#	
	TOTAL over Product Life	0	MWh (=000 kWh)	65
	Heat			
218	Avg. Heat Power Output		kW	
219	No. Of hours / year		hrs.	
220	Type and efficiency (Click & select)	→	85-not applicable	
	TOTAL over Product Life	0.00	GJ	
	Consumables (excl. spare parts)			material
221	Water		m^3/year	83-Water per m^3
222	Auxiliary material 1 (Click & select)	0	kg/ year	85-None
223	Auxiliary material 2 (Click & select)	0	kg/ year	85-None
224	Auxiliary material 3 (Click & select)	0	kg/ year	85-None
	Maintenance, Repairs, Service			
225	No. of km over Product-Life	0	km / Product Life	86
226	Spare parts (fixed, 1% of product materials & manuf.)	0	g	

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)		g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product		g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs per kg final product			
231	Landfill (fraction products not recovered) in g en %	0	5%	88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	0	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	0	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	0	1%	4
235	Plastics: Materials Recycling (please edit% only)	0	9%	4
236	Plastics: Thermal Recycling (please edit% only)	0	90%	72
237	Electronics: PWB Easy to Disassemble ? (Click & select)	0	YES	47
238	Metals & TV Glass & Misc. (95% Recycling)	0.0		fixed

After the inputs for calculating the environmental impacts, there is a small section that allows the calculation of EU totals and of the Life Cycle Costs. The Product Life (in years) is derived from the environmental section. Next the total annual EU sales and the installed EU stock, both in million units have to be given. Follows a section that asks the average price and –if applicable—the installation and maintenance costs of the product to the consumer (incl. taxes). For energy and water some default rates are given. Prices for other consumables can be filled in.

Finally, the last input in the LCC calculation is a rough indicator of the ratio between the energy consumption of the average new product and the energy consumption of the average product installed ('stock'). Approximately, if there has been no revolutionary growth or decrease in sales, the average product installed should equal the average new product a number of years ago, where the number of years equals half the product life. For instance, for whitegoods (refrigerators, dishwashers with a product life of ca. 15 years) this would be the average new product 7 to 8 years ago.

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	1	years
B	Annual sales		mln. Units/year
C	EU Stock		mln. Units
D	Product price		Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate		Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs		Euro/ unit
M	Discount rate (interest minus inflation)	5.0%	%
N	Present Worth Factor (PWF) (calculated automatically)	0.95	(years)
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1.00	

The Output Worksheet immediately reflects the changes in the Input Worksheet. The most important table in the output worksheet is the first one, which indicates the environmental impacts per product over its life-cycle, subdivided in production, distribution, use and end-of-life.

Table 5: Output EuP EcoReport

Nr	Product name						Date			Author	
	Life Cycle phases →		**PRODUCTION**			**DISTRI-**	**USE**	**END-OF-LIFE***			**TOTAL**
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**0**			0	0	**0**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**0**			0	0	**0**	**0**
4	Non-ferro	g			**0**			0	0	**0**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**0**			0	0	**0**	**0**
	Total weight	g			**0**			0	0	**0**	**0**
									see note!		
	Other Resources & Waste							debit	credit		
8	Total Energy (GER)	MJ	0	0	**0**	**0**	**0**	0	0	**0**	**0**
9	of which, electricity (in primary MJ)	MJ	0	0	**0**	**0**	**0**	0	0	**0**	**0**
10	Water (process)	ltr	0	0	**0**	**0**	**0**	0	0	**0**	**0**
11	Water (cooling)	ltr	0	0	**0**	**0**	**0**	0	0	**0**	**0**
12	Waste, non-haz./ landfill	g	0	0	**0**	**0**	**0**	0	0	**0**	**0**
13	Waste, hazardous/ incinerated	g	0	0	**0**	**0**	**0**	0	0	**0**	**0**

Nr	Product name						Date			Author	
	Life Cycle phases →		**PRODUCTION**			**DISTRI-**	**USE**	**END-OF-LIFE***			**TOTAL**
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO_2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
15	Ozone Depletion, emissions	g R-11 eq.	negligible								
16	Acidification, emissions	g SO_2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**0**	**0**	0	0	**0**	**0**
18	Persistent Organic Pollutants (POP)	ng i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
19	Heavy Metals	mg Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
	PAHs	mg Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
20	Particulate Matter (PM, dust)	g	0	0	**0**	**0**	**0**	0	0	**0**	**0**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
22	Eutrophication	g PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
23	Persistent Organic Pollutants (POP)	mg	negligible								

***=Note: Recycling credits only relate to recycling of plastics and electronics (excl. LCD/CRT). Recycling credits for metals and other fractions are already taken into account in the production phase.**

From this table and the inputs for LCC and EU Totals we can now calculate the total environmental impact of all products sold in the most recent years, over the coming years (up till and including the end-of-life). This is not shown here, because the table looks the same as above, only the accounting units are different and of course the data are different.

The last table of the Output worksheet calculates two parameters, that both relate to economic expenditure, but that are otherwise completely different. The first parameter is the Life Cycle Costs of one product to an end-user, i.e. a (potential) buyer that calculates the economic rationale of his or her investment decision today and that looks into the future in terms of discounted running costs. This is important for the Base Case and the evaluation of an appropriate target. The second parameter calculates the EU Total of all expenditure to end-users in the most recent year, i.e. the running costs are not discounted and for the running costs in the use phase the calculation starts from the installed stock.

Market Analysis

The economical and commercial consequences of implementing measures play an important role in the preparatory studies. The study addresses the Market Analysis and related subjects, such as the product definitions and classification. Especially for the latter it is proposed to consider the Eurostat PRODCOM classification at 6 or –in exceptional cases—8 digit level. Regarding existing legislation, the study gives an overview of the worldwide labelling and Minimum Efficiency Standards for EuP that should be taken into account during the preparatory studies. In terms of hard data on sales and stock of particular EuP it is recommended to use both the PRODCOM data for more generic trade and production data that are consistent with official statistics, but also and primarily use specialist marketing sources to generate sales and stock data that are supported by the industry sectors. The last part of this chapter deals with market trends and the pricing data that serve as an input for the monetary Life Cycle Cost definition.

Assessment of Improvement Potential

The last part of the methodology deals with the assessment of the improvement potential. For those familiar with the SAVE studies for the EU Energy Label this methodology will have some very well-known elements. The first step is the definition of one (or more) Base Case(s) that characterize the average new EU product. This sets the reference for improvement. It also bundles all the information from the various environmental, technical and economical information that was assessed in the previous chapters. Apart from the functional parameters, it defines the emissions and resources consumption for the 14 or 15 indicators and it determines the Life Cycle Costs, i.e. the monetary cost to the end-user not only for the purchase of the product but also for the discounted running costs. As a next step, the design options need to be identified and for each design option the price increase of the product and the environmental benefit has to be estimated.

In this context, two types of design options need to be distinguished: The ones that also result in lower monetary running costs (energy, water, detergent, etc.) and that need a full Life Cycle Cost assessment and the ones where there is no benefit in lower running costs, where a simple assessment of the price increase would suffice. For the first type, it is appropriate to rank the design options according to Life Cycle Costs and single out the points with the least Life Cycle Costs (LLCC) and the maximum that could technically be achieved with the Best Available Technology (BAT). Also the long term analysis of as yet experimental options, that we have termed BNAT (Best Not Available Technology), serves that same purpose.

As indicated in Annex II of the 2005/32/EC Directive, the LLCC point could serve as a minimum target level in implementing measures. The BAT point indicates the remaining possibilities for product differentiation once such a minimum target is set. For the second type of design options it only makes sense to rank design options if they relate to improvement of the same environmental indicator. In that case the ranking would indicate to the policy makers what design options yields the highest environmental benefit at the lowest costs.

The final part of the improvement potential is an ex-post study of the environmental gains according to several scenario's, the estimated impact on industry and consumers of certain measures and a sensitivity analysis that shows how robust the rationale for implementing measures is in the light of price variations and alternative partitioning methods (e.g. for recycling).

Product Cases

By way of illustration –not as a substitute for the real preparatory studies-- the Ecodesign methodology was applied to 10 product cases: central heating boilers, room air conditioners, circulators, street lighting, refrigerators, dishwashers, vacuum cleaners, copiers, televisions and personal computers. Although the studies were mere explorations, they suggest that LLCC targets with 20-25% energy savings and BAT targets of 30-40% are feasible.

Conclusion

The Methodology Study was performed by VHK but builds on thousands of literature references and the contribution of stakeholder experts, reviewers, participants and many others that we would like to thank for their interest and contributions. This broad stakeholder involvement also ensured that the methodology is robust, practical and well suited as the basis for the preparatory studies for the 2005/32/EC directive.

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Challenges for Eco-design, Energy Efficiency and Waste Treatment of Electrical and Electronic Products Against the Background of Requests for Exemptions Following Requirements of Article 5 (1) (b) RoHS Directive

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Abstract

EU Directive 2002/96/EC on restriction of use of certain hazardous substances in electrical and electronic equipment (RoHS Directive) provides that from 1 July 2006 new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE). This restriction shall not apply to applications listed in the Directive's Annex.

Article 5 (1) (b) contains criteria for exempting materials and components from above mentioned restriction in order to adopt the Annex to scientific and technical progress. Stakeholders have been invited to address requests for exemption from restriction of use according to the criteria in Article 5 (1) (b) against the background of adaptation of the Annex to scientific and technical progress. Prior to an amendment of the Annex, a public stakeholder consultation has to take place.

Öko-Institut e.V. – Institute for Applied Ecology – together with Fraunhofer IZM – Institute for Reliability and Microintegration – have been appointed by the European Commission to review the requests. It is the experience gained during this work which is introduced in this paper, i.e. a description on how the requirements of the RoHS Directive affect eco-design, energy efficiency and waste treatment of domestic appliances and lighting (DAL) and what possible chances and drawbacks are resulting thereof.

The RoHS Directive and its implications on DAL

Domestic appliances and lighting equipment are part of the product category "electrical and electronic equipment (EEE)". This product category has been subject of recently implemented environmental EU legislation: on the one hand the framework for dealing with these products at their end-of-life has been set by the so called WEEE Directive[1]. On the other hand the use certain substances in these products has been restricted by the so called RoHS Directive[2].

The WEEE Directive is valid for products that are part of one of the 10 product categories listed in its Annexes I A and B. Domestic appliances fall under the following categories "1. large household appliances", "2. small household appliances", "3. IT and telecommunications equipment" and "4. consumer equipment". Lighting equipment is an own product category (no. 5). The RoHS Directive is also valid for those product categories but specifies that concerning lighting equipment it only applies to electric light bulbs and luminaires in households.

The above described RoHS legal framework leads to the following implications for DAL:

- From 1 July 2006 new DAL put on the market are not allowed to contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)
- Manufacturers thus had to start research and development efforts some time ago either in order to find substitute materials for those substances or in order to eliminate these substances or in order to find other technical solutions not using the restricted substances for their applications.
- The Annex to the RoHS Directive contains certain specific exemptions from the requirements of the Directive. Stakeholders in the area of DAL can – in the process of the adaptation of the

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[1] Directive 2002/96/EC of 27 January 2003 on waste electrical and electronic equipment.

[2] Directive 2002/95/EC of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Annex to scientific and technical progress – apply for further exemptions to be taken into consideration.

This paper will - using one specific example - focus on the implications of the RoHS Directive on the eco-design, waste treatment and partly energy efficiency of DAL against the background of requests for exemptions following requirements of Article 5 (1) (b) RoHS Directive.

The critical review process of requests for exemption

In the period between August 2005 and July 2006 about 80 requests for exemption from the RoHS Directive will have been evaluated by the Öko-Institut and Fraunhofer IZM. All these requests have been sent to the European Commission which had to subsequently carry out a stakeholder consultation. In total, during the period of the critical review process, 4-5 stakeholder consultations will have been carried out.

After a consultation has closed and after comments have been received from stakeholders concerning certain requests, the critical review process followed the following procedural steps:

- Check requests regarding completeness / consistency
- Check whether applications fall under scope of RoHS
- Analyse whether requests use justification in line with Art. 5 (1) (b)
- Check stakeholder comments regarding relevance for single requests
- Contact applicant / stakeholder / external expert to clarify open questions
- Assess the gathered information
- Make final recommendation to Commission with wording in monthly reports

During the course of this work, several challenges needed to be met. On the one hand the level of quality of the exemption requests is very different – as much regarding the justification argumentation used as regarding supporting documentation. This led to the fact that – in order to reach a uniform level of the documents to be evaluated – applicants sometimes needed to be asked intensively for further information.

On the other hand many times poor response was received from stakeholders – especially concerning counter-argumentation of the requested exemptions. This was particularly difficult, since the knowledge on existing alternatives and substitute materials is not always widespread and available to public. Hence, in view of a sound review process, it was sometimes difficult to assess in depth whether an alternative was available on the market and would thus not justify granting an exemption.

Furthermore Article 5 (1) (b) of the RoHS Directive explicitly refers to technical / scientific or environmental argumentation which can be used as justification for an exemption request. Nevertheless, this leaves room for interpretation. For example, the non-availability of components in the supply chain can be regarded as an economic argument (thus not being a valid one) or can be regarded as a technical issue hindering substitution (thus being indeed a valid argument). Hence in many cases, it needed to be assessed in a rather general way whether substitution was actually feasible in (technical) practice.

Even though the above mentioned challenges had to be taken into account, it has to be stated clearly that – as a result from the review process – many substitute materials and alternatives exist for applications in EEE. Only in very specific applications, an exemption might be necessary in order to guarantee the technical functionality. For the broad range of DAL applications and products, efforts in substitution have been made and have been put into practice in time for 1July 2006. This can also be seen from the fact that only very few of the requested exemptions belong to the area of domestic appliances and lighting.

Selected Example of requests for exemption

In the course of the review process of requests put forward for exemptions from the RoHs Directive, some requests referred to DAL. This section will introduce one example in order to better understand implications of the RoHS Directive’s requirements on specific applications, i.e. for which applications can granting or refusing exemptions ensure successful eco-design, high energy efficiency and environmentally sound waste treatment. The example will also elaborate what viable substitutes/alternative technologies exist that allow progress in eco-design, energy efficiency and environmentally sound waste treatment.

Discharge lamps containing lead in the form of amalgam

This request has been put forward for the use of lead in the form of PbBiSn-Hg and PbInSn-Hg in specific compositions as amalgam and in the form of PbSn-Hg as auxiliary amalgam in very compact Energy Saving Lamps (ESL). These substances control the mercury vapour pressure inside small compact fluorescent lamps (especially the types with a closed cover) stabilising the light output and lamp efficacy over a wide ambient temperature range, which makes it possible to replace incandescent lamps by energy saving lamps in a wide range of applications, both indoor and outdoor. ESL can only be made in GLS (General Lighting Service) dimensions and shape when Pb-containing amalgam can be applied.

Light output versus temperature of ESL

Lamps with amalgam+Pb (blue curve) have a superior performance across a wide range of ambient temperatures, hence do not suffer from light losses in very compact lamp designs

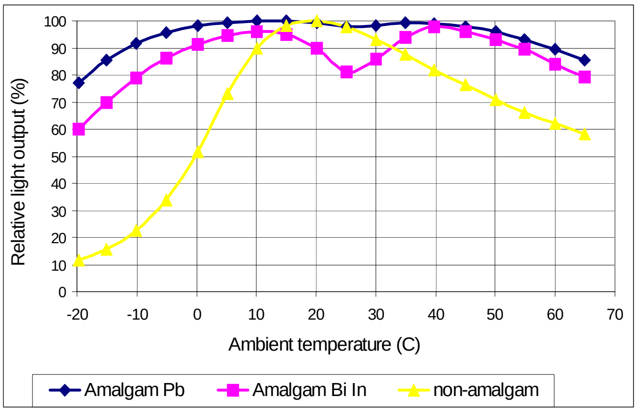

Figure 1: Light output versus temperature of ESL [source: ELCF]

In this case, the exemption requested reflects the need for a differentiated look at every single specific use of certain substances in corresponding applications. Lead is used here to be able to put an ESL on the market which will be able to substitute small GLS lamps – thus leading to energy savings in the use of lighting equipment. Existing lead-free alternatives are not able to create optimum mercury pressure in ESL's with GLS-equivalent dimensions. Consequently either light output will be less when maintaining GLS dimensions, or product dimensions will be significantly bigger when maintaining the light output.

According to the European Lamp Companies Federation (ELCF) the penetration threshold[3] is at 50% - even in developed markets. The annual European market (Western Europe and Eastern Europe) is 2.5 billion for GLS and 0.15 billion for compact fluorescent lamps (CFL). Referring to ELCF documentation, consumers do not use CFL because of dissatisfaction with price, size and odd shape (compared to reference incandescent lamps).

As the market for classic ESL is already well developed, this new market of smaller energy saving lighting equipment is an important target supported by overall environmental policy. However, it has to be checked whether the energy saved (production of energy also leads to mercury and lead emissions) through the 1:1 substitution of GSL lamps with small ESL leads to a higher environmental benefit than the damage lead does (also requiring a certain amount of energy for its production). Former studies and research on the comparison of conventional incandescent lamps and energy saving lamps[4] have concluded that approximately 95% respectively 90% of the environmental impact is generated in the use phase. Hence the production phase does not have a significant environmental impact. The European Lamp Companies Federation (ELCF) states that substitution by non-lead containing products would lead to increased Hg and Pb emissions during electricity generation and can be estimated to be 900 kg Pb/a[5] and 20 kg Hg/a[6] for 15 million ESL. ELCF quantifies the total

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[3] % users of 1/more compact fluorescent lamp

[4] Cf. Pfeiffer, R.; Produktlinienanalyse "Glühlampe versus Energiesparlampe". Öko-Institut e.V., 1994 and AEA Technology Environment. Revising ecolabel criteria for lamps. A report produced for the European Commission DG XI.E.4, Marchh 1999.

[5] ELCF has estimated 10 ppm Pb per ton of coal, or 1.2 ppm per kWh for a coal-fired power plant has been assumed, leading to solid Pb-containing waste.

[6] ELCF has taken an emission into air of 0.0289 mg per kWh, averaged over existing EU power plants, has been taken into account.

potential energy savings as follows: assuming a 10% increase in ESL usage (150 million current market volume + 10%). The annual power consumption would be reduced by 15 million x 60 W x 850 hours[7] = 765 million kWh which equals the emission of approximately 320.000 tons of CO_2[8].

Thus - even though there are differences between the different European countries - in this case, it is considered that within the EU the overall benefit of substituting small GSL with ESL is given.

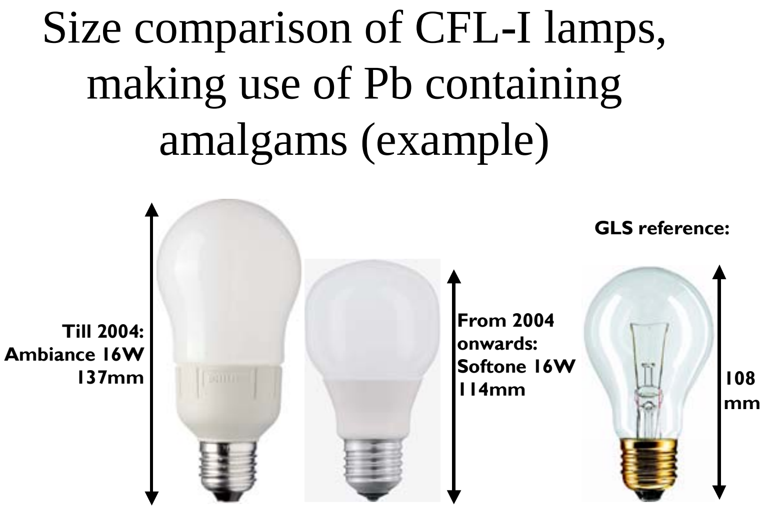

Figure 2: Size comparison of very compact Energy Saving Lamps with GLS [source: ELCF]

Furthermore using lead as an amalgam in very compact ESL allows making these lamps available at a competitive price which is a further asset in the process of substituting “classic light bulbs”.

The above mentioned arguments lead to the recommendation to grant an exemption for this specific application of lead in lighting equipment. However, efforts are made by manufacturers to substitute lead in very compact ESL in the medium term. This is why it was also recommended to limit the exemption to the period of time needed for these R&D activities. This time period is stated to be lasting until 2010 according to ELCF. Since the Annex of the RoHS Directive is reviewed every four years, the exemption would anyway be subject to revision by 2010 and no further time limit has been proposed.

This recommendation has been taken over by the Commission into a Draft Decision in view of amending the Annex of the RoHS Directive. The so called TAC (Technical Adaptation Committee) gave a positive vote on this exemption request. Meanwhile the Commission has published the exemption in its Decision 2006/310/EC of 21 April 2006 (exemption no. 19).

Conclusions

Putting all aspects mentioned in this paper together, the following conclusions can be drawn concerning the impact of the requirements of the RoHS Directive on DAL:

- The restriction of substances in most cases leads to a need for re-designing applications and products, looking for alternatives and substitution possibilities. This can have an impact on the overall eco-design of DAL. At least requirements of the RoHS Directive have to be taken into account during R&D efforts made in the framework of eco-design policies.
- Refraining from using the restricted RoHS substances also has an impact on the waste management of DAL when reaching their end-of-life. Since the RoHS Directive was elaborated within the same general environmental policy framework as the WEEE Directive (i.e. enlarging producer responsibility, reduce load of “priority substances[9]” in EEE and thus reducing contamination of waste, ensure separate collection of WEEE in order to reduce the amount of hazardous substances in municipal waste stream, ensure a special treatment of WEEE taking its particularly high amount of valuable raw material and of hazardous

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[7] Annual average of burning hours.

[8] ELCF has used the EU average value of 0.42 kg CO_2 emission per kWh.

[9] Meaning those substances identified as being particularly harmful to the environment, especially when used in EEE.

substances into account), the desired effect when reducing the amount of hazardous substances at the very beginning of a product's life time is that the negative impact on the waste stream is also reduced.

- In some cases though – as the example on very compact Energy Saving Lamps has shown – it has appeared that it might be necessary to have a closer look on the sensibility of the restriction of use as regards environmental benefits. Here, an exemption of the requirements of the RoHS Directive allows energy savings to be reached. Through making these lamps available on the market – even though they contain lead – conventional light bulbs could be replaced and thus increase energy savings in households.
- Domestic appliances and lighting are a part of electrical and electronic equipment that bears a particularly high potential of increasing energy efficiency. The RoHS Directive may support efforts made in this direction but does not necessarily have a direct impact. Companies aware of the challenges set by environmental policy will incorporate the Directive's requirements in their overall environmental product policy development.
- The adaptation of the Directive's Annex to scientific and technical progress gives companies the opportunity to have a closer look at their products: if they are able to argument that continuing to use some of the restricted substances will lead to energy savings not being possible with the use of substitutes, then the chance of getting an exemption granted is quite high. On the other hand the requirements of the Directive should be taken as a welcome opportunity to consider a re-design of products.
- In the future, product policy development will probably lead to even more restrictions of use concerning substances considered as being particularly harmful to the environment. Linking the efforts made with eco-design, increasing energy efficiency and the efforts in developing products containing less harmful substances can only be of long-term benefit for companies.

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Household Appliances in Croatia – the Market Situation and the Prospects for Introducing EU Based Labelling

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Abstract

The legal basis for the transposition of EU appliances labelling legislation in Croatia is the Energy law which Article 13 says: *"All electricity appliances have to be labelled by energy efficiency labels. The contents and design of energy efficiency labels have to be regulated by sub-law document called An Ordinance on Energy Efficiency Labelling of Households Appliances".* On 17th November 2005 *An Ordinance on Energy Efficiency Labelling of Households Appliances* entered into force (transition period until 1st May 2006). It is based on the Framework Directive 92/75/EEC and implementing Directives 94/2/EC, 95/12/EC, etc for the following appliances: refrigerators and freezers; washing machines; tumble driers; washing/drying machines; dishwashers; electrical ovens; electrical lamps; air-conditioners.

Before 1. May 2006, in the majority of larger retail stores in Croatia, the energy efficiency labelling was present on strictly voluntary basis. Such labels could be found mainly on refrigerators and freezers, washing machines, dryers and dishwashers. Recently, air-conditioners were also very often equipped with labels. These labels were correctly translated in Croatian, although text does not completely match the label defined in the *Ordinance on Energy Efficiency Labelling of Hoseholds* Appliances. Also, sometimes only black-and-white copies of the labels were provided, sometimes only stripes with data and without ground label are attached. Although such labels are not recognized as the appropriate labelling according the Ordinance, they do provide some practical basis for the implementation itself. The most important things at the moment are public awareness and how to find the most cost-effective steps in further process of development and implementation, verification and enforcement of energy efficiency standards and labelling in Croatia as an EU candidate country.

1. Introduction of Croatian Energy Sector

The Croatian energy sector passed through significant changes over the last 15 years. As the energy sector changes were not going to occur spontaneously, the establishment of an organized system of energy management required significant efforts. Experiences from developed countries point to the necessity of finding a right balance between market mechanisms and government interventions, as well as between the technical/technological aspects of energy management and its social significance.

The new energy strategy, being an expression of national needs, reflects sustainable development and environmental protection objectives, having basic features like:

- the legislative regulation of the energy sector;
- public functioning of transmission/transportation and distribution networks for electricity and gas and public ownership over these networks, as a precondition for the development of the non-discriminating market and competition, as well as for the future de-monopolization of the market;
- organized care for the increase of energy efficiency;
- stimulation of the use of renewable energy sources and clean technologies;
- development of education, information and consultation energy services (1).

2. Basic Statistical Data of Croatia

In table 1. some general statistical information about Croatia are presented (2).

Table 1: Statistical data of Croatia

Population	4,442 Million (according the Census in 2001)
Number of inhabited households	1 421 623
Area	56 594 km^2
GDP	5996 USD 2000 per capita (2004)
GDP trend	Continuous growth from 4800 USD 2000 per capita in 1997 to 5996 USD 2000 per capita in 2004
Inflation	2,1% (2004) (measured by consumer price index)
Currency	Kuna (kn) Actual exchange 1 Euro = 7,3 kn (23 March 2006) Trend in the last 2 years: Mild decrease of Euro value from 1Euro = 7,6 in 2003 to 1 Euro = 7,3 kn in March 2006
Average electricity price for households	0,5487 kn/kwh

3. The Energy Legislation in Croatia

Some of the most significant moments for Croatian energy sector development are the following:

1991	Acceptance of National Energy Sector Strategy
1994	Establishment of New Development and Organization Project - PROHES
1997	Establishment of 10 National Energy Programmes (NEP) dealing with Renewables and Energy Efficiency
2001	Acceptance of set of Energy Laws
2002	Acceptance of Energy Sector Development Strategy
2003	Establishment of the Fund for Environment Protection and Energy Efficiency
2004	Preparation of different sub-laws for Energy Efficiency and RES

On 19 July 2001 the Croatian Parliament accepted the set of the following energy laws (figure 1):

1. Energy Law,
2. Law on Electricity Market,
3. Law on Oil and Oil Derivatives Market,
4. Law on Gas Market,
5. Law on Regulation of Energy Activities.

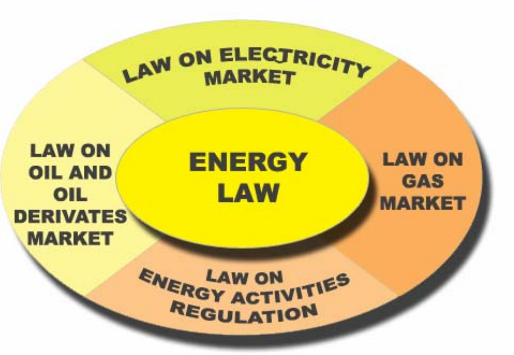

Figure 1: Set of Energy Laws

Based on the provisions of the Energy Law, the basic act setting the energy policies and plans for energy development in Croatia is the Energy Development Strategy, accepted by the Croatian Parliament on February 2002. The Energy Development Strategy has energy, economic, legal, organizational, institutional and educational dimensions, and its primary goal is to prepare the Croatian energy sector for smooth and efficient integration into the European Union.

The Strategy proposes the model of energy sector development which is adjusted to the needs and specificities of Croatia, considering various solutions experienced in the developed countries. The energy strategy envisages five general characteristics of the future energy system: (1) increasingly determined by users' needs; (2) using a range of various energy sources and technologies available, which depends on local conditions and capacities; (3) increasingly decentralized; (4) more attention will be paid to energy efficiency; (5) move forward to the use of clean energy products and technologies.

In 1997, the Croatian Government started 10 National Energy Programs as projects at national level with main objectives being to improve existing and introduce new and advanced technologies into the Croatian energy sector, to utilise renewable energy sources and to increase energy efficiency (3).

The Governmental activities for improving energy efficiency in all relevant energy consumption areas as well as for increased use of RES are conducted through the following National Energy Programs (figure 2):

1. KUEN$_{building}$,
2. MIEE,
3. KOGEN,
4. KUEN$_{cts}$
5. TRANCRO,
6. BIOEN,
7. ENWIND,
8. GEOEN,
9. MAHE,
10. SUNEN.

The Ministry of the Economy, Labour and Entrepreneurship and the Energy Institute Hrvoje Požar are in charge of their realization.

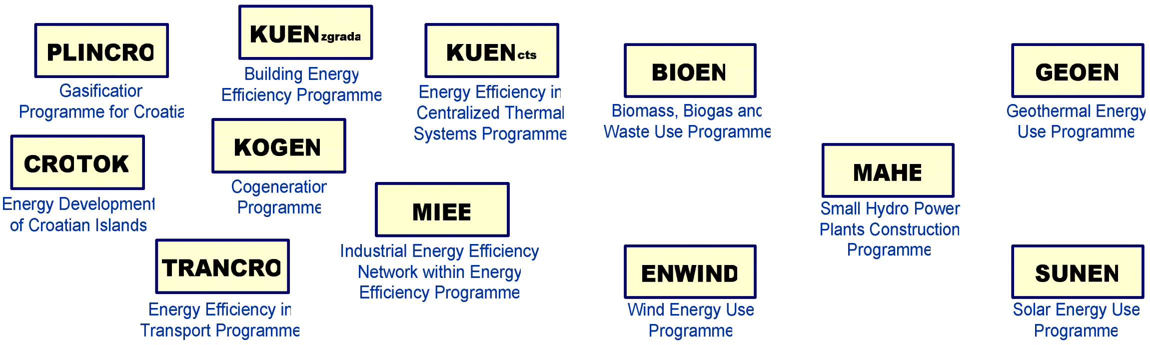

Figure 2: National Energy Programs on Energy Efficiency and Renewables

The main objective of Building Energy Efficiency Program is to establish an organized system in order to increase energy efficiency in building construction and poll all experts in Croatia to deal with respective issues.

Energy conservation in buildings is, also, regulated by the Construction Law from 2003 and the Regulation for Thermal Insulation and Saving Energy in Building Construction from 2005.

The Strategy defines the following targets for the total energy consumption per m^2 in newly built houses:

1. 75 kWh/m^2 in year 2010;
2. 50 kWh/m^2 in year 2020.

According to the Strategy the goal of labeling, standardization, DSM measures and general technological developments is a linear reduction of non-heat electricity consumption in households by 0.7 percent.

In industry and services sectors, the energy efficiency strategy should establish the organized structure within the framework of the MIEE Program. The legal background of energy efficiency should be prescribed by the Rules on Efficient Energy Use. The Rules will stipulate the classification of customers into several categories: industry, non-commercial services sector, commercial sector, transportation, and households. Out of 460 MW_e of actually installed power of cogeneration plants in Croatia, one third are public district heating plants and the rest are industrial plants. Analyses show that this is only about 30% of real potential for cogeneration in Croatia. Therefore in the area of cogeneration (KOGEN Program), the main goal is to stimulate construction and use of cogeneration plants in all those facilities where technological and economic conditions allow. The realization of this Program primarily includes creation of favorable legal, financial and technical and technological framework for cogeneration. Actually the cogeneration is recognized in the Energy Law and Law on Electricity Market through the Rules on Eligible Producer Status that should be prescribed by the Minister of Economy. Besides, the proposal is to update the Energy Law with the rules or sub-law on cogeneration, according to proposed EU directive on the promotion of cogeneration based on a useful heat demand in the internal energy market. More significant growth of small scale cogeneration plants is expected in the following years, particular small scale in service sector (63 MW_e or 18% of potential in 2020) and industry (400 MW_e in 2020). Actual technical potential of micro-cogeneration is estimated at the level of 150 MW_e, but more significant development is not expected before 2010.

Furthermore, the Energy Law proclaimed use of renewable energy resources as the interest of Croatia. The framework for RES implementation will be given by the Ordinance on Use of Renewable Energy Resources, which should be prescribed by the Minister of Economy. The rules will stipulate which renewable energy sources will be used for energy generation, their type, technology, possibilities of their use, as well as the incentives. In Croatia, environmental protection policy falls within the competence of the Ministry of Environmental Protection, Physical Planning and Construction. The State Directorate for Water is in charge of water conservation.

Regarding climate change particularly, the most important regulations are the following:

1. Environmental Protection Law,
2. Air Quality Protection Law,
3. Law on Fund for Environmental Protection and Energy Efficiency
4. Ordinance on Emissions Limits for Stationary Combustion Sources,
5. Waste Law,
6. Rules on Handling Hazardous Waste and
7. Rules on Environmental Impact Assessment.

4. The Appliances Labelling Legislation

The legal basis for the transposition of appliances labelling legislation in Croatia is the Energy law which in Article 13 says: *“All electricity appliances have to be labelled by energy efficiency labels. The contents and design of energy efficiency labels have to be regulated by sub-law document called An Ordinance on Energy Efficiency Labelling of Households Appliances“.*

The Ministry of Economy, Labour and Entrepreneurship is in charge for EU labelling legislation transposition.

On 17th November 2005 *An Ordinance on Energy Efficiency Labelling of Households Appliances* (4) entered into force (transition period until 1st May 2006). The Ordinance regulates the following household appliances:

- refrigerators and freezers;
- washing machines;
- tumble driers;
- washing/drying machines;
- dishwashers;
- electrical ovens;
- electrical lamps;
- air-conditioners.

The Ordinance is harmonized with the following EU directives:

- Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances

- COMMISSION DIRECTIVE 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations
- COMMISSION DIRECTIVE 95/12/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines
- COMMISSION DIRECTIVE 95/13/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric tumble driers
- COMMISSION DIRECTIVE 96/60/EC of 19 September 1996 implementing Council Directive 92/75/EEC with regard to energy labelling of household combined washer-driers
- COMMISSION DIRECTIVE 2002/40/EC of 8 May 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric ovens
- COMMISSION DIRECTIVE 97/17/EC of 16 April 1997 implementing Council Directive 92/75/EEC with regard to energy labelling of household dishwashers
- COMMISSION DIRECTIVE 2002/31/EC of 22 May 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household air-conditioners
- COMMISSION DIRECTIVE 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps
- COMMISSION DIRECTIVE 2003/66/EC of 3 July 2003 amending Directive 94/2/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations

The Ordinance has to be fully adopted until 1 st May 2006. The governmental body responsible for Ordinance verification is the Croatian State Inspectorate. Regarding legal instruments for the enforcement of Ordinance, Article 11 said that inspectors can request distributors to provide correct label in some limited period of time or withdraw any non-correctly labelled appliance from shops. In case that their requests are not respected they can decided about further steps (penalties, etc). The ultimate measure is to close shops.

Regarding EN standards for household appliances, the following were adopted as Croatian national standards (HRN) in 2003 and 2004:

1. *Refrigerators and freezers*

EN 153:1995

2. *Washing machines*

EN 60456:1999+A11:2001+A12:2001+A13:2003

3. *Washing - drying machines*

EN 50229:2001

4. *Dishwashers*

EN 50242:1998+a1:1999+Corr.:2000+A2:2001

5. *Tumble driers*

EN 61121:1999 +Corr.:2000+A11:2000

6. *Electrical ovens*

EN 50304:2001+Corr.:2002

7. *Air- conditioners and heat pumps*

EN 814-1:1997
EN 814-2:1997
EN 814-3:1997.

Standard EN 60598 for electrical lamps is in the process of adoption by Croatian Standards Institute.

5. Test Facilities for Performance Testing of Household Appliances

Regarding Test Facilities for Performance Testing of Household Appliances there are five testing laboratories for electrical safety of household appliances, one for electromagnetic compatibility (EMC), three for Radio frequencies interference (RFI) and two laboratories for Gas appliances safety testing (GAS) in Croatia at the moment.

At the moment, the only facility for testing energy consumption of household appliances is a part of Končar – Household Appliances factory. Apart from few relatively small producers of air-conditioners, water heaters and small appliances, Končar – Household Appliances is actually the only Croatian producer of household appliances. In Končar laboratory, they have verified test procedures for testing energy consumption of electrical ovens and water heaters. It is not accredited test facility and it is intended to test only Končar appliances. As a part of Končar- Institute, there is also a test facility equipped to undertake performance verification testing of energy consumption of refrigerators and washing machines, but it does not do these kinds of tests any more.

The test facility for testing electrical lamps is laboratory of TEŽ factory (Electrical Lamps Factory). Manufactures of appliances often invest in their own (limited) testing facilities that may be used for quality control and product development research. With some modifications and upgrading of these facilities, the performance of these laboratory facilities may be brought up to the level where the test results would be consistent with or comparable to test results from accredited test laboratories. In these cases, manufacturers may be able to declare the performance of their products fairly reliably. Končar – Household Appliances factory would like very much to upgrade its test lab but as any kind of modernization requests significant investment and it is not cost-effective for them at the moment.

One of the accredited, independent test facilities in vicinity is Testing and Certification Laboratory (TLC) Velenje, in Slovenia, founded in 1970 as a part of Gorenje factory but it was separated in 1993. The test facility is equipped to undertake performance verification testing of energy consumption of the following household appliances: refrigerators, freezers, washing machines, tumble driers, washing/drying machines, dishwashers and electrical ovens.

6. Croatian household appliances market

At the moment, in the majority of large retail stores in Croatia, the energy efficiency labelling is present on strictly voluntary basis. Such labels can be found mainly on refrigerators and freezers, washing machines, dryers and dishwashers. Recently, air-conditioners are also very often equipped with labels. These labels are correctly translated in Croatian, although the text does not completely match the label defined in the *Ordinance on Energy Efficiency Labelling of Hoseholds* Appliances. Also, sometimes only black-and-white copies of the labels are provided, sometimes only stripes with data and without ground label are attached. Although such labels are not recognized as the appropriate labelling according the Ordinance, they do provide some practical basis for the implementation itself.

The current situation on Croatian household appliances market is presented in Table 2 where the lists of the most significant market players are given.

Table 2: The lists of Croatian HA manufacturers, importers, wholesalers and retailers

Manufacturers and importers (with 5% or more share on the market):	Wholesalers and retailers
Končar –Household Applinaces	KONČAR
BOSCH	BRODOMERKUR
CANDY	ELEKTROPROMET
ELECTROLUX	ECOS TRGOVINA
GORENJE	E plus
INDESIT	EUROPATRADE
LG	ELEKTROMATERIJAL
WHIRPOOL	ELIPSO
ZANUSSI	GORENJE
ARISTON	IZZI komerc
Mielle	KONIKOM
QUATRO	KRALJ Appliances Shopping Centar
	SPARTAK
	MERCATONE
	Electron
	Frigo &CO
	GETRO
	METRO
	PEVEC
	Robot Commerce
	Merkur international
	Electron

In table 3., the total number of wholesalers and retailers stores in the whole area of country is given (5).

Table 3: The total number of wholesalers and retailers stores

Wholesalers and retailers	**Total number of stores**
KONČAR	12
BRODOMERKUR	52
ELEKTROPROMET	33
ECOS TRGOVINA	33
E plus	37
EUROPATRADE	61
ELEKTROMATERIJAL - Euronics	59
ELIPSO	7
GORENJE	12
IZZI komerc	10
KONIKOM	17
KRALJ Appliances Shopping Centar	6
SPARTAK	14
MERCATONE	3
Electron	8
Frigo &CO	7
GETRO	9
METRO	3
PEVEC	11
Robot Commerce	8
Merkur international	6

The total number of importers of different type of appliances on Croatian market in year 2004 is presented in table 4.

Table 4: The total number of importers

Type of Appliances	**Total number of importers**	**List of the most imported brands**
Refrigerators & freezers	147	Gorenje, Electrolux, Konikom (Ariston, Indesit), Whirpool
Washing machines	97	Gorenje, Electrolux, Konikom
Dishwashers	105	Gorenje, Electrolux, Konikom, Whirpool
Electrical Ovens	47	Gorenje, Electrolux, Whirpool
Air Conditioners	85	LG, ECOS, Europatrade

Regarding different producers shares in sales in year 2005 for 5 main household appliances the situation is following:

1) Washing machines

1. Gorenje – 38% share of sales
2. Whirpool - 13% share of sales
3. Candy – 10% share of sales
4. Indesit - 9% share of sales
5. Bosch - 5% share of sales
6. Končar - 6% share of sales
7. Zanussi - 5% share of sales

2) Tumble driers

1. Gorenje – 48% share of sales
2. Whirpool - 16% share of sales
3. Zanussi - 7% share of sales

4. Electrolux - 6% share of sales
5. Candy – 14% share of sales
6. Bosch - 2% share of sales
7. Mielle - 4% share of sales

3) Refrigerators
1. Gorenje – 46% share of sales
2. Indesit - 9% share of sales
3. Zanussi - 5% share of sales
4. Candy – 6% share of sales
5. Bosch - 4% share of sales
6. Electrolux - 4% share of sales

4) Freezers
1. Gorenje – 63% share of sales
2. LTH - 10% share of sales
3. Zanussi - 8% share of sales
4. Candy – 5% share of sales
5. Končar - 5% share of sales

5) Ovens
1. Gorenje – 61% share of sales
2. Zanussi - 7% share of sales
3. Bosch - 2% share of sales
4. Candy – 6% share of sales

Some of the main conclusions about Croatian HA market are the following:
- retailers brands are not represented significantly and are present only for very cheep HA;
- total number of HA and Audio-video electronics stores in Croatia is approximately 1000;
- 663 stores deal with assortment of HA and are divided as (5):

1. Independent stores - 325
  - small stores – 190 (58 %)
  - middle stores – 103 (32 %)
  - big stores - 32 (10 %)

2. Chains - 338
  - small stores – 100 (30 %)
  - middle stores – 162 (48 %)
  - big stores – 76 (22 %) (nearly 25 are hypermarkets)

3. In total - 663
  - small stores - 290 (44 %)
  - middle stores – 265 (40 %)
  - big stores – 108 (16%)

7. Level of the appliances penetration in Croatian households

According to the GfK Croatia survey that was conducted for 1000 households in September 2005, generally speaking Croatian families are well equipped with most of household appliances (6).
On saturation level are:
- colour TV, radio (95%)
- washing machines (98%)
- refrigerators (100%)
- fixed telephone (90%)

The level of other appliances penetration in Croatian households is as follows:

- mobile phone (85% households have at least 1 mobile)
- video recorder (69%)
- casetophone (79%), hi-fi (61%), CD player/discman (42%)
- DVD player (41%)
- PC / laptop / notebook (48%)
- internet connection (35%)
- printer (27%)
- satellite dish (36%), cable TV (16%)
- microwave (34%)
- dishwasher (29%)
- air conditioner (23%)
- tumble drier (5%)
- video camera (10%)
- oven (94%)

In December 2005, GfK Croatia finished the survey in 1000 households and collected data share of HA depending on age (7):

- washing machines: figure 3;
- tumble driers: figure 4;
- dishwashers: figure 5;
- refrigerators: figure 6;
- freezers: figure 7;
- air conditioners: figure 8;
- ovens: figure 9.

Figure 3. shows the share of washing machines depending of age:

- less then 5 years: 39%
- between 6 and 10 years: 41%
- more then 10 years: 20%.

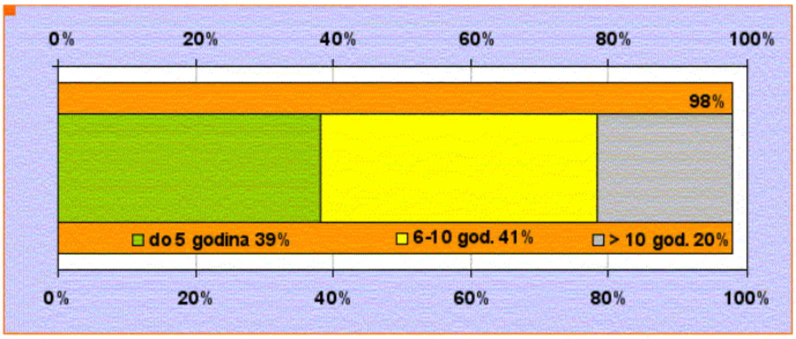

Figure 3: Share of washing machines depending of age

Figure 4. shows share of tumble driers depending of age:

- less then 5 years: 84%
- between 6 and 10 years: 16%
- more then 10 years: 0%.

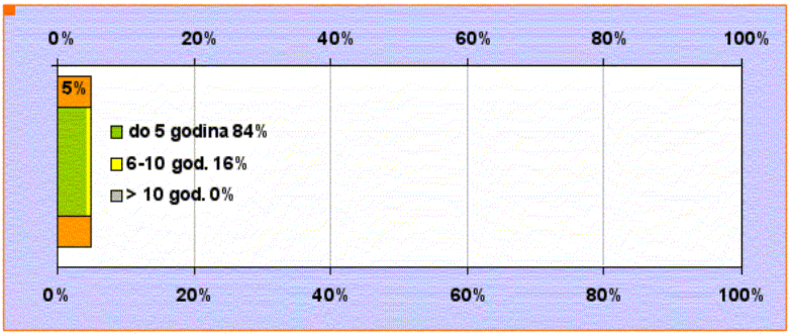

Figure 4: Share of tumble driers depending of age

Figure 5. shows share of dishwashers depending of age:

- less then 5 years: 74%
- between 6 and 10 years: 26%
- more then 10 years: 0%.

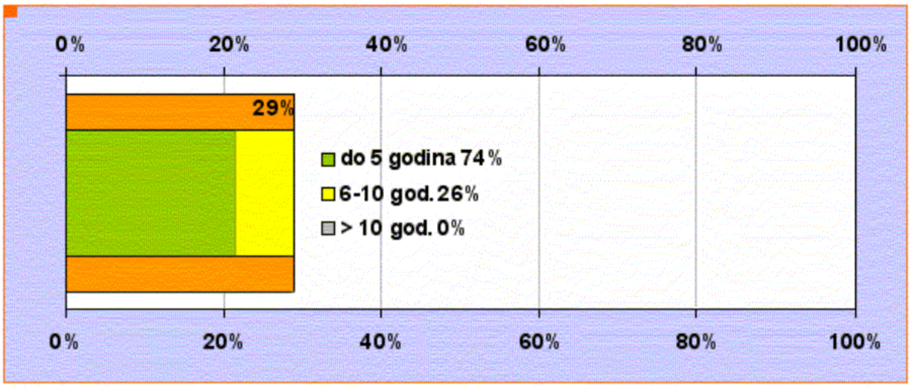

Figure 5: Share of dishwashers depending of age

Figure 6. shows share of refrigerators depending of age:

- less then 5 years: 39%
- between 6 and 10 years: 39%
- more then 10 years: 22%.

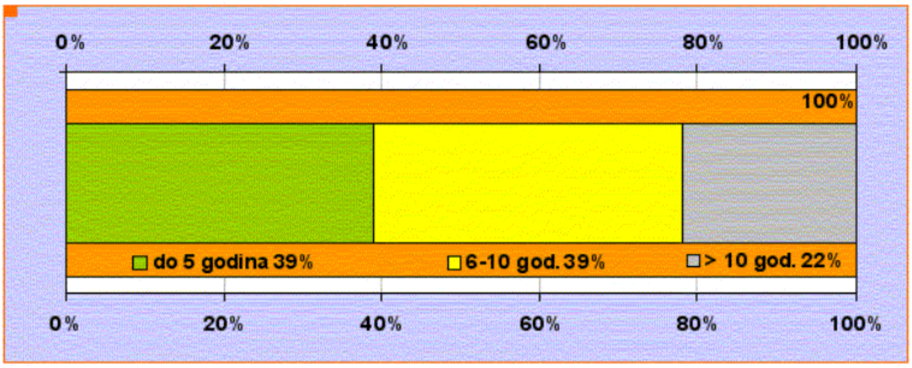

Figure 6: Share of refrigerators depending of age

Figure 7. shows share of freezers depending of age:

- less then 5 years: 31%
- between 6 and 10 years: 34%
- more then 10 years: 35%.

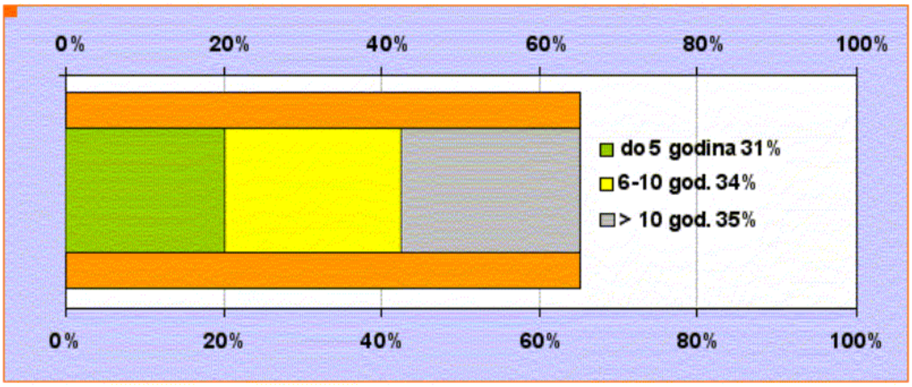

Figure 7: Share of freezers depending of age

Figure 8. shows share of air conditioners depending of age:

- less then 5 years: 90%
- between 6 and 10 years: 10%
- more then 10 years: 0%.

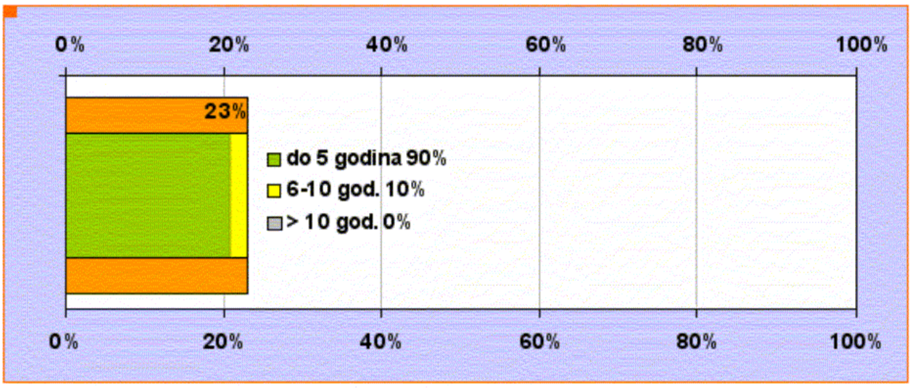

Figure 8: Share of air conditioners depending of age

Figure 9. shows share of ovens depending of age:

- less then 5 years: 38%
- between 6 and 10 years: 34%
- more then 10 years: 28%.

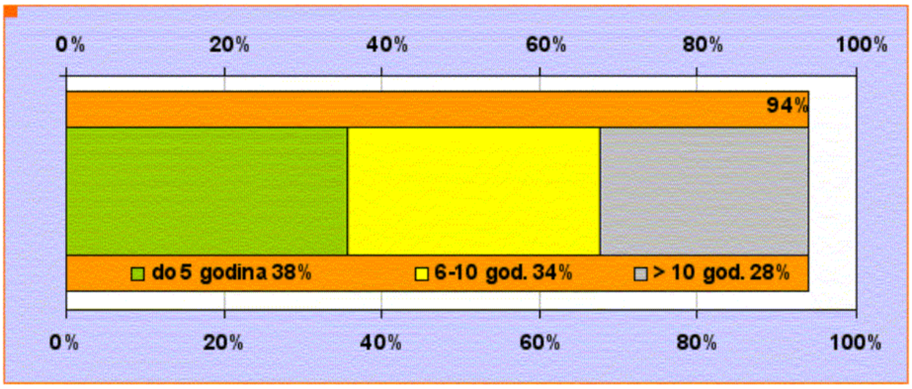

Figure 9: Share of ovens depending of age

According to the GfK survey, Croatian households have plans to buy HA in the year 2006 (7) as follows:

- washing machines: 6%
- tumble dryers: 2%;
- dishwashers: 4%;

- refrigerators: 6%;
- freezers: 3%;
- air conditioners: 5%;
- ovens: 5%.

8. Conclusions

Regarding the fact that the Ordinance on energy efficiency labelling for household appliances is should be adopted by 1st May 2006, the most important things at the moment are public awareness and how to find the most cost-effective steps in the process of development and implementation, verification and enforcement of energy efficiency standards and labelling in Croatia as an EU candidate country.

Generally speaking, the importance of energy efficiency, of energy classes and labelling is not yet recognized in Croatia. An average Croatian HA consumer is much more interested in price and payment conditions (installment rates, reductions, etc) then in energy consumption. Some of the main reasons are that electricity price for households is relativelly low (strong social component) and difference of price for A and B energy class of HA is considerable at the moment (average A+ refrigerator is cca 430 Euros and B refrigerator is cca 360 Euros). Furthermore, in most cases shop assistants are not familiar with energy labels and are not able to give correct information to customers.

HA purchases via Internet are not yet developed in Croatia (there are 35% of Internet users among inhabitants of 15+ years, but HA are not among products that average Croatian consumer orders via Internet.

A very wide range of HA producers and their brands is represented in 663 Croatian HA stores and it is not a problem to find high quality energy efficient household appliances.

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Household Appliances Labeling – Progress Made and Needed in Central Europe

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Abstract

The CEECAP – Implementing EU Appliance Policy in Central and Eastern Europe project was developed with the aim of supporting Central and Eastern European countries in creating suitable conditions for implementing appliance labelling and efficiency policies in accordance with EU Appliance efficiency legislation and programmes.

The project has started in early 2006 and will last for 30 months. It is building upon the previous CEECAP, ELAR and other projects with the involvement of international organisations, such as the IEA, and the European Commission.

CEECAP aims to increase expertise and experience regarding the verification and enforcement, market introduction aspects, strengthen relationships between stakeholders and the start up of national actions to improve energy efficiency.

Main activities are the identification of the national experts and decision maker leaders, their training, design and preparation of national appliance labelling and efficiency actions, set-up of a national multi-disciplinary committees as a forum for discussion about best practices, cooperation opportunities and knowledge transfer.

The results will be an improved policy infrastructure for appliance labelling and efficiency and the future EU policies; a verification infrastructure for product and retailer compliance; collaborative activities to increase the consumer response to labels; and the establishment of a platform for information exchange and transfer.

Introduction

The EU appliance energy efficiency policy has a history of approximately 25 years, originating from the EU trade harmonisation objectives. In the late 1980s, some EU member states wished to introduce mandatory appliance labelling. This led to a mandatory EU policy, laid down in the 1992 Energy Labelling Framework Directive (92/75/EEC).

Appliance energy efficiency policy in Central and Eastern European Countries (CEEC) has started to take off several years ago, and a lot of progress has been made in relations to the EU enlargement and the EU legislation adoption. Most of the countries have been the candidates of the EU membership and therefore they had to comply with EU Acquis upon the EU accession.

All countries, however, did benefit also from early adoption of the EU energy efficiency regulation through reduced energy consumption, lowered energy bills and less CO_2 emissions.

In brief, the status quo in national appliance energy efficiency policy is currently characterised by the following issues:

- All involved countries have created a suitable policy framework for the implementation of appliance energy efficiency policy, all in their own way. Relevant national organisations are involved in the implementation of energy labelling.

- Appliance labelling is often picking up, but the share of labelled appliances and the retailer and sometimes even consumer interest in purchasing efficient appliances doesn't seem to be at the desired level yet. Especially insufficient consumer awareness, low incomes and inadequate testing and enforcement infrastructures are reported as barriers to a well functioning appliance labelling.
- Household possession of appliances varies significantly between countries of the region, particularly with regard to relatively new appliances such as dish washers and home-office equipment.
- Most countries have transposed the EU energy labelling directives, but the later directives have not been transposed without delays.
- Many countries have some experience with EU energy efficiency programmes, especially SAVE and Phare. Only a few countries have some (limited) experience with the EU policy making process.

Summary of the Ceecap project

The CEECAP – Implementing EU Appliance Policy in Central and Eastern Europe project was developed with the aim of supporting Central and Eastern European countries in creating suitable conditions for implementing appliance labelling and efficiency policies in accordance with EU Appliance efficiency Acquis and programmes.

With partners from the Czech Republic, Slovakia, Poland, Bulgaria, Romania, Lithuania, Austria, France and the Netherlands, the project has started in early 2006 and will last for 30 months. It is building upon the previous CEECAP, ELAR and other projects with the involvement of international organisations, such as the IEA, the European Commission, and the UNDP or European Energy Network's Labelling working group, as well as the Croatian Energy institute Hrvoje Požar.

CEECAP aims to increase expertise and experience regarding the verification and enforcement, market introduction aspects, strengthen relationships between stakeholders and the start up of national actions to improve energy efficiency of household appliances.

Main activities are the identification of the national experts and decision maker leaders, their training, design and preparation of national appliance labelling and efficiency actions, set-up of a national multi-disciplinary committees as a forum for discussion about best practices, cooperation opportunities and knowledge transfer.

The results will be an improved policy infrastructure for appliance labelling and efficiency and the future EU policies; a verification infrastructure for product and retailer compliance; collaborative activities to increase the consumer response to labels; and the establishment of a platform for information exchange and transfer.

A special focus of the project is devoted to the work on the newly labelled appliances and the new energy classes, which have been introduced lately or which may be adopted on the European Union level during the course of the project. It also enables an exchange of experience between the new and candidate EU countries, with the adoption and implementation of the label legislation.

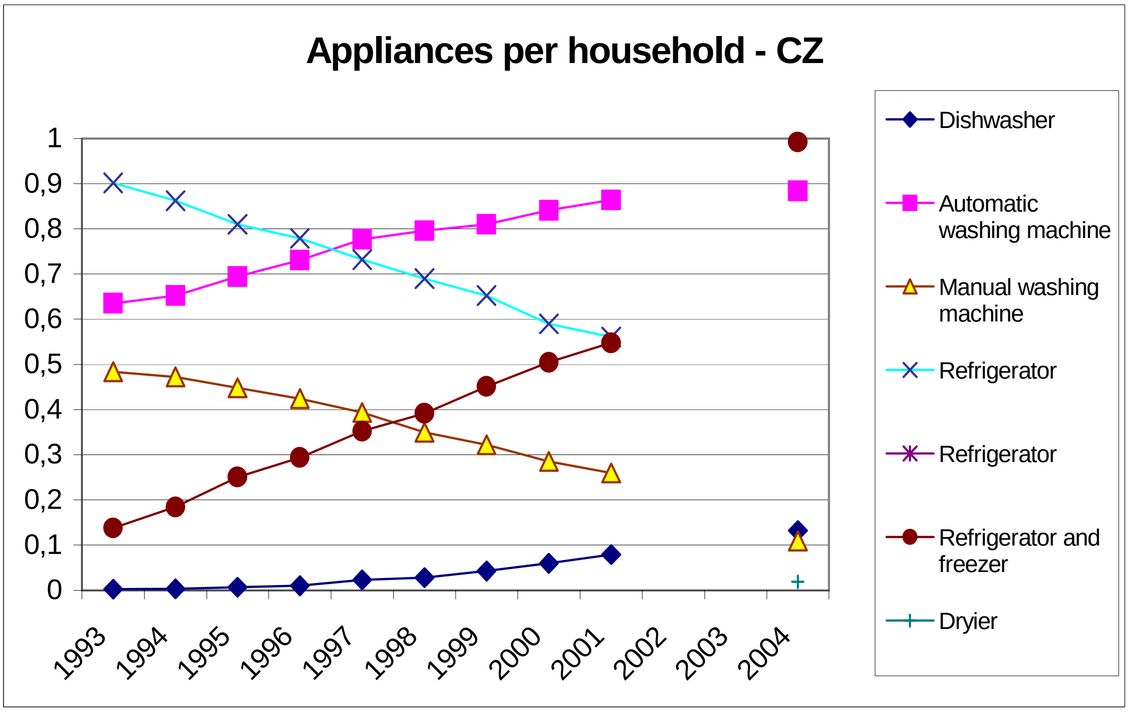
The expected outcome of this project is a significant increase in the energy efficiency of the appliances sold and, thus, energy and carbon emissions savings. The electricity savings, although difficult to estimate, may exceed 3 TWh cumulative due to this project and national implementation activities.

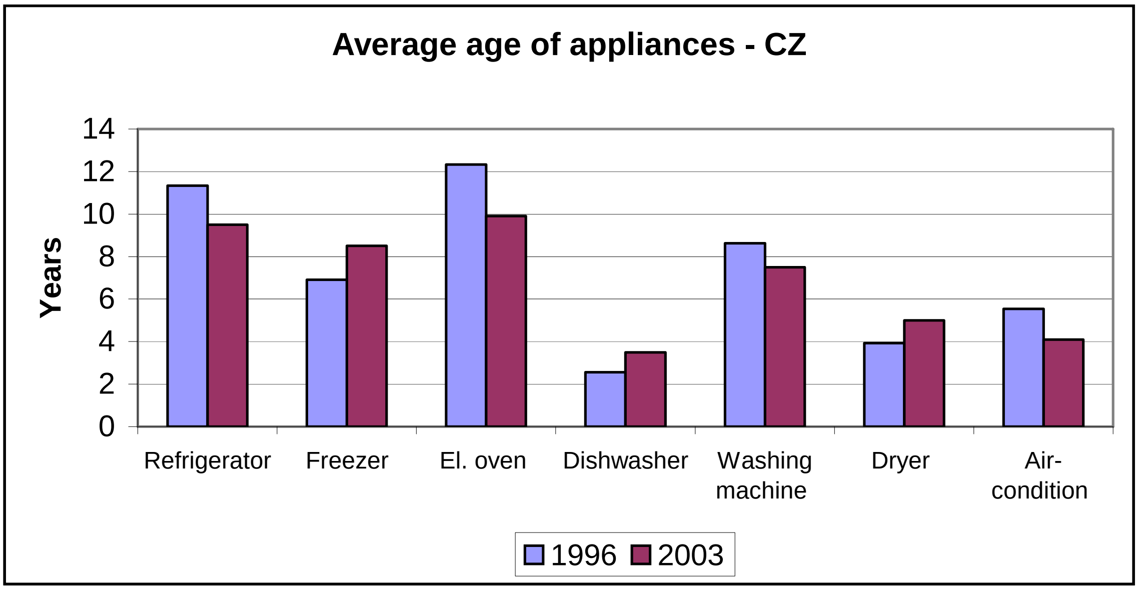
Presence of the household appliances by energy classes

As can be seen from the pictures below (data taken from the GfK's public presentation), there is a difference in the share of energy classes for all major household appliances in the EU 15 (old members) and the new EU member and the candidate countries. In addition, with the exception of freezers, this difference is relatively small and the share of A and A+ labeled appliances is constantly increasing.

Figures: Importance of energy classes in Central European countries

The graphs above show the actual (2004) situation in shops. However, this does not indicate the real situation in households in terms of the energy performance of appliances which are being used. There is a general lack of this type of information which should be improved by better statistics (also due to the increasing electricity consumption in households due to higher appliance penetration). The following charts show the degree of facilities in the Czech households with appliances. Since there is no official statistics available about the energy class of these appliances, the only indicative information available is the average age of these appliances. This is shown in the second graph below.





As can be seen, there is still a relevant gap between the energy efficiency of appliances sold in the region of the EU new member states and the EU candidate countries. It could be also argued that the positive trend of higher share of efficient appliances is due to the fact, that these are being mostly sold by appliance manufacturers (and to some degree chain retailers) whose headquarters or main representation is usually located in the EU 15 region. In addition, there are several other issues which need to be resolved in the region, such as:

- It is mostly only passive transformation of the EU legislation without increased motivation for its updating or comments from national implementation bodies;
- It takes a considerably long time for new appliance labels to be “visible” on the market, due to slow control and motivation procedures from the state;
- In several countries the responsibilities and control mechanisms are not defined clearly which lowers the market control mechanisms;
- There is no control of the information on labels between the competing manufacturers, as was the intention in western Europe when introducing the labels, since these are only regional markets, directed from the headquarters;

- The presence of energy labels on appliances on shops varies considerably and in some countries and in some shops it is still possible to find a very small amount of appliances marked with labels.
- State organizations often show very insufficient support to the promotion of energy labeling principle, which also lowers the profile of information delivered from other, non governmental institutions.

Due to these issues, the CEECAP project was designed to overcome these issues to a large extent and to achieve the following direct outcomes of the project:

1. Increased knowledge and experience of government, energy agency and/or state inspectorate professionals of verification & enforcement requirements and international (best) practices;
2. Increased knowledge and experience of government, energy agency and/or consumer agency professionals in market introduction principles and international (best) practices;
3. Well-functioning national and regional coordination of national government and energy agency experts with stakeholders (appliance manufacturers or importers, retailers and their organisations, consumer organisations, NGOs, and /or inspectorates);
4. Developed national verification & enforcement programmes, including international cooperation between governments / government agencies, allocating national responsibilities to these programmes;
5. Developed new national market information programmes, in collaboration with manufacturers, retailers and other stakeholders, including the allocation of responsibilities, government and private sector resources to the planned activities;
6. Ability to react quickly to new appliance regulations, focusing on new appliances or modifying the energy classes on national level and by all stakeholders, from the government adoption, through the manufacturer and retailer usage and to the consumer understanding.

Planned achievements of the CEECAP project

The CEECAP project was developed with the aim of supporting Central and Eastern European countries in creating suitable conditions for implementing appliance labelling and efficiency policies in accordance with EU Appliance efficiency Acquis and programmes.

It aims to increase expertise and experience regarding the verification and enforcement, market introduction aspects, strengthen relationships between stakeholders and the start up of national actions to improve energy efficiency. The CEECAP Guidelines, on policy design; verification & enforcement; and market introduction, developed during previous stages of the CEECAP project.

Main activities are the identification of the national experts and decision maker leaders, their training, design and preparation of national appliance labelling and efficiency actions, set-up of a national multi-disciplinary committee as a forum for discussion about best practices, cooperation opportunities and knowledge transfer.

The results will be an improved policy infrastructure for appliance labelling and efficiency and the future EU policies; a verification infrastructure for product and retailer compliance; collaborative activities to increase the consumer response to labels; and the establishment of a platform for information exchange and transfer.

The expected outcome of this project is a significant increase in the energy efficiency of the appliances sold and, thus, energy and carbon emissions savings. The electricity savings, although difficult to estimate, may exceed 3 TWh cumulative due to this project and national implementation activities.

CEECAP Guidelines:

Policy Design

Verification & Enforcement

Market Introduction

Updated Edition, 2004

Table: Participants of the CEECAP project:

Participant name:	Participant short name	Country
SEVEn, Stredisko pro efektivni vyuzivani energie, o.p.s.	SEVEn	Czech Republic
The Polish National Energy Conservation Agency,	KAPE	Poland
Romanian Agency for Energy Conservation	ARCE	Romania
Center for Energy Efficiency	EnEffect	Bulgaria
Lithuanian Energy Institute	LEI	Lithuania
Slovak Energy Agency	SEA	Slovakia
Agence de l'environment et de la maitrise de l'energie	ADEME	France
Austrian Energy Agency	A.E. A.	Austria
Klinckenberg Consultants	KC	The Netherlands

Overall, the expected direct outcome of the CEECAP project within the year 2008 is a significantly increased national capacity to design and implement European appliance efficiency and labelling policies and national policies to support and complement these; to verify and – if needed – enforce compliance with the EU-based regulations; and to effectively inform the market about labels, standards and other appliance energy efficiency issues, working in collaboration with market parties (importers, retailers and consumer organisations).

The long-term impact of the project is an acceleration of appliance energy efficiency improvements in new appliances, as a result of higher market shares for efficient products, leading to a more efficient appliance stock and energy and national carbon emission savings.

Target Groups and Key Actors

The target groups for this project are primarily all stakeholders involved in appliance energy labelling and efficiency aspects in the participating Central European countries. This includes both public and private sector stakeholders, and some international stakeholders.

In detail, the target groups (stakeholders) include:

- *Government departments* with primary responsibility for implementing European policies.
- *Energy agencies*, which are the executing bodies for appliance energy efficiency strategies, operating close to the markets and having direct contacts with most stakeholders.
- *State energy and trade inspectorates,* responsible for verifying a wide range of product compliance issues, including appliance energy efficiency issues.
- *Manufacturers & importers of appliances*: Their role in the project is to make sure they fill in their responsibilities related to distribution of labels with the appliances, promote the efficiency aspects of appliances, and help other stakeholders to undertake the promotion to final customers.
- *Retailer organisations*: The role of retailer organisations in the project is to make sure they apply the labelling legislation and promote the more energy efficiency appliances on stock.
- *Consumer organisations,* representing the interests of individuals. Their role is to assist with controlling the accuracy of labels (presence in shops and information accuracy) and promote the labelling and efficiency aspects to the final customers.
- *European & International organisations*: International organisations are important for information exchange between national professionals, international benchmarking and as a source of expertise and best practices. Organisations contributing directly to this project are: The International Energy Agency and United Nations Development Programme, and the European Energy Network's Labelling working group (including SenterNovem as the chair of the group).

The EU 15 country' participants and the supporting international organisations will bring their local and own experience in promoting energy labelling and ensuring its accuracy on the level of their working field.

CEECAP Work Programme

The CEECAP methodology is dominated by training and information exchange in the early stages, followed by the building of stakeholder coalitions and the development of national action plans, and finally by putting the plans into action.
The work plan of the project is divided into work packages, which relate to one or more of the short-term goals of the project, and together these make sure that the project's objectives are realised.

The work packages are:

1. *Verification & Enforcement Capacity Building*: this work package includes the training, and information exchange activities for state officials related to the legislation, verification & enforcement aspects of appliance labelling and energy efficiency policy. This work package directly relates to the understanding of the relevant EU Acquis and the national transposition and implementation process and the knowledge of the relevant EU and individual EU member states policies (negotiated agreements, action plans, programs).
2. *Market Introduction Capacity Building*: this work package includes the training, and information exchange activities for retailers and manufacturers related to the market introduction and consumer & retailer education aspects of appliance labelling and energy efficiency policy.
3. *Stakeholder Collaborations Capacity Building:* this work package focuses on the project participants and includes policy compliance verification and best practice information, as well as training-on-the-job for setting up action-oriented stakeholder consultation platforms, for verification & enforcement actions and for market introduction actions.
4. *National Verification & Enforcement Plans & Actions*: which include the development and implementation of national verification & enforcement action plans for state officials, and the start of the planned actions in the countries. It includes the organisation of activities to enforce energy labelling in practice on national level.
5. *National Market Introduction Plans & Actions:* this work package includes the development of national market introduction action plans for retailers and manufacturers and the start of the planned actions in the countries.
6. *Dissemination of CEECAP Results* deals with the promotion of project results and the involvement of other partners in active support of energy labelling towards the customers. This work package focuses on maximising the impact of the European policies for appliance energy efficiency in both the countries involved in this project, and in other European countries, mainly the new EU member states, EU candidate countries, and other countries in the region of central and eastern Europe.

Main expected project achievements

Below you can find a list of selected main overall achievements, which are planned to be reached during the course of the project:

Performance indicator	Quantification
Energy efficiency achieved	The estimate is 300 GWh of electricity per year in all participating countries combined.
Assessing national priorities	Evaluation of the need to adopt current EC legislation and to comply with the new legislation; to verify the label information and to promote appliance efficiency labelling towards the final consumers.
Initialisation of stakeholder discussions	Level of discussion among the state institutions, manufacturers and retailers and their active labelling promotion. Measured e.g. also by the number of the national promotion materials produced.
Initiating action by national partners	Number of active local partners (among state institutions – at least two, manufacturers – at least three, and retailers – at least four in each country).
Implementation of national plans	Full compliance with the actual European labelling legislation. One of the key foreseen successes of the project, leading to the above mentioned electricity conservation and better consumer protection.
Two training programmes	350 pieces and a web publication of a training manual serving as a source of knowledge for project partners
Two national seminars	At least 30 participants combined in each state, for high level decision makers among state officials and appliance retailers and manufacturers, or the alternative of individual consultations.
Presentation on international and national conferences	At least one presentation on seminar of a non-partner organiser in each participating country among the NMS and the CCs and one international event to widen the audience and promote CEECAP results
Final project dissemination	2500 pieces of final brochure distributed in the year 2008 also to third countries to enable them to share experience

Examples of previous achievements

The importance of the project lies in the fact that the described activities have a strong potential to motivate local actors to start using energy labels fully and to understand them as a positive motivation for attracting consumer attention and for an improved company or institution's image.

A concrete example of such activity, which has already taken place, was the *ELAR* project (Energy Labelling of Large Household Appliance), which took place in the Czech Republic, Slovakia, Poland and Slovenia, with the financial contribution from the European Commission under the SAVE programme framework. The ELAR project's activities in the Czech Republic were selected as a Good Practice Case Study of the EC's Managenergy initiative.

The ELAR project focused on promoting energy labels to appliance producers and retailers as a marketing tool for their sales policy, as well as an information policy for the customers. Project activities took place in the Czech Republic with the main partners being the appliance producers, retailers, energy utilities, and consumer non-profit organisations. It was then possible to increase stakeholders awareness of the labels importance and involve them in their own energy efficiency/labelling activities. Promoting energy labels as a positive marketing tool (not only a strict legal requirement) proved to make this project a success story in the Czech Republic.

- Kupujete nový elektrospotřebič?
- Víte, kolik budete platit za energii?
- Musí se lepší vybavení domácností elektrospotřebiči odrazit na rostoucím účtu za energii?
- Proč zbytečně utrácet za energii, když leckteré nové spotřebiče mají skutečně nízké provozní náklady?
- Dá se už v prodejně poznat, kolik bude stát provoz vybraného spotřebiče?

Když jeden spotřebič potřebuje více energie než druhý, je to na něm vidět!

Slouží k tomu energetické štítky.

Seznam výrobků, pro které je označování energetickým štítkem povinné:

- automatické pračky
- bubnové sušičky prádla
- pračky kombinované se sušičkou
- chladničky, mrazničky a jejich kombinace
- myčky nádobí
- elektrické trouby
- elektrické ohřívače vody
- zdroje světla

In numbers, it can be stated that over 1.5 million of general public members were reached with the project outcomes. This was reached with tens of articles (including ones in the largest Czech newspaper), 180 thousand project leaflets distributed mainly by appliance manufacturers, mainly Bosch-Siemens, 150 thousand leaflets prepared together with the Philips corporation, 30 thousand consumer magazine special issue on labelling prepared with the Prague energy utility, and others. During seminars, conducted mostly in cooperation with Whirlpool, over 370 shop assistants were reached.

One of the proofs of success of the project are independent activities organised by other organisations (some ELAR partners, some not), which represent a follow up to ELAR promotion activities. This for example represents a special leaflet produced by the Prague Energy Utility and distributed to all households in Prague (800 000, including small business customers) which informed about energy labels and energy efficiency aspects of dryers; or a range of promotion activities of various producers aimed at the promotion of the new A+ and A++ energy classes. In addition, Whirlpool and other manufacturers continue using information on energy labels, based on ELAR, in their promotion events and seminars for retailers.

Based on the random control of concrete appliance shops, it can be even stated that the general level of energy labelling presence has increased in there in comparison to the period before the project in the Czech Republic.

Further information about the project:

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[2] Managenergy Case Study: "*ELAR - Energy Labelling of Household Appliances*", Czech Republic, SEVEn, o.p.s., Prague: http://www.managenergy.net/products/R671.htm

[3] Achievements of the previous stages of the CEECAP projects: http://www.ceecap.org/cntnt/ceecap/library

[4] Czech Statistical Office: *"Energy Consumption in Households of the Czech Republic in 2003"*, Prague, Energo, 2004

Legal disclaimer:

The CEECAP project was supported by the European Commission. The sole responsibility for the content of this paper lies with the authors. It does not represent the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

Regional GEF/UNDP Project "Program of Capacity-Building for the Removal of Barriers to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling in EU Candidate Countries, EUCC S&L"

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Abstract

The Program for Capacity-Building for the Removal of Barriers to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling in EU Candidate Countries, EUCC S&L has started work on the development of S&L implementation strategies in Bulgaria, Croatia, Romania and Turkey. This GEF-funded program is currently in the so-called PDF-B phase, and will be proposed for full-project around summer 2006.

The objective is to transform the manufacture and sale of energy consuming products to energy efficiency levels roughly 20% higher than baseline in EU candidate member countries by, 2011. As the countries enter the EU they must transpose the EU Framework Directive and related implementing directives governing energy efficient standards and labelling (EE S&L) for household appliances. This project will help each country to meet these requirements sooner than required by the EU (Croatia and Turkey), and go beyond minimum requirements of Accession (Romania and Bulgaria). The Full-Scale project will focus solely on regional appliances, equipment, and lighting product markets, and it is projected to avoid 1412 kt of CO_2 being released into the atmosphere by 2032.

The main outputs of the project are:

a) To support to finalisition of the national policy and regulatory environment, develop, refine or finalise national labelling program elements, including setting national goals, assigning institutional roles to implement these programs;

b) To improve the national/local capacities needed by providing direct technical assistance to national policy-makers and legislator, national enforcement and verification agencies and institutions, and national manufacturers and the supply chains;

c) Information and awareness-raising to foster verifiable changes in consumer behaviour patterns towards adoption of more energy efficient practices and purchases when selecting major appliances; create higher awareness of international developments, benefits of transposition, and the trade advantages and

d) Implement market-based strategies to support implementation of labelling directives. This could involve the implementation of financial rebate schemes, consumer financing, and other non-GEF financed financial incentives to bring down first costs for consumers and encourage the supply of efficient appliances.

During the implementation process, the project will also build information and awareness, policy support to remove regulatory barriers to EE S&L, investment and financial support, and institutional strengthening in the involved countries.

Introducing EU Standards and Labels in Candidate Countries

The Republic of Bulgaria, Croatia, Romania and Turkey plan to accede to the European Union (EU) in the coming years. Before they do so, each must transpose the EU Framework Directives governing energy efficient standards and labelling (EE S&L) for household appliances.

Bulgaria, Croatia, Romania and Turkey are already transposing EU legislation for S&L as part of their EU accession strategies. This process is the responsibility of the candidate country, but EU-initiated support or coordination for the process is limited to the basic legislative requirements. Evidence from the new central European EU member states (and from the Western European member states) clearly indicates that this is **not sufficient** to achieve significant energy efficiency improvements.

Since the EU does not support transposition and implementation of the Directives[1], efforts to support national endeavours in transposition and compliance have emerged. The IEA and Holland's Novem financed a project for three new member and three candidate countries (supported by two EU15 states) aimed to support the countries in creating suitable conditions for adopting and implementing EU appliance policy. [1]

The current project, initiated by the United Nations Development Program (UNDP) for the Global Environmental Facility (GEF) allows the Republic of Bulgaria, Romania, Croatia and Turkey (two of which participated in the CEECAP project) to have the required support by which to undertake energy efficiency standards and labelling. This project can be considered an extension of the lessons learned in the CEECAP initiative, taking those lessons into non-member countries.

The EU15 experience was that it took a decade after transposition before these countries were able to implement the Directives and the new labels began to have an effect on consumer choices. The rational of this project is to support those governments making serious, concerted efforts to implement the Directives. In short, this project will act as a catalytic force--identifying best practices, building institutions and capacity, designing strategies, and monitoring the impacts—as each country makes the effort to implement the Directives. In doing so, this project will advance market transformation by at least a decade.

Imminent accession to the EU and the subsequent integration into the European market implies that the national markets can benefit from the technical improvements that have been made in Europe in recent years, and only have to stimulate these market developments. Targeted action in Bulgaria, Croatia, Romania and Turkey brings the potential to speed up the market development of energy efficient appliances, most likely by decades. This will also bring forward the energy savings and yearly carbon emission reductions that would otherwise be achieved many years later.

Implementation of the EU standards and labelling Directives in Bulgaria, Croatia, Romania and Turkey would result in a 20% improvement in energy efficiency of refrigerators by the year 2010, estimated to be 3 years after beginning a Full-Scale project and just three years after planned EU accession (in 2007, for Bulgaria and Romania). This means that instead of a decade of lag-time, the result of a typical 1% per year improvement in energy efficiency without active government involvement, the countries would catch up in a third of the time historically achieved by other new member countries. Without this project, the same improvement in efficiency could take up to 20 years.

Under this GEF-supported project, EE S&L programs in these countries will be implemented at a much faster rate than they otherwise would develop. They will also be more harmonized with EU policy, thereby increasing the economic efficiency of these new markets and stimulating faster regional economic growth. The most inefficient products would be gradually removed from the market in a way that is sensible to national conditions, providing an increase in the average efficiency of new products sold.

Manufacturers will be able to introduce new efficient technologies at a faster rate in an effort to distinguish themselves in a marketplace with increased emphasis on efficiency. Overall, the result would be a measurable and verifiable increase in the rate at which the average energy efficiency of all energy consuming products used in our society grows, with substantial economic benefits at the national level. This, in turn, would reduce the overall use of fossil fuel and reduce GHG emissions accordingly

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[1] In fact, EU appliance energy efficiency policy has a history of only 25 years, originating from original EU trade harmonisation objectives. The EU involvement with appliance energy efficiency stemmed from member state initiatives to introduce voluntary appliance labelling in the mid-1970s. At that point, a harmonised approach was considered preferable to minimise barriers to trade while maximising the impact of the policy. This procedure was repeated in the late 1980s, when some EU member states wished to let this policy evolve into mandatory appliance labelling. This led to a mandatory EU policy, set out in the 1992 Energy Labelling Framework Directive (92/75/EEC).

The Status Quo in Appliance Energy Efficiency

The specific situation in Bulgaria, Croatia, Romania and Turkey (being EU candidate countries) may best be seen in a table since the appliance energy efficiency policies they are adopting are essentially EU policies, with some elements developed at the European level, and some elements nationally. Table 1 provides an overview of the seven CLASP Guidebook's [2] recommended steps in the S&L implementation process, the division of responsibilities between the EU and the national governments, and the status quo in the four candidate countries in the project.

Table 1: Steps in Energy Efficiency Standards and Labeling Overview in Selected Countries

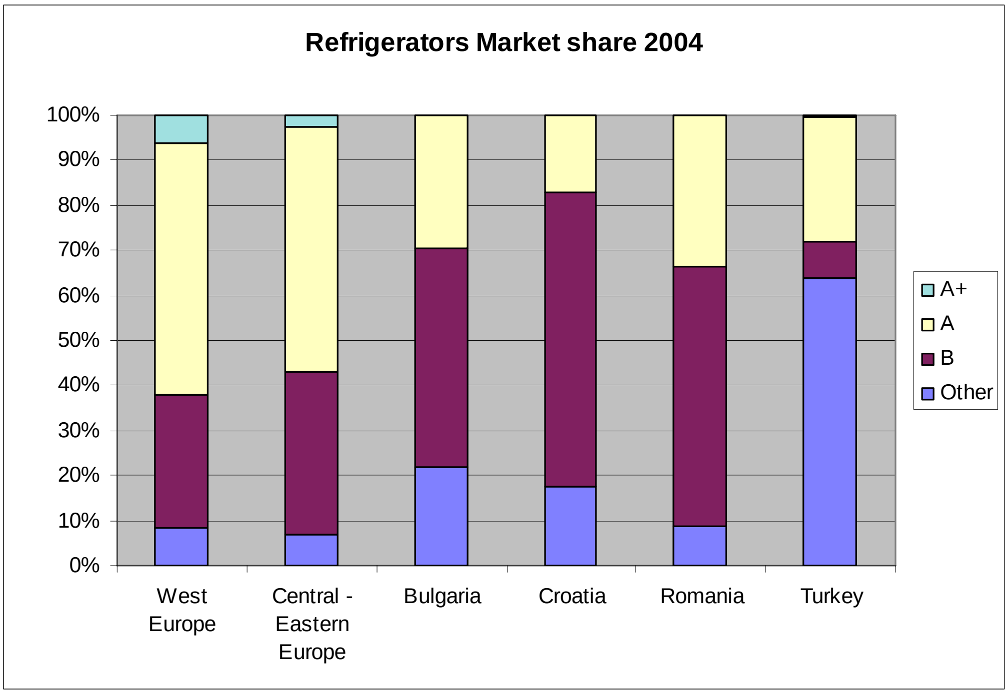
Step	EU Responsibility	National Responsibility	Status Quo
1.Deciding appropriate products, priorities, timing	The EU decided on labelling and standards for appliances, via an established procedure. National actions are in principal not allowed.	Participation in EU decision-making process.	Candidate countries do not participate in the formal decision-making. **Participation in the preparation of legislation needs to be developed.**
2.Developing a testing capability	Setting standards and deciding on test requirements.	Developing a national test capacity is a great advantage for verification and enforcement. However, there's no formal responsibility. (Governments need to be able to perform verification tests, but this can take place in another country)	Some laboratories exist, that could perform verification tests. **Organizational procedures need to be established, and laboratories need to get acquainted to EU practices / codes of conduct for testing.**
3. Designing and implementing a labelling programme	Designing and deciding on the basics of the labelling (label design, categories etc.).	Designing a national implementation programme, to introduce the label in the marketplace, secure retail sector and consumer support.	Labels have been introduced (formally), via the transposition of the EU regulations. **Market introduction is emerging, but needs much more attention, especially in involving market parties in the programme.**
4. Analyzing and setting standards	The EU decided on labelling and standards for appliances, via an established procedure. National actions are in principal not allowed.	Participation in EU decision-making process.	Candidate countries do not participate in the formal decision making. **Participation in the preparation of legislation needs to be developed.**
5. Involving all stakeholders	Involving major stakeholders (principally: manufacturers and consumer organizations) in the policy design and decision process.	Involving all stakeholders (manufacturers, the retail sector, NGOs, consumer organizations) in national label (and/or standards) implementation and endorsement programs.	Stakeholder involvement is relatively low. Large market parties (international manufacturers, large retailers) are interested in involvement. **This needs to be accommodated and coordinated with government initiatives. Smaller stakeholders need encouragement and accommodation to get involved.**

Step	EU Responsibility	National Responsibility	Status Quo
6.Maintaining and enforcing compliance	Designing verification and enforcement (V&E) rules, as part of S&L regulations, and European test standards.	Establishing legal and organizational responsibilities and mandates for V&E; organizing and initiating a V&E program; securing retailer and manufacturer compliance to labels and standards.	Minimal action. Establishing legal and organizational responsibilities has started. **V&E programs need to be developed and initiated.**
7.Evaluating the programme	Evaluating the impact of European S&L and European market developments; updating the program when necessary.	Evaluating the impact of a national implementation strategies, and market developments.	None.

Source: GEF Project executive summary, PDF Request for Pipeline Entry and PDF B Block Approval [3]

The average efficiency of products currently sold in these countries is significantly below that of the best products on the market, and significantly below that of the European Union, largely because of marketers' strong emphasis on first cost at the expense of on-going utility bills, but also because of other barriers to energy efficiency in today's marketplace.

The unit energy consumption levels in Western Europe for these products are generally about 20% less than in Bulgaria, Romania, and Croatia. In the case of refrigerator-freezers, all units in the Northern European countries where labelling programs have been particularly successful (Belgium, Germany, Netherlands and Sweden) are rated B or better, and about 10% of the units are rated A+. **Figure 1** shows the ratings distribution for Bulgaria, Croatia and Romania, along with population-weighted shares for the Northern European countries. As a result of this difference in distribution, the average unit energy consumption for these products is between **10% and 27% lower than the CEE countries**.



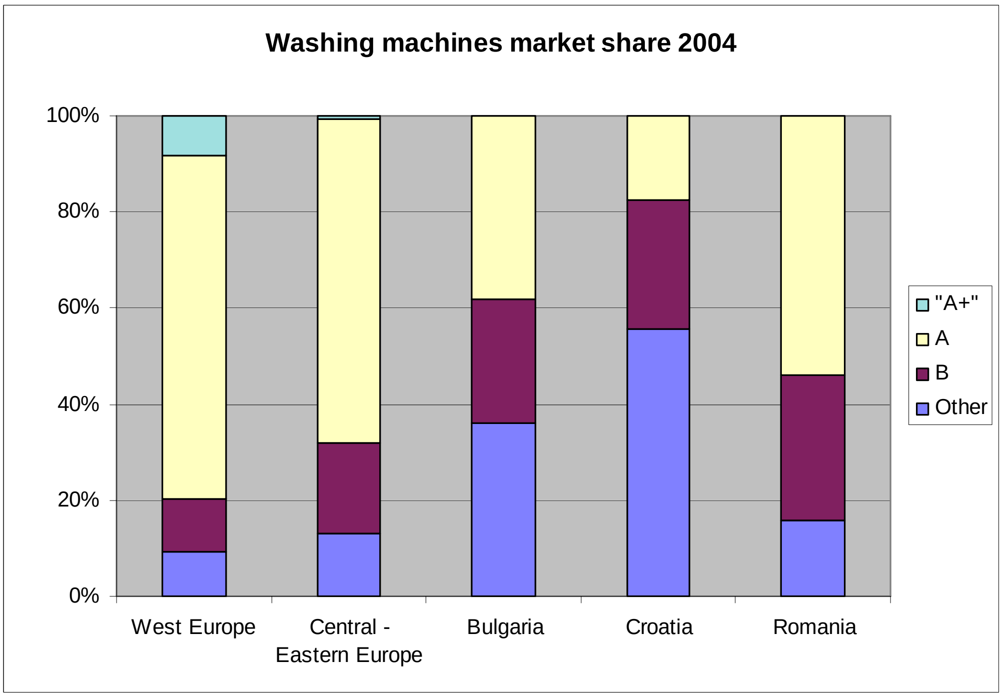


Figure 1: Comparison of Refrigerator/Freezer and Washing Machines Efficiency Market Share

Source: Matilde SOREGAROLI , GfK, Italy - "Overview of sales and trends for main appliances in year 2004" [4]

Per country, the situation can be described as follows:

Republic of Bulgaria

Status of Transposition: The formal process of transposition is completed. In 2004, Bulgaria transposed the Framework directive and all implementing directives in one ordinance. Ministry of economy and energy is the institution responsible for transposition of EU requirements on energy efficiency standards and labels. At this stage Bulgarian government does not consider any financial instruments for the endorsement of products complying with standards or label classes.

Policy Status: Notwithstanding the important progress made, there is still the general problem of the low profile of energy efficiency within the energy policy of the country, although important progress has been made in implementing the Energy Efficiency Law (Nov 2003) and Energy Efficiency Act (Mar 2004).

Enforcement and Verification: Key technical elements (such as technical standards, test procedures, and energy efficiency labels) have been recently adopted for a range of appliances. Verification and enforcement procedures need to be developed and implemented.

Romania

Status of Transposition: The formal process of transposition is completed. In 2001, Romania began the process of transposition by implementing the regulatory frameworks for refrigerators/freezers, dishwashers, washing machines and dryers, ovens, lighting, and air conditioning. The practical process to effectuate the legislation still needs considerable attention.

Romania has transposed all the EU Directives with regard to energy labelling of household appliances during the period 2001- 2003.

Policy Status: With the financial support of Ministry of Economy and Trade, all the EU standards were adopted (e.g., minimum energy performance standards for industrial products). Those standards are in force at present, adopted as Romanian standards, by ASRO (the Romanian Association for Standardization). Between 1996 and 2000, a PHARE project supported the energy efficiency labelling program by setting up one laboratory for energy labelling of refrigerators.

Enforcement and Verification: There is great national interest in developing an EE S&L programme in Romania. In 2003, the Romanian Agency for Energy Conservation has got a strengthened mandate as the specialized national body for energy efficiency in the country. There is a need to provide technical support to the factions promoting an EE S&L programme and to bring this together under one comprehensive program. Romania has three key components that will support this effort: a public relations and communications committee (see www.arceonline.ro), a national network of energy and energy efficiency professionals (such as APER) and cleaner energy consultancy companies (such as Enero).

Croatia

Status of Transposition: The process of transposition has been completed in November 2005 with adoption of Ordinance on Energy Efficiency Labelling of Household Appliances. The Ordiance covers all EU implementing directives for labelling. Croatia is adopting the EN standards on which these labels are based.

Policy Status: While Croatia has an Energy Law (Jul 2001), there is a need for better legislative frameworks around the Directive for Energy Labelling, End-Use Efficiency, and Energy Performances in Buildings. The "Regulative Act on Labelling of the Energy Efficiency" (adopted in 2003) prescribes energy efficiency labels, nearly matching the EU label in all details. Only EU-specific items (in the lower part of the labels) are omitted.

Enforcement and Verification: The new legislation provides a legal basis for mandatory labelling of appliances. However, as long as common test standards are not available, verification and enforcement (V&E) lacks a sufficient legal basis. V&E procedures need to be established, for both product compliance testing and retailer compliance monitoring.

Turkey

Status of Transposition: The Law on the Preparation and Implementation of the Technical Regulations on Products is the legal basis for alignment with the EU framework directive entered into force on 11 January 2002 and a number of regulations are adopted covering all EU implementing directives.

Policy Status A draft Energy Efficiency Law is under preparation and it is expected to put into effect during the year 2006. Under the Energy Efficiency Law minimum efficiency standards will be developed for electrical motors, the household appliances, air conditioners, and lamps

Enforcement and Verification: Ministry of Trade and Industry will launch market inspection activities in 2006 in accordance with the procedures and principles of the Law. Test institutions and facilities need to be further developed and capacity building activities are needed in order to carry out verification and enforcement procedures.

Developing a Program to Build National Capacities and Remove Barriers

The project is currently in the Project Development Stage (PDF-B), intended to analyze in great detail the in-country situation, including a policy, legal & institutional assessment; a market assessment; a stakeholder assessment; and a verification & enforcement capacities assessment.

This project development is conducted by four national teams, each consisting of a national project manager, a policy, legal and institutional expert, a market assessment expert, a stakeholder assessment expert, and verification & enforcement capacities expert. These teams are supported by a team of international consultants, with matching capacities and a broad experience in project development.

Table 2: Organizations involved in the project

Participant name, short name	**Participant role**	**Country**
Center for Energy Efficiency, EnEffect	Implementing and execution agency for national component Regional execution agency	Bulgaria
Romanian Agency for Energy Conservation of the Ministry of Economy and Trade, ARCE	National execution agency	Romania
National institute for Energy Equipment Modernization, ICEMENERG	National Implementing Agency	Romania
Croatian Ministry of Economy, Labor and Entrepreneurship, MELE	National execution agency	Croatia
Energy Institute Hrvoje Pozar	National Implementing Agency	Croatia
General Directorate of Electrical Power resources, EIE	National execution agency	Turkey
CLASP/Econoler consortium	International consultant	International

At the end of the current stage, a proposal for a full-scale follow-up project will be presented to UNDP and the GEF for funding, and national governments and other stakeholders will be invited to participate in that follow-up. As a part of that work, a Logical Framework Analysis (LFA) process will be initiated along with stakeholder feedback and workshops.

The components of the current project, and the results to be achieved, are:

Output 1. Support to finalize the national policy and regulatory environment, develop, refine or finalize national labelling program elements, including setting national goals, assigning institutional roles to implement these programs.

Output 2. Improve the national/local capacities needed to make the standards and labels (defined at the EU level work) by providing direct technical assistance in participating countries. This could include; national policy-makers and legislator, national enforcement and verification agencies and institutions, and national manufacturers and the supply chains.

Output 3. Information and awareness raising to foster verifiable changes in consumer behavior patterns towards adoption of more energy efficient practices and purchases when selecting major appliances; create higher awareness of international developments, benefits of transposition, and the trade advantages. The assumption is that production capacity, access to financing, and stakeholder partnerships will become mature enough to support labelling programs.

Output 4. Implement market-based strategies to support implementation of labelling directives. This could involve the implementation of financial rebate schemes, consumer financing, and other non-GEF financed financial incentives bring down first costs for consumers and encourage the supply of efficient appliances.

Output 5. Monitor and evaluate the market transformation impact of project. This will involve market research, consumer surveys, and other primary data collection.

Output 6. Design as appropriate a nationally driven GEF follow-up phase to transfer national expertise and experience from this project to emerging south-eastern European EU candidate countries.

The PDF-B phase project is designed to facilitate exchanges among governments, energy agencies, industry, inter-governmental organisations, and technical support groups based on the concept of linking assistance providers and assistance recipients in partnerships with a shared responsibility to draw upon and emulate international best practice. National and regional networking and information exchange through workshops is key to sharing project design.

Experience shows that standard-setting and labelling is most effective when the process involves all stakeholders from the onset and when all analyses, interactions and decisions are open to full scrutiny by all parties. In this project, work on standards and labelling development and implementation as well as design and discussions on future project components is done with active involvement and consultation of government, industry (including importers and manufacturers), retailers, NGOs and consumer groups.

The direct outputs of the Full-Scale project will be designed to lead to the implementation of energy efficiency standards and labels in the partner countries more rapidly than would otherwise occur. In the process, the project will also build information and awareness, policy support to remove regulatory barriers to EE S&L, investment and financial support, and institutional strengthening. Experiences in other countries that have undergone similar processes have found related outcomes such as:

1. Lower energy-related emissions of greenhouse gasses and other pollutants:
2. Lower overall energy intensity (energy consumed per unit of GNP) in the partner countries;
3. Increased production and distribution of energy-efficient products by manufacturers, and
4. Lower utility bills for households, businesses, and government agencies in the partner countries.

The current Project Development phase has started in October 2005, and will be concluded in August 2006. Milestones are the completion of a national data collection process, planned for April 2006, and the development of a strategy and activity planning for the full-scale project, in June 2006.

Going Beyond the Requirements of EU Accession

All four countries participating in the project are EU Accession Countries, well underway of adopting the Acquis Communautaire (the European Union legal framework and all its rules and regulations). As part of this, the European directives related to product energy efficiency are being adopted and implemented.

The experience in EU Member States is that just adopting the EU directives, without much national effort to put these into practice, does little to stimulate demand for and sales of more energy efficient appliances. It is therefore that in this project, the countries are aiming to move beyond the minimal required adopting of EU regulations, and develop and implement national programs and activities. These are based on the EU energy labels, and aim to create a more effective response to those by governments, manufacturers and importers, retailers and end-users of appliances.

The impact that a pro-active policy, as opposed to implementing the EU regulations without much national follow-up, can have was demonstrated by the case of the United Kingdom. This country, long considered to be in the lower tier of Member States on appliance energy efficiency in Europe, has shown a dramatic improvement in the average energy efficiency of refrigerators, following the introduction of national programs to support this. Following the introduction of the EU energy label for refrigerators & freezers, in 1995, the UK was among the first countries to legally adopt this, but was not very active in the promotion of appliance energy efficiency. The resulting improvement in the average efficiency of the products was around 1% per year.

In 1999, the EU minimum energy efficiency requirements for refrigerators & freezers was adopted according to schedule, which resulted in significant improvement of the average efficiency of products on the UK market (approx. 9% in a single year). From 2000 onwards, there has been no introduction of new EU policy. The improvement in the energy efficiency of refrigerators & freezers between 2000 and 2004, however, averages 6% per year in this period. This change coincides with the introduction of various national programmes in the UK, notably the Market Transformation Programme, the involvement of the Energy Savings Trust in appliance energy efficiency, and the introduction of Energy Efficiency Commitments for utilities. Although this correlation is no proof of the difference that good national programs can make, the authors definitely consider it to be a strong indication of the major impact that national programs have in making standards and labels work.

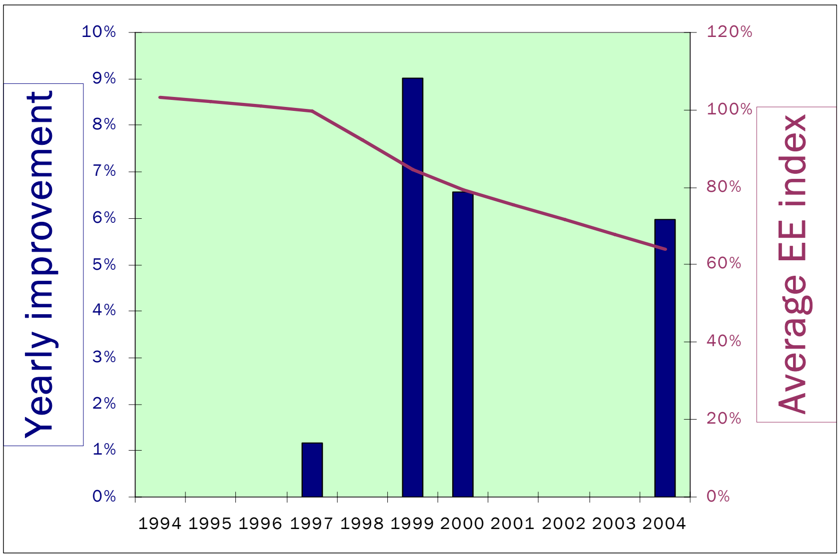


Figure 2: Development of Refrigerator & Freezer Energy Efficiency in the United Kingdom

Source: Compilation of Pernille Schiellerup, Environmental Change Institute, Oxford, United Kingdom – "An examination of the effectiveness of the EU minimum standard on cold appliances: the British case" [5] and Matilde SOREGAROLI , GfK, Italy - "Electricity End-Use Efficiency in New Member States and candidate countries" [6][2]

The Next step: Market Transformation for Energy Efficient Appliances

The overarching objective of the project is to transform the market of appliances, and primarily domestic appliances, to (the sale and purchase of) more energy efficient products. This will be achieved in the next phase, by in-country activities executed by in-country experts. In order to prepare for this, the current project analyzes the status quo, develops a strategy and activities for the market transformation, and builds capacities with national experts.

It is too early to describe the implementation strategy that will be implemented in the full project. A recent inventory, however, does give some indications of potential components of the market transformation strategies. A summary overview of those components is listed in table 3.

Table 3: Potential components for national market transformation programs

Potential project activity	**Possible Content and delivery mechanism**
Minimum energy performance standards (MEPS)	
Extension of EU voluntary agreements	Assessment of the possibility for extension the existing agreements in EU to also cover the 4 countries.
Introduction of MEPS	Adopt MEPS (selection of appliances to be covered is done) for at the same level as EU voluntary agreement requirements.
Enforcement	
Retailers verification program	Development and adoption of detailed procedure for checking retailers compliance
Importer verification	Development and adoption of detailed procedure for checking importers compliance
Manufacturer verification program	Development and adoption of detailed procedure for checking manufacturers compliance
Testing to verify conformity	Development of procedure and setting requirements for appliance testing

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[2] The average EE index was calculated as the sales weighted average of the higher energy index thresholds of the various energy classes; the yearly improvement as the year-on-year difference in the average EE index.

Potential project activity	**Possible Content and delivery mechanism**
Awareness raising	
Awareness for customers	Communication tools including brochures, web site, media activities, national campaign, information centers and show rooms, etc. targeted to raising consumer awareness on energy efficient appliance.
Awareness for large buyers	Dissemination of information about energy efficiency appliances. Club of buyers with regular meeting, seminars, newsletter.
Awareness for retailers, manufacturers and importers	Communication tools targeted to retailers, manufactures, importers web site section, newsletter, and information on project progress.
NGO awareness	Awareness for consumer NGOs.
Institutions awareness	Public relation activities support for development of national/regional/local information centers.
Capacity building	
Capacity building for Project management unit (in 4 countries)	General training on S&L project components, awareness raising tools and how to implement them, study tour.
Retailers	Training of retailers management, including support for product range selection Training for salespersons (including training of trainers)
Utilities	Plan and design a DSM support program, and how to assess impacts.
Consumer awareness training	Training of institutions, NGOs, information center staff on how to provide information to consumers (training of trainers)
Government institutions training	Custom, verification enforcement officers, energy agency Test institute in implementation of existing verification and enforcement procedures Inspector training
Banks	Implementation of financial support (small loans) programs
Market based strategies	
Grants, subsidies or rebates to reduce the price of equipments	Development and implementation of support mechanism that can reduce the price of equipment for consumers.
Financial support for manufacturers	Facilitating the retooling needed for the production of higher efficiency equipment. Either by soft loan or subsidy.
Financial support to set-up and implement test labs	Provide financial support to set-up test labs and implement testing
Utility introduced DSM program	Financial support mechanism through utility.
Regional support	
Regional database?	Database of appliances tested and result of the test.
Regional information network	Web site for networking Regional contact list. Coordination for collection and dissemination of information.
Exchange of information network	Activity to maintain contact with international stakeholders.
Replication strategy	Workshops Web site dissemination and outreach. Assistance to start the project. (e.g., PDF-B proposal for West Balkans)

The reader should consider that the presented information stems from work in progress, and may change rapidly. New information is forthcoming in every activity of this project, and the project implementation is regularly reoriented in response to this. The information in this paper reflects the progress made up to February 2006. The project, however, continues and the reader is encouraged to inform him/herself about recent developments.

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Endorsement Labeling in Developing and Transition Countries: Results and Prospects

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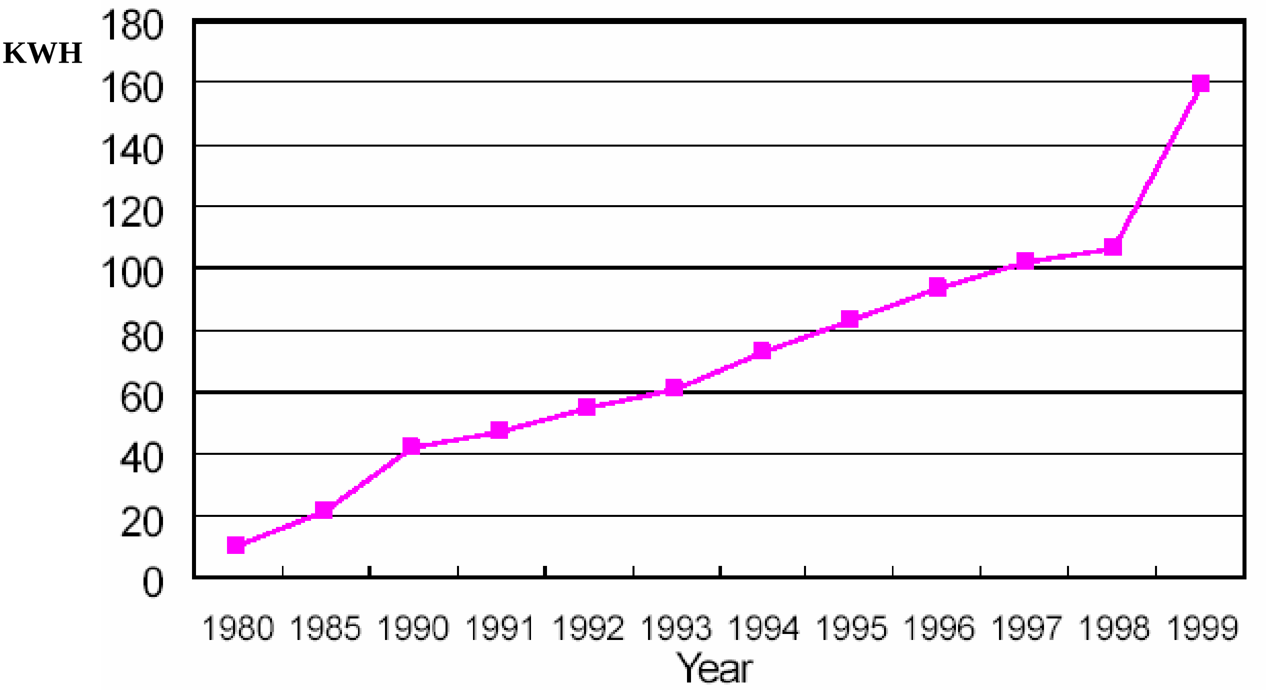
Abstract

Voluntary endorsement labels, such as the ENERGY STAR label, have become prominent and effective tools for promoting energy efficiency and clean technology in many developed countries over the past decade. The effectiveness of such tools in developing countries and countries in transition is less well understood. It could be argued that these “market oriented” voluntary tools might be less effective in emerging markets, where large distortions may exist. Despite these concerns, voluntary labeling programs have been attempted in emerging market countries and have had some success. These include the Efficient Lighting Initiative (ELI) supported by the Global Environment Facility (GEF) and the International Finance Corporation (IFC), and voluntary labeling programs in China, and Thailand. There is beginning to be empirical evidence on the effectiveness of voluntary labeling programs in developing and transition countries.

This paper reviews the concepts underlying voluntary endorsement labeling and results from some existing programs to assess the roles similar programs might play in developing and transition countries, particularly those that are in the early stages of standards and labeling programs. The findings suggest that voluntary endorsement labeling can be effective if properly designed and combined with appropriate incentive programs. Voluntary programs may offer a quicker start up and a less confrontational approach in initial introduction of standards and labeling programs. They can begin to show some results within a short time, and allow stakeholders to become familiar with the operational aspects of energy efficiency testing, specifications and labeling. They can also serve as a foundation upon which mandatory programs can be added later. Attention to promotional and incentive programs, as well as monitoring and evaluation can be key determinants of success.

Introduction

Saving energy has become a high priority of national governments and international programs for many reasons including economic growth, costs of electricity capacity expansion and shortages, cost of fossil fuel imports and energy security. The environmental impacts of electricity generation are well known, and make a compelling case for energy efficiency, globally and locally, but most urgently, in developing and transition countries. Ownership of appliances, office equipment, computers, consumer electronics, and other energy consuming products is increasing rapidly in these countries. Figure 1 illustrates the rapid growth in electricity consumption in Chinese residences due to this phenomenon.



Source: Liu and Li, 2003

Energy efficiency standards and labels (S&L) are among the most effective policy tools available for any government's efforts to improve energy efficiency of products. Currently more than 55 countries around the world have launched programs and have issued an efficiency standard or label for at least one product[1].

Voluntary endorsement labels, such as the ENERGY STAR label, have become well established and effective tools for promoting energy efficiency and clean technology in many developed countries over the past decade. The effectiveness of such tools in developing countries and countries in transition is less well understood. There are differing views among experts as to the value of voluntary programs in emerging market countries.

One survey of S&L programs noted that the overwhelming majority of the programs have focused first on "cold appliances" – refrigerators, freezers and air conditioners—as they account for a large part of domestic electricity consumption. The study goes on to conclude that "comparison labeling is considered to be the most effective since it enables comparison of all the appliances on the market rather than simply identifying the most efficient models" [2] One could argue also that "market oriented" voluntary tools might be less effective in emerging markets, where large distortions may exist, for example, in access to capital, lack of information, limited enforcement of regulations, etc.

Despite these concerns, voluntary labeling programs have been attempted in developing and transition countries, and have had some success. Examples of voluntary labeling programs include the endorsement label of the Efficient Lighting Initiative (ELI)[3]; endorsement labeling by the China Standard Certification Center (CSC) (formerly the Center for Energy Conservation Products – CECP); and the voluntary comparative labeling programs implemented by the Electricity Generating Authority of Thailand (EGAT). As a result of these programs, there is empirical evidence to suggest that well-designed voluntary endorsement labeling can be an effective tool for achieving energy efficiency improvements in developing and transition economies.

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[1] See www.clasponline.org for a comprehensive list of standards and labeling programs worldwide.

[2] Menanteau, 2000

[3] ELI was implemented between 1999 and 2003, managed by the International Finance Corporation, and seeded by a $15 million investment from the Global Environment Facility (GEF), in Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. ELI was re-launched as an independent, self-sustaining global progam in early 2006, and the program is now managed by the ELI Quality Certification Institute in China.

This paper reviews the potential advantages of voluntary endorsement labeling based primarily on the design and experience over the past decade in developed countries. It then summarizes some of the published results of programs in developing and transition countries, and offers some suggestions about where and how such programs might be useful to a wider range of countries.

Advantages of Voluntary Endorsement Labeling[4]

Endorsement labels are simple and easy to understand – if it has the label, the product is energy efficient. Because they provide minimal information directly on the label, they require minimal thinking by the consumer. For consumers who are weighing many other factors when making a purchase and who prefer a simple endorsement from a trusted source, this benefit should not be underestimated. On the other hand, if endorsement labels are combined with well designed communications campaigns and are well publicized they may also appeal to a targeted mix of consumer preferences (e.g., environmental protection, monetary savings, product quality, international credibility) and be quite effective, with several different types of consumers.

They are also widely applicable across many energy using products. The ENERGY STAR label now applies to more than 40 categories of products, including household appliances, home electronics (televisions, audio systems, etc.), computers and other office equipment, residential heating and cooling equipment, and a range of commercial products and equipment. Many of these products are difficult to include in mandatory programs for several reasons: Many have shorter lifetimes and design cycles, and some, such as consumer electronics and computers, or have relatively narrow ranges of energy consumption among models or bimodal distributions related to specific efficiency features (e.g., the sleep mode on computer monitors). In these cases, voluntary endorsement labels are the most efficient option. Even if the range of energy consumption among products is relatively narrow, a high and expanding rate of market penetration can mean sizeable energy savings for countries that promote energy-efficient models. Because the label is seen across so many products, its importance is reinforced in the minds of consumers, and with manufacturers

Because endorsement labels are voluntary and limited to the high-efficiency end of the market, these labels tend to engage progressive manufacturers in a constructive relationship, without the adversarial nature often associated with regulatory processes. Endorsement labeling can be a good mechanism for introducing industry to standards and labeling programs, particularly in countries where policy makers and private companies are hesitant about or averse to such efforts. The simplicity of endorsement labeling allows for easy integration with product marketing by manufacturers, retailers, and others.

Because of their voluntary nature and simplicity, endorsement labels generally require less time than comparison labels and no regulatory process for implementation and revision. Endorsement labels can stay relevant in markets that shift every few years or less. As manufacturers improve the energy efficiency of their products over time so that the majority of products meet the specifications, endorsement label criteria can be more easily adjusted to track this market shift and thus can continue to differentiate the most-efficient products.

Because endorsement labels are non-regulatory and simpler than comparison labels, government administrative costs are lower. From the perspective of individual manufacturers, the costs of participation are voluntary rather than being required as a part of a regulatory burden. The program benefits by leveraging the significant resources that manufacturers routinely devote to their own product advertising.

Qualification for the endorsement label can be utilized as a basis for other market-transformation programs such as financial incentive programs, and government procurement. This can reduce the financial, staff and transaction costs associated with the supplemental programs, and bring consistency across a range of programs making the combined efforts more effective.

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[4] Much of the information in this section is adapted from Wiel and MacMahon, 2005

Endorsement labels quite often include specifications for *non-energy* performance features that may be as important, or more important than energy performance in consumer choices. The facility to include these other performance measures and their test procedures in the technical specification is a key advantage of endorsement labeling that might be particularly important in some developing country situations. For example, the color and other qualities of light or the delay in start-up for some fluorescent bulbs may be critical for consumer acceptance of lighting products. Cleanliness, noise, and time per wash may be greater determinants of the desirability of a clothes washer than energy performance. If some manufacturers were to meet energy requirements at the expense of these features, consumers might be dissatisfied, which would undermine the credibility of the entire labeling program. This linkage of energy efficiency with high quality in endorsement labeling can be extremely valuable for developing and transition countries. With CFLs, for example, the problem in many developing countries is not whether the bulbs are efficient relative to incandescent bulbs, but whether they are durable, and maintain lumen output over the rated life, especially given electric power quality problems that may exist. The endorsement label provides a tool for easily identifying those products that not only meet energy efficiency requirements but also specifications for durability, lighting quality and other important performance features.

Figure 2: Thai Energy Efficiency Label

In recent years, increasing attention has been paid to opportunities for internationally coordinated or harmonized testing procedures, technical specifications and sometimes policies for products that are globally traded and virtually homogeneous. The efficient lighting initiative (ELI) played a key role in promoting global harmonization of testing procedures and specifications for efficient lighting. In addition to lighting, coordinated international processes are addressing office equipment, televisions, external power supplies, and other products. Leading Chinese labeling experts believe that

> "International coordination and mutual recognition of product certification labels will be the general trend for the development of product certification. It can not only improve the overall technical level of product certification agencies and promote international exchange and cooperation, but also can break through the technical barriers set up by international trade, and help enterprises to save certification time and win invaluable opportunity for bringing their products into the international label." [5]

These processes are not exclusively focused around voluntary endorsement labels – testing and technical specifications can be used for mandatory standards and labels at the discretion of participating countries -- but for many participating countries it is simple and effective to seek to harmonize voluntary endorsement (or certification) labels at least initially. These processes offer some new and efficient opportunities for developing countries to initiate endorsement labeling programs with less additional technical work and with clear linkages to international trade.

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[5] Zhang, et al. 2005

Some Experiences In Developing Countries

Thailand was one of the first developing countries to implement a successful nation-wide energy labeling program for household appliances and other products. Labeling programs were started as part of the national demand-side management (DSM) program implemented by The Electricity Generating Authority of Thailand (EGAT), the state-owned generating utility. Labels for refrigerators and freezers were launched in 1994, air conditioners in 1995 and, and fluorescent lamp ballasts in 1996. There has also been a separate program since 1994 to endorse highly efficient clothes washers, computers, lamps and motors, as well as refrigerators, air conditioners and ballasts with a green label for environmental criteria, including energy efficiency. Highly efficient electric motors have also been able to receive a separate endorsement label since 1996[6].

For refrigerators and air conditioners, EGAT introduced a categorical comparison label that ranks the products on a scale of # 1 to # 5,
Where a rating of # 5 is the highest efficiency level and # 3 is average (see figure 2). The label also shows consumers the average energy consumption per year (kWh/year) and the average electricity operating costs per year (Baht/year). Since these programs are voluntary, there is little incentive for manufacturers or distributors to choose to label their products if tests reveal that they are less efficient than the average (# 3). As a result, no products in the market were labeled # 1 or # 2 label, and only an extremely small share (<< 1%) were labelled # 3[7]. Thus this label, initially designed as a categorical comparison label, in practice functioned in much the same way as a voluntary endorsement label, identifying and promoting only the more efficient products in the market (ones labelled # 4 and # 5).

Box 1: Existing Labels Benefit the Thai Economy
Benefits from 1994-2000 for 2 Products

- Government spending = US$0.20 per household
  Efficiency investments stimulated = US$2.40 per household
  Energy bill savings = US$3.60 per household
  Net savings to the Thai economy = US$0.90 per household
- Average benefit/cost ratio = 1.3:1
- *Primary energy* savings = 1.3% of 2000 national electricity use
- *Peak power* savings = 1.4% of 1994-2000 growth
- Cumulative net dollar savings = US$56 million
- *Carbon reductions* = 0.9 million metric tons of carbon

Source: Calculations by Steve Weil, CLASP, based on Singh and Mulholland, 2000

Refrigerator labeling during this period was quite successful, possibly due to the fact that most refrigerators were produced by five main, large manufacturers, all of which accepted labeling. By 1997, more than 2.7 million refrigerators had been labeled, reducing electrical energy demand by 297 GWh and peak demand by 39 MW. By 2001, energy savings from efficient refrigerators had increased to 849 GWh and peak demand reduction to 84 MW. There were also more than 200,000 labeled air conditioners in 1997, reducing energy demand by 196 GWh and peak demand by 12 MW. By 2001, efficient air conditioners had produced energy savings of 318 GWh and peak shaving of 84 MW. [8]

A Canadian consortium, commissioned to evaluate the impact of its DSM programs in 1999, surveyed and interviewed the manufacturers to evaluate the impact of energy labeling on production decision-making. The Thai labeling programs are a successful example of a voluntary energy labeling effort in a developing country. Voluntary labeling was effective in transforming the refrigerator market. The data from EGAT showed that the share of # 5 labels relative to all labels ordered by manufacturers and distributors increased from 11.6% to 96.8%. The number of # 4 and # 3 labels ordered decreased from 74.6% to 2.8% and 13.8% to 0.4%, respectively. Further, the collected data indicated that the percentage of labeled units sold compared to the

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[6] APERC, 2003
[7] Na Phuket and Prijyanonda, 2000
[8] APERC, 2003

total units sold ranges from 85-92% in 1996-1998.[9] The DSM Program Office estimated in 2000, that about 84% of all refrigerators sold in Thailand qualified for the level 5 label and that the program has contributed to a 21% reduction in overall refrigerator energy consumption. On average, refrigerators receiving the level 5 label in Thailand are slightly less efficient than those qualifying for the "Energy Star" label in the U.S.

More recently the Thai labeling program has evolved significantly. After several years of experience with the voluntary label, and with the adjustments in manufacturing to make more efficient products, the manufacturers were able to agree to more stringent specifications and to a mandatory label for all refrigerators (1999 and 2002, for single door and 2 door models respectively).[10] Additionally, EGAT has been using the # 5 label as a *de facto* endorsement label for certain products, such as magnetic ballasts; compact fluorescent lamps, and fluorescent lamp ballasts: only products that meet a certain threshold are allowed to use the # 5 label.

One of the most extensive voluntary endorsement labeling programs in the developing world is the energy efficiency certification label managed by the China Standards Certification Center (CSC). [formerly the China Certification Center for Energy Conservation Products (CECP)] The CSC label (see figure 3) identifies products with superior energy efficiency, and manufacturers voluntarily decide to use the label, since the label enhances the attractiveness of their products in the Chinese consumer marketplace.

The Chinese government launched the energy conservation certification program and established CECP to implement it in 1998.[11] In late 1999, the Director of CECP proposed a partnership with the ENERGY STAR program to assist in the development of a voluntary endorsement labeling program based on two key factors. First, as the largest and longest-running national voluntary energy efficiency labeling program in the world, ENERGY STAR offered potentially useful lessons for an equally ambitious program in China. Second, the U.S. Environmental Protection Agency (EPA) had a successful history of working with Chinese partners on promoting energy efficiency in consumer products.[12] . EPA entered into this partnership in 1999, and continues to support this program. CECP granted its energy conservation label to 103 models of refrigerators from 9 major manufacturers. At the end of 2000, there were a total of 203 different models of labeled refrigerators from 20 manufacturers.

Figure 3: China Standard Certification Center (CSC) Label

According to a CECP analysis, labeled refrigerators consume an average of 18% less electricity than non-labeled products.[13] The CSC labeling program has expanded to include more than 40 product categories. Although the impacts of China's labeling program have not yet been comprehensively documented, a recent review[14] found that existing Chinese standards and labeling requirements for appliances

are already having a substantial impact on slowing the growth of residential electricity demand. Experts from Lawrence Berkeley National Laboratory (LBNL) working with CSC staff, have estimated future impacts of the CSC labels for some products. Estimates have been made for 9 product types, and project that within 10 years existing specifications will reduce annual electricity demand by 12 TWH and

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[9] Na Phuket and Prijyanonda 2000

[10] Singh and Mulholland, 2000

[11] Liu and Li, 2003

[12] McNeil and Hathaway, 2005, also see case study articles on prior EPA collaboration on energy efficiency in China at http://www.usctcgateway.net/casestudies/CasestudiesMore.cfm?Custom27=&Custom25=China

[13] CNIS, 2000

[14] Lin 2002

GHG by 4 MMTCE [15] Figure 4 shows the 10 year cumulative estimate CO2 reductions estimated for these products.

CSC's product labeling program has also been adopted as a basis for the very ambitious government efficient procurement program initiated in January 2005 by the Ministry of Finance and the National Development and Reform Commission[16]. The program covers 7 categories of energy efficient products and requires purchase of the CSC labeled products in each. An initial analysis of the technical potential for savings from China's current procurement program estimates that cumulative 10-year savings could be as high as 10.9 TWh and over 10 million tonnes of CO2. The net present value of the cost savings total RMB¥ 8.7 billion (US$1.1 billion).[17]

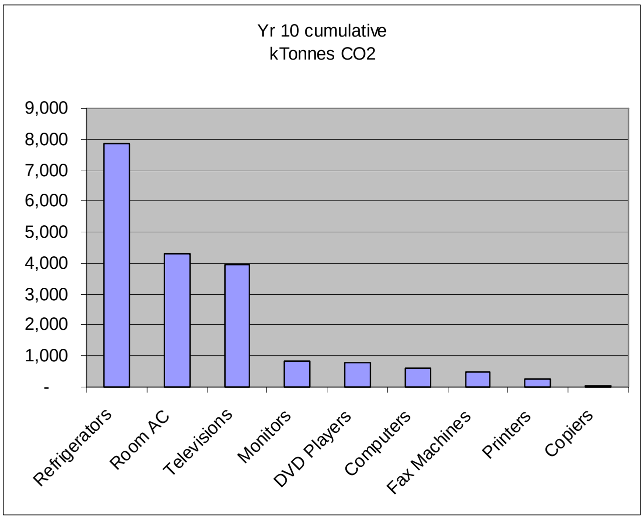

Figure 4: Estimated Impacts of China Labeled Products (ktonnes CO2)
Source: Fridley, 2006

The Efficient Lighting Initiative (ELI) implemented from 2000-2003 by the International Finance Corporation (IFC), with support from the Global Environment Facility (GEF) is one of the most effective multi-country energy-efficiency programs that has been carried out. ELI was designed to reduce greenhouse gas emissions by expanding the markets for energy-efficient lighting technologies in seven countries: Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines, and South Africa. The program achieved major reductions in greenhouse gases, and created a foundation for sustainable efficient lighting programs in the future. It also focused a great deal of attention to program evaluation and documentation that has and will continue to generate valuable information and insights for other programs.

To accelerate development of sustainable markets for efficient lighting in all seven countries, the program developed a "toolkit" of interventions to overcome market barriers, that were then tailored to the specific needs and conditions of each country. These included working with utility demand-side management programs and stimulating regulatory changes to allow utilities to bodies sell CFLs, and lease them to consumers through. "pay-on-the-bill" installments, and promoting innovative commercial financing for lighting investments through energy service companies (ESCOs). ELI also organized bulk procurement of efficient lighting products and used targeted short term subsidies to support activities, like public education, that would have long term market impacts.

ELI established an endorsement label (figure 5), as a fundamental component of its design and success. "The ELI logo became the centerpiece of ELI's marketing activities in all seven countries. Consumers were encouraged to "Look for the Leaf!" to identify and in efficient lighting products. Results from consumer surveys, manufacturers, and retailers indicate that the ELI logo came to signify a high quality product. The logo was adopted widely by the lighting industry in all seven countries with

Figure 5: Efficient Lighting Initiative Logo

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[15] Lin, 2002, Fridley, 2006

[16] see http://www.pepsonline.org/publications/Treasury%202004%20Number%20185.pdf for an English translation of the policy notice

[17] Fridley, 2005

more than 200 products from 14 different manufacturers receiving ELI qualification."[18]

Results from the preliminary program evaluation indicate that ELI achieved substantial impact in each of the seven countries. During the life of the program, the ELI quality certification mark – part of the ELI program toolkit -- also established a broader presence on the global market beyond the seven ELI countries.[19] Over all seven countries the evaluation estimated that the program reduced energy consumption by 2,590 gigawatt-hours (GWH), and CO2 emissions by 2,018,000 tonnes between 2000-2003. The program provided a foundation for sustained market development, reducing product prices and increasing market share of efficient products.

The ELI had an explicit strategy to harmonize its testing procedures and specifications with international standards such as the ENERGY STAR label specifications. Through this strategy and its work with seven countries and 14 manufacturers, the program has stimulated significant progress toward international harmonization efforts for lighting technologies.[20]

Since 2003, IFC has been working to re-brand initial ELI program as a springboard to basis for a self-sustaining, fee-based, quality certification service for efficient lighting products worldwide, with an emphasis on developing countries. The 'ELI Certification Institute', administered by the China Standard Certification Center (CSC). will maintain ELI's quality mark, sustained by manufacturers. CSC will build on institutional partnerships established in the ELI countries to extend product certification to an expanding range of efficient lighting technologies worldwide.[21] After a two-year period of inactivy during 2004 and 2005, the ELI program was re-launched in early 2006 as an independent, self-sustaining, global program.

Some Thoughts on Roles for Voluntary Labeling

There is clearly evidence that voluntary endorsement labeling programs can be effective in developing and transition economies, particularly when combined with other market transformation measures such as incentives and bulk procurement. More systematic, published and widely disseminated evaluations would be useful to provide convincing evidence of the benefits of voluntary endorsement labeling (or other standards and labels for that matter) in the developing country context. Careful evaluation of the successful programs is ongoing in some cases, but could be enhanced. Such evaluations can provide helpful guidelines and lessons for new programs and the international partners supporting them, in avoiding a number of pitfalls in program design and implementation.

Voluntary endorsement labels lend themselves to providing a basis for other programs. In the three example summarized, the label has been promoted in the context of other market transformation programs. The successful Thai labeling was carried out within a DSM program funded through the electricity tariff; China's labeling program is reinforced by government procurement and other programs; and the ELI supported its label with a comprehensive toolkit of market transformation measures.

While voluntary endorsement labels can be less costly and time-consuming than mandatory programs, there are still significant resource requirements. It is critical that a funding source(s) be established early on to ensure the programs can maintain a high standard of quality and credibility. Revenue can be obtained from electricity tariffs as in Thailand, from fees for label certification as in China, from international donors initially, or other sources. Credible programs will require resources to carry out monitoring and enforcement to maintain the quality and value of the label; significant investments in consumer outreach and education; market surveys and evaluation of impacts; and other activities needed in order to transform product markets.

Voluntary endorsement labels work well with office equipment, consumer electronic products, lighting and other miscellaneous products like power supplies. All of these are rapidly changing products with short design cycles, and are relatively homogeneous around the world. They are all subject to active

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[18] ELI, 2005

[19] Sturm, 2005

[20] As one example of the impact of ELI, and the need for, a international specification program for efficient lighting products, a number of large compact fluorescent lamp programs launched in 2005 and 2006 have used the ELI specification as the basis for their procurement of CFLs: Vietnam (1 million lamps), Bangalore, India (175,000 lamps) (du Pont and Gooneratne 2006)); South Africa (more than 7 million lamps) (Bredenkamp 2006); and Uganda (800,000 lamps) (Limaye 2006).

[21] ELI, 2005

discussion of, or growing interest in international harmonization of test procedures, technical specifications, etc. And many of these products are widely traded internationally.

There is an opportunity for developing and transition economies, particularly those just getting started, to join in these processes and benefit greatly from the work that has been already done and will continue in the more established programs. In many cases, where products are all imported, countries may be able to adopt international specifications with minimal disruption to local economies. If there are domestic producers, they may benefit from engagement with international standards processes that will increasingly define international trade competition and opportunities.

Because voluntary programs can be implemented relatively quickly, they may offer a quicker start up and a less confrontational approach in the-initial introduction of standards and labeling programs. They can begin to show some results within a short time, and allow stakeholders to become familiar with energy efficiency testing, specifications and labeling issues. This can be a foundation for mandatory programs to follow, and well-designed voluntary programs can continue and complement mandatory labeling and standards programs.

The experience with refrigerator labelling in Thailand provides an example of how a voluntary program focusing on endorsement of the most efficient products can produce significant early efficiency gains, and build a strong program foundation and stakeholder relationships that allow a relatively smooth transition to mandatory comparison labelling in the longer term.[22]

It would be worthwhile for countries and institutions starting out in the labeling and standards area, and the international partners who support and advise them, to give some serious and objective thought to whether the conventional wisdom that mandatory programs for cold appliances should always be the first steps of such a program.[23] These are hugely important energy users and they should be included in all programs over time. A case can also be made that the mandatory programs are the appropriate tools (though both Thailand and China have had early success with voluntary labels.) Program managers should also consider electronic products whose sales are growing exponentially in most developing countries. It may make sense to tackle these products with the less costly and politically difficult voluntary labeling approach early on as first steps or in parallel with the mandatory measures. This is particularly true for products where internationally accepted test procedures and specifications are in place or under development.

Endorsement labels are a useful addition to the S&L toolkit, not an alternative to mandatory standards and labels. The endorsement labels, combined with market transformation measures like incentives and bulk procurement, have the potential to show results on the ground more quickly than mandatory standards and information labels and to build a foundation for mandatory measures to come. This could be an extremely valuable early step for countries starting S&L programs, as well as a major component of comprehensive longer term strategies.

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[22] It should be cautioned that the Thai refrigerator program has worked well because of the relatively uniform distribution of efficiency levels for refrigerators. After just four years, nearly 90% of all Thai single-door refrigerators had the # 5 label, and this paved the way for subsequent mandatory labeling. A similar voluntary labeling approach for air conditioners -- a product for which efficiency levels have a bimodal distribution, with lower-quality inefficient domestic products, and higher quality domestic and imported products – has been less successful. After 9 years of labeling only approximately 40% of air conditioners carried the voluntary label, and the balance were low efficiency models sold without consumers being informed of the unit's efficiency level (DEM 2004).

[23] In early 2006, for example, the Malaysian Energy Commission launched a voluntary comparative labeling scheme for refrigerators. Malaysia adopted this approach in order to build support among a majority of manufacturers to join the scheme, before making the transition to a mandatory label in approximately two years time. The Energy Commission will also be launching an endorsement label, which will be applied to the 10-20% most energy-efficient refrigerator models on the market.

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Method for Determining the Energy Efficiency Indexes of Energy Standards and Labels

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Abstract

In recent years, China's government has been focused on the construction of energy efficiency standard system and its implementation measures. Energy efficiency standard (MEPS) has become an important tool for energy conservation and environmental protection. The number of energy efficiency standards already implemented has reached 20, covering household appliances, commercial equipment, and industrial equipment etc. In combination with the establishment of energy conservation product certification system, energy labeling system, energy conservation incentive policy, the implementation of energy efficiency standards has been greatly promoted, and huge amount of energy has been saved, and reduced the emission of Greenhouse Gases.

This article describes the present status and main implementation measures of China's energy efficiency standard system, and taking household appliances for example to describe the method that how to determine the five energy efficiency grade indexes for national energy standards and label, how to quantitatively analyze the effect of energy-saving and emission reduction being brought about by energy efficiency standards in China.

1 . Present status and implementation approaches for China's energy efficiency standards

1.1 Describes the present status of China's energy efficiency standard system

1.1.1 Definitions of the concept and contents for energy efficiency standards in China

China's energy efficiency standards specify the minimum allowable values of energy efficiency or the maximum allowable values of energy consumption of for products without lowering any other performance such as quality and safety. Manufactures and importers are required to meet the requirements in the standards when they produce or sell products. Below are the basic contents of energy efficiency standards in China, but the contents of a specific standard might be adjusted according to the need of the government's energy conservation work.

（1） Limited value of energy efficiency (or energy consumption), mandatory requirement. Products will not be allowed to be manufactured or imported if they fail to meet this requirement；

（2） Evaluating value of energy conservation, voluntary index. Products can be called energy conservation products only when they meet this requirement. Only qualified products can apply the logo for China's energy conservation products;

（3） Energy grade, products are divided into 5 grades. Grade 1 is of the highest efficiency, and grade 5 is the minimum efficiency requirement for market entrance. Energy grade is the basis for the implementation of China's energy label system;

（4） Judging methods, test methods and inspecting rules for energy efficiency indexes.

1.1.2 Implementation mode

In China, the implementation mode for energy efficiency standards is mandatory, i.e. mandatory only for certain selected clauses (such as Limited value of energy efficiency), not the whole standard.

In terms of the "implementation time" of China's energy efficiency standards, there are about 6 months' time from government promulgation to implementation.

In order to adapt to the China's market economy, and respond to enterprise's voices, we are now trying to develop and implement "reach" energy efficiency standards. Normally, "reach" standards will be implemented 4 years after promulgation, with the purpose of leaving enough time for manufactures to take necessary measures to improve the energy efficiency of products to meet the requirements in the standards.

1.1.3 Revision of energy efficiency standards

Normally, China's energy efficiency standards will be revised every 4 years. The newly promulgated standards will replace old ones. Presently, "reach" standards have been developed for refrigerators and room air conditioners. "Reach" standards and "present status" standards (standards that will be implemented shortly after promulgation) coexist.

1.1.4 China's management organizations for energy efficiency standards

- General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ)

AQSIQ is a government organization, that is responsible for the planning, approval promulgation and market monitoring of China's national standards

- China National Standardization Technical Committee for Energy Basis and Management (CNTC)

CNTC is a professional national standardization technical committee, responsible for developing and technical examination of energy efficiency standards.

1.2 China's energy efficiency standards already developed

From the mid 1980's, China has already developed 20 national energy efficiency standards.

Table 1: Chinese national energy efficiency standards (until Dec. 2005)

Category	**Standard Number**	**Standard Title**	**Time of implementation**
Household appliances	GB12021.2-2003	The maximum allowable values of the energy consumption and energy efficiency grades for household refrigerators	2003
	GB12021.3-2004	The minimum allowable values of the energy efficiency and energy efficiency grades for room air conditioners	2004
	GB12021.4-2004	The minimum allowable values of the energy efficiency and energy efficiency grades for household electric washing machines	2004
	GB12021.5-1989	The limited value of energy consumption and method of testing for electrical iron	1989
	GB12021.6-1989	The limited value and testing method of efficiency and warming energy consumption for automatic rice cookers	1989
	GB12021.7-2005	The limited value and testing method of electrical energy consumption for broadcasting receiver of colour and monochromic television	2005
	GB12021.8-1989	The limited value of efficiency and methods of measurement on radio receivers and recorder	1989
	GB12021.9-1989	The limited value of energy consumption of electric fans and its measuring method	1989
	GB****	Minimum allowable values of energy efficiency and energy efficiency grades for domestic gas instantaneous water heater and gas fired heating and hot water combi-boilers	being approved in 2006
Commercial equipment	GB19576-2004	The minimum allowable values of the energy consumption and energy efficiency grades for unitary air conditioners	2004
	GB19577-2004	The minimum allowable values of the energy consumption and energy efficiency grades for water chillers	2004

	GB19578-2004	Limits of fuel consumption for passenger cars	2004
Lighting equipment	GB17896-1999	Limited values of energy efficiency and evaluating values of energy conservation of ballasts for tubular fluorescent lamps	1999
	GB19043-2003	Limited values of energy efficiency and rating criteria of double-capped fluorescent lamps for general lighting service	2003
	GB19044-2003	Limited values of energy efficiency and rating criteria of self-ballasted fluorescent lamps for general lighting service	2003
	GB19415-2003	Limited values of energy efficiency and evaluating values of energy conservation for single-capped fluorescent lamps	2003
	GB19573-2004	Limited values of energy efficiency and rating criteria for high-pressure sodium vapour lamps	2004
	GB19574-2004	Limited values of energy efficiency and evaluating values of energy conservation of ballast for high-pressure sodium lamps	2004
Industrial equipment	GB18613-2002	Limited values of energy efficiency and evaluating values of energy conservation of small and medium three-phase asynchronous motors	2002
	GB19153-2003	Limited values of energy efficiency and evaluating values of energy conservation for displacement air compressors	2003
	GB19761-2005	Limited values of energy efficiency and evaluating values of energy conservation for fan	2005
	GB19762-2005	Limited values of energy efficiency and evaluating values of energy conservation of centrifugal pump for fresh water	2005

Figure 2: Label pattern for China's energy label

Figure 3: Logo of energy conservation product of certification

1.3.3 China's energy conservation product certification

China's energy conservation product certification program started in 1999. The label is voluntary (belongs to endorsement label，figure 3). And the implementation mode is:

Factory condition Check + product test + monitoring, checking and testing after certification

1.3.4 Incentive mechanism for energy conservation

At present, Government departments such as NDRC and the Ministry of Finance etc. are doing research on the relevant tax and financial incentive measures, determining the recommended product list of energy conservation products so as to guide manufactures and consumers to produce or purchase energy conservation products, and create market demands. At the same time, the government also clearly specifies the requirement for government procurement: putting energy conservation products at the highest priority.

2．Method of determining the five energy efficiency grade indexes for national energy standards and labels

2.1 Procedures for the development of energy efficiency standards

The basic procedures for the development of China's energy efficiency standards are listed as follows:

- Evaluate whether there is a need for the development of this energy efficiency standard and whether the condition for the implementation is sufficient;
- Submit application to Standardization Administration of China for the development;
- Establish standard preparation group, and involve stakeholders
- Engineering analysis
  - Evaluate whether the fundamental conditions for the development of the standard are ready, including whether there is suitable test procedures, lab test ability, etc.;
  - Collect data needed for the analysis, including market data, engineering data, application data etc.;
  - Analyze the relation of different technical approaches Vs the costs; determine the baseline and energy-saving technical options to be selected; predict the impacts of each option to consumers, manufactures, energy suppliers and environment;
  - Select the best choice from the proposed options, form the standard document after the agreement is reached.
- Broadly collect comments from stakeholders;
- CNTC examine the standard, then submit it to SAC;
- Notify the standard to WTO member countries;
- The Standardization Administration of China approves and promulgates the standard.

2.2 Principles for the determination of energy efficiency indexes

(1) The indexes for energy efficiency standard should be in harmony with the target stipulated in "National medium and long term energy conservation"
According national energy conservation plan, the goal indexes of energy efficiency should be divided into phase targets and set the achieving dates. The indexes for energy efficiency standard and implementation period should assure that efficiency level of products in the market should be arrived or exceeded the phase target during this period.

(2) Establish a specified market share distribution of products with different energy grades
Energy efficiency label provides consumers with a mechanism to identify energy efficiency indexes. It is an important basis for consumers to choose efficient product to purchase.

– First stage (at the beginning when energy labeling system is implemented): distribution of products with different energy grades should be even in consideration of China's cultural background and consumer's preferences. Especially, there should be certain amount of grade 1 and 2 products for consumers to choose. Consumers will make their purchase decisions based on their considerations on energy conservation, purchase cost, operating cost, environmental effect etc.

– Second stage (entering a mature stage): the energy efficiency indexes can be reasonably higher than market. The barrier of added production cost can be covered by the financial incentive policies from the central and local governments.

Specification of 5 energy efficiency grades:

– Grade 1 is the goal for manufactures to strive for. The number of products of this grade is relatively small, representing products with advanced energy-saving technology, and the cost is comparatively high;

– Grade 2 is the doorsill for energy conservation products, representing products with minimum LCC(life cycle cost)

– Grade 4 represent the average energy efficiency level;

– Grade 5 is the market entrance criteria, products with this level of energy efficiency will be eliminated from the market in the future.

(3) Take sufficient consideration of energy efficiency requirements of products in other countries, get harmonization to the international level as possible
Now household appliances, office equipment, lighting equipment, motor product industries are typical assembling industries, with the characteristics of global purchasing and distribution. It is more important to have a harmonization international standard or comparable method.

(4) Take sufficient consideration of China's technical development ability of enterprises and the technology reserve status.

– The availability and feasibility of technology, including energy conservation approaches, the resource of energy conservation technologies, price of the spare parts, the amount of spare parts able to be supplied etc.

– Economic justifiability of energy improvement. Through analysis, seek the best benefit point— making the total expenses minimum (sum of purchase cost, operating cost, maintenance cost, utility investment decrease, emission reduce).

2.3 Analytical methods for energy grading indexes

According to the principles for the determination of energy efficiency indexes mentioned in 2.2, energy efficiency indexes can be determined according to the following calculation method. Here we take China's room air conditioners for example.

2.3.1 Analytical approach

The analysis can be conducted according the following diagram (figure 4).

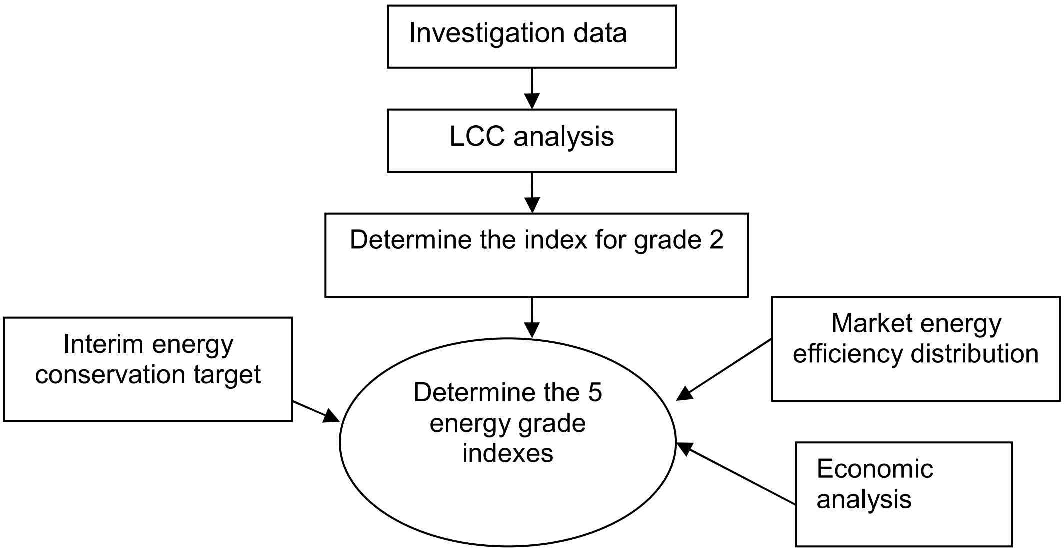

Figure 4: map of the analysis of energy efficiency grade indexes

2.3.2 Calculating methods

2.3.2.1 Determination of phase energy conservation gargets

Calculating procedures：

- Obtain the formally released energy-saving target of product specified in national energy stratagem and workplan, and the deadline to achieve the goal;
- Determine the schedule for the future revision of the standard (normally every 4 years), and how many phases will be included; predict the energy conservation target and implementation dates for every revision of the standard or each phase;
- Calculate the average values of market energy efficiency of the product at present;
- Determine and evaluate the phase target values of energy conservation and the implementation time period of the standard presently being developed or revised.

According to the requirements of China's "Medium and long term energy conservation plan", in 2010, the energy efficiency level of room air-conditioners will reach that of the international level, the average energy efficiency level in the market will be no less than 3.2W/W; in 2020, the energy efficiency level of household appliances will reach that of the advanced international level.

2.3.2.2 Life-cycle cost analysis model

The aim of the analysis is to check whether products of different energy efficiency level can recover the added cost for consumers who purchase high efficiency products in the lifetime of the products. The calculating include: cost-benefit for energy conservation measures, product payback period and life-cycle cost etc. the following is the calculating method:

LCC= purchase cost + operating cost (+ maintenance cost).

The minimum values of LCC has the largest cost-effect ratio, should be used as the doorsill for energy conservation product. The index should be determined as grade 2.

Table 2: Summary of LCC analysis results of present products

Cooling capacity	EER values for minimum LCC value（W/W）	Average value（W/W）	Conditions		
			operating time（hours/year）	Electricity price（Yuan/degree）	Markup
2500	3	3.18	500	0.6	1.3
2500	3.51		500	0.6	1.3
3500	3.1		500	0.6	1.3
3500	3.1		500	0.6	1.3
4800	3.2	3.05	500	0.6	1.3
6800	3		500	0.6	1.3
7100	2.9		500	0.6	1.3
7100	3.1		500	0.6	1.3
10759	2.9	2.97	500	0.6	1.3
12000	3.04		500	0.6	1.3

Note: EER values for minimum LCC values done by difference manufactures, use the average value as one for the RAC's minimum LCC value in China market）

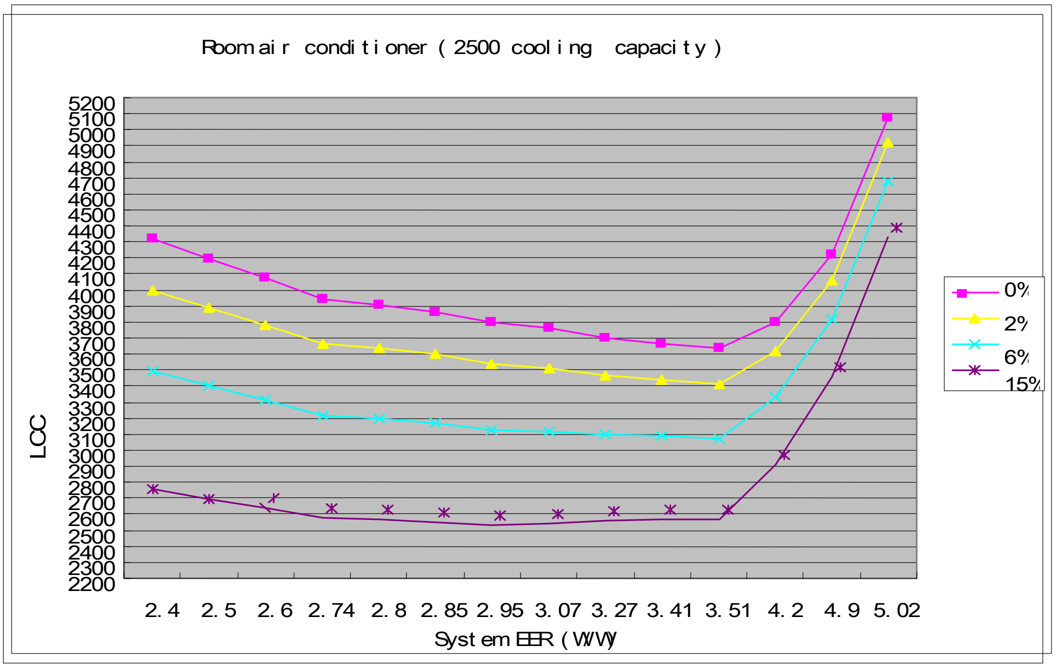

Figure 5: LCC analyses for the room air conditioners (cooling capacity 2500W.)

So the energy index of grade 2 is determined based on the LCC analysis. Please see table 3

Table 3: Indexes of grade 2 in energy efficiency standard for room air conditioners

Product type		Grade 2
Window type		2.90
Split	CC ≤4500	3.20
	4500<CC≤7100	3.10
	7100<CC≤14000	3.00

2.3.2.3 Statistical analyzing methods

According to the statistical analysis theory, analyze and compare the functional differences of product over its energy consumption, classify products in the market, obtain statistical data of products according to energy efficiency level, production etc. and predict the market influences of energy efficiency to the market. The aims are:

- Determine the present market energy efficiency level and energy efficiency distribution;
- According to the target values of energy conservation, adjust the energy efficiency indexes of the 5 energy efficiency grades, and make the average values reach the phase target requirements(table 4);
- Verify the market share of products with every energy efficiency grades, making the amount of products of different energy efficiency levels “small head and big tail” so as to push the market to advance towards a higher energy efficiency one(Figure 7).

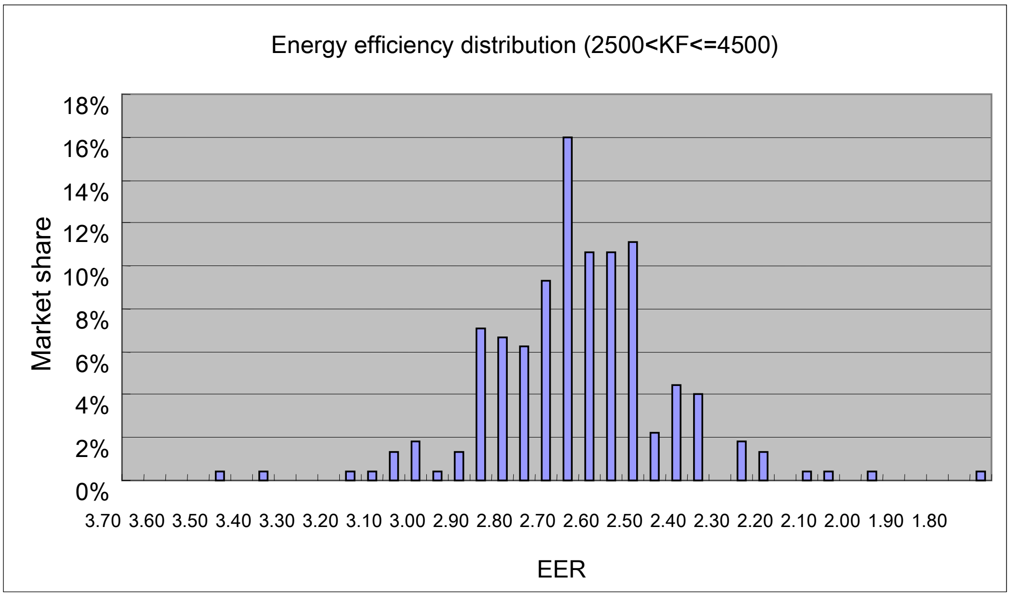

Figure 6: Energy efficiency distribution of major energy using product in the market

Table 4: The 5 energy grading values for room air conditioners

Type	**Rated cooling capacity (CC, W)**	**Energy grades**				
		5	4	3	2	1
Window type		2.30	2.50	2.70	2.90	3.10
split	CC ≤4500	2.60	2.80	3.00	3.20	3.40
	4500<CC≤7100	2.50	2.70	2.90	3.10	3.30
	7100<CC≤14000	2.40	2.60	2.80	3.00	3.20

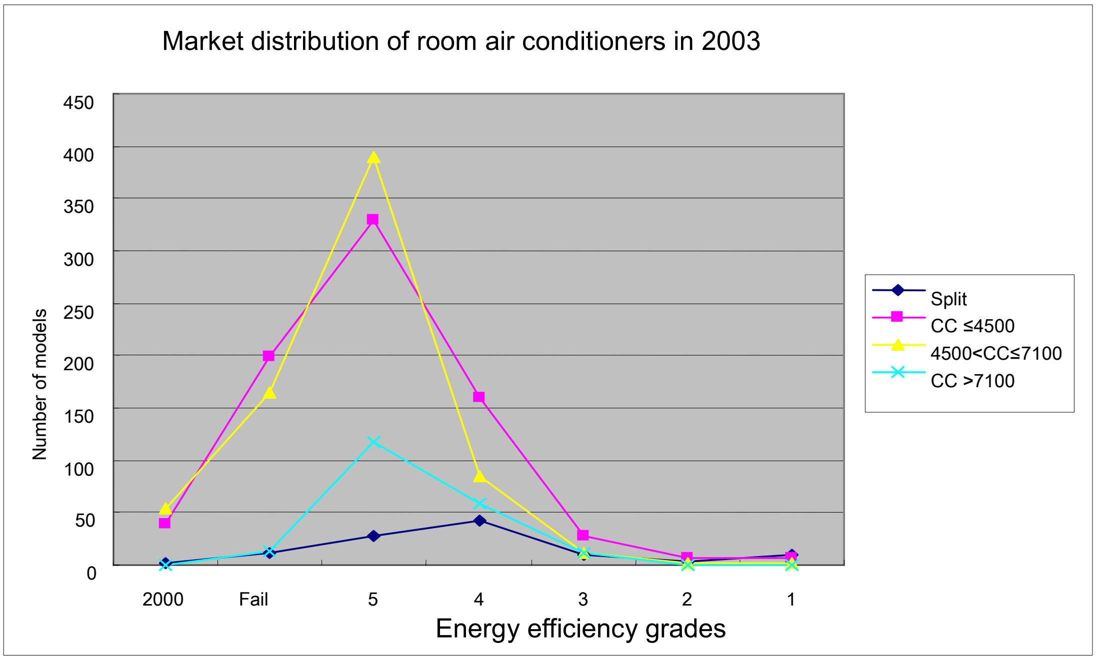

Figure 7: Market shares of products with different energy efficiency grades

2.3.2.4 Evaluation of the increase of energy efficiency

Based on the draft index table, the prediction of the increase of the average energy efficiency in the market can be seen in table 5 below.

Table 5 Prediction of average energy efficiency increase in the market

Specification		**Market share**	**Market status （EER）**	**New standard （EER）**	**Energy efficiency increase**
Window type		6%	2.245	2.47	10%
Split	1HP	38%	2.455	2.765	13%
	1.5HP	26%	2.455	2.765	13%
	2HP	18%	2.235	2.64	18%
	3HP	12%	2.36	2.64	12%
Average			2.39	2.71	13%

2.3.2.5 Indexes for the evaluation of energy saving and environmental benefits analysis

The main contents of the analysis and the indexes for calculation include:

- Analysis on the changes of the nation’s energy supply;
- Calculate the cost through the amount of energy reduced in the peak hours；
- Predictions of the emission reduction of greenhouse gases and other waste products

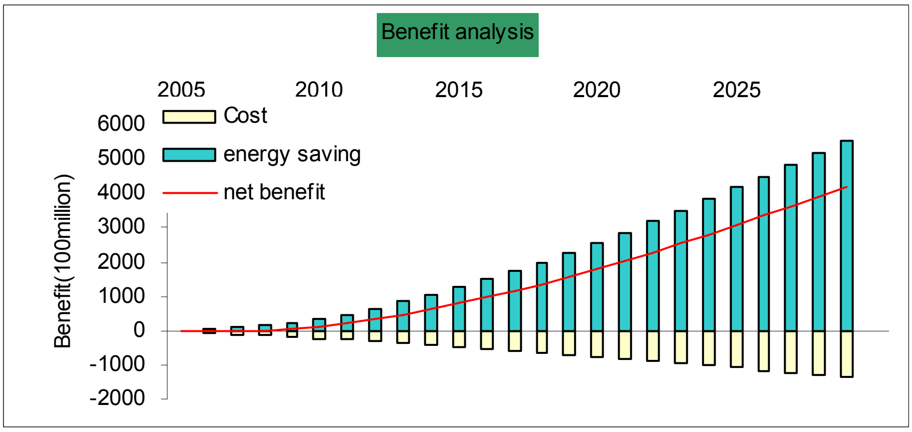

Figure 8: Prediction of direct economic benefit after the implementation of new standard

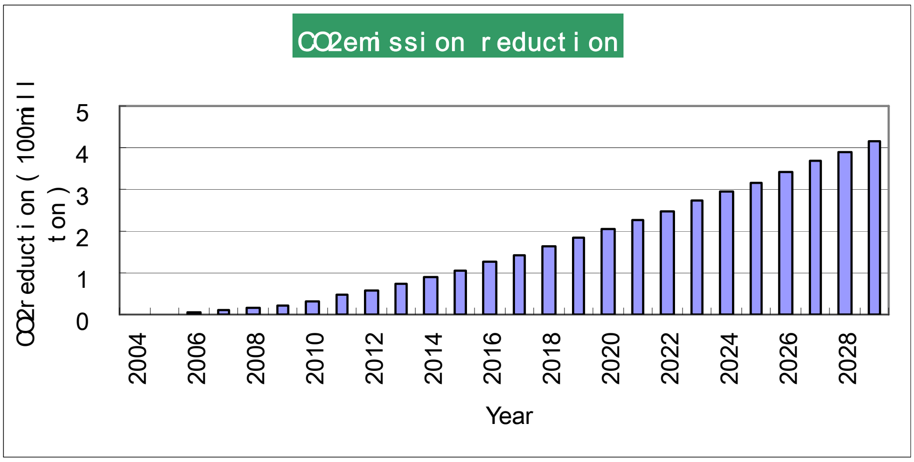

Figure 9: CO_2 emission reductions after implementing the new standard

The Implications and Impacts of China Energy Label

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Abstract

China has formally enforced a new energy efficiency information label entitled “CHINA ENERGY LABEL”, in tandem with a serial of integrated energy efficiency actions, to respond the increasing dual pressures in energy security and local environmental pollution due to dramatic increases in energy consumption. Household refrigerators and room air conditionings without this label were forbidden to be sold in Chinese market after March, 1st, 2005.

In this paper, framework and key elements of China Energy Label are presented as follows. This mandatory information label will cover appliances and lighting products with huge energy saving potential step by step by central government issuing product lists. Manufactures should report related data and send test reports to authorized agency after self declaration of their product’s energy efficiency. Energy efficiency criteria relies on product’s Life Cycle Cost and its efficiency distribution in market. The compliance and enforcement regime is complicated because it depends on local government sectors responsible for quality surveillance or/and energy inspection.

This paper highlights energy saving potential and emission mitigation from the label based on engineering and economic analysis. Some post- evaluations of label’s impacts indicated the label played an active role in market transformation. Statistics analysis showed penetration rate of efficient refrigerators was significantly higher than that of air conditioners. Site surveys validated that the label had already seized “eyeball”, influenced purchase decision of consumers, stimulated retailers to promote efficient appliances and fostered awareness of energy efficiency in market.

1. Background

To respond well to the increasing dual pressures in energy security and local environmental pollution, China government pledged to cut 20% of energy consumption Per 10000 RMB GDP with maintaining economic growth by 7.5% per year in the next 5- year from 2006 to 2010. As energy labelling and standards of appliances and equipment has proven to be one of the most promising policy instruments in energy efficiency field, China have tried his best to introduce and adopt a new energy efficiency information label, in tandem with a serial of integrated energy efficiency actions, to achieve the ambitious energy conservation goal.

On August 13, 2003, *The administrative regulation on Energy Efficiency Label,* hereinafter referred to as *the Administration Regulation*, was duly promulgated by the National Development & Reform Commission (NDRC), the State General Administration for Quality Supervision and the Inspection and Quarantine (AQSIQ). representing successful establishment of a energy label entitled “CHINA ENERGY LABEL” in China. On March 1, 2005, the refrigerators and air conditioners were covered by the label as a first batch of product.

2. Legislation and Administration Frame of China Energy label

2.1 Legislations and regulations

2.1.1 Supreme laws

Supreme laws for *the Administration Regulation* consist of *Energy Conservation Law of the PRC*, *Product Quality Law of the PRC, Legislation on Certification & Accreditation of PRC*. *Energy Conservation Law* furnishes a legal foundation for China energy label system. Pursuant to provisions in Article 26 in the Law, the enterprise manufacturing energy-consuming products must affix the product with a label, indicating the energy technical index. *Product Quality Law* principally regulates the product label and administrative organs. Article 27 in the Law regulates that product specifications, grades, ingredients and contents shall be in Chinese and be consistent with product performance and utilization requirements. *Legislation on Certification & Accreditation* furnishes professional and technical supports for implementation of China energy label system by regulating the qualification and competence of the test laboratories.

2.1.2 Administration regulation

the administration regulation formally set up China Energy label in China. The regulation, which contained 27 articles and 5 chapters including general, implementation of Energy-Efficiency Label, supervision and administration, penalties and supplementary Provisions, offered basic element of the label system.

Article 2 clarifies the label is not a continued label but a categorical label. Article 3 defines that the candidate products for the label is energy using products that widely used and have greater energy-saving potential, and explains that the product lists will be issued by government authorities step by step. Article 4 endows the label with mandatory attribute for the listed product. Article 5 enforces the manufactures or imports covered by product list to register their product's energy efficiency in the authorized registrar, Article 12and 13 give the general procedure of the register, and Articles 14 points out the register is free. Article 6, 7 and 22 identify administrative and surveillant frame of the label. Article 8 give basic information item in the label. Article 9 assign the self-declaration model for label's implementation. Other article regulate the obligations of stakeholders and penalties.

2.1.3 Implementation specifications and other documents

Under the umbrella of the administration regulation, NDRC, AQSIQ and CNCA(Certification and Accreditation Administration of PRC) should jointly issue implementation specifications for each listed product to offer detail requirements for implementation. The implementation specification clarifies the detail design and contents of the label for each product, technique criteria for classification of energy efficiency, document list and format for register. Of course, the energy efficency standard shall also be harmoniously incorporated in relevant regulations and rules for the energy label.

2004, Nov, the first batch of product list, the basic pattern of China Energy Label, two implementation specifications for refrigerators and room air conditioners were publicized. 2005, Jan, NDRC and AQSIQ authorized China National Institute of Standardization(CNIS) to undertake the register, bulletin of the label. NDRC and AQSIQ also issued relevant Notifications twice to future identify and strength the surveillance tasks.

Legislation frame on the energy label, refer to Diagram 1

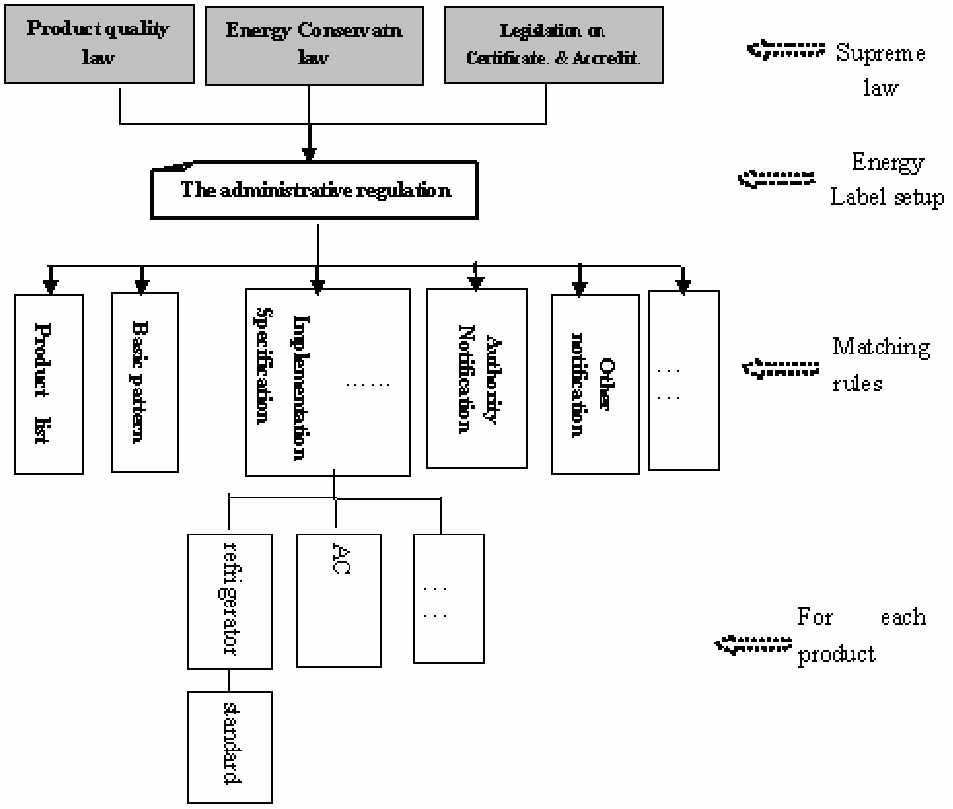

Figure 1: Legislation frame on the energy label

2.2 Administration system and responsibilities of concerned parties

The energy label management involves in many concerned parties, including administrative agencies, manufacturers/importers, sellers/retailers, consumers, inspection agencies, etc. For the organizational management structure, see Diagram 2.

2.2.1 Government agencies involved in Management and supervision

The energy label management agencies consist of two levels: Level 1: NDRC, AQSIQ and CNCA. The three authorities respectively take own responsibilities under the State Council to establish and implement the system. Specifically, their responsibilities include setup and announcement of the product catalogue, development and issuance of the implementation rules and label pattern/specifications, designation of authorized agency, organizing supervision and inspection of the energy label, etc. Among which, NDRC, as the macroeconomic control & energy conservation authority, shall take the lead role in managing the system. Whereas, Level 2 management authorities mean local authorities for supervision and management of the system, including energy conservation department, quality inspection department, as well as Entry-exit Inspection & Quarantine at provincial, municipal and town levels. Level 2 authorities are mainly responsible for supervision and performance of the system on the production and market, and investigate any relevant illegal activities.

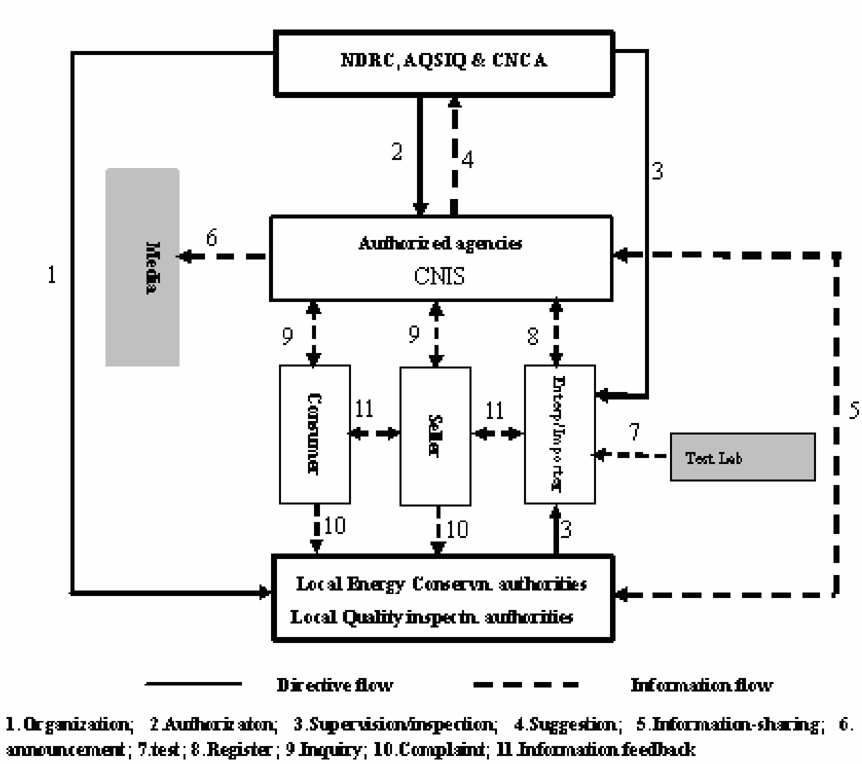

Figure 2: The organizational management structure for the energy label

2.2.2 Authorized agency

The authorized agency is of particular importance for the organization and implementation of the energy label. The agency, authorized by NDRC and AQSIQ, shall be responsible for the following works:

- Acceptance and inspection of the energy label registrations;
- Announcement of the energy label Information;
- Establishment and execution of energy label information registration, announcing and inquiring system;
- Publicities and trainings of the energy label I;
- Receipt of relevant complaint and supply of treatment measures
- Arbitration for disputes on relevant energy information
- Other works required for supervision & management of the energy label.

2.2.3 Manufacturer/importer

The manufacturer/importer, who plays the most important role in the implementation of the energy label, takes the following responsibilities:

- to test product energy efficiency pursuant relevant standards;
- to identify label information based on relevant standard and test report;
- to print the label and ensure correct labels affixed to the product in the Catalogue.;
- to submit acceptable registration documentations to the authorized agency and ensure trueness and completeness of the registration documentations;
- to accept social and governmental supervision and inspection.

2.2.4 Seller

The seller shall set and implement the purchase inspection and checking system to ensure the sold products within the Catalogue are affixed with correct label.

2.2.5 Test lab

Test lab shall be responsible for testing energy efficiency of relevant products and arbitrating relevant disputes, whose responsibilities and liabilities are as follows:

- To ensure just and fair test results;
- To exercise the strict sampling procedures, inspections & tests in a just and fair way;
- To be liable for protection of the business secrets they are familiar with.

2.2.6 Consumer

The consumer is not only the target audience of the label, but an important force to supervise the label by complaining the incorrect label to relevant agencies.

3. Key elements of China Energy label system

3.1 Nature of the implementation

China Energy Label shall be compulsory for the listed products. Due to different actual conditions of the products and resource requirements, China, by means of issuing the product list (catalogue), gradually executes the energy label system for the products that are extensively used and have large potential in energy saving. Any product listed in the catalogue must be affixed with unified energy label pursuant to relevant provisions; otherwise, it would be forbidden to sell or import such products.

3.2 Mode of certification

China Energy Label employs the pattern of “manufactures self-declaration + Energy data registration + post-Market supervision”.

The pattern of enterprise self-declaration is embodied in the following aspects:

- The enterprise by himself or entrusts the test agency certified by state to identify the product energy efficiency;
- The enterprise determine the label information in accordance with the test results and relevant standards;
- The enterprise prints the labels by himself in conformity with relevant requirements;
- The enterprise affixes the labels by himself;
- The enterprise shall be responsible for the accuracy of the label information and accept the supervision and inspection.

3.3 Implementation procedures

The energy label shall be implemented in the following procedures: test of the energy index & identification of the energy information, printing & utilization of the label, registration, re-examination and announcement of the energy label, supervision of the energy labels, etc. For implementation procedures for the energy label, refer to Diagram 3.

3.4 Supervision mechanism

3.4.1 Supervision organs

supervision parties cover the administrative sectors and other stakeholders. The administrative sectors including energy conservation administration departments, quality supervision and inspection department, as well as Entry-exit Inspection & Quarantine at center provincial, municipal and town levels. The other stakeholders come from the market actors, such as manufacturer, media, retailer, consumer, media etc.

3.4.2 Contents of the supervision management

Contents of the supervision management are as follows:

- Whether products within the Catalogue are affixed with the energy label or n not\ or whether the product operating manual is marked with energy grade or not?;
- Whether the labeling information is correct or not?
- Whether the label is registered or register was updated or not?
- Whether the label pattern is in conformity with regulations or not?.

In order to ensure fair supervision and accurate test results, AQSIQ, NDRC and their provincial counterparts will take responsibilities to check accuracy of information involve the energy performance parameters in the label, including energy efficiency grade, energy consumption, etc.; in addition, the third party of national certified test bodies accredited by CNCA will undertake relevant test arbitration. For disputation in energy performance. To facility help to inspect accuracy of the energy information and organize arbitrative inspection, the authorized agency will frequently report the label utilization to AQSIQ and NDRC based on complaints and information from registration database.

Local energy conservation management department and quality supervision & inspection department shall be responsible for supervision on the utilization conditions of the energy labels under own jurisdiction. Such conditions include: if the listed products are affixed with the unified labels; if the label pattern satisfy relevant requirements; if the used label is registered, if the labeling information is true (among which, such indexes as energy efficiency grade and energy consumption, etc. shall be supervised and inspected by AQSIQ, NDRC, provincial energy management department, provincial quality inspection department, etc;)

3.4.3 Supervision method

The energy label employs manufacturer's self-declaration model, which requires a high-degree self-discipline from the enterprise and strict inspection from the government. Therefore, diversified supervisions shall be adopted, including administrative supervision, social supervision, etc. The following supervision methods may be adopted:

- Random inspection by state authorities
- Routine random inspection by supervision authority
- Mutual tests between manufacturers
- Inspection by the retailers
- Complaints from the consumers
- Report and check by the media

3.4.4 Penalty types

Enforcing legal responsibilities shall be an important way to ensure successive execution of the energy label system. Meanwhile, appropriate penalties shall be given for lawless activities mentioned above. Possible penalty includes:

- Make a correction within a fixed term;
- Announcement and exposure in public;
- Fine 10,000 RMB for failure in label's pattern and without register.
- Fine of 50,000 RMB for forgery, fraudulence of label's information
- Forbid selling products without the label.
- Other penalty

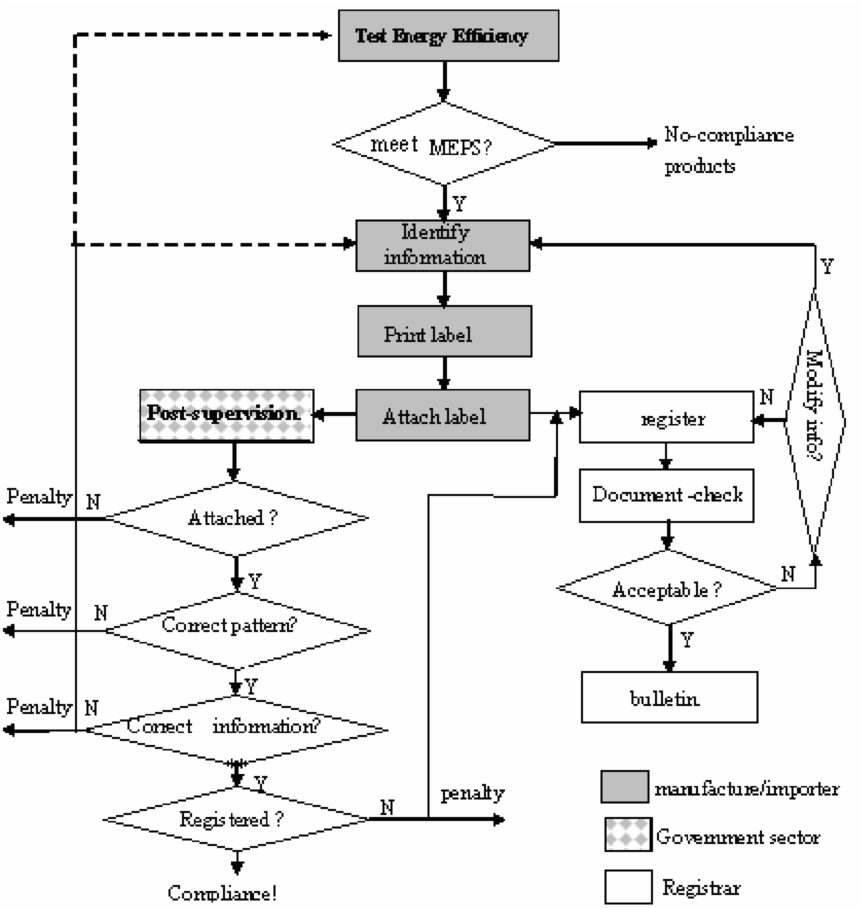

Figure 3: The implementation procedures for the energy label

3.5 product list

On 1st March, 2005, the refrigerators and room air conditioners were enforced to implement the label. The detail models of the refrigerator covered are electric motor driven compressive type refrigerators with volume of 500L and below. The model of ACs covered air conditioners using air cooling condenser, closed motor-compressor, with cooling capacity under 14000W, working under climate T1, no covering speed-variable, mobile and multi-connected air-condition(heat-pump) unit.

The label will cover cloth washers and unitary air condition in a year, and will possibly stretch into lighting products, water heater, motors and passenger cars based on practical implementing resource and potential of market transformation from each candidate label program.

3.6 pattern of the labels

China energy label pattern shall include basic pattern and specific pattern for each product. The basic pattern means general template for all the products' energy label. The basic pattern regulates the label shapes, colors, designs, overall layout, etc. in addition to other energy characteristics. Detailed patterns and specifications are provided in the implementation specification for different products, considering different sizes of energy-consuming products (e.g. refrigerator, air conditioner) and diversified energy consumption indexes (e.g. power consumption/24h for the refrigerator, energy efficiency ratio, refrigerating capacity for the air conditioner). The specific pattern comes from proportional zooming-in or zooming-out of the basic pattern, and meanwhile adding relevant information in connection with the product energy characteristics.

After a mixture of qualitative and quantitative market research to rank, screen, modify the label design, and several rounds of stakeholder workshop to solicit opinion and reach consensus on the nature of the final design, the basic pattern was determine. See Diagram 4. The label is a colorful one with blue-and-white background, somewhat similar with EU counterpart, but only 5 grades, include following items: manufacture name, product model, efficiency grade, energy consumption or energy efficiency indexes, other indexes deep involved with energy efficiency, and the adopted energy efficiency code.

The label for refrigerator is 62mm long and 98mm wide and their energy indexes are power consumption (kWh/24 hrs), Cubage of each compartment (L), such as those for chilling, freezing, fresh food storage, etc. The label for room air condition is 109mm long and 66mm wide and their energy indexes are energy efficiency ratio, power input (W), cool capacity.

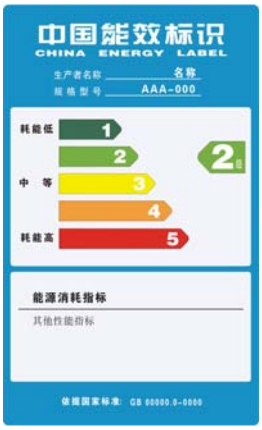

Figure 4: The basic pattern and specification of China Energy Label

3.7 Energy efficiency standards

Energy efficiency standards which is mandatory and offer MEPS and(or) grade criteria of energy performance is the technical basic of the label program. National energy efficiency standards classify refrigerators and room air conditioners' energy efficiency to 5 grades. For refrigerators, the standard is GB 12021.2-2003,the maximum allowable values of the energy consumption and energy efficiency grade for household refrigerators. For room air conditioners, energy efficiency standard is GB 12021.3-2004, the minimum allowable values of the energy efficiency and energy efficiency grades for room air conditioners.

China have absorbed the best practices from experienced economies in developing energy performance standards. The economic-engineering model and statistics analysis was pre-requisite methodology for drafting mandatory standards. Additionally, deep involvement of manufactures, patient negotiation, and market survey largely balance the count-interest between government aggressive goals on energy conservation and manufacturer' worries on rising cost for more efficient product and facilitate consensus on the new rigorous MEPS.

Generally, in those standards, the following criteria on energy efficiency classification was adopted: the grade 1 means international advanced efficiency, the grade 2 reflects the point of lowest Life Cycle Cost of the product, or accounts for top 20% of product distribution in term of energy efficiency, the grade 3 stands for average efficiency, the grade 5 identifies the batch of lowest efficient but qualified product which will be removed from market in the next round of MEPS revision and grossly share10% of product in market.

Table 1 indicates the Chinese energy efficiency criteria is more stringent than that of EU. The gap of requirement of refrigerators between EU and China seems narrow. But compared to the grade A+ and A++ of EU, Grade 1 and 2 of China are less ambitious. But appliance's energy efficiency in local market considered, the Chinese energy efficiency criteria less advanced than that of Korean,

Table 1: The comparison of energy efficiency criteria between EU and China

EU			CHINA		
Grades	**EER for ACs**	**EEI for refrigerators**	**Grades**	**EER for ACs ***	**EEI for refrigerators**
A++		30			
A+		42			
A	＞3.20	55	1	＞3.40	55
B	3.00～3.20	75	2	3.20～3.40	65
C	2.80～3.00	90	3	3.0～3.20	80
D	2.60～2.80	100	4	2.80～3.00	90
E	2.40～2.60	110	5	2.60～2.80	100
F	2.20～2.40	125			
G	≤2.20	＞125			

Note: * ACs with cooling capacity less than 4500W.

4 Energy saving potential of the Label

From findings of Project entitled " Energy saving potential of major types of energy-using products from energy efficiency standards and labeling", which funded by Energy foundation(US), and technically supported from ACEEE, the huge energy saving and pollutant mitigation will be achieved from successful implementation of energy information label. 14.2Twh of electricity or 5.5 MTce of primary energy in 2010, and 21.6Twh of electricity or 7.8MTce of primary energy in 2020 can be saved from label's program if it covered 8 types product such as refrigerators, room air conditioners, TV, commercial freezers, clothes washers, CFLs, and unitary ACs. In the term of summer peak load' reduction, the label will save a total of about 3.8 GW and 5.8GW of power in the year 2010 and 2020, respectively. Cumulative mitigation of C emission will reach 74.6 Mt from 2005 to 2010. the deep research showed that the average benefit-cost ratio of labels in China is about 2.0.

5 Impacts on Market transformation of the label

Though only one-year enforcement of refrigerators and room air conditioners' label, initial post-evaluation showed the label have played an active role in market transformation and yielded substantial benefit.

5.1 energy efficiency database

From March 1st, 2005 to March 1st, 2006, the two products accounted for more than 98% of turnover in Chinese Market were attached with the label and registered. For the product models still manufactured after March 1st, 2005, energy efficiency data of about 2293 models of from 98 refrigerator manufacturers and 4568 models from 75 air conditioner manufacturers, which accounted for more than 98% of turnover in Chinese Market, were recorded by the energy efficiency database in the registrar. For the product models not yet manufactured but still sold in market, energy efficiency data of more than 1800 models of refrigerators and more than 3000 models of air conditioners were recorded by the database.

5.2 Penetration of efficient products

Diagram 5 shows the energy efficiency distribution of those models which still manufactured after 1st, March, 2005. Compared two caky charts, it is very clear that penetration rate of efficient air conditioners was very lower than that of refrigerators. For refrigerators, about 40% of the models belonged to grade 1 and more than 70% of models met energy efficiency requirement (grade 1 and 2) of China Energy

Conservation Product (CECP, a endorsement label). Reversely, less than 10% of air conditioner model met the endorsement label requirement, and about 70% of model is low efficient(very cheap). The main reasons are possibly as follows: a),GB 12021.2 was issue by May, 2005 and enforced by Nov. 2003, but GB 12021.3 was issue by Aug. 2004 and enforce by Mar. 2005. So, refrigerator enterprises have relatively enough time to adjust strategies of product model and manufacture and promote efficient model than air conditioner company; b), in recent 5 years, the market of air conditioner fluctuated dramatically, violently shifting seller's market to buyer's market. Supply severely exceeding supply caused irrational price war to alleviate manufacturer's storage. Many manufactures desperately cut the air conditioner's cost at the expense of product's performance including energy efficiency. but for refrigerator, the market is more mature. The efficiency approach is one of key market strategy; c), In Market, the awareness of energy efficiency for air conditioners was very lower than that of refrigerators. In general, for air conditioners, the manufacturer and retailer enthused about cost promotion but reluctate declaration of energy efficiency. Most of consumers ignored energy performance but reveled in the manufactures' promotion of very cheap air conditioners. Reversely, the concept of energy consumption per day was rooted into consumers by the refrigerator manufactures and retailers' advertisement and sale promotion. Consumers associated the energy performance with quality and money benefit.

The mode distribution both refrigerators and air conditioners did not belong to Gaussian distribution. The distribution informed that refrigerator' market is efficiency driving, air conditioner is the cost driving.

5.3 market transformation

Comparing the distribution of product mode manufactured from 1st March, 2005 to 1st, March, 2006 with that manufactured before 1st march, 2005, we can find both refrigerator and air conditioner's market transformed from a low level of energy efficiency to a higher level.

Air conditioners : the diagram 6 shows a moderate increase by 6% in proportion of the efficient modes （grade 1 and 2）and a significant decrease of the less efficient models(model 5 and below) by 10% in a year. More important, 30%of models which did not reach the MEPS were eliminated.

Refrigerator: the diagram 7 shows a significant increase by 13% in proportion of the most efficient modes （grade 1）and a significant decrease of the average efficient models(model 3) by 9% in a year. About 4%of models which did not reach the MEPS were eliminated.

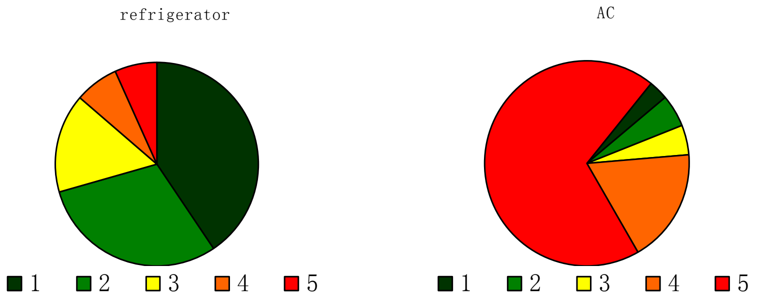

Figure 5: the energy efficiency distribution of model of refrigerators and air conditioners, respectively.

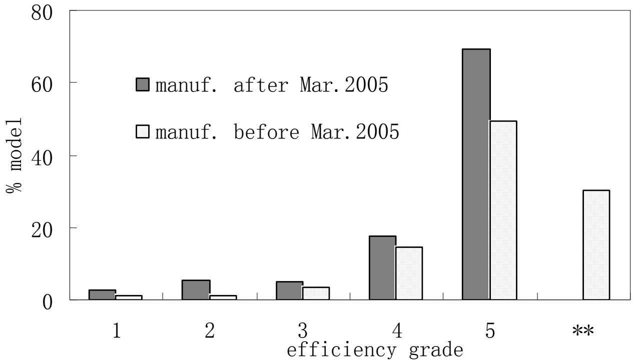

Figure 6: Comparison of the energy efficiency distribution in term of models between room air conditioners manufactured after Mar. 2005 and those manufactured before Mar. 2005

Note: * * means efficiency below grade 5, namely, not meet MEPS

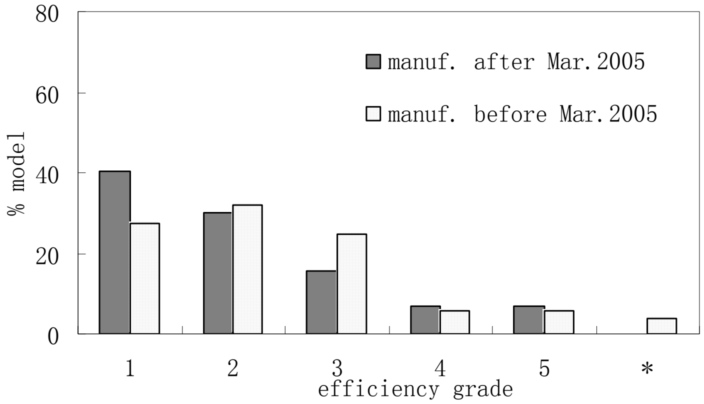

Figure 7: Comparison of the energy efficiency distribution in term of models between refrigerators manufactured after Mar. 2005 and those manufactured before Mar. 2005

Note: * means efficiency below grade 5, namely, not meet MEPS

The label pushed the transformation from the following dimensions: a) label facilitated the removal of lest efficient products(30% of air conditioners' model were push out from the market). Because of implementation and promotion, the local supervision authorities strengthened intension and frequency of market surveillance and manufacturers well recognized that the listed products with efficiency below grade 5 belongs to unqualified product. So label enhanced the compliance of the MEPS; b), manufactures were roused to development of products. The drives at least include the NDRC and AQSIQ's periodic official notifications of the manufacturer and model lists of products with grade 1 and 2, which advertised their products and (more important)boasted their brands, and relevant incentives such as the government procurements. The products with label 1 or 2 met the efficiency requirement of the CECP label. if they was granted to use the label after a voluntary third party certification, they had some advantages in competence of bid of government procurement; c), most importantly, more and more consumers were familiar with label and consider the efficiency and operation cost as a key factor in their purchase decision. the label tells a consumer the true cost of a appliance and changes their choice, thus impress on the manufactures' strategies of product model.

A survey with 600 samples from more than 100 appliance chain shops in six big cities was conducted by CNIS to figure out attitude of consumers and retailers toward the label. The findings shows the label has already attract "eyeball"the retails and consumers as a distinct advertisement. 40% of consumes are very interesting in the products with grade1 label and 35% for grade 2, and only less 10%, for label 3, 4, 5, respectively. Most of retails can correctly understand the label and confess they are willing to show the label to consumer to promote the high pole of products.

From this reliable and reasoned energy efficiency date of all models in market and some surveys, a primary assessment indicated about 1.8 billion KWh electricity was saving from the label's implementation for the refrigerators and air conditioners in one year. About 20% manufacturer's were shut down because of their uncompetitive products in efficiency.

Of course, a well designed survey and evaluation research needed to further unveil the impacts of the label on market transformation.

6. Conclusions

China Energy Label was mandatorily implemented for the listed products in the mode of manufacture self-declaration + register of energy efficiency + post- surveillance. NDRC, AQSIQ and CNCA are responsible for issuing relevant legislation and specifications to set up the scheme of the label and planning & organizing national supervision within their respective jurisdiction. The local administrative counterparts undertook the market supervision and surveillance to enforce the compliance of the label. CNIS, the authorized register agency, took charge of recording, checking, bulletin of energy efficiency data.

From statistic analyses of recorded data from official register data, the penetration rate of efficient refrigerators was significantly higher than that of air conditioners. The label played an active role in market transformation by strengthening implementation of MEPS and sharpening of penetration of efficient models. A assessment showed about 1.8 billion KWh electricity was saving from the market transformation. Site surveys validated that the label influenced purchase decision of consumers, incented retailers to promotion of efficient appliances and fostered awareness of energy efficiency in market.

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Framework of China’s Energy Efficiency Standards Enforcement and Monitoring

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Abstract

China started to develop energy efficiency standards for appliances in the mid-1980s, and by now has implemented minimum energy performance standards (MEPS) for about 20 product groups, such as refrigerators, room air-conditioners, clothes washers, fluorescent lamps, and electric motors. In addition, standards for metal halide lamps and ballasts are near approval. China has introduced a voluntary certification label for energy conservation products in 1998, and a mandatory energy information label in 2004. However, China has not yet established a comprehensive framework of energy efficiency standards enforcement and monitoring. This paper addresses the present status of energy efficiency standards development, enforcement and monitoring in China. It identifies the problems and obstacles when implementing the energy efficiency standards. Based on the analysis of the status and obstacles, the paper provides policy recommendations for framework of China’s energy efficiency standards enforcement and monitoring, such as to develop elimination system of high energy consuming products, to promote market monitoring scheme.

1. Review of the development of China’s energy efficiency standards (MEPS)

1.1 History of the MEPS development

China started to develop energy efficiency standards for appliances in the mid-1980s and has experienced 3 stages: first stage (1989-1995), 9 household appliances had been covered in MEPS; second stage (1995-2000), lighting, and commercial & industrial equipment had been covered; from 2000, research work has been done for energy efficiency classification, reach standards, and target limited values of energy efficiency have been introduced to the standards. By now China has implemented minimum energy performance standards (MEPS) for 24 products, in 5 product categories, including household appliances such as refrigerators, color TVs, lighting products such as self-ballasted fluorescent lamps, ballasts for tubular fluorescent lamps, industrial equipment such as motors, air compressors, commercial equipment such as unitary air conditioners, and passenger cars (Table 1).

Table 1: China energy efficiency standards for products & equipments

Standard Code	Covered Products	Effective year	Agencies Developing Standard	Contents
GB12021.2-2003	Refrigerator	2003	CNIS	MEPS,* * , * * *
GB12021.3-2004	Room air conditioner	2004	CNIS	MEPS,* * , * * *
GB12021.4-2004	Cloth washing machine	2004	CNIS	MEPS,* * , * * *
GB12021.5-1989	Electric iron	1989	CNIS	MEPS
GB12021.6-1989	Electric rice cooker	1989	CNIS	MEPS
GB12021.7-2005	Color TV	2005	CNIS	MEPS
GB12021.8-1989	Radio	1989	CNIS	MEPS
GB12021.9-1989	Electric fans	1989	CNIS	MEPS
GB 17896- 1999	Ballasts for tubular fluorescent lamps	1999	CNIS	MEPS, * * *
GB 18613-2002	Small and medium three-phase asynchronous motor	2002	CNIS	MEPS, * * *
GB 19043-2003	Double-capped fluorescent lamps for general lighting service	2003	CNIS	MEPS,* * , * * *
GB 19044-2003	Self-ballasted fluorescent lamps for general lighting service	2003	CNIS	MEPS,* * , * * *
GB 19153-2003	Displacement air compressor	2003	CNIS	MEPS, * * *
GB 19415-2003	Single-capped fluorescent lamp	2003	CNIS	MEPS, * * *
GB 19576-2004	Unitary air conditioner	2004	CNIS	MEPS,* * , * * *
GB 19577-2004	Chiller center air conditioner (heat-pump)	2004	CNIS	MEPS,* * , * * *
GB 19573-2004	High-pressure sodium lamp	2004	CNIS	MEPS,* * , * * *
GB 19574-2004	Magnetic ballast for high-pressure sodium lamps	2004	CNIS	MEPS, * * *
GB19578-2004	Passenger car	2004	*	MEPS
GB19762-2005	Centrifugal pump for fresh water	2005	CNIS	MEPS, * * *
GB19761-2005	Industry fan	2005	CNIS	MEPS, * * *
GB20052-2006	Distribution transformers	2006	CNIS	MEPS, * * *
GB20054-2006	Metal halide lamps	2006	CNIS	MEPS,* * ,* * *
GB20053-2006	Ballasts of metal halide lamps	2006	CNIS	MEPS,* * ,* * *

* : China research center of Car. * * : Energy efficiency classification, * * * :Evaluating value for certification program of energy conservation products

The products covered by MEPS which have been developed and are about to be issued include distribution transformers, metal-halide lamps, ballasts for metal-halide lamps. The standards for gas water heaters, adapters, motors, air conditioners with variable speed are under development. The standards for electric water heaters, boilers, power transformers, commercial freezers, microwave ovens, copy machines, set-top boxes, multi-connected air-condition (heat-pump) units are under consideration.

1.2 Contents of China's energy efficiency standards

All energy efficiency standards that have been issued in China are mandatory. The information specified in the standard are mainly about product classification, limited values of energy efficiency, evaluating values of energy conservation, energy grades, target limited values of energy efficiency, test methods, and checking & inspection rules. Among them, limited values of energy efficiency are crucial which specified the minimum requirements for the market access of the products. Evaluating values of energy conservation, and energy grades are recommended indicators. They are the basis of the certification program for energy conservation products which was launched in 1998, and the mandatory labelling programme which was launched in 2005. Several types of analyses, such as engineering analysis, national impact analysis, and consumer analysis have been conducted when determine the values.

2. Current status for the MEPS enforcement in China

A whole picture for the framework of energy efficiency standards enforcement and monitoring is shown in figure 1. The following section will give more details about each part.

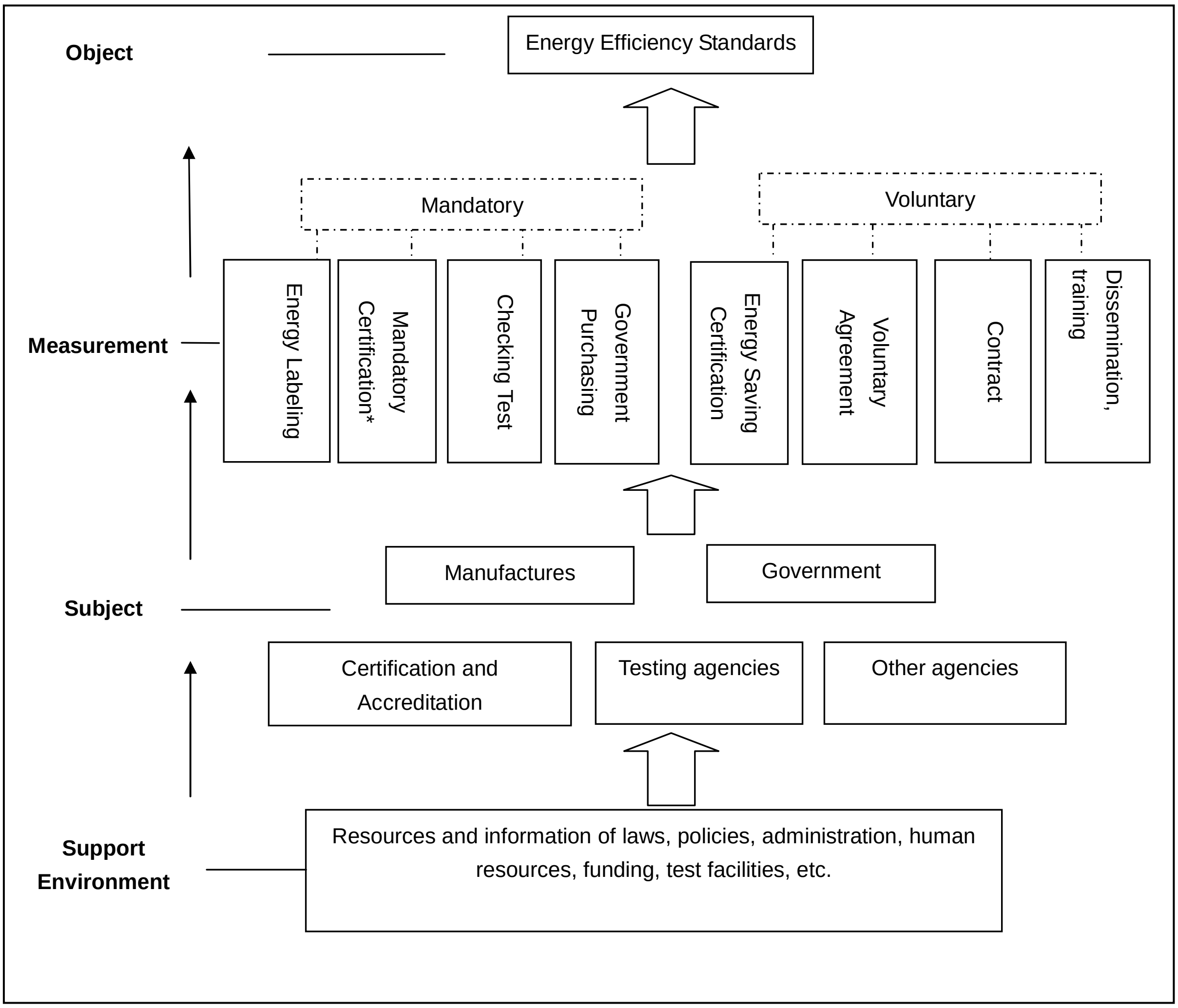

Figure 1: Panorama of Energy Efficiency Standards Enforcement and Monitoring
Note：* -- or called measurement to eliminate high energy consuming products

2.1 Support environment

2.1.1 Law, regulation, and policy

Standardization Law of The People's Republic of China (1989[1]), Implementation Rules of Standardization Law (1989), Regulation on Energy Standardization Administration (1990), Energy Conservation Law of The People’s Republic of China (1998), Regulation on energy conservation

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[1] Issued year, the same in other parentheses

production certification (1998), Regulation on Products Quality Monitoring and Checking Administration (2002), China Medium and Long Term Energy Conservation Plan (2004), Regulation on Energy- Efficiency Labeling Administration (2004) have built up the legal basis for energy standardization. For example, Article 33 in Implementation Rules of Standardization Law states:" manufactures that produce the products which fail to meet the mandatory standards should be stopped. The products should be confiscated and destroyed under monitoring or technically treated. Fine should be paid by manufactures upon 20-50% of the product's value. Personnel who is responsible should be fined under RMB5,000." Penalty for retailers and importers who violate are also specified in it. Article 8 in *Regulation on Energy Standardization Administration* states that mandatory energy standards should be complied with. Violation should be dealt with according to *Implementation Rules of Standardization Law.*

2.1.2 Administration system of standards enforcement in China

By law, General Administration of Quality Supervision and Inspection and Quarantine of People's Republic of China (AQSIQ) is responsible for administration of national standardization (strategies, policies, plans, projects, examination, publishing, and registration), coordinating with other administrative agencies which supervise industrial standardization. For example, Department of Environment and Resource Conservation, of National Development and Reform Commission (NDRC) supervises energy efficiency standards, and energy labeling programme. The whole administration system includes: government and market monitoring system, standards and conformity assessment procedures, testing and inspection, resources (human resources, funds, and testing facilities).

2.2 Enforcement and monitoring agencies (Subject in Figure 1)

2.2.1 Government agencies

Government agencies which involve in energy efficiency standards enforcement and monitoring include NDRC, AQSIQ, State Administration for Industry and Commerce of the People's Republic of China (SAIC), and their local administrative bureaus. NDRC's liabilities are to propose strategies and policies for energy conservation and draft relevant regulations, such as *China Medium and Long Term Energy Conservation Plan*, to organize and supervise the development of energy efficiency standards, to guide the certification program for energy conservation products, and energy labeling programme.

Three departments of AQSIQ, Standardization Administration of the People's Republic of China (SAC), Certification and Accreditation Administration of the People's Republic of China (CNCA), and Department of Supervision on Product Quality (DSPQ), supervise standardization, certification and accreditation, product quality monitoring and checking work related to energy efficiency respectively. State Administration for Industry and Commerce of the People's Republic of China (SAIC) supervises market monitoring, and administrative law enforcement.

2.2.2 Other organizations

Industrial associations/consortia, certification & accreditation organizations, testing labs, consulting firms, consumers' association, and media, etc., also involve in energy efficiency standards enforcement and monitoring. They provide services in many aspects, such as market monitoring, certification, testing, and consultancy. For example, energy conservation centers in many provinces help government to carry out energy policies, provide consulting, evaluation, information distribution, and training. Active associations in this area include China Household Electrical Appliance Associations (CHEAA), and China Association of Lighting Industry (CALI). China Standardization Certification Center is the organization of third-party certification for energy conservation products, water conservation products, and 3C certificated products. China Consumers' Association has a well organized national network with more than 3,100 sub-associations, and 100,000 volunteers could be very powerful in this area.

2.2.3 Manufactures

Individual manufacture is the first in the row for energy efficiency standards enforcement and monitoring. According to the questionnaire [1] which covered 12 refrigerator, and 15 air conditioner major manufactures in China, the results (Table 2) indicated that the proportion of compliance varies dramatically, from 75% of refrigerator manufactures to 27% of air conditioner ones. Although energy efficiency standards are mandatory, they are depend on manufactures to comply with. Very limited monitoring is from government.

Table 2: Results from a questionnaire about compliance with energy efficiency standards

	Involve in Standard Development	Compliance	Standards Impact on Manufactures		Standards Implementation
			Reply	Cost	
Refrigerator Manufactures	83%	75% pass, 5-10% failure	New model; technical improvement	Average increased RMB50, Max. RMB400	Depend on manufactures
Air Conditioners Manufactures	53%	53% uncertain, 27% pass	Quality control; design improvement	Average increased RMB125	Depend on manufactures

2.3 Measurement of energy efficiency standards implementation

2.3.1 Mandatory certification

Certification and accreditation scheme are important components of standards implementation system. The combination of certification and market access scheme is a powerful incentive to push the standards implementation. China Compulsory Certification (3C) was launched on August 1, 2003. It is applied to products related to human life and health, animals, plants, environmental protection and national security. One *Catalogue of Products Subject to Compulsory Product Certification*, one set of applicable technical regulations, national standards and conformity assessment procedures, one obligatory mark and one structural fee chart are announced for statutory implementation. Now it covers 132 products in 19 categories. Though mandatory certification has not been introduced to high energy consuming products, China's MEPS has specified the limited value of energy efficiency, that means the baseline to eliminate high energy consuming products has been established.

2.3.2 Voluntary certification

The certification program for energy conservation products had been launched in 1998. *Regulation on energy conservation production certification* specifies general requirement, certification procedure, certificate and label, penalty for the scheme. It is an endorsement label on voluntary basis, similar to US *Energy Star* program. Evaluating values of energy conservation in MEPS are adopted in the program. The certification mode is: factory examination + product test + reexamination & inspection. It covers 17 products of 5 categories now, such as home appliances, lighting, office equipments, industrial equipments, etc.[2]

2.3.3 Government purchasing

Government purchasing is an important tool for standards implementation. In December 2004, NDRC and Department of Finance jointly issued *Advice on Government Purchasing for Energy Conservation Products.* More than 100 products in 8 categories, such as air conditioners, refrigerators, fluorescent lamps, TV, computers, printers, faucets, and toilets are covered in the first purchasing catalogue. The catalogue is updated according to needs. If the duration??? (which duration?? Maybe life time, or the list?) is over, or fail to certain standards, those products which are in the catalogue will be removed; if meet the requirements, those products which are not in the catalogue will be supplemented. In April 2005, the catalogue had been adjusted at the first time.

2.3.4 Monitoring and Checking

Effective in 2002, *Regulation on Products Quality Monitoring and Checking Administration* states that products which are associated with public health, safety, important industrial products (such as energy using products), and products which have quality issues exposed by consumers are regulated to be monitored and checking. Two types of checking on national level are classified in it. One is the checking on regular basis, one time in each quarter. The other is the irregularly specified checking. AQSIQ and its local agencies are responsible for supervision and inspection. They are responsible to develop the checking list of products which are regulated. Monitoring and checking is the major measurement for government to control products quality. However, energy efficiency has not been covered in the system.

2.3.5 Mandatory energy label

August 2004, *Regulation on Energy- Efficiency Labelling Administration* has been issued. On March 1,2005, the mandatory programme for household refrigerators and room air conditioners had been launched. Until October, 2005, 6223 models of 146 manufactures, including 2100 models of 78 manufactures of refrigerators, 4123 models of 68 manufactures of air conditioners had submitted application materials. Among them, 111 manufactures, including 53 manufactures of refrigerators, and 58 manufactures of air conditioners had registered [3].

Table3: Ratio of each grade refrigerators, and air conditioners in all registered ones

	Refrigerator (%)	Air conditioner (%)
Grade 1	37	3
Grade 2	31	5
Grade 3	19	4
Grade 4	5	17
Grade 5	8	71

From Table 3, the energy efficiency level for refrigerators is much better than that of air conditioners that the sum of ratio of Grade 1 and 2 for refrigerators is 68%, only 8% for air conditioners. When compare the energy efficiency level before and after the introduction of energy label (Table 4, 5), although implemented for only 8 month, the programme has dramatically impact. For example, the market share for air conditioners with energy grade lower than Grade 5 is 31.4% before March 1, 2005. But energy grade for all the air conditioners produced after March 1 are over Grade 5. The market share for Grade 1 refrigerators increased 15.2%.

Table 4： Energy Efficiency Level Comparison for Room Air Conditioners，Before and After the Energy Labelling Implementation

	Market share（%）			
	Grade 1	**Grade 2**	**Grade 5**	**Lower than Grade 5**
Produced between March 1 and October	2.6%	4.3%	69.4%	0%
Produced before March 1	1.2%	1.1%	47.7%	31.4%
Increasing rate	1.4%	3.2%	21.7%	-31.4%

Table 5： Energy Efficiency Level Comparison for Refrigerators，Before and After the Energy Labelling Implementation

	Market share（%）			
	Grade 1	**Grade 2**	**Grade 5**	**Lower than Grade 5**
Produced between March 1 and October	41.6%	34.9%	3.3%	0%
Produced before March 1	26.4%	32.3%	6.1%	4.1%
Increasing rate	15.2%	2.6%	-2.8%	-4.1%

2.3.6 Other measurements

Voluntary agreement is a successful measurement adopted by many countries for the purpose of energy conservation, energy efficiency improvement, and environment protection. It benefits both government and industries on a voluntary basis. Technically, national reach standards and association standards are used. Self declaring & contract is a measurement to push technical standards implementation driving by market force. Pilot studies had been introduced to China. They are still in the early stage. We hope that these measurements will become more and more promising in China.

3. Problems in Energy Efficiency Standards Implementation

Generally speaking, China has not established a set of implementation and monitoring system for energy efficiency standards. The implementation status of energy efficiency standards is not so optimistic. Therefore, energy efficiency standards are actually not as that effective as they are supposed to be, especially lack of powerful implementation and monitoring measures for the mandatory requirements of energy using products on whether those products meet the minimum requirements of the limited values of energy efficiency or not, which resulting in that the market for energy using products is not a regulated one and large amount of high energy consuming products still exist in the market. The main problems existed when implementing energy efficiency standards are as follows:

3.1 Legal system is not sufficient, penalty is not stringent enough

Although it has been established for energy saving as mentioned in previous sector, the legal system is not sufficient. For example, checking on energy efficiency values have not been in AQSIQ's monitoring and checking system. The energy labeling scheme in China now is manufacture's /importer's self declaring + registration+ monitoring. No clear rules in regulations on what kind of penalties would apply, and how to punish if the violation is exposed. How to deal with the competitor's complaints is not clear as well.

Energy Conservation Law of the People's Republic of China indicated the framework for the scheme to eliminate high energy consuming products. The purpose is to establish the mechanism to eliminate high energy consuming products from the market periodically, in order to improve energy efficiency, to apply new technology, to favor the market transformation. Limited values of energy efficiency can be used as the threshold. So far, the detailed regulation on implementation rules has not been in place yet [4].

3.2 Product energy efficiency performance is not in government's product quality monitoring and checking system

As an important performance of energy using products, energy efficiency is the most important embodiment for the quality of energy using products. According to *The Product Quality Law* and *The Standardization Law*, any product which doesn't meet the requirement specified in the mandatory standard is an unqualified one. So far, the Chinese government hasn't put the requirement on product energy efficiency standards into product quality monitoring and checking system, resulting in lack of the powerful platform when supervising the implementation of energy efficiency standards.

3.3 Market monitoring system is not established

Market monitoring system here means that the measurements taken by agencies, industrial associations, consumers' association, even manufactures on their own other than government agencies so as to monitor standards implementation. Standards implementation could cost a lot of money. Only the official input is far from enough. The successful stories from other countries, such as US, CECED suggest that market monitoring is efficient, cost effectively, sometimes could avoid long time, expensive and complicated legal process and reach the same results. However, due to the asymmetry of energy efficiency information, the channel for consumer complain is not well established, especially that consumer's energy efficiency awareness is not high enough, resulting in that the effective social monitoring and supervising system has not been established yet, and lacking the broad support from the society when implementing energy efficiency standards.

3.4 Incentives is limited

The questionnaire (Table 2) shows that manufactures must go through technical improvement in order to meet energy efficiency standards' requirements. The cost rises accordingly. Because price takes more weight when most Chinese consumers make decision, people are more likely to buy cheaper products. Manufactures are reluctant to produce higher efficiency products if they couldn't benefit by doing so. People lack motive to buy higher efficiency products if there is no subsidy.

3.5 Information dissemination & education is not good enough

Today, the compliance with the mandatory limited values of energy efficiency is relying on manufactures themselves in China because of insufficient legal system, and lack of monitoring and checking scheme. Many manufactures even do not know there are mandatory energy efficiency standards in place. Due to the shortage of necessary fund and effective operating mechanism, the publicity to the public, the education to manufactures, retailers and consumers on energy efficiency standards is far from satisfying the need of the society. The lag of training work resulted in that public's awareness on energy efficiency standards is limited, and the market is not ready for an energy efficient one. All these fact really greatly hampered the effective implementation of energy efficiency standards.

4. Policy recommendations for framework of China's energy efficiency standards enforcement and monitoring

Types of enforcement models adopted by other countries can be classified as follows: 1) Australia: government performs compliance verification; 2) EU: manufactures self declare with testing within a regional policy framework; 3) USA: self- enforcement: government relies on manufacturers self reported test results, and non-compliance of a competitor, plus trade associations voluntary programs to help regulate the industry; 4) Tunisia and the Philippines: government controls the certification [5]. In addition, all regulated products must bear a verification mark from a Standards Council of Canada (SCC) accredited certification body to prove that the product was verified for energy performance in Canada [6].

By comparing Chinese status of economic development, production, and market with those countries, taking the international experiences as reference, analyzing the status and problems in energy efficiency standards implementation in China, and considering the transition period from planned economy to market economy, the policy recommendations are not only to enhance government monitoring and checking, but also to gradually establish market monitoring scheme. In detail,

- To enhance law system for energy efficiency standards development, implementation, and monitoring, such as to develop *Regulation on Energy Efficiency Standards Administration*
- To add energy efficiency values to the national products quality checking criteria
- To develop elimination system of high energy consuming products, such as to add it to 3C scheme, to establish mandatory manufacturing license scheme according to national manufacturing license system
- To establish mandatory certification scheme by introducing Canadian experience
- To introduce China Energy Label to more products
- To promote certification program for energy conservation products
- To provide financial incentives to benefit high efficiency products
- To promote market monitoring scheme, such as third-party certification, competitors' & industrial association's challenging testing, etc.
- To enhance information dissemination, education, training, etc.

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The Role that the Energy Efficiency Standards played in China Green Lights Project

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Abstract

Lighting is responsible for over 10% of national electricity consumption in China. The development and enforcement of energy efficiency standards for lighting products is an effective way to save electricity. The National Energy Efficiency Standard Study & Establishment Project for Lighting Products was one of the important sub-projects of China Green Lights Promotion Project. The major target of the Project was to establish mandatory national energy efficiency standards focusing on six types of lighting products including double-capped fluorescent lamps, self-ballasted fluorescent lamps, high-pressure sodium lamps, ballasts for high-pressure sodium lamps, metal-halide lamps and ballasts for metal-halide lamps. The standards mainly consist of limited values for energy efficiency, evaluation values of energy saving, energy efficiency grades and target limited values of energy efficiency.

This paper addresses energy conservation potential of the National Energy Efficiency Standard for lighting products, the project implementation status, main experience from the project, and the role that energy efficiency standards played in China Green lights project.

1 Market status and energy conservation potential of lighting products in China

The “China Green Lights Project” is a joint initiative between the Chinese Government’s National Development and resource Commission (NDRC), the United Nations Development Programme (UNDP) and the Global Environment Fund (GEF). The project aims to promote the conservation of energy used by lighting whilst simultaneously improving the quality of lighting products and the light output they produce.

At present, lighting consumes 12% of all electricity generated in China. The replacement of traditional inefficient lighting products with efficient units would bring about electricity savings of between 60% and 80%, with associated reductions in carbon and other emissions. Further, the adoption of more efficient lighting products would reduce both the quantity of raw materials used and the amount of waste generated. China is now the leading producer of lighting products in the world. There are over 8,000 lighting manufacturers in China producing US$11bn of products and employing 5 million people. As China exports US$5.4bn of this production to over 150 countries, the actions being stimulated by the China Green Lights project will benefit lighting efficiency worldwide.

The overall goal of the China Green Lights Project is to reduce lighting energy use in China by 10% (saving a cumulative total of 100 billion kWh of electricity and reduce 97 million tons of CO_2 emission and 5 million tons of SO_2 emission) by 2010. This will be achieved through stimulation of both the supply of efficient, higher quality lighting products, and the demand for these products both nationally and internationally.

The current “China Green Lights Promotional Project” was preceded by the “China Green Lights Programme”. The earlier programme was undertaken during the 9th “5-year plan “(1996-2000) and was also a joint initiative between a number of Chinese Government organizations and the UNDP. This initial programme stimulated interest in more efficient, less polluting products and their cost effective potential. The success of the project in demonstrating the place efficient lighting holds in supporting the sustainable development of China led to the development of the current China Green Lights Project.

2 Project objectives and main activities of the China Green Lights Project

The aims of the China Green Lights project are to promote energy conservation, to advance environmental protection and improve standards of lighting to assist social and economic progress in China. The main objectives include:

- Removing the market barriers to widespread adoption of energy efficient lighting in China.
- Working with manufactures to improve the quality of efficient lighting products and expand the share efficient lighting has within the domestic market.
- Increasing consumer awareness of the economic and environmental benefits of energy efficient lighting systems.
- Expanding exports of efficient lighting products to aid the Chinese economy.
- Developing new mechanisms and programs for sustainable development in efficient lighting products and systems.

The main activities include:

- Establishing lighting product efficiency standards.
- Developing energy conservation certification and labeling schemes.
- Designing and implementing market aggregation activities（bulk purchase）.
- Piloting demand-side management (DSM) Lighting initiatives.
- Piloting quality commitment programmes.
- Developing building standards.
- Improving consistency between test laboratories.
- Improving the quality of key lighting products, raw materials and components through technical support and the development of retrofit plans.
- Mass media and educational activities.
- Activities to educate industry professionals have included.

The National Energy Efficiency Standard Study and Establishment Project for Lighting Project For Lighting Products was one of the important sub-projects of China Green Lights Promotion Project. Its major target was to provide scientific and technologic foundation for other activities of China Green Lights Project.

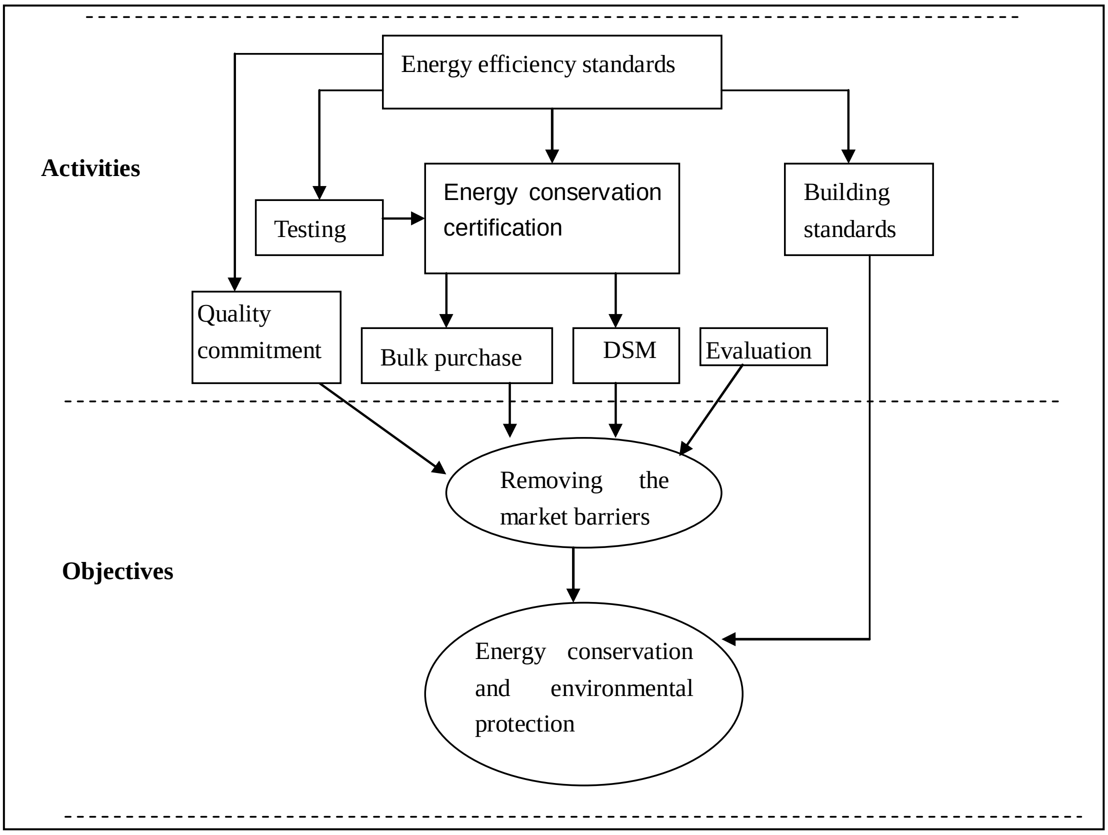

Figure 1: Schematic view of project elements in Green Light Project

3 The project implementation status

The research and establishment of sub-project of the national energy efficiency standard for lighting products was divided into three phases, each of which was required to establish two energy efficiency standards for lighting products.

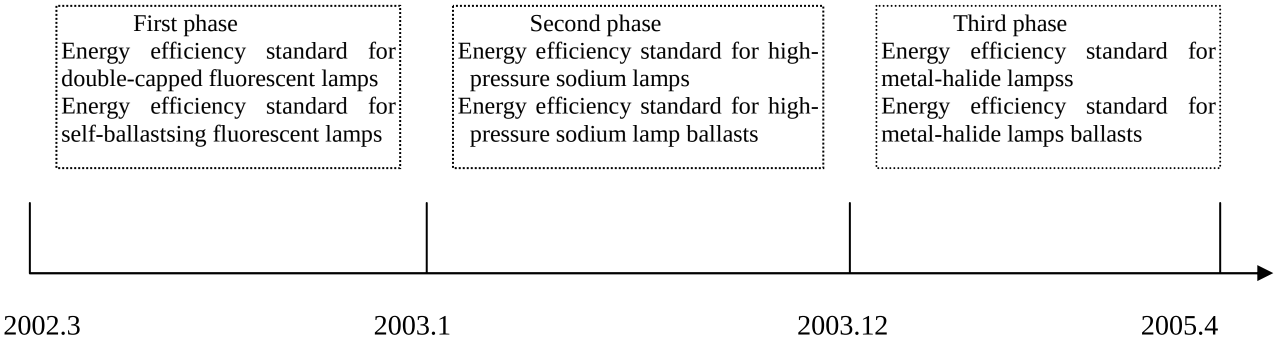

Figure 2: Arrangement of Project phases

For the research and establishment of each standard, there were normative processes:

- According to the products related to the standards, make industrial survey, collect related domestic and foreign standard information and materials in wide range, sort and analyze the information and materials;
- Sample and test lighting products sold in domestic market, compare and analyze home and foreign technical indices and technical feature;
- Make calculation, evaluation and selection based on different solution, preliminarily determine the limited value of energy efficiency, evaluation value of energy saving, energy efficiency grades and advanced limited values of energy efficiency for various products on the basis of the result of above analysis and calculation;
- Meanwhile compile the standard drafts;
- Finally decide all energy efficiency indices of various products through widely soliciting suggestions and validating the standards with testing data, formulate the submission and examination draft, submission and approval draft and compiling explanation;
- Organize to compile the standard promotion and education materials after finishing the technical analysis report of standard, hold the standard promotion and education conference.

The Standard research and establishment started with the first meeting of drafting group and finished with the examination & establishment meeting passing through checkup. The examination & establishment meeting consisted of cadres and experts from various areas. The memorandum of standard examination meeting should evaluate and summarize the standard. From June 2001 to 2004, China has finished six energy efficiency standards.

3.1 GB 19043-2003 Limited values of energy efficiency and rating criteria of double-capped fluorescent lamps for general lighting service

3.1.1 Scope

The Standard is applicable to cathode preheat double-capped fluorescent lamps with starters working under AC frequency and cathode preheat double-capped fluorescent lamps working under high frequency, with rated wattage ranging from 14W~65W.

3.1.2 Energy efficiency

The energy efficiency of double-capped fluorescent lamps is classified into three levels, in which level 1 is of the highest energy efficacy. The initial luminous efficacy of products of all levels shall be no less than the values specified in table 1. The limited values of energy efficiency of double-capped fluorescent lamps are specified as the values of grade 3 in Table 1. The evaluating values of energy conservation are specified as the values of grade 1 in Table 1 for double-capped fluorescent lamps with high luminous efficacy (14W、21W、28W、35W); the evaluating values of energy conservation for other double-capped fluorescent lamps are specified as the values of grade 2 in Table 1.

Table 1: Energy efficiency grades of double-capped fluorescent lamps

Range of rated wattage W	Initial luminous efficacy lm/W								
	Energy efficiency grades（Color temperature: RR,RZ）a)			Energy efficiency grades（Color temperature: RL,RB）a)			Energy efficiency grades（Color temperature: RN,RD）a)		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
14~21	75	53	44	81	62	51	81	64	53
22~35	84	57	53	88	68	62	88	70	64
36~65	75	67	55	82	74	60	85	77	63
a) The color temperature in the table 1 shall be in compliance with the requirements of the chroma coordinate in GB/T 10682[1]. Enterprises may manufacture lamps of non-standard colors according to the requirements of their customs, but shall offer the target values of the chroma coordinate of the non-standard colors at the same time, with its tolerable deviation within 5SDCM. For lamps of non-standard colors, their luminous efficacy shall be evaluated according to the values of their neighboring of lamps of standard colors with a higher energy efficiency grade.									

3.1.3 Lumen maintenance

For double-capped fluorescent lamps of each energy efficiency grade, their lumen maintenance shall meet the requirements of GB/T 10682.

3.1.4 Target limited values of energy efficiency

Please see table 2 for the requirements of target limited values of energy efficiency to be implemented on August 1, 2005.

Table 2: Target limited values of energy efficiency for double-capped fluorescent lamps in 2005

Range of rated wattage W	Initial luminous efficacy lm/W		
	RR,RZ	**RL,RB**	**RN,RD**
14~21	53	62	64
22~35	57	68	70
36~65	67	74	77

3.2 GB 19044-2003 Limited values of energy efficiency and rating criteria of self-ballasted fluorescent lamps for general lighting service

3.2.1 Scope

The Standard is applicable to self-ballasted fluorescent lamps for general lighting services used in household or similar circumstances, working under rated power of 200V, 50Hz AC frequency, with screw cap or bayonet caps that integrate start control and stable ignition parts, with rated wattage of 60W and below.

This standard is not applicable to self-ballasted fluorescent lamps with lampshades.

3.2.2 Energy efficiency

The energy efficiency of self-ballasted fluorescent lamps are classified into three levels, in which level 1 is of the highest energy efficacy. The initial luminous efficacy of products of all levels shall be no less than the values specified in table 3. The limited values of energy efficiency of self-ballasted fluorescent lamps are specified as the values of level 3 in Table 3. The evaluating values of energy conservation of self-ballasted fluorescent lamps are specified as the values of level 2 in Table 3.

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[1] GB/T 10682 *Double-capped Fluorescent Lamps Performance Specifications*

Table 3: Energy efficiency grades of self-ballasted fluorescent lamps

Range of rated wattage W	**Initial luminous efficacy lm/W**					
	Energy efficiency grades（Color temperature: RR,RZ）a)			**Energy efficiency grades(Color temperature: RL,RB,RN,RD）a)**		
	1	**2**	**3**	**1**	**2**	**3**
5～8	54	46	36	58	50	40
9～14	62	54	44	66	58	48
15～24	69	61	51	73	65	55
25～60	75	67	57	78	70	60
a) The color temperature in the table 3 shall be in compliance with the requirements of the chroma coordinate in GB/T 17263[2]. Enterprises may manufacture lamps of non-standard colors according to the requirements of their customs, but shall offer the target values of the chroma coordinate of the non-standard colors at the same time, with its tolerable deviation within 5SDCM. For lamps of non-standard colors, their luminous efficacy shall be evaluated according to the values of their neighboring of lamps of standard colors with a higher energy efficiency grade						

3.2.3 Lumen maintenance

For self-ballasted fluorescent lamps of each energy efficiency grade, their lumen maintenance shall be no less than 80% when burned for 2000 hours.

3.3 GB 19573-2004 Limited values of energy efficiency and rating criteria for high-pressure sodium vapour lamps

3.3.1 Scope

The Standard is applicable to HPSLs for indoor and outdoor lighting with transparent glasses, ballasts and starters, able to start and working normally within the range from 92％～106％ of the rated power supply, with rated wattage ranging from 50W~1000W.

3.3.2 Energy efficiency grade

The energy efficiency of high pressure sodium lamps is divided into 3 levels, in which level 1 is of the highest energy efficacy. The initial luminous efficacy of sample products of all levels shall be no less than the values specified in table 4. The initial luminous efficacy of any single sample shall not be lower than 90% of the average initial luminous efficacy in each level. The limited values of energy efficiency of high pressure sodium lamps are specified as the values of level 3 in Table 4, the initial luminous efficacy of any single sample shall not be lower than 90% of the values for level 3. The evaluating values of energy conservation for high pressure sodium lamps are specified as the values of level 2 in Table 4, the initial luminous efficacy of any single sample shall not be lower than 90% of the values for level 2.

Table 4: The energy efficiency grades for high pressure sodium lamps

Rated wattage/ W	**The lowest average initial lumen/lm/W**		
	Energy Grades		
	Level 1	**Level 2**	**Level 3**
50	78	68	61
70	85	77	70
100	93	83	75
150	103	93	85
250	110	100	90
400	120	110	100
1000	130	120	108

3.3.3 Lumen maintenance

When burning to 2000 hours, for high pressure sodium lamps with wattage of 50W, 70W,100W and 1000W, the lumen maintenance shall not be lower than 85%; for those with wattage of 150W, 250W and 400W, the lumen maintenance shall not be lower than 90%.

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[2] GB/T 17263 *Self-ballasted Lamps for General Lighting Service Performance Requirements*

3.4 GB 19574-2004 Limited values of energy efficiency and evaluating values of energy conservation of ballasts for high pressure sodium lamps

3.4.1 Scope

This standard applies to independent and integrated ballasts for HPS lamps with rated power between 70W and 1000W and for connection to 220V and 50Hz alternating power supply.

3.4.2 Limited values of energy efficiency

The limited values of energy efficiency of the ballasts for high pressure sodium lamps with different rated powers shall be not less than the corresponding value specified in Table 5.

The target limited values of energy efficiency of the ballasts for high pressure sodium lamps with different rated powers shall be not less than the corresponding value specified in Table 5 and will be in effect after 4 year form the effective date of this standard.

Table 5: Limited values of energy efficiency and evaluating values of energy conservation of the ballasts for high pressure sodium lamps

Rated Power, W		**70**	**100**	**150**	**250**	**400**	**1000**
BEF	Limited values of energy efficiency	1.16	0.83	0.57	0.340	0.214	0.089
	Target limited values of energy efficiency	1.21	0.87	0.59	0.354	0.223	0.092
	Evaluating values of energy conservation	1.26	0.91	0.61	0.367	0.231	0.095

3.4.3 Lumen factor

Calculate the lumen factor of the ballast using formula（1）

$$\mu = \frac{\phi_1}{\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

where:

μ —— is the Ballast Lumen Factor;

ϕ_1 —— is the luminous flux measured with reference lamp and test ballast (lumens);

ϕ —— is the luminous flux measured with reference lamp and reference ballast (lumens).

3.4.4 Ballast Efficacy Factor

Calculate the efficacy factor of the ballasts（BEF）using formula（2）：

$$BEF = \frac{\mu}{P} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

where:

BEF—— is the Efficacy factor of the ballast, (W－1);

μ —— is the Ballast Lumen Factor;

P—— is the circuit power consumption (W)

3.5 Minimum allowable values of energy efficiency and rating criteria for metal-halide lamps

3.5.1 Scope

This standard applies to clear glass scandium sodium metal-halide single-capped lamps (hereafter referred to as 'metal-halide lamp') with the power between 175W and 1500W. The metal-halide lamps compliant with this standard can be normally ignited within the scope of 92% ~106%of rated voltage if of the ballasts reach the standard of QB/T2511.

3.5.2 Energy efficiency grades

The standard sets three energy efficiency grades for metal-halide lamps and the first grade means most efficient. The initial luminous efficacy of all grades of products should not lower than the values set in Table 6. The minimum allowable values of energy efficiency for metal-halide lamps are the ones set as level 3 in Table 6. The evaluating value of energy conservation for metal-halide lamps are the ones set as level 2 in Table 6.

3.5.3 Lumen maintenance

For 175W, 250W, 400W, 1000W metal-halide lamps, after 2000 hours, the luminous flux maintenance should not be lower than 75%. For 1500W metal-halide lamps after 500 hours, the luminous flux maintenance should not be lower than 75%.

Table 6: Energy efficiency levels of metal-halide lamps

Rated Power (W)	**Minimum values of initial luminous efficacy lm/W**		
	Energy Efficiency Level		
	1	**2**	**3**
175	86	78	60
250	88	80	66
400	99	90	72
1000	120	110	88
1500	110	103	83

3.6 Minimum allowable values of energy efficiency and rating criteria of ballast for metal-halide lamps

3.6.1 Scope

This standard applies to single-capped meta-halide lamps with LC style independent and internal ballast, using rated power of 220V, frequency of 50Hz alternating power supply and rated power is from 175W to 1500W.

3.6.2 Energy efficiency grade

The standard sets three energy efficiency grades for ballasts of metal-halide lamps and the first grade means most efficient. The BEF of all grades of products should not lower than the values set in Table 7. The minimum allowable values of energy efficiency for ballasts of metal-halide lamps with different rated powers can not be lower than the level 3 values listed in table 7. The evaluating values of energy conservation for ballasts of metal-halide lamps with different rated power can not be lower than the level 2 values listed in table 7.

Table 7: Energy efficiency levels of metal-halide lamps' ballasts

Rated Power (W)		**175**	**250**	**400**	**1000**	**1500**
BEF	Level 1	0.514	0.362	0.233	0.0958	0.0638
	Level 2	0.488	0.344	0.220	0.0910	0.0606
	Level 3	0.463	0.326	0.209	0.0862	0.0574

4 Main experience from the project

4.1 Relevant governmental guidance and policies are the basis for the implementation of energy efficiency standards

The minimum allowable values (limited values) are mandatory, other terms set in China's energy efficiency standard are voluntary. Without the help of relevant energy-saving law and the incentive policies by state, the energy efficiency standard can't be implemented as expected. Before China Green Lights Project, the manufactures were not willing to develop high efficient lighting products because there are no financial incentive government policies. Therefore, energy efficiency level of lighting products in China is always in a comparatively low level. The Introduction of China Green Lights Project has bring some incentive measurements along with the project, then most of manufacturers had been beginning to develop high efficient products and apply for energy-saving certification which resulting in a big step improvement in energy efficiency for major lighting products.

4.2 Reasonable design of the project contributes to efficient implementation of the energy saving standards

China green lights project is a systematic project, and each sub-project plays an irreplaceable role in the system. In addition, maximum implementation efficiency is obtained for each sub-project, as a result of reasonable design of the project, constitution of energy efficiency standard, certification of energy saving products, bulk purchasing, DSM, publicity, demonstrative project, market supervision, spot check, etc.

Since certification of energy saving products, bulk purchasing, DSM, market supervision and spot check are based on the efficiency standard for lighting products, so the energy efficiency standard becomes more influential among enterprises, and enterprises attach more importance to the standard and care its development, and actively participate in the research and discussion of the standard.

4.3 Project management supplies reliable assurance for the success of the project

Furthermore, a set of comprehensive management system is established for China green lights project, covering from project plan, project design, project coordination, project evaluation to project acceptance. This set of scientific management system ensures successful accomplishment of each sub-system. Quarterly report system, particularly, can promptly show Green Lights Office the development status and problems of sub-systems; moreover, coordination work will be carried out in order to solve the problems as soon as practical and ensure harmonic development of sub-systems.

Scientific methods are also adopted for the management of research and preparing of the Energy Efficiency Standard; meanwhile the implementation of the sub-system is strictly controlled through time management, communication management, quality management, expense management, scope management, personnel management, etc., which has efficiently ensured on-time accomplishment of the research and preparing of the Energy Efficiency.

4.4 Funds supply contributes to deepening research on the energy efficiency standard

Huge amount of human resources and financial resources are required for preparing of high-level energy efficiency standard. Since China green lights project has supplied reasonable amount of funds for the research and preparing of the standard in purchasing sample, measuring the energy efficiency value of the sample, investigating production & utilization state of the project, and employing foreign experts, which have greatly enhanced the quality of the energy efficiency.

Market Transformation in South Africa: are we Cutting it?

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Abstract

The objective of market transformation is to induce lasting structural and behavioural changes in the marketplace, resulting in the increased adoption of energy-efficient technologies. Market transformation activities, aimed at overcoming market barriers, are important supportive instruments to other main policy drivers in South Africa.

Eskom DSM has been developing an integrated marketing communication (M&C) strategy to overcome market barriers and ultimately to stimulate market demand and achieve sustainable behavioural change amongst consumers. This M&C strategy is not implemented as a stand-alone, but rather in support of policy and the DSM delivery programme (which collectively should effect market transformation).

The greatest challenge, however, lies in evaluating the success (or otherwise) of the market transformation initiative. Although international protocols for monitoring and verification (M&V) exist, such internationally accepted protocols for evaluation are still in development.

In an attempt to quantify the success, effectiveness and cost-effectiveness of the strategy, a range of tools were used to evaluate the DSM M&C strategy. These tools are currently being developed into a comprehensive performance measurement framework to enable continued appraisal and refinement of the strategy and the performance measures.

This has resulted in an innovative and evolving evaluation toolbox, which can be used to monitor the performance of the strategy and to inform future strategy decisions. It is in effect, however, not only the strategy that is under constant review, but also the toolbox itself - as it develops.

Introduction

The South African DSM initiative effectively consists of three components, namely: a policy and legislative aspect driven by government (including the current appliance labelling drive); a project/subsidy component which is administrated by Eskom DSM (primarily an implementation subsidy programme) and then the integrated marketing and communication campaign lead by Eskom DSM.

It is the objective of these combined initiatives collectively to effect market transformation by overcoming market barriers and achieving market demand and sustainable behaviour change amongst South African consumers.

Key market barriers in South Africa are low awareness levels and unfamiliarity with the concepts of Demand Side Management (DSM) and energy efficiency. The main aim of the market transformation drive for the DSM concept is therefore to create an environment that is favourable to the acceptance of DSM intervention. The expectation is that a receptive environment should lead to improved levels of participation in response to DSM projects.

The second most significant market barrier is associated with the cost of efficiency measures. The low cost of electricity in South Africa and thus the limited financial savings, limits the feasible expenditure on energy efficiency amongst high income households and commercial consumers. Paradoxically, a large percentage of low income households stand to benefit most from efficiency measures, but their limited financial resources are employed for more essential purchases.

The market transformation initiative therefore expressly targets these barriers.

Furthermore, the South African market transformation effort has a deliberate focus on the household based on the assumption that market transformation essentially requires a culture change which is best initiated where people live. Marketing, awareness and education to promote and bring to market more efficient technologies and behaviour have formed an integral part of the Eskom DSM initiative since it officially commenced in 2003. It is anticipated that behavioural modification will come through the use of an array of communications vehicles to achieve awareness of the subject, developing buy-in to the principles, and by employing appropriate methods by which energy efficiency can become normal everyday practice.

The 2005 integrated marketing and communication campaign has incorporated most of the consumer marketing strategies commonly employed by market transformation initiatives (efficiency appeals, advertisements, incentive payments, labelling [DME]), with the basis of appeals having been mainly economic to date. These efforts have been combined with a comprehensive portfolio of programmes directed at the domestic market, including national sales promotions of energy-efficient equipment and a roll-out of free CFLs to low income households.

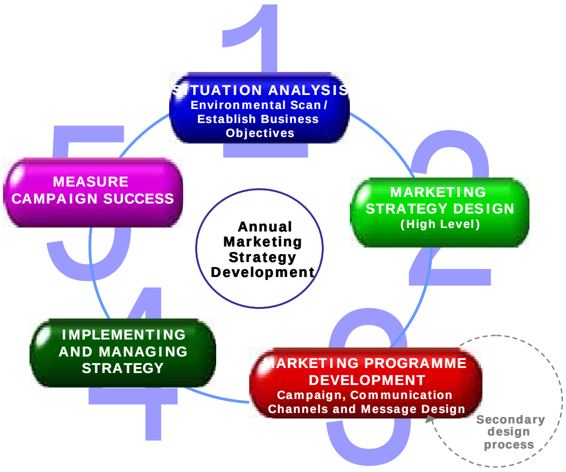

Figure 1: Annual integrated marketing and communication strategy development and evaluation process

In contrast with project specific measurement and verification, the evaluation of market transformation achievements is less conclusive and has remained a challenge for the South African initiative. But, quantification is essential for budgetary purposes and the evaluation of strategy and future decision making. In an attempt to ensure the greatest impact from the available funding a concerted effort is being made in South Africa to benchmark and track progress of the market transformation strategy that can justify the expenditure made (refer Figure 1)

To date a set of tools has been developed and used to measure performance. This evaluation toolbox of is now being integrated into a complete performance measurement framework to assess achievements and inform decision-making.

This paper focuses predominantly on the restructured evaluation approach and existing tools used to assess the level of market transformation success achieved in South Africa during 2004 and 2005. The paper concludes by identifying focus areas for further improvement and future expansion of the evaluation approach.

Performance Measurement Framework and Integration of Existing Toolbox

Independent review and evaluation are the key to maximizing market impact. The accurate assessment of the effects of market interventions remain, however, a major challenge as standard protocols for evaluation are not available. For the purpose of measuring the Eskom DSM M&C campaign, a series of tools and performance indicators have been developed to assess the overall effectiveness and efficiency of the integrated M&C strategy and its activities.

More recently these tools have been incorporated into a multi-criterion measurement approach as shown in Figure 2 below.

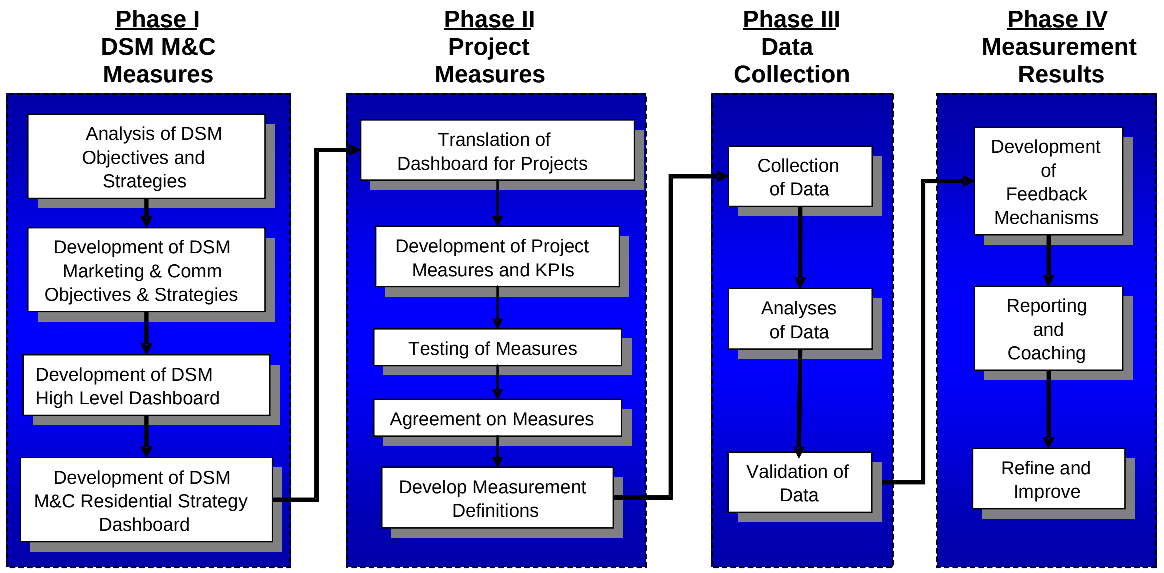

Figure 2: Integrated performance measurement approach

This integrated approach enables an assessment of whether all critical objectives and targets are tracked and whether all determinants are included. It also allows the optimisation of the existing set of measurement tools by assessing their suitability (addressing measurement need), consistency (consistent reliability of measured data), feasibility and actionability (value of input for subsequent strategy development).

The current composition of identified strategies and objectives, the market barriers targeted (indicated by high LSM[1]/low LSM) and the corresponding projects are captured below. Also indicated are those activities that are currently measured. This integrated structure enables the identification of gaps in the DSM M&C Strategy, current project composition and the existing project measurement tools.

			Projects											
No	Segment	Strategies	Communication Campai (Radio & TV)	PowerPlay	Energy Efficiency Monti	Sales Promotions	CFL Role out	EL Competition	Schools Programme	CBC Sponsorship	RLM	SAICE Sponsorship	Capacity building	BEE ESCO Dev
1	High LSM	Build awareness of energy efficiency using mass media to communicate cost saving and environmental messages	⬤ ✓		⬤ ✓						● ✓			
2	Low LSM	Build awareness of energy efficiency by using Mass Media and an Edutainment theme to break through communication clutter	● ✓	⬤ ✓	⬤ ✓						● ✓			
3	Learners	Build awareness of energy efficiency through specialized mediums	•		● ✓			⬤ ✓	⬤ ✓	⬤ ✗				
4	High LSM	Product promotions and joint marketing initiatives for CFLs through project partners	•			⬤ ✓								
5	Low LSM	Provide CFLs through selected project partners		•			⬤ ✓							
6	High LSM	Focus on interruptibility by implementing Residential Load Management project in alliance with project partners	•								⬤ ✓			
7	Low LSM	Focus on interruptibility by implementing Residential Load Management project in alliance with project partners									⬤ ✓			
8	All	Build ESCO market and BEE involvement										⬤ ✗	⬤ ✗	⬤ ✗

Index ✓ -Currently Measured ✗ -Not Measured ⬤ - Primary Focus ● - Secondary Focus • - Minor Impact

Figure 3: Measurement Status

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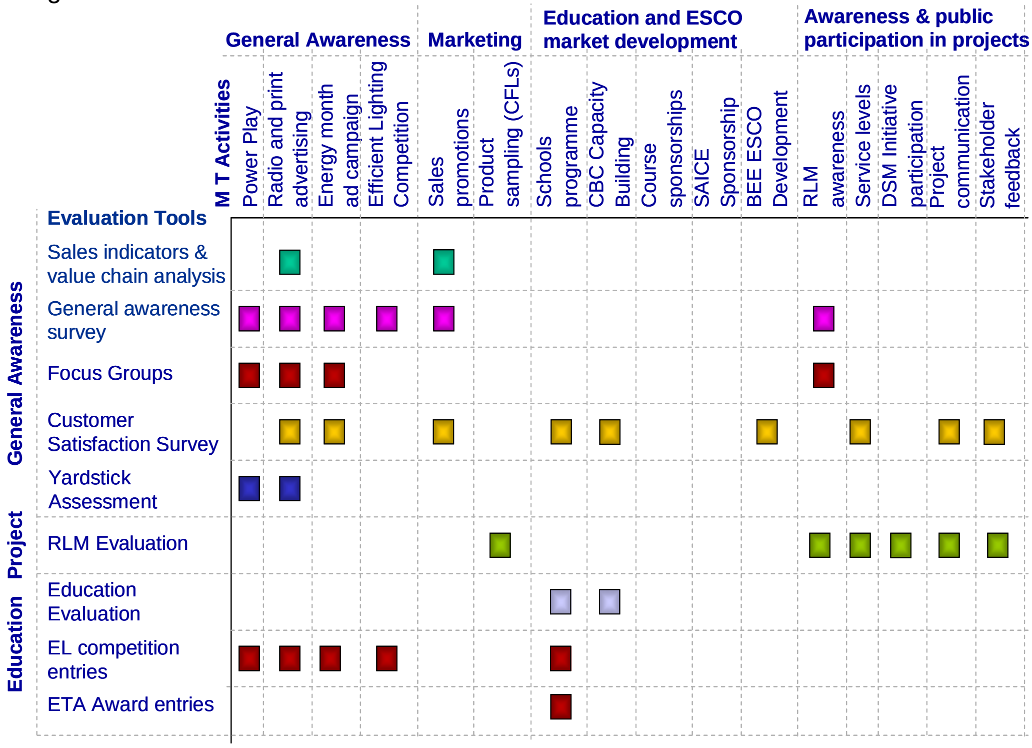
[1] Living Standards Measure is a unique classification system used in South Africa, which segments the population according to their living standards using criteria such as the degree of urbanization and the ownership of cars and major appliances.

From the above, it is apparent that the evaluation of training and the development of the ESCO market major exclusions are the major lacunas in terms of measurement. The above framework may also indicate potential optimization of the measurement activities directed at general awareness.

The complete list of existing evaluation tools and the corresponding measured activities are provided in Figure 4



	M T Activities	General Awareness				Marketing		Education and ESCO market development					Awareness & public participation in projects				
	Evaluation Tools	Power Play	Radio and print advertising	Energy month ad campaign	Efficient Lighting Competition	Sales promotions	Product sampling (CFLs)	Schools programme	CBC Capacity Building	Course sponsorships	SAICE Sponsorship	BEE ESCO Development	RLM awareness	Service levels	DSM Initiative participation	Project communication	Stakeholder feedback
General Awareness	Sales indicators & value chain analysis		■			■											
	General awareness survey	■	■	■	■	■							■				
	Focus Groups	■	■	■									■				
	Customer Satisfaction Survey		■	■		■		■	■			■		■		■	■
	Yardstick Assessment	■	■														
Project	RLM Evaluation						■						■	■	■	■	■
Education	Education Evaluation							■	■								
	EL competition entries	■	■	■	■			■									
	ETA Award entries							■									

Figure 4: Measurement tools

As indicated above, these tools are categorised as a general awareness tool (a measure of general awareness resulting from the integrated marketing and communication campaign), a project tool (measure of the project specific communication efforts) or an education tool (a measure of the impact of the education programme).

As market transformation is reliant on a good understanding of the market, several of the evaluation tools have a dual function. While (primarily) evaluating achievements of current efforts, they are also designed to collect information about the market that will inform and refine future decision-making, planning and subsequent implementation.

Each of these evaluation tools is described in greater detail in the subsequent paragraphs.

Measure General Awareness

As indicated in Figure 3and Figure 4, the primary focus of evaluation activities to date has been on assessing general awareness and marketing activities. Evaluation tools in this category include general sales indicators, an awareness survey, a customer satisfaction survey, the Yardstick assessment of power play and focus groups.

Sales Indicators and Value Chain Analysis

Sales promotions of CFLs have been sustained (initially through the Efficient Lighting Initiative (ELI) Bonesa project) for a period of 7 years and thus making this the longest standing DSM project in South Africa.

Originally **changes in sales and patterns of sales** were used as indicators of the market transformation achieved through these sponsorships.

This methodology has, however, presented some challenges. Sales data is increasingly difficult to obtain; where available, it is limited to annual and national wholesale data which complicates the analysis of sponsorship specific sales versus actual market changes. The impact on substitute and complementary products is not evident, which also complicates the assessment of real market changes.

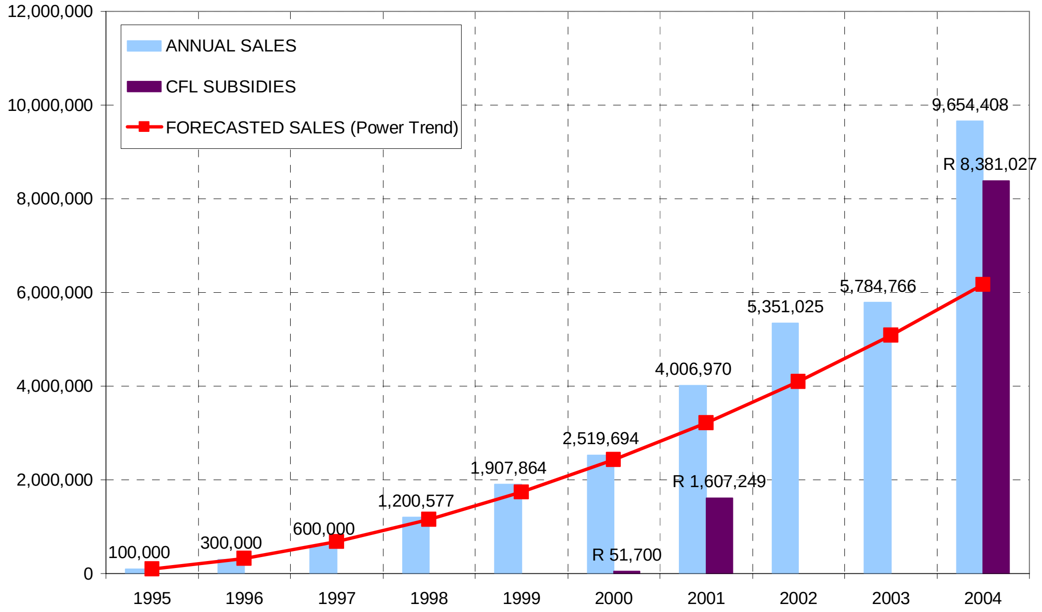


Figure 5: CFL Sales Impact for the Period from 1995 – 2004.

For the first time in 2004 the increased sales were converted into an estimated savings totalling 61.4 MW for the year. Final sales data for 2005 is not yet available, but sales translating to 18.6 MW were already achieved by mid-2005. The claimed savings are based on additional sales achieved over and beyond the annual sales forecasts of suppliers.

During 2005 sales promotions were extended to include products other than CFLs which necessitated a revision of the impact indicators. This led to a lighting industry **value chain analysis** to investigate the impact of sales promotions on the industry.

The value chain analysis serves to develop a thorough understanding of all market participants (consumers, producers, distributors, vendors, regulator/s and providers of secondary market services and market systems). This is essential for the understanding of Market Transformation, which focuses on markets rather than end-users.

From an evaluation perspective the value of this analysis was mostly in developing an understanding of the specific industry (role players, trends, activities) thus enabling the identification of key indicators that can be used for impact quantification and tracking. In the case of the lighting industry, it was evident that most products are imported for distribution in South Africa and that importation trend data should provide a very good idea of changing market demand.

Disaggregated sales data (e.g. monthly, regional, local, product model specific) will remain important for more detailed analyses.

General Awareness Survey

There is substantial literature that relates awareness and communication campaigns to the change in market demand. Measuring or quantifying this change, however, remains a challenge.

In 2004 an independent survey was commissioned to evaluate (and track in subsequent surveys) the impact on general awareness levels resulting from the DSM awareness activities.

The survey is structured to measure different stages of transformation i.e. awareness, knowledge and motivation to change. Since the initial benchmark survey in 2004, five subsequent surveys were conducted. Comprehensive time series data that is linked to intensity (i.e. reach and frequency) and type of activity/intervention for the preceding period, has therefore been developed.

Irrespective of the quality of the survey and questionnaire design, a level of uncertainty nonetheless remains concerning the accuracy with which surveyed data relates to actual behavioural change[2]. An innovation unique to this study was that the behavioural patterns of the survey participants were tracked through actual consumption. Because of the dominance of Eskom in the South African electricity market, it was possible to determine and track the consumption patterns of the population.

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[2] A survey typically only indicates brand or product awareness and intention to act based on this awareness.

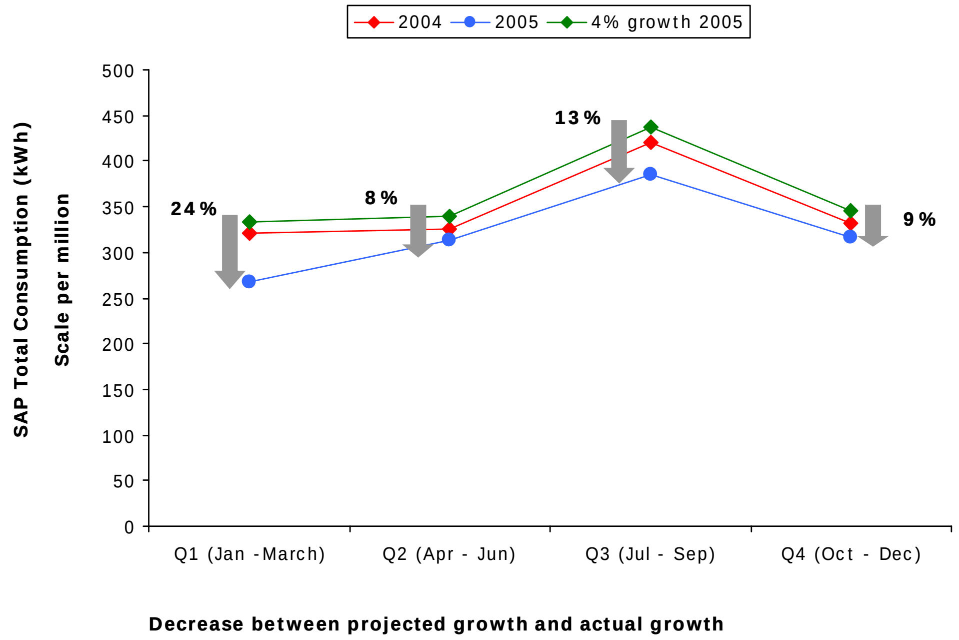

Figure 6: Comparative Consumption data for 2004 and 2005

The linking of the general awareness levels to the consumption of the sample group enabled the quantification of a 10% awareness increase (double the target set), a 13% decrease in consumption in winter and 1.5 MW[3] savings across the three market sectors.

Customer Satisfaction Survey

The customer satisfaction survey study was originally commissioned for the purpose of stakeholder management and service delivery assessments. Stakeholders, in this instance, include Government, the Regulator, M&V teams, ESCOs and participating consumers.

In addition to measuring satisfaction with the processes for project subsidization (proposal assessment, funding, implementation and baseline development), willingness to continue or repeat participation, perceived value and quality of communication and marketing efforts (i.e. receptiveness of the market when approached) are also assessed. This evaluation is conducted annually.

This is an indirect measure used predominantly to verify the general awareness survey results as well as track changes in market and industry acceptance of the DSM initiative. The 2005 tracking study indicated increased loyalty, trust and reputation ratings for the DSM initiative by all stakeholders.

Yardstick Assessment of Power Play

In 2005 Power Play, an entertaining and educational interactive family TV game show, was introduced to convey the energy efficiency message. The show was screened weekly for 26 consecutive weeks after which an independent evaluation of the effectiveness with which the game show had conveyed the energy efficiency message was conducted. This evaluation was conducted by Yardstick, a local company specialising in measurement.

The evaluation entailed a comprehensive review of stated objectives, operations and logistics, supporting promotions, legal agreements, financial management, outputs, outtakes and outcomes. For part of the evaluation Adtrack, a research tool that measures a TV commercial's verified noting relative to its media support, and compares this with normative data[4] within its category, was used to assess (through statistical analysis) the impact and retention/decay rate for the game show. This analysis was supplemented by the inclusion of select questions regarding the game show in the general awareness survey that coincided with the screening period. The Adtrack findings, which indicated 10% increase in awareness, were confirmed by the general awareness survey results.

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[3] No weather adjustment has been applied, but a current study is looking at refining a weather adjustment factor for relevance i.e. incorporating factors such as economy and electrification.

[4] The overall Adtrack database consists of a an initial measure of virtually every commercial flighted in SA over the past 20 years, constituting the largest database of its kind in the world.

The evaluation team also used an adaptation of Comtrak, a propriety communication measurement framework (developed by Yardstick), to evaluate the success of the game show. This analysis evaluates the success of both short-term measures and outputs as well as long-term measures and outputs (i.e. purchase of efficient appliances and efficient consumption of electricity). This included a content analysis, media analysis, share of audience, audience ratings and reach and frequency assessment.

Unfortunately this evaluation was only commissioned on conclusion of the project, which impeded effective performance tracking and the ability to introduce modifications during the project. Nonetheless, the Power Play performance summary and evaluation provided invaluable conclusions and recommendations, which will guide implementation of future interventions of this nature.

Energy efficient lighting design competition

Participation levels in the annual energy efficient lighting design competition offer a basic indicator used to demonstrate growing interest amongst students and design professionals active in the energy industry as well as general awareness levels.

A proposed improvement for 2006 is to include a short questionnaire together with the entry forms to further exploit the potential of this as an evaluation tool (e.g. most effective communication media, demographics of participants and knowledge of efficiency).

Focus Groups

Focus groups were conducted independently to assess target audience, motivational drivers, campaign evaluation and to test creative execution.

The primary benefit has been to develop a better understanding of the market, and to identify issues and factors that will enhance transformation and test programme design.

Inputs from focus groups essentially provided real-time evaluation at an early stage of programme development, which was used for timeous redesign and adaptation.

Measure Project Level Awareness and Communication

Currently, only one formal measurement tool has been established on project level as discussed below.

There is at present no measurement tool to assess the market transformation achieved through the national roll out of 3 000 000 CFLs to participating communities in the low LSM bracket. This programme is designed specifically to overcome the high cost barrier of energy efficient equipment to low LSMs.

Residential Load Management (RLM) Evaluation

The residential load management programme entails the remote control of hot water cylinders in thousands of residential buildings throughout the country to curb peak demand. Implementation depends on access to residences to install controllers and thus requires acceptance of the concept by participating residential consumers.

Strategic communication is therefore a vital link in the successful implementation of the projects and technical execution is preceded and accompanied by a large-scale awareness and communication campaign to obtain acceptance of the concept and obtain voluntary access to homes, while also creating general awareness of energy efficiency amongst participants.

The “non-technical” evaluation effort is three-pronged and includes:

1. Monitoring of the media campaign in terms of publicity (coverage) received on radio and in papers.
2. Electronic and telephonic surveys (a 5-6 item questionnaire) of stakeholders to obtain feedback about the impact of the communications campaign, the success and results.
3. Bi-weekly meetings are held to evaluate execution and monitor the process. This allows the communications strategy and execution to be adapted where needed.

Increased levels of acceptance and participation will be assessed and sustained participation levels (relative to those of previous RLM interventions) will be tracked through the regular M&V process. Analysis of this data may provide an indication of the success of the accompanying communication campaign.

This tool has recently been developed and implemented alongside the current national roll-out of the RLM programme and no formal results have been delivered to date. Parallel implementation will provide the ability to conduct performance tracking and introduce required modifications in the programme.

Measure Education and Training Efforts

The only activity focused on education that is currently measured is the schools programme. As mentioned previously, the impact of the training and development of the ESCO industry on market transformation is not currently being assessed.

Schools Programme

A number of measures are used to assess the success of the efficiency education programme offered to schools. Firstly participation levels, both repeat participation (currently 100% of all participating schools) as well as growing participation numbers (currently 20% increase year on year) are used as an indicator of the perceived value offered by the programme.

Secondly, the achievement of participating schools in the annual national ETA awards competition is used as an indicator of the effectiveness of the programme. Participating schools have had winning and runner-up entries (category specific) in both years since the inception of the schools programme.

Finally, the representatives responsible for the roll-out of the schools programme are required to submit reports detailing, *inter alia*, the geographic location of school, demographics of the area and the number of children participating,

A shortfall of the tools specifically targeted at measuring the schools programme is the inability to quantify the impact of the programme on market transformation and behaviour change. The current logic is that the national awareness survey and consumption tracking will include participants in the school programme. Verification of this may be achieved by testing this in the survey questionnaire.

Limitations and Challenges

The restructuring of the evaluation toolbox into an integrated performance measurement framework has highlighted some glaring deficiencies of the existing evaluation toolbox. The following have been identified as limitations and focus areas for future development.

1. The objective of market transformation initiatives is to achieve sustainable market effects. Sustainability has, however, not been the focus of evaluation to date (given the short implementation period for DSM in South Africa), but rather perceivable impact. Evaluation is currently part of an iterative process of continual measurement input and programme adaptation to maximize effect. The evaluation of the sustainability of interventions will be a future objective.
2. Unfortunately, none of the measurement devices is infallible and even though market effects have been seen, it is impossible to rule out other effects completely. The evaluation tools themselves are therefore continually being refined to improve the accuracy with which they quantify load impacts.
3. Current evaluation tools (as well as DSM programmes) are commercially focused and may be enhanced if extended to include external benefits (e.g. environmental and societal benefits). The greatest challenge would be to define external objectives as specific, formal and measurable targets.
4. Current evaluation tools are predominantly impact focused with limited process evaluation to date.

In 2006, however, the immediate focus will be to finalise the integration process and fully implement the integrated performance measurement approach prior to addressing the issues listed above.

Conclusions

If marketing, awareness and education are to be taken seriously as market transformation tools, their benefits need to be clear, measurable, verifiable, and transparent. Quantifiable benefits are especially important for justifying the continued allocation of adequate funding and resources to market transformation efforts.

In addition to justifying program funding, evaluations serve a second, equally important function. They have the potential to assess the efficiency and effectiveness of the program process, revealing potential weaknesses in program implementation in order that these problems can be corrected. In the long run, this helps guarantee and enhance the impact of the programme.

The Eskom DSM marketing and communication division has, in its short period of existence, made significant progress towards establishing a measured market transformation initiative. The following are considered to be achievements of the current initiative:

1. The most recent advance has been the combining of the quantitative tools into an integrated performance measurement framework. It is expected that this will present the most objective and accurate read of the market transformation impact achieved by the Eskom DSM initiative.
2. Because of the implementation of these evaluation tools the DSM M&C campaign is based on thorough strategic market transformation research. The evaluation tools, as described above, allow ongoing learning and the development of a greater understanding of the market, which in turn informs programme development.
3. In most instances evaluation and planning has been introduced at the start of the programme to establish baselines and to develop time series evaluation data.

In addition to the above list, the first two years of measured market transformation activity have already seen marked improvement in the measurement approach with a visible benefit to the integrated M&C strategy. As such, the integrated M&C campaign in general, and the monitoring of progress specifically, can be considered a success.

Early indications, based on results of the performance measurements to date, point towards a gradual achievement of the transformation of the South African market.

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Promotion of Efficient Lighting, Standards and Labeling Program within the Energy Efficiency and Greenhouse Gas Reduction Project Activities

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Abstract

National Energy Efficiency Standard and Labeling Program:

The Ministry of Electricity and Energy of Egypt (MOEE) within its strategy of energy efficiency improvement and supported by the Global Environment Facility (GEF)/United Nations Development Program (UNDP) is implementing the "Energy Efficiency Improvement and Greenhouse Gas Reduction" (EEIGGR) project. The EEIGGR is to assist Egypt in reducing long-term growth of Greenhouse Gas (GhG) emissions from the electric power generation, and consumption of fossil fuels.

These objectives are to be achieved through a range of activities among which, the development of a *National Energy Efficiency Standard and Labeling Program*.

In this context, extensive surveys and studies have been conducted in order to determine the equipment that are of intensive energy consumption and offering high opportunities for energy efficiency improvement.

Accordingly, the energy efficiency standards and energy labels have been developed for three of the most market-penetrated appliances in Egypt, namely, room air conditioners, refrigerators, and clothes washing machines. The Minister of Industry and Technological Development has issued decrees in year 2003 to enforce these standards as well as the energy efficiency labels, starting by a voluntary period, followed by a mandatory one.

The Government of Egypt had succeeded in obtaining a fund from the UNDP Thematic Trust Fund for the establishment of an accredited energy efficiency testing laboratory to support the national energy efficiency standards and labeling program.

Efficient Lighting Program

In Egypt, the share of lighting in energy consumption accounts for nearly 25 % of the total energy sold in the country. Compact fluorescent lamps (CFLs) and electronic ballasts have been targeted to reduce the share of lighting in total energy consumption, due to their simple technology and pay back period and their high impact on energy saving and CO2 reduction.

For the diffusion of efficient lighting, several demonstration projects have been executed and a leasing program has been successfully implemented in some distribution companies, in addition to campaigns and seminars.

All these actions led to the growth of the market size of compact fluorescent lamps from 245 thousands lamps in year 1999 to 1.9 million lamps in year 2003 achieving an energy saving of 0.5 MTOE and a CO2 reduction of 1.5 MTons. (Calculations based on accumulated savings for the number of lamps, a saving of 80 watts per lamp, 2920 hours per year, an average fuel consumption of 223gm of oil equivalent /kWh.

To decrease the cost of CFLs and electronic ballasts and allow a larger diffusion, EEIGGR has assisted manufacturers to locally manufacture these equipment, currently four manufacturers are locally manufacturing CFLs and electronic ballasts (Manufacturers assisted by the project)

Introduction

Energy Efficiency Improvement and Environmental Protection have ranked first priorities in utility policies in developed as well as developing countries.

Over the past ten years, electrical energy consumption and peak demand in Egypt have been growing rapidly at rates of 8.6 % and 8.1% respectively. For residential and commercial users, the rate of increase of electrical energy use was 14% for the same period. Extensive efforts have been conducted by the Egyptian Electricity Holding company to improve generation efficiency and reduce transmission and distribution losses. This resulted in reducing the overall average specific fuel consumption from 340gm to 223gm of oil equivalent per kWh and reducing the losses from 18% to 12% Egyptian Electricity Holding Company statistics.

Energy Efficiency Improvement and Greenhouse Gas Reduction Project

The Ministry of Electricity and Energy of Egypt (MOEE), within its strategy of energy efficiency improvement, is conducting similar efforts on the demand side for effective utilization of electrical energy

In 1999, and as a continuation of these efforts, MOEE has and is still implementing one of its most important projects which is the" Energy Efficiency Improvement and Greenhouse Gas Reduction" project for a total budget of MUS$ 5.9, jointly financed by the (GEF), the (UNDP) with the support of the Government of Egypt, and the technical and executive management of the United Nations Department of Social and Economic Affairs (UN/DESA).

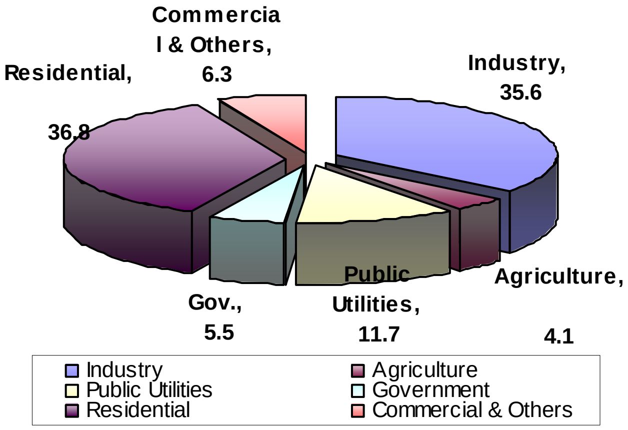
The overall objective of this project is to meet the suppressed and still growing power and energy demand through reliable, efficient and rational consumption patterns, thereby reducing greenhouse gas emissions, protecting the local environment while at the same time providing a sustainable alternative to capacity expansion as the sole method of meeting the demand.

For that purpose (MOEE) has expressed its full commitment to sponsor the objectives and outputs of this project and to continue with their full implementation beyond the project completion where it is expected to reduce energy consumption by a total of 4.2 million tons of oil equivalent (MTOE)/year by the year 2010. These energy savings represent 11.8% of Egypt's total estimated energy use and are equivalent to 11.7 million tons of CO2 per year (estimation from the project document based on information received from the Egyptian Electricity Holding company at the time of project document preparation)).

Electrical Energy Consumption Patterns

In order to assess the potential of energy savings, it was of importance first to evaluate the share of energy consumption of different sectors.

Sector	Electricity Consumption	
	Million kWh	**%**
Industry	30.284	35.6
Agriculture	3.460	4.1
Public Utilities	9.930	11.7
Government	4.710	5.5
Residential	31.211	36.8
Commercial & Others	5.393	6.3
Total	**85.088**	**100.0**



Electrical energy consumption of different sectors and the percentage share for the year 2004/2005

The figure shows that the industrial and residential sectors are the largest energy consuming sectors with about 35.6% and 36.8% respectively of the total consumed power. The residential and commercial sectors together consumes about 43% of the total consumption.

For that reason the project have focused its activities towards reducing energy consumption through the following:

- **Industrial sector:**
  - Demand side management (efficient lighting, power factor correction, efficient motors, insulation, combustion control, energy management system, waste heat recovery, conversion to natural gas…etc.)
  - Load shifting
- **Residential & Commercial:**
  - Demand side management (efficient lighting, heating, ventilation and air conditioning)
  - Standards and labels for efficient equipment
  - Energy efficient design and construction for new buildings

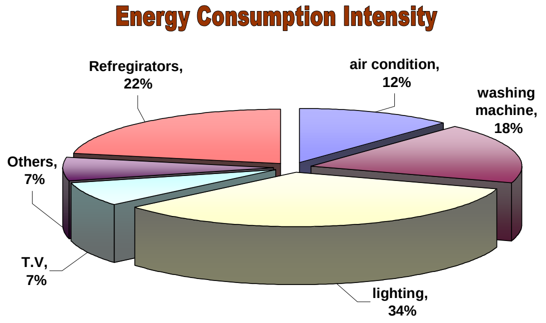
Electrical Energy Consuming Equipment

Electrical energy is mainly consumed by four types of electrical loads which are:

- Lighting loads
- Motive power loads (electric machines)
- Heating, ventilation and air conditioning load (HVAC).
- Household appliances (Refrigerators, washing machines iron etc….)

Extensive field surveys and studies have been conducted in order to determine the equipment that are of intensive energy consumption and offering high opportunities for energy efficiency improvement.

These surveys, conducted in year 2000, have analyzed energy patterns and percentage energy consumption share of each type of equipment for different samples of residential and commercial sectors.



Results of analyses showed that the lighting loads represent the highest energy consuming application with around 34% of the total consumption followed by the refrigerators 22%, washing machines 18%, and air conditioning 12%.

In fact, lighting is the largest electricity user in different sectors of consumption, it accounts for nearly 25% of the total energy sold in the country The residential and commercial sectors consume nearly 34% of their energy -estimated at 43% of the total energy for lighting purposes, the lighting consumed by the industrial sector accounts for 10%, while the public lighting consumes 5% and governmental buildings lighting accounts for nearly 70% of their consumption estimated at 5.5% of the total energy consumption. (Figures based on surveys conducted -by the Organization for Energy Planning- for the residential, commercial and governmental sectors, as well as statistics from the (Egyptian Electricity Holding Company reports).

Most of the lighting used in Egypt is to a great extent responsible for the system peak time electricity production; In addition to high electricity bills, it has a negative impact on the environment by requiring the combustion of greater quantity of fuel in power plants resulting in atmospheric pollutants shown to cause global warming, acid rain, smog etc…

In order to reduce energy consumed by lighting equipment through its efficient utilization, it was necessary to assess the following:

- The most common types of lighting used in Egypt.
- The market size of the lighting equipment in Egypt.

Types of Lighting Used in Egypt

The most common basic types of lighting used in the residential and commercial sectors are incandescent, fluorescent and recently CFLs.

Incandescent lamps (Household and Commercial)

Incandescent lighting is the most common type of lighting used in residences, they are the least expensive to buy but the most expensive to operate; in addition to their shortest lives, they are also relatively inefficient compared with other lighting types.

Fluorescent lamps (Commercial, Household and Industry)

Fluorescent lighting is used mainly indoors; they needs ballast for starting and circuit protection, the electro magnetic ballasts currently used consume higher energy than the electronic ones.

Compact Fluorescent lamps {CFL} (Commercial, Household and Industry)

CFLs used by both residential and commercial sectors but on small scale.

Market Size of Lighting Equipment in Egypt

An assessment of the market size of lighting equipment based on the Central Agency for Public Moblization and Statistics indicated that for year 2000, the number of consumed incandescent lamps was 85.2 million units, as for the fluorescent lamps 16.7 millions and 0.278 million for the imported CFLs

Technical and Financial Feasibility of Efficient Lighting Equipment

Based on the findings of the surveys of pattern consumption and the market size, the technical and financial feasibility concluded the following:

- Large potential for replacing incandescent lamps with compact fluorescent ones (CFL). The CFL lamp saves 80% of the electricity consumed by the equivalent incandescent one, therefore leading to a corresponding average energy savings per one lamp over its lifetime of about 750 kWh and a corresponding fuel savings of 225 kg oil equivalent and 675 kg CO2 reductions.
- Using of low Wattage tubular fluorescent lamps. The potential energy savings are 10% of its current consumption.
- Gradually, replacing magnetic ballasts by electronic ones. The potential energy savings are around 30%.
- Based on current market prices and electricity tariff, CFL is financially feasible for residential, commercial and industrial users.

Moreover, CFLs and electronic ballasts have been targeted to reduce the share of lighting in total energy consumption, based on the following:

- Simple technology, does not need special preparation.
- Simple and short pay back period.
- Direct and high impact on energy saving and CO2 reduction.

Despite the benefits on both the customer as well as the utility, the CFL market in Egypt at that time was still low, mainly due to:

- High capital cost of CFL.
- Lack of public awareness.

EEIGGR Project Initiatives to Promote the Use of Efficient Lighting in Egypt

To promote the use of efficient lighting and overcome the barriers limiting implementation, several actions have been taken by the project:

Replication of the leasing program applied at Alexandria Distribution Company in other distribution companies for the distribution of the CFLs.

Prior to the project, Alexandria Distribution Company had and is still implementing a successful leasing program for the diffusion of CFLs to its customers. The leasing process is applied by selling the CFL to the customer for a down payment representing 10% of its price, the remaining amount is added to the electricity bill in equal installments over a period of two or three years.

Through the project activities a CFL leasing program similar to that of Alexandria has been established in three other electricity distribution companies: Cairo, Middle Delta and Canal distribution companies.

Implementing a study for reducing the custom duties on imported CFLs to minimize their cost.
One of the ways of minimizing the cost of CFL is reducing the currently applied custom duties on imported CFL, which amounts to 30%.For this reason the project has undertaken a study for reducing the custom duties on imported CFL and assess the overall economical impact, the study recommended the rate of 5% as custom duty for imported CFL to decrease its price. These recommendations have been raised to the Minister of Electricity & Energy for seeking possibility of implementation with the Minister of Finance.

Assisting local manufacturers to partially assemble some CFL components and electronic ballasts.
The project has in parallel considered the option of local assembly and manufacturing of some components of CFL in order to lower the price while maintaining a good level of quality for the products offered to customers.

Within this scheme, local manufacturers can decide to import the tube bulb that is the costly part of the lamp and to locally manufacture both the ballast and enclosure for the CFL. This option has the advantage to create an important local content for the product and has some potential to bring down the price of the CFL introduced in the Egyptian market especially when the glass tube can be designed with a special fitting that allows replacement.

EEIGGR has technically assisted manufacturers to locally manufacture these equipment, providing them with the required market study. Currently four manufacturers are locally manufacturing CFLs and electronic ballasts. The project is supporting these manufacturers and allows them to sell their products through exhibitions organized by the project.

Implementing demonstration projects in different governmental buildings.
To promote the use of efficient lighting equipment, many demonstration applications have been executed using CFL and electronic ballasts in the following locations:

Replacing incandescent lamps by CFL:

- Ministry of Electricity and Energy (MOEE) building: the Minister office, Chairman and Deputies chairman offices, the parking area where over than 700 CFL have replaced existing incandescent lamps.
- The office of Cairo Governor

Replacing magnetic ballasts by electronic ballasts

- Canal Electricity Distribution Company (CEDC)
- El-Behera Electricity Distribution Company (BEDC)
- Delta Electricity Distribution Company (DEDC)

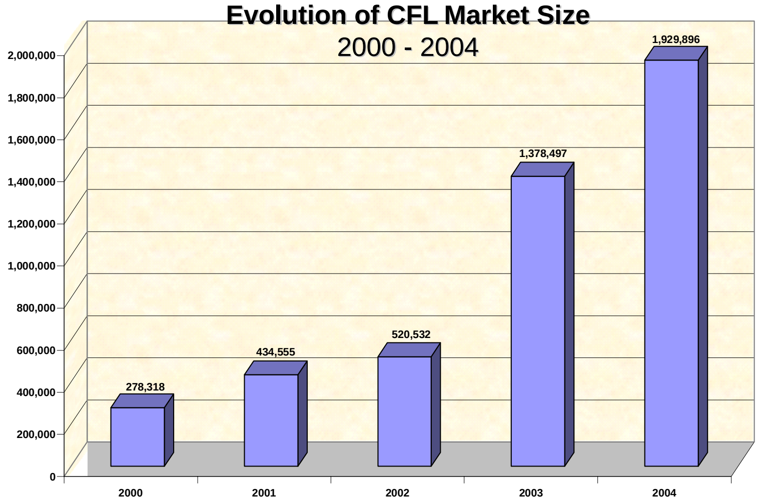
Information	**Magnetic Ballasts**	**Electronic Ballasts**
Technical Data	W=730 A=6,2amp VA=1340 VAR=1130	W=495 A=2.52amp VA=510 VAR=135
Temperature	high	Low
Critical Voltage	Does not work if the voltage drops to less than 180 volts	Works if the voltage drops down to 80 volts
Noise Leve	Noisy	No noise
Power Factor	0.540	0.994

The demonstration project applied at Delta electricity distribution company is an example of the technical and economical benefits gained when comparing the performance of 16 existing magnetic ballasts with 16 replaced electronic ballasts
These measurements have been carried out for 1000 hours and showed that in addition to the technical benefits, the percentage of energy saving is 33% when using electronic ballasts.

The payback period for replacing incandescent lamps by CFLs is 0.34 year based on first category of commercial tariff (0.189 L.E.) and the price of the CFL is 15L.E. and 0.8 year based on the second category of the residential tariff (0.08 L.E.) with the same price of the CFL.
The higher the applied tariff the shorter the pay back period.

Cooperation with the NGOs, in increasing customer awareness on benefits of energy efficiency in general and efficient lighting particularly.

Promotion of efficient lighting use has also been achieved through seminars, media and assisting NGOs working in the field of energy and environment in organizing promotional campaigns and training technicians in the field of efficient lighting application.
All these actions led to the increase of market size of compact fluorescent lamps from 278 thousands lamps in year 2000 to 1.9 million lamps in year 2003 achieving an energy saving of 0.5 MTOE and a CO2 reduction of 1.5 MTons



(1999 – 245 thousand; 2000 – 278 thousand; 2003 - 1.9 million)

Organizing Exhibitions for the Diffusion of Efficient Lighting Equipment.

For a larger diffusion of CFLs, an initiative has been taken for the diffusion of efficient lighting equipment locally manufactured to employees of organizations and institutions through organized exhibitions, this mechanism is financed through the loan guarantee program of the EEIGGR project and consists of selling the compact fluorescent lamp or electronic ballast with a down payment of 20% of the price and the remaining price is settled through installments over a period of 18 months which is the guarantee period. This initiative has the advantage of promoting the local manufactured CFLs and at the same time, diffusion at a larger scale to employees (representing the residential sector) through their organizations.
As a start, three exhibitions have been organized in small enterprises where 5000 lamps have been sold at an average rate of 1.5 lamp per employee, exhibitions are planned to be organized in large industrial complexes where the target to be achieved is around 50000 lamps by June 2006 and 100000 lamps through the second half of year 2006.

Public Lighting

Street lighting represents almost 5% of the total electricity consumption at the national level. To reduce this relatively high percentage and as a demonstration project, 20 sodium 6 meters poles street lighting were replaced by CFL at Alexandria with the cooperation of Alexandria Distribution Company and are successfully operating.
Another project was implemented with the cooperation of one non-governmental organization (NGO) for lighting 20 streets with a total number of 600 CFL bulbs (65W) instead of using 250W bulbs thus saving about 80% of the electricity consumption.

Energy Efficiency Improvement in Governmental Buildings

Within the project activities a study has been undertaken for improving energy efficiency in governmental buildings.

- This sector has been selected for the following reasons:
- It is one of the substantial consuming sectors, about 5.5% of the country total consumption.
- The energy consumption patterns of these buildings are very similar, which support replication of feasible energy efficiency projects.
- There are no programs or efforts regarding raising the capabilities of the technical operators of governmental buildings on energy efficiency and energy conservation.
- No awareness efforts are directed to the workers and employees occupying these buildings regarding energy conservation practices.
- The used procurements guidelines for governmental buildings for new equipment have no energy efficient constrains or incentives.

Therefore, the study objective was to develop a list of energy conservation opportunities economically feasible and technically proven, that is applicable to most of electricity-intensive consuming governmental buildings with implementation program.

Implementation of some pilot projects and cost benefits analysis have been achieved for two energy conservation and energy efficiency options to assess their cost effectiveness, these are the compact fluorescent lamps and the electronic ballasts.

Results of this part indicated that there is a great opportunity for energy savings in the governmental buildings through these two main options.

The study concluded three main clusters of recommendations on short, medium and long term implementation timeframe.

The short term recommendations include:

- Appointment of an energy manager for each governmental building provided with sufficient training, responsible for following up the energy conservation measures.
- Conducting awareness programs targeting the employees occupying the governmental buildings.

The medium term recommendations include:

- Implementing retrofits of the current governmental building facilities especially for the lighting system, including replacement of incandescent lamps by the compact fluorescent lamps and using electronic ballasts instead of the magnetic ballasts, in addition of improving power factor for these buildings.

The long term recommendations concentrate on:

- Developing governmental procurement guidelines to take into consideration energy efficiency concept. This stage will rely on the results and experience gained from the medium term recommendations.

To encourage implementation of such programs, It was decided to start first by the governmental buildings belonging to the Ministry of Electricity and Energy as an example to be applied by other ministries.

A program for implementation of energy efficiency projects was proposed by EEIGGR and to be implemented in cooperation with the electricity distribution companies, through the following mechanism:

- The project will work in close cooperation with the distribution companies and provide the necessary technical assistance through training programs for conducting energy audits and implement energy efficiency projects
- The project will bear cost of energy audits and implementation of recommended energy efficiency options for two buildings belonging to each of the 9 distribution companies.
- The distribution company will refund these costs to the project over a duration of two years or more according to an agreement settled between the project and the distribution company, in addition to a relatively low interest rate.

Once the savings realized, the saving amounts will be shared equally between the project and the distribution company, these amount will be the base for a revolving fund to allow distribution companies implementing more energy efficiency projects.

In a later stage, the distribution company would be able to apply this mechanism with its own customers, i.e the company will act as the project and its customer will take the role of the distribution company in the present mechanism.

Recommendations of this study have been approved by the Ministerial Committee for Services for its application at the national level.

The project has started in conducting training courses to employees of governmental buildings for assisting them in conducting energy audits and deciding upon the energy efficiency options to be applied in these buildings.
Efficient lighting specifications are now under preparation, and the efficient lighting testing laboratory will be established by 2006.

Energy Conservation Pilot Project Applied in a Governmental Building.
The following is an example of an energy efficiency pilot project implemented at the Ministry of Electricity and Energy for the replacement of 1560 incandescent lamps by CFLs ones, as well as installation of capacitor banks.

Year	Energy Consumption (KWH)	Energy Cost (L.E)	Power factor correction savings (L.E)
2002/2003	5316780	1063356	97317
2003/2004	4736340	947268	58162
2004/2005	4279800	855892	45463

Energy saving from 2002/2003 – 2003/2004
Energy Cost Difference= 1,063,356 – 94,7268 = 116,088 L.E.
Energy saving (power factor correction) =
97,317 – 58,162 = 39,155L.E.
Total annual saving = 116,088 + 39,155 = 155,243 L.E.
Energy saving from 2003/2004 – 2004/2005
Energy Cost Difference= 947,268- 855,892 = 91,376 L.E.
Energy saving (power factor correction) =
58,162 - 45,463 = 12,699L.E.
Total annual saving = 91,376 + 12,699 =104,075 L.E
Investment during 2003/2004
Capacitor banks = 33,000 L.E.
CFLs = 57,700 L.E. (1,560 lamp * 35 L.E)
Total Investment = 33,000 + 57,700 = 90,700 L.E.
Net Saving for the 1st year = 155,243 – 90,700 = 64,543 L.E.
Net saving for the 2nd year = 104,075 L.E.

National Energy Efficiency Standard and Labeling Program

Substantial energy saving opportunities can occur from improving the energy efficiency of the most wide spread and energy consuming appliances and equipment.

Standards and labeling programs provide enormous energy savings potential that can improve end-use efficiency and contribute significantly to sustainable development. They also have the potential of bringing benefits to consumers through reducing their electricity bills and increasing consumer purchasing power for other products, thus, helping increase cash flow in the local economy. For manufacturers, standards and labeling programs would improve competitiveness in the international markets and improve national trade balance. One of the project main activities is to develop a National Standard and Labeling Program for the three most consuming electrical appliances. Accordingly, EEIGGR in cooperation with the Organization for

Energy Planning (OEP), and the Egyptian Organization for Standardization (EOS) have conducted extensive surveys and studies covering different residential and commercial sectors and based on the following selection criteria:

- Degree of saturation,
- Energy consumption intensity
- Growth rates
- Potential savings

In order to determine the most market-penetrated appliances in Egypt of intensive energy consumption and offering high opportunities for energy efficiency improvement. This has resulted in selecting room air conditioners, refrigerators, and clothes washing machines as the candidate appliances, where energy efficiency standards, energy efficiency options have been developed and cost effective analyses have been calculated for the three selected appliances.

Regarding Refrigerators:

- The scope includes: all electrical refrigerators, refrigerator-freezer, and freezers up to 28 cu.ft.
  adjusted volume (AV).
- The energy performance requirements include the test procedures, test conditions.
- Maximum annual energy consumption in (kWh). The consumption limits for each refrigerator type are classified according to the following equations;
  - For Manual refrigerators 0.48* AV + 784
  - For De-frost refrigerators 0.37* AV + 721
  - For No-frost refrigerators 0.57* AV + 1130

Regarding Air Conditioners:

- The scope includes: Room Air Conditioners (AC), window units up to 36000 Btu/hr cooling capacity, and up to 65000 Btu/hr for split units.
- The energy performance requirements include the test procedures, test conditions.
- The minimum limits for energy efficiency ratio (EER) which is measured in Btu/Wh. are:
  - For window AC the Minimum EER is 8.5
  - For split AC the Minimum EER is 9

Regarding Clothes Washing Machines:

- Scope: for automatic clothes washing machines that has capacities up to 10 kg of the dry washing load.
- Energy performance requirements: include the test procedures, test conditions.
- Maximum energy consumption per cycle is measured in kWh/kg.
- Maximum Energy Consumption is 0.26 kWh/cycle-kg

Proposed Energy Efficiency Options

Washing Machines	**Air Conditioners**	**Refrigerators**
Tub Insulation	Hi-Efficient Compressor	Hi-Efficient Compressor
Hi-Efficient Motor	Hi-Efficient Indoor & Outdoor Coils	Efficient H.T.
Jet System Tech.	Adv. Control System	Adv. Control System
Adv. Control System	Alternative Refrigerants	Proper Insulation (Thickness – Type)
Hi-Efficient Fan-Motor	Hi-Efficient Fan & Fan Motor	Hi-Efficient Fan-Motor

Cost/Efficiency Analysis for Refrigerator Improvement Technology Options

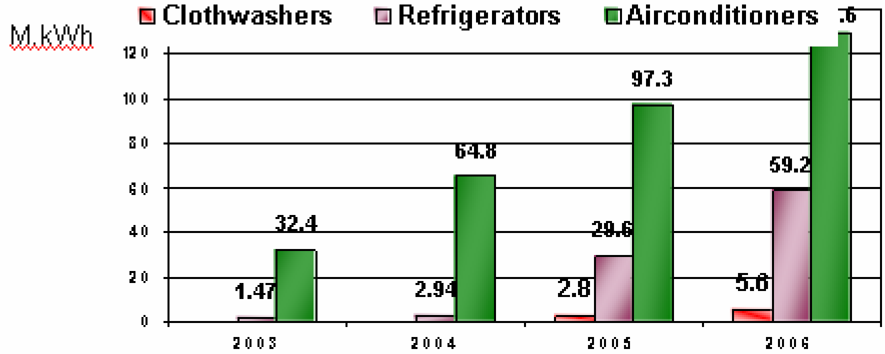
Additional Cost (%)	**Energy Savings (%)**	**Proposed Option**
2 – 5	*6 – 15*	High efficient compressor
5 - 10	*6 – 12*	Side insulation
	2 – 5	Top insulation
	4 – 8	Back insulation
2 – 4	*3 – 5*	Heat transfer improvement
2 – 5	*12 – 20*	Best matching

Cost/Efficiency Analysis for Air Conditioners Improvement Technology Options

Additional Cost (%)	Energy Savings (%)	Proposed Option
1 –2.5	5 -10	High efficient compressor
0.5 – 1.5	10 -15	Expanded surface tubing
0.3 – 0.8	1.5 – 3	Efficient fan motor
0.3 – 0.8	5 – 10	Turbulent flow split fins
2.2 - 5	12 – 15	Oversized heat exchangers
1 –2.5	5 -10	High efficient compressor

Cost/Efficiency Analysis for Washing Machines Improvement Technology Options

Additional Cost (%)	Energy Savings (%)	Proposed Option
0.3 – 0.5	2 - 4	Improved water level controller
0.3 – 0.7	3 - 6	Improve programmer performance (long time, lower temp.)
4 – 6	8 - 12	Improve thermal Efficiency
8 – 12	4 - 7	Efficient Motor
7 - 10	15 - 20	Jet system
0.3 – 0.5	2 - 4	Improved water level controller



Expected Energy Savings

Currently, the efficient specifications for electric heaters are under preparation, this will be followed by compact fluorescent lamps and magnetic ballasts.

Labeling Program

The energy efficiency labels are part of the energy efficiency standards and clearly identify the maximum and minimum energy efficiency levels for each type of appliances.

The labels appliances objectives are to:

- Create consumer awareness about cost of operation.
- Create a demand for more efficient products.
- Provide a new avenue for competition.
- Reduction in energy use and lower operating cost.
- Prevent “dumping” of inefficient products.

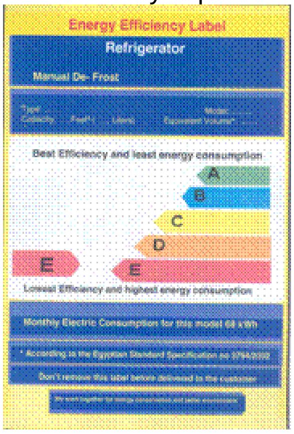
They give the following information:

- Energy efficiency Level for the denoted appliance.
- Range of energy efficiency for equivalent models.
- Annual or monthly energy consumption.
- Annual or monthly operating cost.

Labeling Program steps in Egypt:

☐ *Buyer market assessment has been conducted as follows:*

- Consumers Survey
  A sample of 5000 consumers in five major cities with different income levels, social classes, geographical locations and educational levels had been surveyed targeting the priority of purchasing factors as well as the source of consumer information about purchasing.
- Distributors & Retailers Survey
  A sample of 50 owners / managers of shops in five major cities with different income profitability had been surveyed targeting priority of equipment selection and awareness of the energy efficiency.
- Manufacturers Survey
  A sample of 10 manufacturing companies had been surveyed to get information on interest in manufacturing competitively low priced equipment, relatively low interest in energy efficiency aspects and willingness to consider energy efficiency aspects in future



☐ *Label design*

Ten samples of energy labels, have been designed taking into consideration Egyptian culture, the education levels and the
previous designed ones in other countries and a survey has been conducted for the selection of the best designed and the most accepted one. This led to the selection of the label that has been accredited.

The Minister of Industry and Technological Development has issued decrees number 3794/2002, 3795/2002, 4100/2003 respectively for energy efficiency standards for the three appliances and the energy labels for the three appliances were ratified through the Ministerial decree number 180/2003.

The Government of Egypt had succeeded in obtaining a fund from the UNDP Thematic Trust Fund for the establishment of an accredited energy efficiency testing laboratory to support the national energy efficiency standards and labeling program. This fund has been utilized to upgrade the existing testing facility at the New and Renewable Energy Authority (NREA) in order to be capable of performing necessary energy efficiency tests.

The energy efficiency testing laboratories for the washing machines and the refrigerators have been accomplished and ready for testing once accredited, as for the air conditioners the offers have been evaluated and the contract will be awarded mid May to the Italian Company Angelantoni.

Some issues are still to be addressed:

Low market understanding of label objectives

- Conducting market research to help define barriers,
- Design of simplified campaigns to educate on purpose of and how to use information on label.

Low consumer awareness of importance of energy efficiency

Continued outreach through consumer seminars, articles in popular media.

Low consumer awareness of label

- Supplier funded/co funded advertising
- Media, journalists seminars to encourage promotion
- EEIGGR promotions of energy efficiency message and label use and objectives.

Low supplier trust of compliance with decree

- Modification of decree to address consequences of non appliance
- Need for label to be visible to consumers
- Requirement of retailer cooperation for annual delivery of data

Low retailer understanding and promotion pf labels and high efficient products

Training of retailers through seminars in-store literature and video

Lack of base line data on consumers

Market research to determine baseline awareness understanding and use of labels in decision making

Lack of base line data on supplier activities

- Interviews with key manufacturers, distributors and retailers regarding label awareness, compliance and promotion
- Informal survey of retailers to measure compliance by company, record pricing between rated models and assess retail store manager understanding and promotion of energy efficiency message and label.

An electricity efficiency market survey is currently conducted to assess the current degree of awareness among Egyptian consumers regarding the energy efficiency in general and the standards and labeling program in particular in order to raise their awareness, in addition to seek and encourage cooperation with different stakeholders

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Regional Cooperation in Energy Efficiency Standard-Setting and Labeling

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Abstract

Three years ago at EEDAL 03, the first author presented a paper reporting on regional activities to harmonize various aspects of energy efficiency standard-setting and labeling (S&L). Since then, the number of multinational collaborations and the level of activity in S&L alignment and harmonization have increased dramatically. This paper provides a status report on regional cooperation in S&L worldwide.

Many countries are participating in regional activities directed at unilaterally *aligning* energy efficiency standards and labels and the testing that underlies both these measures with their neighbors and trading partners. Some countries are more formally *harmonizing* elements of S&L through multilateral agreements. Such activities are being undertaken by the Asia-Pacific Economic Cooperation (APEC), the South Asia Regional Initiative for Energy Cooperation and Development (SARI), the Asia and South East Asia Network (ASEAN), the North American Energy Working Group (NAEWG), the European Union (EU), and a variety of regional collaborations orchestrated by the United Nations Development Program's Global Environmental Facility (UNDP/GEF). In these activities, the common interests of the participants are harmonized test facilities and protocols, mutual recognition of test results, common comparative energy label content, harmonized endorsement energy labels, harmonized minimum energy performance standards for some markets, shared learning of the labeling process, and shared learning of the standard-setting process. This plethora of geographical S&L collaborations is being enhanced by newly emerging global collaborations directed at harmonizing various aspects of individual products.

The authors predict continued expansion of multilateral collaboration in S&L over the next decade with UNDP/GEF providing the primary impetus through its already extensive and rapidly expanding global S&L initiative.

Executive Summary

An increasing number of countries are adopting S&L programs that ban products outdated in performance, especially on their energy performances, from their markets. The technologies contained in these banned products are no longer economical under any economic circumstances. These products, however, are still being manufactured, and shipped to countries and regions without the protection of effective energy efficiency standards. Unfortunately, the countries without such protection of their markets, and thus households and businesses, are mainly found in the developing world and the economies in transition.

Activity in energy efficiency standard-settings and labeling (S&L) around the world has been expanding dramatically. Over the four years from 2000 to 2004, the *number of countries* engaged grew from 46 to 62. The *number of products* treated by at least one country increased from 43 to 81. The *quality of the treatment* has generally been improving along with the number of participants and coverage of products as information about best practices has spread, and *interaction among practitioners has flourished*.

The *flourishing of interaction* among practitioners comes primarily from sharing of information through workshops and conferences, distribution of papers presented at these meetings, the free availability of CLASP's guidebook for S&L practitioners [8], provision of technical assistance by S&L experts, and the assembly of *regional S&L collaborations*, all stimulated by foreign aid agencies and other international funding organizations.

The assembly of *regional S&L collaborations* is the subject of this paper.

Standard-Setting and Labeling

Four decades ago, some governments began to address the concern that consumers in general were paying unnecessarily large utility bills for the sake of buying appliances, equipment and lighting products at the lowest possible purchase price. This practice results in a large cost to society in economic inefficiency and environmental stress. There are many reasons why consumers behave this way, ranging from electricity and fuel prices that do not reflect true economic costs to a lack of money and/or information. Since then, governments around the world have been increasingly implementing energy efficiency standard-setting and labeling programs to help create a more economically efficient and environmentally sustainable society. Today, over five dozen countries have initiated such programs and both the number of countries participating and the number of products covered are expanding rapidly.

Over the four years from 2000 to 2004, the *number of countries* engaged grew from 46 to 62. Over the same period, the *number of products* treated by at least one country increased from 43 to 81 as shown in Table 1. [8]

TABLE 1. Products Covered by at Least One Standard or Label

Regulated somewhere in 2000	Newly regulated since 2000
HOUSEHOLD APPLIANCES	
Refrigerators Freezers Clothes Washers Clothes Dryers Dishwashers Ranges/Ovens Microwave Ovens Rice Cookers Electric Kettles Vacuum Cleaners Irons Icemakers Water Heaters Solar Water Heaters Showerheads (water use) Range Hoods Faucets	Kimchi Fridges Washer-dryers Showerheads (energy use) Toilets (water use only) Toilet Seats Urinals (water use only)
HVAC	
Room AC Central AC Boilers (electric and gas) Dehumidifiers Fans Furnaces (gas) Heat Pumps Pool Heaters Space Heaters	Room Air Cleaners Boilers (oil) Chillers Furnaces (oil) Programmable Thermostats*
LIGHTING	
Ballasts Lamps	Exit Signs Residential Lighting Fixtures Traffic Signals Wall packs

Regulated somewhere in 2000	Newly regulated since 2000
HOME ELECTRONICS	
Televisions VCRs Radio Rcvr/Rcdr	Digital TV services DVDs TV\ VCR and TV\ DVD Combination Units Set-top boxes Portable Personal audio Analogue Satellite Receivers Home Audio* * Answering Machines Cordless and mobile phones Battery chargers
OFFICE EQUIPMENT	
Computers Monitors Copiers Printers Fax Machines Scanners	Multifunction devices Mailing machines Hard-disk Drives Drinking Water Coolers (Hot & Cold) External Power Supplies
COMMERCIAL & INDUSTRIAL EQUIPMENT	
Motors Pumps Distribution Transformers	Commercial HVAC Commercial Fryers Commercial Hot Food Holding Cabinets Commercial Refrigerators Commercial Steam Cookers Vending Machines
BUILDING MATERIALS	
Doors Windows Skylights	Building insulation Reflective Roof Products

Building and industrial sector only

The *quality* of S&L programs has generally been improving along with the number of participants and coverage of products as information about best practices has spread and interaction among practitioners has flourished. By *quality* we mean 1) test criteria that allow fair comparisons of how different products will consume energy in normal use, 2) testing that is accurate and consistent, 3) labeling that effectively communicates the desired message and influences consumers to choose products that result in the greatest social welfare, 4) and standards that lead to the acceleration into the marketplace of technology that provides the greatest social welfare. An *underinvestment* in energy efficient features in any appliance, equipment or lighting product will lead to costs incurred for fuel, lost social amenities, and environmental damage that exceed the initial investment. An *overinvestment* in energy efficiency features will wastefully exceed the costs incurred for fuel, lost social amenities, and environmental damage. Effective 'quality' S&L optimizes the social investment.
As globalization advances, however, the way neighboring countries and strong trade partners implement S&L programs is affecting their impact. As exporting manufacturers face a variety of differing national programs, their costs of manufacturing and testing to meet each market’s requirements rise as well. As the number of national programs grows, the opportunity arises to lower the cost impact of these standards and labeling programs through regional harmonization.

Regional S&L Alignment/Harmonization

What is regional alignment/harmonization?

Alignment and harmonization both may involve the adoption of the same test procedures, mutual recognition of test results, common comparative energy label content, harmonized endorsement energy labels, and harmonized minimum energy performance standards (MEPS). Recently, more and more countries have been making a distinction between unilateral *alignment* of elements of standards-setting and labeling programs with those of trade partners and *harmonization* of these program elements in multilateral forums and compacts. The benefits from these two approaches to cooperation are basically the same.

By design, government standard-setting and labeling programs are targeted at influencing the way manufacturers of energy-consuming products produce and distribute their products. Alignment and harmonization not only facilitate economic globalization of appliance, equipment and lighting product markets, they offer governments the opportunity to make energy efficiency standard-setting and labeling programs more stringent and more effective.[1] *Harmonization* discussions are complex and slow because standards, harmonization, and trade regulations are negotiated on the basis of strategic advantages: reduction of trade barriers is not necessarily "beneficial" to all concerned. World bodies and others promoting regional endeavors can target their resources most effectively by understanding and accounting for the trading patterns of the manufacturers they are trying to influence. [3] Unilateral *alignment* is easier to achieve than harmonization, but still requires sometimes difficult tradeoffs among feelings of national sovereignty, protection of local businesses, considerations of social and climatic differences, and S&L program cost. It is usually significantly less costly and time consuming to adopt elements of one's S&L program that have been previously designed and proven in application by other countries or whose development costs are shared with neighboring trade partners.

Benefits and motivations

As labeling and standards-setting programs proliferate, international cooperation is becoming increasingly advantageous in reducing the resources needed for developing these programs, in increasing the effectiveness of the S&L programs and efficiency of energy use, and in fostering global trade by avoiding or removing indirect trade barriers. Countries more and more want to learn from the experiences of the labeling and standard-setting processes of other countries. The International Energy Agency (IEA) identifies several forms of cooperation, including: collaboration in the design of tests, labels, and standards; harmonization of the test procedures and the energy set points used in labels and standards; and coordination of program implementation and monitoring efforts. Such cooperation has five potential benefits (IEA 2000):

- greater market transparency,
- reduced costs for product testing and design,
- enhanced prospects for trade and technology transfer,
- reduced costs for developing government and utility efficiency programs, and
- enhanced international procurement.

In addition to these five benefits are two additional benefits worth mentioning:

- reducing program costs by adopting program elements from trade partners,
- avoiding the dumping of inefficient products on trading partners.

Nations joining in regional harmonization activities that CLASP has worked with have expressed differing reasons for their participation. These include the desire to: [7]

- Improve energy efficiency,
- Improve economic efficiency (improve market efficiency),
- Reduce capital investment in energy supply,
- Enhance economic development (enhance quality of life),
- Avert urban/regional air pollution,
- Help meet goals to reduce climate change,
- Strengthen competitive markets (reduce trade barriers),
- Reduce water consumption, and
- Enhance energy security.

The list above describes the benefits of well-designed and effectively implemented labels and standards. Ill-advised or poorly designed or executed programs can actually harm consumers, manufacturers, and other stakeholders, as well as the overall economy and the environment. Some

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[1] For example, Mexico's participation in NAEWG appears to have accelerated the harmonization of its minimum energy performance standard for refrigerators with the U.S. and Canada. [4]

examples of negative effects of ineffective efforts are worth noting. With regional cooperation, formal harmonization of standards by treaty rather than voluntary unilateral alignment might result in adoption of a “least common denominator” that may restrain the more progressive countries. A regional harmonized approach might also add administrative complexity and delay the process. Perceptions that a country is surrendering sovereignty to other countries as part of a harmonization effort can create political impediments as well. In national programs, inattention to detail in the development and implementation of the program can have especially devastating impacts on poor consumers or small manufacturers. Standards that are too weak, endorsement labels placed on average-performing products, and comparison labels that communicate poorly offer little relief from high utility bills or from low-quality products. Standards that are too strong can cause overinvestment in energy efficiency, resulting in overly stressed manufacturers and in consumers paying, on average, more for a product than they will recover in utility-bill savings. This in turn decreases national economic efficiency. Careful attention to current best practices can help countries avoid some of the pitfalls mentioned above.

Common interests

The diversity in rationale for participating in regional harmonization activities has not diminished the commonality of interest in achieving harmonization. In every instance that CLASP has encountered, delegations of countries and participants in various regional harmonization efforts have agreed, with little controversy, to seek one or more of the following: [7]

- Harmonized test facilities and protocols,
- Mutual recognition of test results,
- Common content for comparison energy labels,
- Harmonized endorsement energy labels,
- Harmonized MEPS for some markets,
- Shared learning about the labeling process, and
- Shared learning about the standards-setting process.

There is clearly interest in both: 1) substantive achievements in harmonizing testing, MEPS, and labels (the first five items); and 2) the process of standard-setting and labeling (the last two items). In the latter case, an exchange of information and experiences has been a high priority.

Link to economic cooperation

In all cases, the creation of an S&L harmonization activity has been an outgrowth of a broader collaborative effort. For example, the North American Energy Working Group (NAEWG) Energy Efficiency effort (which focuses on S&L) grew out of the broader NAEWG collaboration (which focuses on all aspects of energy policy), which grew out of the North American Free Trade Agreement (NAFTA) (which focuses on all aspects of trade). The Asia Pacific Economic Cooperation (APEC) Experts Group on Energy Efficiency and Conservation (which includes S&L Harmonization) grew out of the APEC Energy Working Group (which focuses on all aspects of energy), which grew out of APEC (which focuses on economic cooperation). The EU S&L program is perhaps the most prominent example of the S&L policy being one element of a broad economic alliance. [7]. The existence of a framework for mutual cooperation on a broader, higher-level mission like economic development appears to be a prerequisite to establishing a thriving cooperative activity addressing S&L. S&L is not a big enough political or economic issue for it to stand on its own. [7]

Barriers

Despite some interest here and there in achieving regional harmonization in several aspects of S&L programs, harmonization activities are complicated and have a long time horizon. First, numerous countries have little experience, and others little willingness, to work on any topic with their neighboring countries. At best, they may recognize interest in working with their major trading partners. Energy policies remain dominated by national issues. In most countries, energy efficiency ranks low on the government’s agenda. So recognizing the benefit of working collectively, at least regionally, on energy efficiency is far from being a reality. Appliance energy efficiency standards and labels may appear to some as a rich-world’s topic. The authors strongly oppose this view. On the contrary, the appliance market in numerous developing nations, often times the least developed ones, could be compared as a dumping ground of the world market[2]. The lack of interest from governments may create the conditions for generating an extra burden to economic development as the least energy efficient products dominate the market.

Secondly, when interest for regional energy efficiency S&L activities exists, there are the formalities of establishing official organizational bodies that represent the respective governments. The process goes faster when supranational bodies exist and are already in place. Once legitimized, i.e. when a body in question has received a mandate for coordinating regional S&L efforts, harmonization bodies must be endowed with adequate resources (financial and human) to accomplish their goals. As important, the organizational bodies must have access to critical data about each country's energy efficiency programs. Language issues lengthen the time needed to carry out many activities, since documents (e.g., test procedures to undergo comparison, final reports issued by the group) may need translation. In addition, setting priorities, creating an ongoing program, and developing written documents can take time and patience in a cross-cultural setting. Finally, any official outputs from the group need official approval from all of the governments involved.

Opportunities

Though formidable, the barriers mentioned above are by no means insurmountable. Once the barriers have been addressed, it is often the case that opportunities for harmonization are abundant. Appliance and equipment markets are increasingly open and competitive, worldwide, and the products traded across borders. The world's industry has been marked by consolidation over the past two decades. Some products have become true global products for a global marketplace. Other appliances may offer different features on different continents, but still evolve within a wide market. Countries or markets without advanced standards and labels can take advantage of work done in other countries, including work by governments to develop standards and labels and work by manufacturers to produce products that meet those requirements.

Any developing country may decide to implement its own appliance energy efficiency policy. However, what is currently being observed is that a country introducing a new energy efficiency label or minimum standard for its appliance market usually seeks the support or wisdom of the most advanced countries in the field. From a development perspective, developing countries often lack basic capacities to properly develop their own standards and labels. These capacities can be developed, but at a significant price, in resources required and time lost. The product improvements that they desire are already available and marketed somewhere in the world, often within the same trading zone, and could fairly easily be transferred. Through collaboration, countries can benefit from the technologies developed in their main trading partners' economies, instead of becoming the dumping ground for the obsolete products of OECD countries.

A growing number of international organizations as well as multilateral and bilateral development funds recognize the benefits of accelerating the transfer of good practices in energy efficiency policy in developing countries. Thermal Building codes and appliances Standards and Labels can be considered as favorite "best practices", especially for encouraging climate change mitigation measures. International or national aid agencies have developed strong interest over the past several years to provide financial, technical or policy assistance to governments willing to employ standards and labels. For all the reasons listed above, they favor regional coordinated S&L programs. Supporting S&L programs, especially regional ones, has become a priority in the Global Environment Facility's fourth cycle (2006-20100).

Overview of Regional S&L Collaborations

Many countries are participating in regional activities directed at harmonizing energy efficiency standards and labels and the testing that underlies both these measures. Such activities are being undertaken by the European Union (EU), the Asia-Pacific Economic Cooperation (APEC), the South

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[2] Although there is no published research to demonstrate that this 'dumping' has happened, there are many indications that this is a common practice. Anecdotal evidence is that this has happened and may still be happening in some countries in Central Europe during the transition of the economies, distorting markets in vulnerable countries for the most vulnerable customers (e.g., low-income families, which have a high first-cost barrier). One of the reasons why developing countries with no manufacturers of a particular appliance (or with manufacturers of high-end, more efficient appliances) express interest in S&L is to curtail perceived dumping of older and less efficient models into their country.

Asia Regional Initiative for Energy Cooperation and Development (SARI), the Asia and South East Asia Network (ASEAN), the North American Energy Working Group (NAEWG), and the Pan American Standards Commission (COPANT). UNDP-GEF has recently stimulated collaborations among four Southern European accession countries and six countries in the Andean trade region and is working to establish many more such collaborations.

The following are observations and speculations based on UNDP's and CLASP's experiences in supporting regional S&L harmonization activities.

European Union (EU)

The Single European Market created in 1992 seeks to eliminate inter-community trade barriers within the European Union. This has meant that regulatory policies concerning tradable goods – including appliance labels, MEPS and voluntary agreements – are developed at EU-wide harmonized levels. Other appliance measures, such as information, procurement and financial incentive programs, are carried out at the Member State and local levels. In recent years, other OECD European countries have adopted appliance efficiency policies that are largely consistent with those of the European Union.

In 1992 a European framework energy-labeling Directive was passed which authorized the Commission, in consultation with a regulatory committee composed of representatives of the 15 EU Member States, to issue mandatory comparative energy labels for household appliances. The labeling specifications are spelled out in individual implementing directives for each product type. Label promotion and information activities to increase the public's awareness and understanding of the labels lies with the public authorities (at the national and local levels), some utilities and retailers. For its part, the European Commission is conducting pilot projects on increasing consumer awareness and training retail staff.

Specific directives imposing MEPS for boilers and for refrigerators and freezers were passed in 1992 and 1996 respectively. In 2005, a new Directive was passed and provides a policy framework to introduce additional harmonized minimum energy performance standards on energy consuming product (Directive 2005/32/EC).

Asia-Pacific Economic Cooperation (APEC)

The 21-member Asia Pacific Economic Cooperative (APEC) was established in 1989 to further enhance economic growth and prosperity for the region and to strengthen the Asia-Pacific community.3[4] Although APEC member economies represent vastly differing cultures and levels of economic development, since its inception, APEC members have worked together to reduce tariffs and other trade barriers across the Asia-Pacific region, creating efficient domestic economies and dramatically increasing exports.

In the years after its formation, APEC created an action agenda with fifteen specific areas that needed to be undertaken. Standards and Conformance was one of the areas that the agenda targeted with the following four goals:

1. Ensure the transparency of the standards and conformity assessment of APEC economies.
2. Align APEC economies' mandatory and voluntary standards with international standards.
3. Achieve mutual recognition among APEC economies of conformity assessment in regulated and voluntary sectors.
4. Promote co-operation for technical infrastructure development to facilitate broad participation in mutual recognition arrangements in both regulated and voluntary sectors.

While APEC established an Energy Working Group (EWG) in 1990 as one of ten sectoral groups, the Energy Ministers of the APEC economies met for the first time only in 1996. At this meeting, the Ministers embraced APEC's new action agenda and instructed officials from member economies to work together to achieve the benefits of increased cooperation on energy standards by:

- developing firm proposals for establishing a base on which mutual acceptance of accredited test facilities and standard test results obtained at these facilities [could] be achieved;

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[3] APEC's 21 Member Economies are Australia; Brunei Darussalam; Canada; Chile; People's Republic of China; Hong Kong, China; Indonesia; Japan; Republic of Korea; Malaysia; Mexico; New Zealand; Papua New Guinea; Peru; The Republic of the Philippines; The Russian Federation; Singapore; Chinese Taipei; Thailand; United States of America; Viet Nam.

[4] see http://www.apecsec.org.sg/

- working towards the establishment of bases for the direct comparison of the outcomes of testing to different standards so that the need for testing to multiple standards [could] be reduced or removed; and
- developing a general policy framework that would allow for the progressive development and implementation on a bilateral or multilateral basis, and product-by-product, as technical details [were] established and mutually agreed.

The EWG formed an Expert Group on Energy Efficiency and Conservation (EGEE&C) with a general mission “to advance economic and social well being in the Asia-Pacific region through energy conservation and the application of energy-efficient technologies”. In 1996, EWG created a separate ad hoc APEC Steering Group on Energy Standards (SGES) to design a general policy framework to guide future energy efficiency standards related work within APEC economies.. In 2000, SGES submitted its report to EWG, completing its mandate and recommending that EGEE&C implement the proposed framework. The report concluded that the successful implementation of the general policy framework requires the active participation by member economies in future APEC workshops and international standards processes. It also requires the existence of an infrastructure that will create transparency of action on the development and use of energy efficiency test procedures and that will monitor and coordinate related activities in the APEC region. The SGES concluded that in order for the framework to be implemented effectively, a web-based Standards Notification Procedure needed to be established and an APEC Energy Efficiency Test Procedures Coordinator should be appointed. [5]

At their second meeting in 1998, APEC Energy Ministers endorsed the establishment of a Standards Notification Procedure and agreed to consider other new programs related to energy efficiency test procedures. The subsequent meetings of the energy ministers to date have all provided further encouragement and guidance to EGEE&C for its standards and labeling initiative with language such as this from its sixth meeting in 2004, "We encourage all member economies to participate in the Energy Standards and Labelling Cooperation Initiative and the web-based APEC Standards Notification Procedure aimed to facilitate trade in efficient energy using equipment used within the region."

Since 2000, EGEE&C has:

- Prepared a report on the applicability of algorithms for comparing test results
- Conducted a regional symposium on the status of standards in APEC economies
- Conducted a regional seminar on cooperation in energy labeling in APEC economies
- Sponsored a series of vision workshops on the future of S&L
- Established the web-based Energy Standards Information System (ESIS)
- Shared information among members about the progress of S&L at its twice-a-year business meetings

The three-day regional symposium on the status of energy efficiency standards in APEC economies, held in Taipei in 2002 was attended by over two dozen participants from 11 different countries. The labeling seminar, held in Kaohsiung in 2003, was also a three-day event attended by over two dozen participants, in this case from 14 different countries. The series of vision workshops were sanctioned by EGEE&C and hosted by the Australian Greenhouse Office on three continents in 2003 and 2004 to develop a consensus vision for the future of S&L. The resulting report, *A Strategic Vision for International Cooperation on Energy Standards and Labeling*, called for continued international information exchange (including the proposed use of “communities of practice” organized around product categories), increased emphasis on alignment and harmonization of standards and labels beginning with common or readily translatable test procedures, and international benchmarking of appliance standards and labeling “tiers” as a means to advancing Best-Practice levels of performance [1].

The ESIS web site was begun in 2002 under an APEC grant and has been maintained since then under a self-funded project of Taiwan. In 2004, APEC partnered with CLASP to expand the standards database beyond the APEC economies. The joint ESIS-CLASP database has information on over 1700 standards. The site also provides contact information on personnel involved in S&L among the 17 participating economies, information about *What's New*, useful data called *Quick Facts*, a library of publications, a site for benchmarking studies, and portals for Communities of Practice to exchange information. [2]

The progress in stimulating S&L in its member economies that APEC has been able to achieve over the past decade is due to a combination of dedicated people and ongoing reliable funding. Just three high-energy individuals committed to S&L have provided expertise and enthusiasm to create and maintain the primary momentum for the initiative. Support from over two dozen dedicated and competent representatives from member economies has contributed to the initiative's viability. Importantly, the venture was facilitated by APEC's robust mechanism for funding such initiatives. By annually making ample project funds available from member economy contributions and by sponsoring member economy self-funded projects, APEC provided funding for participant travel to the workshops and for the development and maintenance of the ESIS web site. Without any one of these three components, much of the APEC support for S&L would not likely have happened. Also, without the initial mandate from the highest level within the member economies and specifically from their Energy Ministers, the initiative would not likely have gained the traction that it has.

Asia and South East Asia Network (ASEAN)

The Association of Southeast Asian Nations (ASEAN) was established in 1967 by five original Member Countries. Today there are 10 members.5 The aims and purposes of ASEAN are to accelerate the economic growth, social progress and cultural development in the region, and to promote regional peace and stability. Some of the earliest economic cooperation schemes of ASEAN were aimed at increasing intra-ASEAN trade, including the launching an ASEAN Free Trade Area or AFTA.

Today, ASEAN economic cooperation covers 12 areas, one of which is energy. An ASEAN Centre for Energy (ACE) was established as an intergovernmental organization to serve as a catalyst for the economic growth and development of the ASEAN region by initiating, coordinating and facilitating regional as well as joint and collective activities on energy that are in harmony with the environmental sustainability of the region. ACE now facilitates and coordinates the work of the Energy Efficiency and Conservation Sub-sector Network (EE&C-SSN), a body established in 1997 to coordinate ASEAN's energy efficiency activities. Funding for ACE is provided by an Energy Endowment Fund established from equal contributions of the ten member countries.

Since its establishment, ACE has been instrumental in preparing two ASEAN Plans of Action for Energy Cooperation, one for the period 1999-2004 and one for 2004-2009. Each has an S&L program. The 1999-2004 plan includes "Formulate ASEAN EE&C Labeling System" as one of four strategies. The 2004-2009 plan includes "Continuation of ASEAN Energy Standards and Labeling as one of six strategies, listing the following five actions for this strategy:

- Review country S&L programs and testing capacity
- Study international experiences through study tour and joint workshops
- Formulation of common Technical Bases
- Development of Control Mechanisms and Implementation process
- Dialogues with stakeholders and promotion

Since 1997, ACE and EE&C-SSN have:

- Conducted an inception workshop and subsequent meeting of members to set up an ASEAN energy efficiency performance labeling system
- Conducted an appraisal of the ASEAN ballast market, coordinated comparative testing of magnetic ballasts, developed a common testing procedure for magnetic ballasts, and evaluated alternative endorsement label designs in support of the ASEAN labeling system
- Conducted an Australian study tour
- Monitored and supported the above S&L activities at the annual meetings of EE&C-SSN

The First ASEAN Energy Efficiency Standards and Labelling Workshop was held in Thailand in 2001. This inception workshop had the specific objective of addressing the benefits and issues on the harmonization of S&L in the ASEAN region and setting up an ASEAN energy efficiency performance labeling system. It resulted in agreement to pursue a voluntary standard endorsement label for energy efficient products, starting with magnetic ballasts. The Regional Working Committee on ASEAN Energy Efficiency Standard and Labelling that was created for this task held a second meeting in the

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[5] ASEAN members are Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam

Philippines in 2003 and a third in Pattaya in 2004. The Philippines was assigned the lead on the ballast labeling project.

Since 2001, ACE has coordinated and conducted activities to support this initiative. It engaged CLASP to help conduct an appraisal of the ASEAN ballast market, conduct comparative “round-robin” testing for magnetic ballasts in six ASEAN countries, develop a common testing procedure for magnetic ballasts, and organize a technical study tour for ASEAN technical personnel to visit Australia to study Australia/New Zealand's harmonized ballast standard. ACE also evaluated alternative endorsement label designs in support of the ASEAN labeling system. A final report on the ballast test standard and round-robin testing was released by the Philippine project leader in early 2006 and launch of the ASEAN label for magnetic ballasts is expected to follow shortly.

The application of the ASEAN endorsement label is to be voluntary. Individual Member Countries will develop their own national guidelines to implement the label and to ensure that the label is properly used and attached to products that are made by manufacturers accredited by proper authorities in the Member Countries. Magnetic ballasts with a power loss of not more than 6 watts will be considered as ASEAN energy efficient products.

When work on the label for magnetic ballasts is complete, ACE and EE&C-SSN are planning to next turn their attention to labels for refrigerators and air-conditioners with Thailand leading the effort.

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Figure 1. Regional Endorsement Label Adopted by ASEAN

South Asia Regional Initiative for Energy Cooperation and Development (SARI)

The South Asia Regional Initiative for Energy Cooperation and Development (SARI/Energy) program was launched by the US Agency for International Development (USAID) in 2000 to build mutually beneficial energy linkages among the countries of South Asia. SARI/Energy’s approach is to help decision-makers understand how sustained cooperation in energy trade and harmonization of energy standards benefits all of the countries in the region. The participating countries are Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka, Afghanistan and Pakistan.

USAID employs consultants to operate the program. Since 2000, SARI/Energy has sponsored training, capacity building, and networking addressing clean energy trade, energy efficiency, rural energy supply, energy regulatory issues, energy statistics, and private sector involvement. It focuses its energy efficiency activities, one of its four major programs, on continuing evolution of regional standards and labeling for selected electrical appliances and providing limited technical support for increasing regional trade in energy efficient appliances within the region.

SARI/Energy has provided technical assistance to the Nepal Bureau of Standards & Metrology to design & implement a program to introduce standard setting & labeling of end-use appliances through replication of Sri Lankan best practices related to fluorescent ballast labeling. SARI/Energy has also begun efforts to harmonize standards developed by each country in the region in order to isolate the region from cheap & inefficient appliances and improve quality of manufactured appliance in the region. In an effort to harmonize refrigerator standards white papers were prepared on testing facilities and protocols, and key regional technical expects met in Sri Lanka to discuss the regional implications of the refrigerator standards already developed by India & Sri Lanka. This historic meeting led to the formation of an informal regional technical group to discuss future regional standards. < www.sari-energy.org>

North American Energy Working Group (NAEWG)

The North American Energy Working Group (NAEWG) was established in the spring of 2001 by the Canadian Minister of Natural Resources, the Mexican Secretary of Energy, and the U.S. Secretary of Energy. The goal of the Group is "to foster communication and cooperation among the governments and energy sectors of the three countries on energy-related matters of common interest, and to enhance North American energy trade and interconnections consistent with the goal of sustainable development, for the benefit of all". This cooperative process fully respects the domestic policies, divisions of jurisdictional authority, and existing trade obligations of each country. [4]

The scope of the NAEWG's discussions includes the full range of energy development, production, transport and transmission, distribution, and consumption in North America, including the efficient and clean production and use of energy. At its outset, NAEWG established teams to address each aspect of the energy sector. One, the Energy Efficiency Expert Group, chaired by Mexico and comprised of officials from the Mexican Energy Secretariat, Natural Resources Canada, and the U.S. Department of Energy, with technical support from CLASP, initiated activity in three areas:

1. Analyzing commonalities and differences in the test procedures of Canada, Mexico, and the United States, and identifying specific products for which the three countries might consider harmonization;
2. Exploring possibilities for increased mutual recognition of laboratory test results; and
3. Looking at possibilities for enhanced cooperation in the Energy Star voluntary endorsement labeling program.

At the time, all three countries had well-established domestic programs relating to MEPS, test procedures, comparative labeling, and endorsement labeling which were key elements in support of each country's goals in such areas as energy security, environmental protection, and economic growth. These programs, implemented in varying ways and within different institutional contexts, were already highly effective in reducing energy intensity in North America, and were supporting growing markets for energy-efficient products and services. On a regional level, the North American Free Trade Agreement (NAFTA) was stimulating a North American market for efficient products. A large number of products in North America are manufactured in one country and installed and used in the others. However, different requirements in MEPS, test procedures, comparative labeling, and endorsement labeling have the potential to result in unnecessary barriers to trade within the region. By collaborating, the three countries hoped to reduce the costs of compliance with standards and mandatory labeling programs in the region, accelerate the replacement of less-efficient products, facilitate the transformation of the regional market for energy-efficient products, and attenuate of some of the environmental impacts of energy production.

In 2002, NAEWG's Energy Efficiency Expert Group initiated detailed comparisons of the three countries' test procedures, to identify areas for potential harmonization. The Expert Group determined that there were 46 energy-using products for which at least one of the three countries had energy efficiency regulations. Three products—refrigerators/freezers, room air conditioners, and integral horsepower electric motors—appeared to have nearly identical test procedures in the three countries; ten other products had different test procedures, but near-term potential for harmonization. Through line-by-line comparisons of the three most similar test procedures, the NAEWG Expert Group verified that—apart from minor wording differences—they were identical. [6]

Since then, the Expert Group has met regularly about twice a year, and has engaged in the following activities:

<u>Test Procedures</u>: Having verified that the first group of products was substantively identical or nearly identical in the three countries, the Expert Group is comparing test procedures for residential central air conditioners and is investigating other products for similar test procedure comparisons.

<u>Voluntary Endorsement Labels</u>: With consultative support from the United States and Canada, Mexico is exploring possibilities for extending the Energy Star endorsement label to Mexico.

<u>Mutual Recognition</u>: The Expert Group also has been exploring mechanisms for facilitating the mutual recognition of testing laboratory results among the three countries, hoping to minimize duplicative testing requirements. Starting with electric motors, the Group is creating a series of guidance sheets on requirements for manufacturing and selling different products in the three countries (including certification requirements), and is exploring ways to help the process at each stage. It also is comparing data reporting requirements that each country has for each product, and exploring possibilities for harmonization.

<u>Stakeholder Involvement</u>: Each country solicits the input of its stakeholders on the harmonization of test procedures and endorsement labels, and mutual recognition of test results. In addition to domestic manufacturers and trade associations, the Expert Group is collaborating with the international Council for Harmonization of Electrotechnical Standards of the Nations of the Americas

(CANENA). Stakeholders generally have expressed positive support for continuing cooperation on these elements of the three countries' standards and labeling efficiency programs, and some have made recommendations on which products may be appropriate for harmonization.

Long-term Harmonization: The Expert Group continues to gather information that would be necessary for preparing a long-term harmonization plan for additional test procedures and voluntary endorsement labels, mutual recognition of laboratory testing and results, and other harmonization and energy efficiency promotion activities.

Standby Power Losses: The Expert Group is exploring possibilities for harmonizing regulations on standby losses in the three countries and is preparing a white paper on that topic.
In June 2005, the broader trilateral Security and Prosperity Partnership of North America (SPP) initiative was formed, and NAEWG was adopted as its energy arm. The NAEWG/SPP's Energy Efficiency Expert Group continues to focus on standards and labeling, although SPP has added transportation efficiency to the Group's portfolio.

United Nations Development Program's Global Environmental Facility (UNDP-GEF)
In 2002, CLASP began working with UNDP-GEF to develop a series of regional projects to foster regional collaboration in S&L. By 2004, several such projects were in development in several regions and UNDP-GEF brought a S&L international expert to its staff full-time in order to further develop and coordinate this effort. As of the spring of 2006, UNDP-GEF has completed one and has three active regional S&L projects underway, as shown in Table 2, with more under development.

Table 2. GEF Regional S&L Projects*

Project Name	**Stage**	**Run Date**	**GEF $ (millions)**	**S&L Activity**
The Efficient Lighting Initiative (**ELI**) *	Full Project Complete			CFL Labeling by the project without a national or legislative base
Technical Capacity-Building to Eliminate Barriers to the Development and the Implementation of Energy Efficiency Standards and Labeling (CSL-**Andean**)	PDF B Approved	Depends on start date		
Removal of Barriers to the Cost-Effective Development and Implementation of EE S&L in **EU Candidate Countries**	PDF-B Ongoing			Compliance with all EU S&L Framework directives including information labeling, MEPS and Energy Star
Building Codes, Energy Efficiency Standards and Labels in **Arab States**	PDF A Complete			Proposal Development Workshop

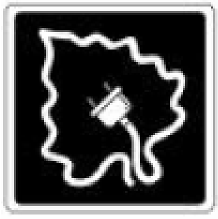
* all but the ELI project are UNDP led projects, Source: UNDP-GEF Desk Review …..

The four projects listed in Table 2 are described briefly in the following paragraphs.

ELI
The Efficient Lighting Initiative (ELI) was designed by the International Finance Corporation (IFC) and funded by the Global Environment Facility (GEF) as a three-year, US$15 million program to accelerate the penetration of energy-efficient lighting technologies into emerging markets in developing countries. ELI was a market transformation program designed to lower greenhouse gas emissions by catalyzing markets for efficient lighting in Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines and South Africa through a set of multi-country initiatives, local and global partnerships, and interventions tailored to individual country conditions.
A key element in the ELI strategy was the development and application of an ELI certification and branding system globally that provides an endorsement of the quality and efficiency of lighting

products. The ELI program also promoted utility DSM programs, conducted mass media campaigns, ran training courses, promoted energy-efficient streetlighting, worked with low-income program managers, and strengthened capacity of test labs. The original ELI program was considered to be successful over its 1999 to 2003 existence, receiving credit for reducing energy by 2,600 GWH and CO2 by 2 million tones across the seven participating countries. ELI has now been transformed into a new institute, the ELI Quality Certification Institute, which is led by the China Standard Certification Center with assistance from a team of international experts from Asia, North America and Latin America.

Andean



ELI Label

The first UNDP-GEF regional S&L project to gain approval (in April, 2005) was a PDF-B project definition phase for the Andean region entitled *"Andean Region: Capacity Building for Removal of Barriers to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling (Andean-CSL) Programme".* The countries collaborating in this project are Bolivia, Colombia, Ecuador, Peru, and Venezuela. The primary purpose of this project definition phase is to define the work program and prepare the documents required by UNDP and the GEF Secretariat for a 'full project', including a baseline analysis to describe the status of S&L in the region at the inception of the project. Since GEF projects are 'country driven', the PDF project includes a significant degree of the intended collaboration. The primary objective of the full project will be to eliminate barriers to the development and implementation of S&L in the region. This five-country regional project is scheduled for completion in 2007, led by the executing agent, Colombia's Unidad de Planeación Minero Energética (UPME), with technical support from CLASP in baseline assessment and full project document preparation.

EU Candidate Countries

In 2005, UNDP-GEF gained approval and initiated a PDF-B project entitled *"Programme of Capacity-Building for the Removal of Barriers to the Cost-Effective Development and Implementation of Energy Efficiency Standards and Labelling in EU Candidate Member Countries".* This Southern Europe regional cooperation supports the Republic of Bulgaria, Romania, Croatia, and Turkey as they prepare to transpose the EU Framework Directives governing energy efficient standards and labelling for household appliances. This project is similar to the Andean PDF-B project with the addition of a training component. Training materials will be developed and used at three workshops on project design; policy, legal & institutional assessment; market assessment; stakeholder assessment; and verification & enforcement capacities assessment. CLASP is providing 1) a policy, legal & institutional expert; 2) a market studies expert; 3) a stakeholder assessment and awareness raising expert; and 4) a verification & enforcement capacities expert.

Arab States

In numerous Middle East and Arab States countries, promoting energy efficient standards and labels are now viewed to be among the most cost-effective tools to reduce the rapidly growing energy and especially electricity demand. For instance, in Egypt, the second largest CO_2-emitter of the Arab States[6] with an estimated 34.7 million tons of carbon per year in 2002/2003, the residential and service sector (including public sector) were responsible for about 23 % of the final energy consumption and about 60 % of the final electricity consumption. The vast majority of this consumption is to serve the energy needs of the buildings and building appliances, including lighting, heating and cooling, hot water preparation, washing machines etc. The electricity demand in the residential and service sector was growing with the average rate of close to 9% between in 2001/2002 and 2002/2003. Similar energy consumption structures and development trends can also be observed in other countries of the region.

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[6] Saudi-Arabia being the largest with the estimated 82.2 million tons of carbon in 2002

In order to reduce the growing demand and thereby reduce the need for new, costly supply side investments, several countries of the region have adopted, or are in the process of developing and adopting new energy sector legislation, with stronger emphasis on end-use energy efficiency.

Seven countries in the Arab States region have decided to engage in a regional collaborative S&L effort and are requesting the financial support of the GEF. The objective of the project is to facilitate broader adoption of harmonized standards and labels and the related testing and certification procedures in Arab States, by building on the experiences and lessons learnt up to date. Project activities should start in 2006.

What's Ahead

Even after most nations have adopted best practice S&L, continuing improvements in technology will provide a continuing need for countries to update test procedures, ratchet up MEPS and improve label effectiveness. But for now, the pressing need is to help nations adopt best practice S&L as they initiate and expand their S&L programs. Obsolete technologies abound, mainly in low-end appliances and equipment, intended for customers just able to afford the initial purchase price. These vulnerable households and businesses are thus provided with significant running costs and the need to spend a large share of their income on energy.

New Technologies

Numerous opportunities exist to phase out obsolete technologies NOW.

Most promising and immediate of these opportunities are the elimination of future sales of:

- low-efficiency **electric motors**;
- low-efficiency **air-conditioning**;
- low-efficiency **refrigerators**;
- low-efficiency **electromagnetic ballasts** (for fluorescent lighting);
- low-efficiency **distribution transformers**;
- inefficient **standby power**

In addition, there are some technologies that are quickly becoming obsolete, but for which the alternative is not yet cost-effective for all sectors and applications. Examples of these are:

- incandescent **lighting** (alternative technology: compact fluorescent lights, or LED-lights): also the desired market transformation should address the phasing out of kerosene lighting, which is a health hazard still in numerous countries and has the worst ratio between the service provided (the light output) and the greenhouse gas emissions (GHG).
- Cathode-ray tube **televisions** (alternative technology: LCD screens)

These technologies should be closely monitored, and their use discouraged for those sectors and applications where there is no economic or technical rationale any more.

Regional Collaboration

Regional and global collaboration will continue to increase over the coming decade as nations work together to phase out obsolete technologies through S&L. The first and most productive area for exploring alignment and harmonization is in energy performance **test procedures and recognition of test results** from accredited laboratories across international borders, since this facilitates the ability to manufacture and sell products across different markets, and also allows a consistent comparison of energy performance and energy efficiency. This is a consensus of the participants (including the authors of this paper) in a series of four invited workshops conducted by APEC in 2003 and 2004 on four continents to prompt discussion about a common strategic vision on energy standards and labeling. [1]

The participants in the APEC-sponsored vision workshops also agreed that there may be an advantage to harmonizing “steps” in a comparative **label**; however, due to differences in cultural symbols and understanding, there is little hope in the short term of developing single label designs that would be applied across many countries. The exceptions are where there are trading blocs such as for the comparative label for the European Union or the ASEAN endorsement label for lamp ballasts.

Likewise, the vision workshop participants agreed that alignment of **MEPS** levels across economies is likely to happen for products that are widely internationally traded, with an evolution to a single international MEPS level (e.g., standby power loss) or to natural efficiency “tiers” from which economies can select a MEPS level (e.g., Europe's EFF1, EFF2, EFF3 labeling scheme for electric motors).

More importantly, there is an urgent and immediate need for the comprehensive collection, analysis and dissemination of S&L **best practices**. The best practice topics should include product characteristics (e.g., performance parameters, standard levels, endorsement label thresholds, etc) for specific products (e.g., CFLs, air conditioners, TV set top boxes) as well as administrative processes of standard-setting and labeling programs (e.g., funding test facilities, setting standard levels, enforcing compliance).

There is also a growing need for standardized and regularly conducted **training** courses on all aspects of S&L, as the body of practitioners grows worldwide. With 62 countries currently participating and the number continuing to grow, the number of practitioners of S&L -- from testing to design to administration and enforcement to consumer education -- can be expected to be several thousand. This is a large enough base to warrant a globally designed training program offering courses regionally.

As mentioned in Section 4.6, UNDP-GEF is instigating what will likely become a GEF-wide S&L initiative. UNDP-GEF is developing new regional S&L projects in Asia, Central America, the ConoSur region of South America, Southern Africa, Francophone Africa, and Anglophone Africa. It is also collaborating with UNEP-GEF to institute a global S&L project to coordinate the activities and share the results of the national and regional S&L projects and to develop and maintain a toolkit for S&L support. The UNPD-GEF S&L initiative is emerging as the central focus of S&L technical assistance.

Global Alignment/Harmonization

It might also be useful to discuss phasing out obsolete technology through S&L with the world industry, by branch. This may be an innovative and highly cost effective Climate Change mitigation strategy. The UN (UNDP, UNEP, UNFCCC) could be the forum for a series of international governments-industry agreements, maybe under the agenda of the Millennium Development Goals and guided by the Committee for Sustainable Development.

The time may have come to call for an international forum and possibly an international body (a subdivision of the UNDP for instance?) to encourage and monitor worldwide S&L efforts and to coordinate effective communication among S&L policy managers and practitioners. UNEP's program on Sustainable Production and Consumption bears the seed for such global scheme (www.unep.or/sustain).

UNFCCC flexible mechanisms, such as Clean Development Mechanism (CDM), might evolve to provide certified emission credits (CERs) that would help finance S&L *activities*. Such S&L activities might be comprised of, for instance, the upgrade of appliance manufacturing plans or assemble lines in developing nations, the testing of appliances in accredited laboratories, the operation of a system of monitoring and enforcement, or the communication and information campaign targeting appliance stakeholders, especially retailers, and the general public.

Among the many benefits that S&L provide, they represent a unique opportunity for a concrete and visible public policy for national governments, possibly for international organizations like the Global Environment Facility and national aid agencies. Energy efficiency standards and labels clearly deliver key outputs and satisfy key GEF objectives. We can expect the growing number of national governments that are members of the global S&L club to greatly increase their collaboration regionally and globally over the next decade.

Acknowledgement

This work was supported by 1) the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, State and Community Programs, Office of Building Research and Standards of the US Department of Energy under Contract No. DE-AC03-76SF00098, 2) the Bureau of Economic Growth, Agriculture, and Trade, Office of Environment and Science Policy, of the United States Agency for International Development (USAID), and 3) UNDP-GEF.

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Reducing the Price of Development: The Global Potential of Efficiency Standards in the Residential Electricity Sector

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Abstract

The last two decades have witnessed the development of minimum efficiency performance standards (MEPS) for appliances and lighting equipment as an effective policy for market transformation in the residential sector. In industrialized countries, government portfolios of standards programs promulgated to date will have a significant effect on sector consumption. For example, standards already written into law in the United States are expected to reduce residential sector consumption and carbon dioxide emissions by 8-9% by 2020[1]. Although in recent years the development of MEPS has spread throughout the globe, including many developing economies, the full potential of these programs is far from realized. Since much of the growth in global energy consumption over the next decades will come from the developing world, a global estimate of the potential impacts of standards programs that includes these countries is critical for prioritizing policy options.

This paper presents a step forward in the assessment of the global impacts of efficiency standard programs. Unlike previous assessments, it uses a bottom-up methodology to forecast residential end use consumption and evaluate the policy potential for each end use individually. Electricity consumption growth in developing countries over the next 20-30 years will be driven by households acquiring new appliances, in contrast to industrialized countries, where appliance markets are saturated. Currently, many households in developing countries do not have access to electricity, or may use electricity only for lighting and one or two appliances. As household incomes grow, however, more and more will purchase energy consuming equipment. Electricity consumption and the potential of mitigation by standards therefore depend on the affordability and purchase order of each end use. Unlike models that forecast total electricity consumption in proportion to per capita GDP, we forecast household electricity consumption by modeling ownership of individual appliances using an econometric parameterization calibrated to household survey data. By applying estimates of efficiency improvement for each end use according to current best practices, we then calculate the potential for mitigation of electricity consumption and related carbon dioxide emissions from standards programs. We believe this to be the first study to make such an evaluation with a global scope and at the end use level of detail.

Introduction – Standards and Labeling Programs Past and Future

For many decades, energy consumption and its associated greenhouse gas emissions have emanated predominately from the world's major industrial economies in North America, Western Europe, and Japan. This era is coming to a close, as developing countries, especially in Asia, are enjoying rapid economic growth. So far, the relationship between energy consumption and economic growth in these regions seems to be echoing the history of countries that experienced it decades ago. Growth in emerging economies is occurring even more rapidly, however. The resulting demand for power is straining an already inadequate energy infrastructure, causing environmental damage and hindering economic development. Fossil fuels are often imported, leaving national economies vulnerable to supply limits and price shocks. Global environmental impacts associated with energy consumption, including climate change will present significant non-economic limits to carbon emissions.

Figure 1 summarizes the current state of affairs and outlook for global energy consumption in the building sector and fuel that is the focus of this paper –*electricity*. The projections correspond to the IPCC's Special Report on Energy Scenarios – Scenario B2, which forecasts intermediate economic growth and moderate population growth[1]. The figure shows that, by 2020, electricity consumption in

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[1] SRES electricity consumption projections are available only for the buildings (residential + commercial) sector. Results shown are from estimates of fraction attributable to residential sector only.

buildings will have doubled. Much of the growth will come from the developing world. Consumption in the Pacific OECD countries, North America, and Western Europe will double by 2030, mostly driven by commercial buildings, as well as larger homes and additional 'supplementary' appliances. By contrast, building electricity consumption in developing countries will be largely driven by growth in the residential sector. The majority of households in the developing world currently consume very little commercial energy. The influence of income growth, urbanization and universal electricity access in these countries will create new utility customers, who can afford major appliances for the first time, causing a quadrupling in consumption by 2030.

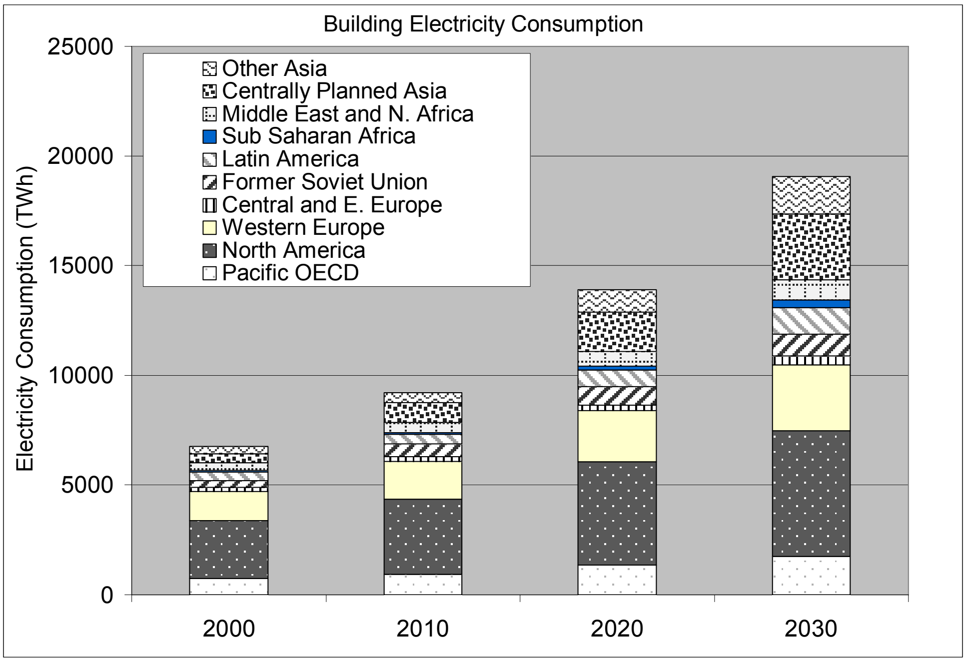

Figure 1: Building Energy Consumption by Region

To varying degrees, and in a variety of areas, industrialized countries have been successful in mitigating their consumption through efficiency. In particular, the adoption of energy efficiency standards and labeling programs (S&L) has demonstrated an ability to significantly reduce energy consumption in a cost effective way, and with little or no reduction in the utility provided to the end user. Minimum efficiency performance standards (MEPS) and information labels (both comparative and endorsement) have been implemented for a wide variety of equipment for all sectors and fuels. For example, the average new refrigerator sold in the U.S. today uses only a quarter of the electricity per year than those sold 30 years ago when standards and labels were first introduced, in spite of increases in size and added features. The U.S. program of national, mandatory energy-efficiency standards began in 1978 and has now reached 39 residential and commercial product standards. Projected annual residential carbon reductions in 2020 are approximately 35 metric tons, an amount roughly equal to 9% of 1990 residential carbon emissions [1].

Similarly, the European Union has achieved significant results in efficiency improvement from its labeling program. In particular, the efficiency of refrigeration appliances improved by 29% between 1992 and late 1999, with about one-third of the impact attributable to labeling [2]. Without standards and labeling programs and voluntary agreements, electricity consumption in OECD countries in 2020 would be about 12% higher than is now predicted. Furthermore, these policies are estimated to generate a net cost savings of 137 billion € in OECD-Europe by 2020 (IEA 2003).

S&L programs are no longer limited to industrialized countries. The number of programs throughout the world has increased dramatically over the past 15 years, from 12 in 1990 to over 60 in 2005 [3]. Most developing countries still do not have standards programs in place for many products, however. S&L programs are mature in the major industrialized economies, and the impacts of such programs to date are well understood. Going forward, however, the global picture is not so clear. Besides the more routine forecasts of advances in energy efficiency in industrialized countries, predictions of future impacts of S&L programs must rely on estimates of: (1) the growth in use of energy-consuming equipment in developing countries (2) the baseline technology that is now being used in developing countries, and (3) the adoption of efficiency programs in these emerging economies.

To date, analyses that try to present a comprehensive picture of future efficiency scenarios are few. The goal of the research presented here is to improve the state of understanding for the potential of efficiency improvement in both industrialized and developing countries worldwide. It takes a global perspective, but assesses savings potential individually in 10 regions. It focuses on a single major product, refrigerators. A global perspective allows for a comparative evaluation of opportunities for support. The reason for concentrating on refrigerators is twofold. First, refrigerators constitute a major fraction of household energy consumption, especially in developing countries, and are among the first major appliances adopted by low-income households. Their use is highly correlated to income, and therefore to economic growth. Second, refrigerators are relatively well-understood, since the ownership of refrigerators in developing countries is relatively well documented, and since there is a relative abundance of technical efficiency data.

Overview of Methodology

Previous estimates of global potential benefits have relied on sector level estimates based on the percentage of overall sector savings achieved to date in countries with mature programs. This paper goes beyond this to make an end use estimate. It trades detail for completeness, but provides a framework for extension to recover coverage through the addition of new products. Enduse level analysis is particularly appropriate for forecasts that include the developing world because the relative importance of enduses differs significantly between regions. For example many low–income households may use electricity only for lighting, refrigeration, and a television, so the percentage of sector consumption for refrigerators will be higher than in industrialized countries. An accurate assessment of enduse consumption relies on the ability to forecast household appliance ownership rates as a function of economic development.

The methodology brings together three main components comprising four analytical steps. The first component is appliance ownership modeling. We take advantage of previous work [4], which developed an econometric relationship between household income and refrigerator ownership in developing countries on a household basis. In Step 1 of the current analysis, we generalize this relationship to *predict average saturation (ownership) rates* as a function of national macroeconomic variables. This type of analysis is particularly relevant for refrigerators which, while highly sought-after, are relatively expensive. More than any other appliance, their ownership is determined largely by economic considerations.

The second component is to gather the best available estimates of baseline unit energy consumption and realistic potentials for unit efficiency improvement on a regional or national basis. Step 2 of the current analysis estimates baseline consumption by existing and new refrigerators and Step 3 estimates reduced energy use by new refrigerators from standards, along with feasible dates for standards implementation. Geographical detail is important in this component because there is significant variability in product classes. Secondly, efficiency technology varies significantly, largely dependent on the past history of standards. Countries with stringent standards already in place will have less room for improvement, while countries with no standards in place may still take advantage of ‘low-hanging fruit’. An accurate assessment of savings potential relies on knowledge of baseline energy consumption and costs and benefits of efficiency design option implementation. These are certainly not available for every country. Therefore, the best estimate relies on dividing the world into ‘technology regions’ that are thought to have a similar baseline and savings potential of certain ‘marker economies’ for which these data are available. Savings estimates are based on an assumption that moderate or stringent standards are implemented by 2010. Figure 2 shows the analysis flow, containing these two main components.

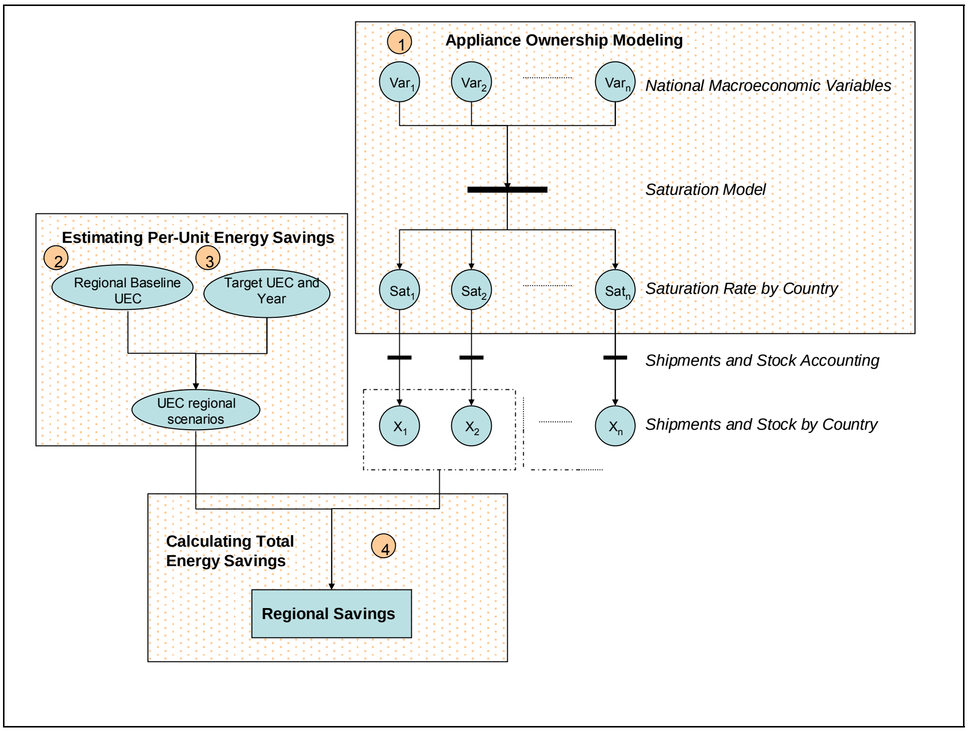

Figure 2: Analysis Flow

The third component is the integration of the results of the first two components to estimate total energy savings. In Step 4 saturation results are combined with regional per unit savings scenarios through a stock accounting model that takes into account of the rate at which new products replace inefficient models. The result is a region-by-region estimate of the final electricity consumption and savings for each year through 2030. In addition to providing a more accurate estimate of global savings potential from refrigerator standards, the methodology provides an expandable framework that links regional and global consumption forecasting to regional and country-based estimates of baselines, achievable targets, and timelines. It unifies two critical, but distinct areas of research – the forecasting of energy consumption in the face of dynamic economic growth in the developing world, and the real-world potential for well-established efficiency policies, and unites the macro- and micro-picture by focusing on individual end use and engineering-based country specific technologies.

Appliance Ownership Modeling

The forecast of energy used by refrigerators proceeded by developing an econometric formula relating saturation (ownership rate) to macroeconomic variables. Variables investigated were those for which both historical data and forecasts were available for a wide range of countries. The general strategy was to optimize the variables, parameters and form of the relationship in order to best explain the variation in current saturation levels between countries.

To begin the estimation of saturation rates, which is Step 1 of the current analysis, we gathered 60 average refrigerator saturation rates[2] for 57 countries across a wide range of economic development. These data were obtained from different sources, including standard of living surveys and general census surveys taken between year 1991 and 2002 (data were available for some countries for multiple years). Saturation rates from this sample vary from 0.008 (Chad 1998) to 1.29 (United States 2002) per household. These data are detailed in Appendix A.

Model Variables and Parameters

The variables found to best describe the range of refrigerator saturation rates in the data were: household income, urbanization percentage and electrification rate. Unavoidably, there is significant correlation between these variables, since urban households tend to have higher income, and the average income is low in countries where many people lack access to electricity. By far, the most significant determining variable for national average appliance ownership is average household

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[2] We define the saturation rate as the average number of refrigerators per household, which can be greater than one.

income, but the other variables were also found to provide additional resolving power, since they serve as indirect indicators of the distribution of wealth and access to infrastructure.

Our estimate of base income is calculated from GDP per household per month. GDP is estimated through 2003 by the World Bank. In order to more accurately relate income to ability to purchase appliances, household income is corrected for Purchase Power Parity. The factor *PPP* gives an equivalent measure of comparison of wealth between countries taking in account the difference in prices for a generic basket of goods, since in general, disposable income is related to the cost of living[3].

In order to provide an accurate estimate of appliance saturation for a wide range of countries, input variables relied on publicly available global databases, such as those provided by UN agencies. Electrification rates are from various sources: IEA's World Energy Outlook (2002), various national census reports, demographic health surveys (DHS), and World Bank data. The general form of the saturation relationship follows a modified logistic 'S-shaped' function. In a simple binary choice model, maximum penetration is 100%. In the case of appliances however, saturation commonly exceeds 100%. For example, many households in industrialized countries own more than one refrigerator. Therefore, we use a modified logistic function

$$Sat = (K \times I)^{\lambda_a} \times \left[1 - \exp\left(-\left(bE^{\lambda_b} + cU^{\lambda_c}\right)\right)\right]^a$$

Where:

Sat_i is the saturation of the appliance i

I is the monthly household income

U is the national percentage of urbanization

E is the national percentage of electrification

A least squares fit to the data for each appliance yields the parameters given in Table 1.

Table 1: Model Parameters for Refrigerator Saturation

Parameter	K	a	λa	b	λb	c	λc
Fit Value	0.103	1.24	0.208	0.0317	4.00	0.158	0.679

Figure 3 demonstrates the ability of the model to parameterize the saturation data. Each pair of data points represents a different country. The strong correlation between ownership and monthly income is evident, although many data points that fall off the main income trend are still relatively well modeled, indicating the resolving power of the other variables, which are not shown.

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[3] We recognize, however that this factor may overcompensate in some cases, since prices of major appliances may not scale in the same way as the products used in evaluating *PPP*.

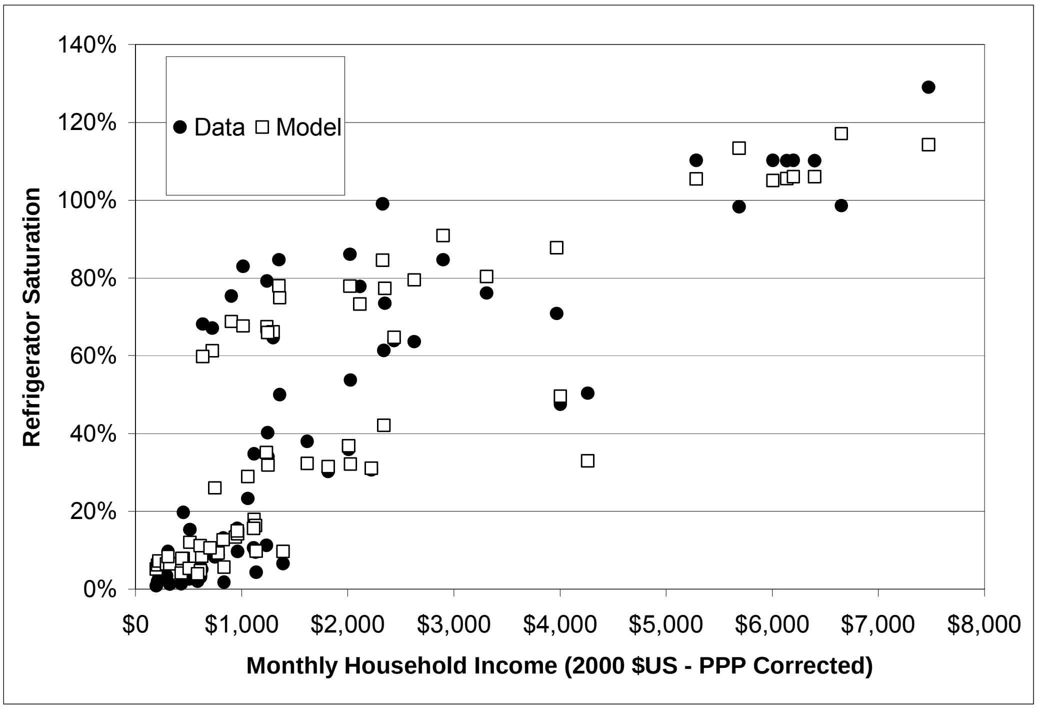

Figure 3: Refrigerator Saturation vs. Monthly Household income

Forecasting Saturation

Once the relationship between macroeconomic variables and refrigerator saturation is constructed, ownership can be forecast according to a variety of scenarios, completing Step 1 in the current analysis. The forecast follows scenarios defined in IPCC's Special Report on Emissions Scenarios, which correspond to particular assumptions of economic growth on a region-by-region basis. We used SRES scenarios B2 as the default. For comparison, we also calculated results using SRES scenario A1, which assumes higher economic growth, and lower population growth. Average income growth rates for both scenarios are shown in Table 2.

Table 2: Scenario Income Growth Rates by Region

Regions	B2, Intermediate Growth				A1, High Growth			
	2000-2010	2010-2020	2020-2030	**2000-2030**	2000-2010	2010-2020	2020-2030	**2000-2030**
Pacific OECD	1.2%	1.0%	0.7%	**1.0%**	1.3%	1.5%	1.5%	**1.5%**
North America	1.9%	0.8%	0.6%	**1.1%**	1.6%	1.6%	1.6%	**1.6%**
Western Europe	2.1%	1.3%	0.9%	**1.4%**	1.8%	1.8%	1.8%	**1.8%**
Central and E. Europe	2.4%	1.4%	2.7%	**2.2%**	5.5%	4.2%	4.5%	**4.7%**
Former Soviet Union	1.4%	1.8%	3.3%	**2.2%**	5.5%	4.2%	4.5%	**4.7%**
Latin America	0.7%	1.8%	2.6%	**1.7%**	5.0%	4.8%	4.7%	**4.8%**
Sub Saharan Africa	0.0%	1.1%	3.0%	**1.4%**	3.0%	2.8%	2.7%	**2.8%**
Middle East and N. Africa	-0.2%	0.3%	1.7%	**0.6%**	3.8%	3.6%	3.6%	**3.7%**
Centrally Planned Asia	5.9%	3.5%	2.9%	**4.1%**	5.4%	5.7%	6.7%	**5.9%**
Other Asia	2.6%	3.1%	2.4%	**2.7%**	5.2%	4.6%	4.2%	**4.7%**

Population and Urbanization forecasts were provided for each country by the United Nations Department of Economic and Social Affairs (UNDESA). Household size forecasts were provided for most, but not all countries by UN Habitat. Where household size was not available, we used regional averages, weighted by population. We forecast electrification rates by assuming an electrification growth rate related to economic growth and to the current electrification rate.

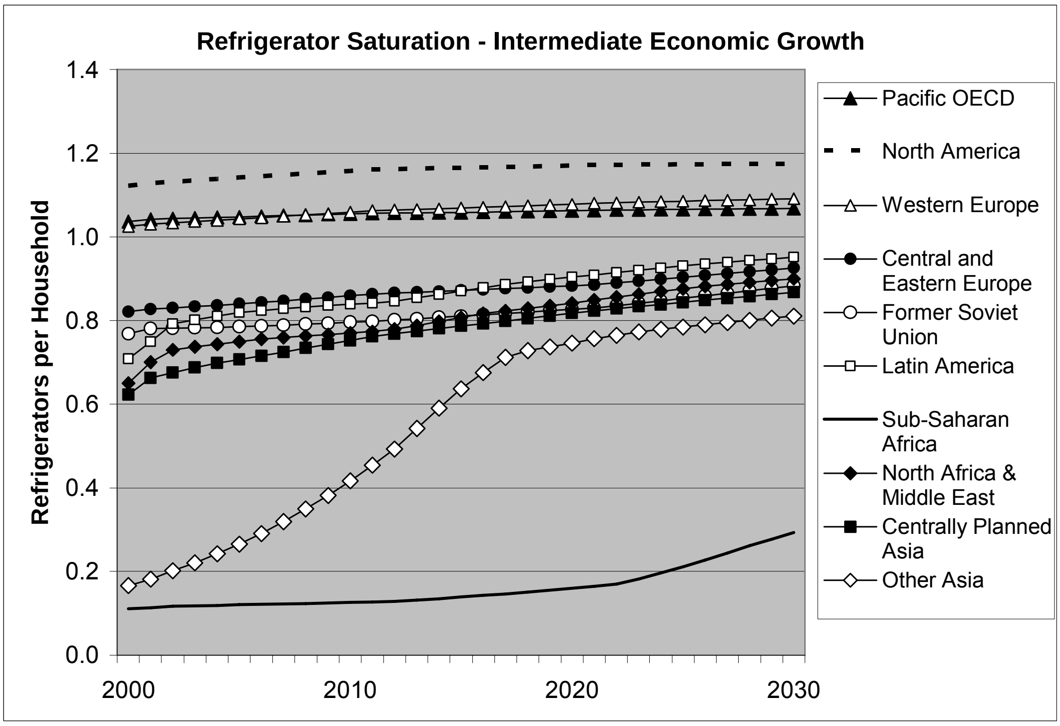

Figure 4: Refrigerator Saturation Forecast by Region

Figure 4 shows the results of the forecast for the default economic growth scenario – Scenario B2. Individual countries are grouped into regions weighted by the number of households in each year. Saturation for the first three regions is already over one per household, but is not expected to increase much in the next three decades. Saturation is very low in the Other Asia region, which includes India, Indonesia and South-East Asia, but is expected go grow rapidly, nearly catching up to China (Centrally Planned Asia) by 2010. Ownership is expected to grow more slowly in Sub-Saharan Africa – by 2030, still only half of households will own a refrigerator.

Estimating Per-Unit Energy Savings

In order to estimate baseline refrigerator energy consumption, and potential for improvement via standards, we draw on data from 11 major economies. We then associate scenarios for these economies with other regions with similar products. In some cases, efficiency levels are assumed to parallel marker economies due to explicit policy harmonization. In others, policies are assumed to follow proxy economies after some delay. Some or all of each region is modeled in this way, except for Sub-Saharan Africa. For this region, we take the conservative approach of assuming no standards in light of the uncertainty over the future of refrigerator standards in those countries. The third column of Table 3 is the percentage of regional GDP for which future efficiency programs are modeled, either directly, or via marker economies.

Table 3: Regions, Marker Economies, and % of GDP Addressed by Future Efficiency Programs

IPCC Region	Marker Economies	% of GDP (Region)	% of GDP (World)
1 - Pacific OECD	Australia/New Zealand + Japan	100%	18%
2 - North America	United States + Canada	100%	29%
3 - Western Europe	European Union	100%	31%
4 – Central and Eastern Europe	European Union	96%	1%
5 - Former Soviet Union	Russia	71%	1%
6 – Latin America	Brazil + Mexico	100%	6%
7 – Sub-Saharan Africa	European Union[1]	0%	0%
8 – Middle East + North Africa	European Union	37%	1%
9 – Centrally Planned Asia	China	85%	4%
10 – Other Asia	India + Korea	57%	3%
World			94%

[1] For Sub-Saharan Africa, the European Union is used as a proxy for baseline consumption, though some estimates put African refrigerator consumption much higher. No standards are assumed for Sub-Saharan Africa in this analysis.

Baseline Unit Energy Consumption and Scenarios

The following paragraphs provide detailed assumptions for each region covered. They describe product characteristics, history of standards to date, and likely degree and timeline of future improvement for each marker economy. We define two scenarios to serve the two steps in the analysis: Case 1, which includes the effect of standards to date, is the basis for Step 2 of the current analysis. Case 2, which includes the impact of future programs, is the basis for Step 3. We use MEPS as the model for efficiency programs, since we assume that a particular efficiency level is achieved in a certain year, based on cost effectiveness or the existence of such models already on the market. This does not exclude the contribution of labeling programs or voluntary programs, which could achieve the same level.

United States

Refrigerators in the United States are characterized by their large size, and relatively stringent efficiency regulations. U.S. refrigerator MEPS, implemented and updated in 1990, 1993 and 2001 are widely considered to be the most stringent in the world. It is unlikely that additional standards will produce dramatic further improvement in efficiency. Recent research [5] indicates, however, that, a further increase of about 10% would be cost effective, and therefore a potential target for standards. In Case 2, such a standard is assumed to take effect in 2010, while Case 1 assumes no further improvement.

Australia/New Zealand and Canada

Canadian refrigerators and those used in Australia and New Zealand are more similar to U.S. models than those used in Europe. Therefore, we use U.S. Unit Energy Consumption (UEC) as a proxy for these countries. In addition, refrigerator standards in both countries closely follow those of the United States, but for slightly different regions. Canadian policymakers generally harmonize efficiency standards with the U.S. due to the strong trade relationship and efforts arising from NAFTA [6]. Australia/New Zealand[4] has made a policy decision to align their MEPS with the most stringent standards in the world [7], which for refrigerators are currently those implemented in the U.S. For these reasons, both Case 1 and Case 2 are assumed equal to the U.S. for these countries.

Japan

Japan has well-established and successful efficiency programs covering many types of equipment. As a result the consumption of the average refrigerator has decreased dramatically, from 1900 kWh in 1995 to 535 in 2004 [8]. We assume that by 2010, Japan's voluntary Top Runner program will result in an additional improvement of 10%.

European Union

Overall, there has been an estimated 27% net efficiency improvement for post-MEPS cold appliances on the EU market compared with pre-labeling efficiency levels [9]. According to the EU report "As a

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[4] These two countries issue efficiency regulations jointly.

result of these efficiency improvements, the average energy consumption of cold appliances declined from about 450 kWh/year in 1990-92 to an estimated 364 kWh/year immediately post MEPS." The European *Energy Efficiency Index* (EEI) is calibrated with the pre-program baseline at 100. By 1999, the average EEI was already 75. In spite these improvements, further improvements would still be highly cost effective, with the least life-cycle cost occurs at about EEI of about 50 [10]. Therefore we assume that, in Case 2, the average EEI will decrease to 55, which corresponds to the current 'A' level.

Eastern Europe

Countries included in the expansion of the European Union to 25 states and candidate countries cover 96% of GDP in this region. As member states, they will be required to adopt EU MEPS and comparative labels. Due to the already close trade ties with the EU, we assume that products are similar. In Case 1, we assume that harmonization occurs by 2009. In Case 2, harmonization occurs by 2007, and adoption of more stringent EU standards occurs simultaneously in 2010.

Russia

Russian refrigerators have already experienced improvement efficiency. A recent publication [11] reports that between 1993 and 1999, the capacity of typical refrigerators in Russia doubled, while energy consumption remained constant. In Case 1, current consumption levels are expected to prevail. In Case 2, further technological advancement and increased trade is assumed to facilitate S&L programs, which will result in an equaling of the current EU efficiency levels by 2010, and match the EU 2010 levels by 2015.

Korea

Korea shows similar evidence of the impact of labeling as does the European Union [12]. In that country, refrigerator efficiency improved by 18% from the time that labels were implemented in 1993 till 2000. We assume that through continuation of this program, and with the possible addition of MEPS, Korean refrigerators will reach the EU 'A' level by 2010.

Brazil

Brazil has had a successful labeling program for many products since 1984, and is currently considering MEPS for refrigerators. A recent analysis based on the most popular Brazilian refrigerator models suggests that an efficiency improvement of 39% would be cost effective [13].Case 2 therefore assumes MEPS at this level of efficiency implemented in 2010.

Central and South America

Central and South American markets are assumed to closely follow those of Mexico and Brazil, respectively, with some lag time. In Case 1, we assume a Central American baseline at the level of Mexico before standards implementation (1995), and South American baseline at current Brazilian level. Regional (UNDP/GEF) programs are under development or consideration for Central America, ANDEAN and ConoSur regions. Case 2 assumes that, as a result of the success of these programs, Central America will reach current Mexican levels, and all of South America will reach the Brazilian 2008 standards by 2010.

Mexico

Mexico has a well established refrigerator efficiency program with both MEPS and labels. The first set of Mexican refrigerator MEPS were enacted in 1995, and have had several updates. Mexican standards parallel those of the United States, with the last MEPS being equivalent to U.S. standards enacted in 1993. Case 1 therefore assumes no further improvement of Mexican efficiency, but Case 2 assumes an additional 10% improvement by 2010, as in the case of the U.S.

China

China first implemented MEPS for refrigerators in 1989. Since then, they have updated standards twice in 2000, 2004 and will do so again in 2007. These standards will make the efficiency of Chinese refrigerators comparable to current EU levels. We assume that in Case 2, they will make a further improvement to the 2010 EU standards, in terms of efficiency increase.

India

The average consumption of Indian refrigerators is growing over time, due to the increase in market share of larger two-door frost-free units. India is currently in the process of implementing both standards and comparative labels. An analysis of typical Indian refrigerators [14], suggests that efficiency can be improved by 45% cost effectively. In Case 2, we assume that standards will be made more stringent over time, reaching 45% improvement by 2010

North Africa
MEPS exist for refrigerators in Egypt and Tunisia [15]. Standards for appliances are under consideration in Algeria [16] and Jordan. Refrigeration products are assumed to be generally of the same class and size as in Western Europe. We assume that in the absence of further standards, typical consumption will remain at pre-standards EU levels, but that in Case 2, expansion of standards will lead to meeting current EU levels by 2010.
The assumptions described above are summarized in Table 4.

Table 4: Summary of Baseline and Efficiency Scenarios

	Case 1	**Case 2**	**2010 UEC Case 1 (KWh)**	**2010 UEC Case 2 (KWh)**
United States	MEPS in 1990, 1993, 2001	MEPS in 2010 increase efficiency by 10%.	562	506
Canada	Synchronized with U.S.	Synchronized with U.S.	562	506
European Union	Average EEI decreased from 100 in 1992 to 75 in 1999	Average meets current 'A' level by 2010	364	268
Australia / New Zealand	AUS/NZ MEPS in line with U.S. MEPS after 2005	Synchronized with U.S.	562	506
Eastern Europe	Lags EU by 10 years	Meets current EU standards by 2007, synchronized by 2010	364	268
China	MEPS in 2000, 2004 and 2007.	Average meets current 'A' level by 2010	489	353
Russia	Significant improvement between 1993 and 1999	Match EU 1999 MEPS by 2010. Average meets current 'A' level by 2015.	420	243
India	No Standards	45% improvement by 2010.	548	301
Korea	Efficiency improved 18% from 1993 -2000	Average meets current 'A' level by 2010	536	402
Japan	UEC decreased from 1900 kWh in 1995 to 535 in 2004 from Top Runner Program	Additional improvement of 10% from Top Runner Program	535	482
Brazil	No additional standards.	39% improvement by 2010.	493	237
Mexico	Follows U.S. with some lag.	Synchronized with U.S.	341	307
Central America	Pre-standard Mexican Levels	Meets current Mexican levels by 2010	564	307
South America	Remains at Current Brazilian Levels	Meets improved Brazilian levels by 2010	493	237
North Africa	Remains at pre-standard EU levels	Achieves current EU levels by 2010	445	364

Calculating Total Energy Savings

In the final step, Step 4, of the current analysis, we calculated refrigerator final electricity consumption and savings for each year in the forecast by bringing the two previous analysis elements together in a spreadsheet model. The econometric saturation forecast provides the basis for stock accounting. The size of the refrigerator market in each country has two components. First purchases are equal to the difference in the total stock (saturation times the number of households) in each year compared to the previous year. Replacement purchases are then estimated according to a normally distributed retirement probability function assuming an average lifetime of 15 years, and a standard deviation of 2 years.

The Unit Energy Consumption (UEC) of refrigerators sold in each region for Case 1 and Case 2 is then calculated for each year by summing the consumption of each cohort according to the UEC in shipments in each year. Savings in each year is the difference in total consumption between the two cases. Savings increases steeply after the year of program implementation as more and more efficient refrigerators are brought into the stock. Table 5 shows refrigerator consumption in both cases. We use the B2 Scenario as a reference.

Table 5: Consumption and Savings Results by Region – B2 Economic Growth Scenario

	Case 1 Consumption			Case 2 Consumption			Savings		
	Region 1-3	Region 4-10	Total	Region 1-3	Region 4-10	Total	Region 1-3	Region 4-10	Total
Year	TWh	TWh	TWh	TWh	TWh	TWh	TWh	TWh	TWh
2005	226	308	535	226	308	535	0	0	0
2010	211	362	574	210	349	559	2	13	15
2015	200	429	629	188	371	559	12	58	70
2020	202	485	687	180	382	563	22	102	124
2025	206	530	736	177	397	575	29	133	161
2030	213	581	793	180	426	606	33	155	188

According to the ownership model, and subsequent stock estimation, refrigerator consumption in regions 4-10 already accounts for 58% of global refrigerator consumption. By 2030, in the absence of aggressive efficiency programs, this fraction will have grown to 73%. Not surprisingly, the great majority of potential savings will also be dominated by these regions, because not only will they possess larger stocks, but there is more room for improvement.

We estimate annual global savings from refrigerator efficiency programs to be 124 TWh in 2020, and 188 TWh in 2030. By this year, once the stock has been completely replaced with efficient product, S&L programs will have reduced refrigerator consumption by 24% relative to Case 1. This also corresponds to over a third of current (2005) refrigerator consumption, and 2.3% of total residential electricity consumption in that year. Electricity savings are converted to primary (input) energy savings and carbon dioxide emissions mitigation according to country-by-country evaluations of electricity generation fuel mix, as provided by the International Energy Agency (2002 data). IEA also provides electricity carbon factors for most countries. Primary energy savings and carbon dioxide emission mitigation global totals are given in Table 6. In addition, the table shows savings and emissions for a high economic growth scenario (SRES A1). Savings in the high economic growth case are on the order of 10% higher than for the intermediate growth case. This is due to the more rapid accumulation of stock with higher incomes. The difference between scenarios can be taken as indicative of the sensitivity of this type of analysis to uncertainties in forecasting macroeconomic driver variables.

Table 6: Primary Energy Savings and Carbon Dioxide Emissions Mitigation

	Primary Energy Savings		CO_2 Mitigation	
	Intermediate Growth (B2)	High Growth (A1)	Intermediate Growth (B2)	High Growth (A1)
Year	MTOE	MTOE	Mt (CO_2)	Mt (CO_2)
2010	4	4	10	11
2015	17	18	48	49
2020	30	31	83	86
2025	38	41	106	112
2030	45	48	123	133

Conclusions and Outlook

In conclusion, we believe that the analysis presented gives the most accurate estimate to date of the level of refrigerator efficiency savings that could be achieved throughout the world. In addition to being based on specific program scenarios in each country or region, it makes a country-specific evaluation of refrigerator consumption, given specific assumptions about economic growth. We believe that this adds insight into the global picture, and allows for a comparison of the different opportunities at the regional level.

In the longer term, we hope to have shown the usefulness of a framework that unifies a generic econometric relationship for product ownership and engineering data. This framework provides the potential of straightforward expansion of the analysis of efficiency programs, in both scope and detail. The product ownership model can be replicated to other products, like air conditioners and washing machines provided sufficient country data. The unit consumption inputs can be further disaggregated as data for specific countries becomes available, and can also be expanded to cover other products. The methodology presented therefore provides a basis for the first ever estimate of the full global potential of S&L programs.

Finally, an important tool in evaluating efficiency programs is the estimation of financial impacts, such as net financial savings to consumers. Such an analysis could be built up from the current energy parameters, in combination with local energy prices and equipment costs.

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Appendix – Saturation Rate Data

Country	Year	Monthly .Income ($2000)	Elec	Urb	Sat
United States	2002	$7,116	100%	79%	129%
Japan	1999	$6,009	100%	65%	110%
Japan	2002	$5,854	100%	65%	110%
France	2002	$5,081	100%	76%	110%
Japan	1991	$6,402	100%	63%	110%
Japan	1996	$6,139	100%	65%	110%
Croatia	2000	$2,331	100%	58%	99%
Singapore	1991	$5,688	100%	100%	98%
Turkmenistan	2000	$2,025	100%	45%	86%
Bulgaria	2000	$1,355	100%	69%	85%
Jordan	1997	$2,900	95%	78%	85%
Albania	2000	$1,016	100%	42%	83%
Kazakhstan	1999	$1,238	100%	56%	79%
Brazil	1996	$2,116	95%	78%	78%
CostaRica	2000	$3,310	96%	59%	76%
Armenia	2000	$906	100%	65%	75%
Thailand	2000	$2,353	82%	31%	74%
Mexico	2000	$3,969	95%	75%	71%
Uzbekistan	1996	$636	100%	38%	68%
Kyrgyzstan	1997	$725	100%	36%	67%
Egypt	2000	$1,298	94%	42%	65%
DominicanRep	1999	$2,439	91%	57%	64%
Colombia	2000	$2,628	81%	75%	64%
Belize	2000	$2,340	79%	48%	61%
Panama	1997	$2,026	76%	55%	54%
SouthAfrica	1998	$4,264	66%	53%	50%
Romania	2000	$1,362	100%	55%	50%
Gabon	2000	$4,006	31%	81%	48%
China	2002	$1,241	99%	36%	40%
Philippines	1998	$1,619	87%	54%	38%
Peru	2000	$2,010	73%	73%	36%
Honduras	2000	$1,118	55%	44%	35%
Bolivia	1998	$1,249	60%	59.4%	34.0%
Guatemala	1999	$2,224	67%	43.1%	30.6%
Morocco	1992	$1,817	71%	48.4%	30.3%
Nicaragua	1998	$1,058	48%	54.5%	23.3%
Yemen	1997	$1,039	50%	23.6%	19.7%
Côted'Ivoire	1999	$961	50%	41.7%	15.6%
Nigeria	1999	$515	40%	39.5%	15.3%
Ghana	1998	$943	45%	40.2%	14.1%
Senegal	1997	$830	30%	43.8%	13.2%
Indonesia	1997	$1,236	53%	35.6%	11.3%
India	1999	$1,117	43%	26.6%	10.6%
Zambia	2002	$324	12%	35.1%	9.7%
Cameroon	1998	$963	20%	44.7%	9.7%
Haiti	2000	$706	34%	35.6%	9.5%
Mauritania	2001	$1,187	22%	57.7%	9.5%
Comoros	1996	$780	29%	30.4%	8.7%
VietNam	1997	$2,642	76%	22.2%	8.3%
Guinea	1999	$1,392	16%	28.8%	6.6%
Benin	2001	$621	22%	42.3%	6.0%
Mali	2001	$711	11%	30.2%	5.1%
Togo	1998	$1,138	9%	30.8%	4.3%
Kenya	1998	$438	8%	30.0%	3.8%
Mozambique	1997	$292	7%	26.2%	3.5%
BurkinaFaso	1999	$615	13%	15.2%	3.1%
Niger	1998	$508	7%	18.2%	2.6%
Uganda	2001	$592	4%	12.0%	2.1%
Tanzania	1999	$210	11%	26.9%	2.0%
Cambodia	2000	$834	16%	16.9%	1.8%
Rwanda	2000	$432	6%	13.6%	1.4%
Madagascar	1997	$324	8%	25.5%	1.3%
Chad	1997	$195	2%	22.2%	0.8%

Balancing the Need for, and the Hurdles Associated with Implementing 'Energy Efficient Appliance Labelling' in the South African Context

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Abstract

The South African energy market is unique in that although the country is *'officially'* regarded as a developing country, the energy infrastructure is significantly advanced, with Eskom (the national utility), consistently rated amongst the top 10 global utilities worldwide, in terms of generating capacity.

However, and due to significant growth in the South African post-apartheid economy, together with an aggressive domestic electrification programme, the existing capacity is close to being exhausted. This has prompted the South African government to look at various radical measures to save energy. Amongst these, is the development and implementation of an ***'Energy Efficient Appliance Labelling Programme'***, initially looking at domestic refrigerators. Substantial amounts of donor and local funds have been invested in this programme to-date *(Phase 1),* which was officially launched by the National Minister of Minerals and Energy during the 'South African Energy Efficiency Month' in May 2005. This milestone marked the start of an 18-month 'voluntary' implementation period, whilst legislation is put in place to make 'Energy Efficient Labelling' mandatory.

Another serious problem relates to the mix of locally manufactured appliances in South Africa, versus imported products. The latter manufacturers have access to international test facilities, having been part of the European Union's Appliance Labelling Programme for sometime, and have developed their products to 'A' and 'A++' levels, leaving the local manufacturers of refrigerators at a serious disadvantage to their competitors.

This paper will therefore analyse the root cause of these problems and debate the strategies put in place, to overcome these 'barriers'.

Introduction

The average efficiency of electrical domestic appliances currently sold in South Africa is significantly below that of the best products in the global market, largely because of customers' and marketers' strong emphasis on first cost purchase decision-making and not focussing on life-cycle cost considerations. There are also various other barriers such as the relatively low cost of electricity in the country, the lack of awareness, information and appropriate energy efficiency incentives and/or regulations, and many others.

To transform this situation, the South African Department of Minerals and Energy (DME) is planning to implement a nation-wide appliance efficiency programme, using standards and labelling as key instruments under the framework of the national Energy Efficiency Strategy. Energy efficiency labels are informative labels affixed to manufactured products, indicating products' energy performance and efficiency in a way that allows for comparison between similar products, and/or endorses the products' use. "Energy Efficiency Standards" are a set of procedures and regulations that prescribe the minimum energy performance of manufactured products. Together, energy efficiency standards and labelling can be one of the most cost-effective means to help South Africa reduce energy demand, while stimulating economic growth.

In essence, this programme aims at transforming the market by providing information that assists consumers in making rational decisions based on life-cycle cost, rather than initial investment cost. Recent additional Global Environment Facility (GEF) funding for the project *(Phase 2),* will continue to analyse and address the proposed policy, financial, communication (education) and technological barriers that still block the widespread introduction of more energy efficient domestic appliances in general, as well as the introduction of a mandatory standards and labelling programme for all appliances in South Africa, including the introduction of a comprehensive consumer awareness and information dissemination campaign and the targeting of retailers who play a very important role in influencing the consumer's purchase decision. Additional assistance will focus on improving and strengthening relevant institutional capacity through training and technical assistance in the formulating of a standards and labelling policy for South Africa. Specific attention will be given to addressing financial barrier issues, while additional potential funding sources for energy efficiency will be identified and evaluated, to support long-term sustainability in this particular area.

The developmental objectives of this initiative coincide with the goals of the recently approved national South African *Energy Efficiency Strategy*, namely (1) Improving the health of the nation (reducing the emission of toxic substances), (2) Job creation (by spin-off effects of energy efficiency implementation), (3) Poverty alleviation (by reducing the energy bills of end users), (4) Improving industrial competitiveness (by exporting high-quality products), (5) Enhancing energy security (by reducing the necessary volume of imported energy and increasing resilience against external supply disruptions) and (6) reducing the necessity for additional power generation capacity (by reducing peak load growth).

Background

The South African government's stated intention to prioritise the implementation of energy efficiency in the country, is clearly stated in two crucial policy documents, namely the White Paper on Energy and the National Energy Efficiency Strategy.

The *White Paper on Energy Policy*, published in 1998 states that "… significant potential exists for energy efficiency improvements in South Africa. In developing policies to achieve greater efficiency of energy use, government is mindful of the need to overcome shortcomings in energy markets. Government would create energy efficiency consciousness and would encourage energy efficiency in commerce and industry, and will establish energy efficiency norms and standards for commercial buildings and industrial equipment and voluntary guidelines for the thermal performance of housing. A domestic appliance-labelling program will be introduced and publicity campaigns will be undertaken to ensure that appliance purchasers are aware of the purpose of the labels. Targets for industrial and commercial energy efficiency improvements will be set and monitored… "

The recently approved South African *Energy Efficiency Strategy* on the other hand, sets a national target for energy savings of at least 12% to be achieved by the year 2015. The draft strategy covers all economic sectors, including public and commercial buildings, residential sector, transport, industry and transportation. The Strategy further mentions that energy efficiency improvements are to be achieved through a mix of instruments and interventions:

Support mechanisms, that are independent of financial and policy instruments, including:

Appliance labelling for domestic appliances, agree through the adoption and adaptation of European standards for labelling, followed later by efficiency labelling of motor vehicles

Energy efficiency standards, by amending the existing systems of (safety) standards and codes of practice to include efficiency aspects

Certification of energy auditors and testing laboratories by the South African Bureau of Standards and the accreditation of inspectors of efficiency labels and standards by DME

Information dissemination to manufacturers, retailers and architects on the new regulations, as well as awareness raising of the public at large, through education and mass media awareness campaigns

Appropriate research and possible adaptation of internationally available technologies

Energy audits and energy management systems within industry and commercial sectors

Finance instruments, to supplement the implementation of labels, standards and regulation tools, including:

Revision of the tax system, for example reducing VAT on efficient appliances and other incentives for energy efficiency

Cost-effective capital measures in the public buildings sector, comprised of state-owned enterprises, national, provincial and local government authorities

Energy pricing will slowly shift from cross-subsidies towards cost-reflective tariffs

Linkage of energy efficiency with load management in ESKOM's demand-side management (DSM) programme, in which energy efficiency and load management programmes are implemented via a third-party, (ESCO, Energy Service Company)

Policy and regulatory instruments, meaning:

Preparation of appropriate legislation to implement the Energy Efficiency Strategy

Implementation of regulatory means where necessary, for example, ***efficiency standards and labels will have limited impact unless made mandatory.***

Barriers to Implementation

South Africa is a developing nation with significant heavy industry, which is by its nature energy intensive. This energy intensive economy largely relies on indigenous coal reserves for its driving force and, consequently, South Africa remains one of the highest emitters of the greenhouse gas CO_2 (carbon dioxide) per capita and in particular per GDP in the world. In 2000 the total primary energy supply to the nation was nearly 4,300 petajoules (PJ), of which 79% was attributable to coal.

Key electrical appliances in the residential and commercial buildings sectors include refrigerators, washing machines, tumble dryers, dishwashers, air conditioners, electric stoves/ hot plates, electric space heaters, air conditioning and water heaters. Opportunities for improving energy efficiency lie in the supply of more efficient models of these appliances. For example, highly energy-efficienct refrigerator models have thicker insulation and increased thermal capacity of the evaporator and condensor and have better door sealing. A general market characteristic in South Africa is that appliances are penetrating urban and peri-urban areas rapidly, but generally speaking, high-efficiency models have a small market share.

A number of barriers exist that block the widespread introduction of more energy efficient appliances (not only in the residential and buildings sectors, but also in other sectors):

Awareness barriers:

Lack of knowledge and understanding amongst consumers of energy consumption and energy efficiency improvement opportunities of appliances, making energy efficiency a non ‘top-of-mind’ factor in their purchase decision

Uncertainty about market demand of high-efficiency models, making manufacturers reluctant to tie up financial resources in more costly plant and equipment, resulting in dealer/retailer reluctance to stock energy-efficient models

Information and policy barriers:

Difficulty to make informed decisions and develop appropriate regulations, due to lack of and accuracy of market data on appliance supplies and stocks, their energy consumption, and on the potential for improving the energy efficiency of such appliances

Lack of appropriate regulations, allowing domestic production and imports of highly inefficient appliances

Cost barriers:

The low unit price of coal and electricity in South Africa influences the mind-set of consumers and companies, with the argument that the higher initial investment cost cannot be justified, due to lengthy payback periods

Low purchasing power of the majority of South African households.

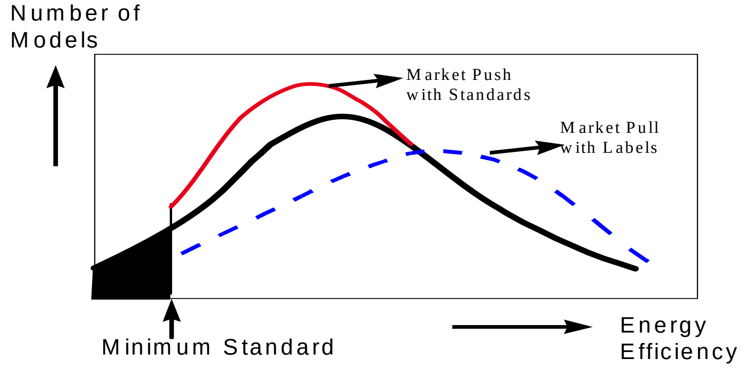

Figure 1: The role of energy labels and meps in transforming the market towards higher average efficiency of appliances

The ‘Base Case’

In the absence of a comprehensive and targeted Standards and Labelling programme in South Africa, the efficiency of new energy consuming appliances, equipment and lighting products sold in the country would likely continue to increase slowly from existing levels. However, the average efficiency of products currently sold is significantly below that of the best products on the market, largely because of customers' and marketers' strong emphasis on first cost purchasing decisions, at the expense of life-cycle cost considerations. There are a number of other considerations, including those barriers referred to above.

While the *Energy Efficiency Strategy* foresees the introduction of a standards and labelling programme, the challenge for South Africa is not only to overcome the barriers to the introduction of high-efficient appliances in general, but also to overcome the barriers to the adoption and implementation of a labelling and standards programme in particular, taking into consideration the existing insufficient institutional capacity and lack of specific expertise for such programme implementation and financing options in developing countries,

With the additional support funding from GEF, a standards and labelling programme for domestic appliances will be implemented at a much faster rate than it would otherwise develop. Consequently, the most inefficient products will be gradually removed from the market in a way that is sensible to the national conditions, providing an increase in the average efficiency of new products sold. Also, manufacturers will be able to introduce new efficient technologies at a faster rate, in an effort to distinguish themselves in a marketplace with increased emphasis on efficiency and *'status products'*.

Energy labelling programs for household appliances have been introduced in nearly 40 countries around the world. Informative labels affixed to manufactured products describe the product's energy performance (energy consumption, energy efficiency, energy cost, or combinations thereof). Energy labels empower consumers to make informed choices about the products they buy and to manage their energy bills. Labels "pull" the distribution of energy-efficient models upward (see figure 1, above), by providing information that assists consumers in making rational decisions and stimulating manufacturers to design products that achieve higher rating levels. More efficient appliances not only save consumers money normally spent on energy bills but also have a social and environmental impact in decreasing pollution levels.

Minimum Performance Efficiency Standards (MEPS), as a complementary tool to appliance labelling, have been successfully applied overseas and have brought about predictable, significant and lasting improvements in efficiencies. Once an energy label is in place and there is a shift in the efficiency levels in the market, MEPS can be enacted to remove the most inefficient product from the market. This effect is a "market push" (see figure 1, above). South Africa has a well-developed system of standards and codes of practice that could be amended to include efficiency aspects, without the need to establish radically new standards.

Currently, the voluntary use of these labels is taking place in South Africa, with the aim of this activity being made mandatory in the first quarter of 2007.

Programmatic Solutions

Technical specifications and launching of energy labels for domestic appliances

South Africa has introduced a number of standards for the safety and performance of domestic appliances through Standards, South Africa (STANSA). Some of these standards are compulsory, while others are voluntary. Goods may display the energy used, as required by existing specifications from South African National Standards (SANS), IEC and ISO, (International Electro-technical Commission and International Standards Organisation), respectively. This information is usually displayed on the model and serial number tag at the back of the appliance and is not clearly visible from the front of the appliance. The marking does not carry a norm or "bench mark" figure. Therefore, the customer cannot compare the energy efficiency of one make to another, or to a norm for that type of appliance.

In 2004 DME decided to introduce the European comparative labelling system, because many of the current safety standards are based on ISO and IEC standards and also because Europe is South Africa's major trading partner for electrical household appliances. The process for launching the label encompassed the following steps:

Energy data was collected to create a database and a norm for the label

Consensus was built among stakeholders in drafting technical parameters

SABS/SANS safety standards and performance specifications were amended to include the energy label

Design of the visual format of the label (based on the European energy labelling system)

Defining compliance deadlines (adaptation times, line changeover schedules, inventory clearing and product availability, based on product development cycles and production).

Awareness creation and information campaigns

Placement of labels is only one step in attempting to influence the consumers' purchase decision. With GEF support, appliance-specific consumer awareness/ education campaigns on labelling will be undertaken. The campaign will inform consumers about the label features, the importance and potential impact of selecting efficient products for households, etc.. The consumer awareness programme will encourage consumers to consider the performance and lifecycle cost of owning an electric product, and not just the initial *(higher)* capital cost.

In addition to the planned labelling campaign, a massive countrywide campaign promoting energy efficiency in general will be launched through television, radio, magazine and newspaper advertisements, which will be an annual (on-going) activity for the next couple of years. Furthermore, and although promotion and education are valuable aids to increase the effectiveness of an energy label, government promotion programmes (e.g., annual efficiency awards), manufacturers campaigns (marketing of their energy-efficient products), training of retailers (shop managers and sales persons), publication of lists of current models on the market (e.g., through easy-accessible brochures and a dedicated internet website), as well as educational programmes at schools, will be undertaken.

Conducive policy and policy instruments regarding energy efficiency

Various gaps in information still exist and need to be addressed, before mandatory legislation can specifiy the norm for a label and a MEPS, which is currently being addressed:

Market data about appliances in South Africa: This activity is currently being commissioned, concentrating on the market penetration of appliances, consumer behavior and consumer buying preferences. There is also a need for sector-wide information on segmentation of the appliance market, based on household income, education, and distribution in terms of rural and urban areas.

Baseline energy use for appliances: The energy used by most common household appliances is insufficiently known and/ or documented. Appliances are generally not tested and little disaggregated data exists on residential electricity demand. This information is needed to establish a baseline for program design and for evaluating the impact of the campaign.

Energy efficiency improvement potential for selected appliances: Little information is available about the potential for improving the energy efficiency of domestic appliances in the South African market. This will be addressed through international benchmarking and engineering analysis of the products targeted for the programme (such as dish washers, stoves, washing machines, space heaters, refrigerators and air conditioners).

Regulation and legislation

The labelling scheme was first launched and introduced on a voluntary basis for refrigerators in 2004. The historically low unit price of energy, coupled with limited awareness on energy savings potential, may result in only modest success arising from voluntary measures and other non-legislative instruments. Whilst South African industry has to a large extent, voluntarily adopted the energy efficiency label as a competitive tool, when goods are imported into the country, as is often the case in South Africa, importers tend to bring in goods without the label, at lower prices and poorer performance. For this reason, the *Energy Efficiency Strategy* aims to implement mandatory labelling of products in the first quarter of 2007.

The GEF-funding *(phase 2)* will be used to enhance the framework plan for the widespread introduction of labels for a broader range of appliances and will be enacted into framework legislation, specifying:

Overall objectives of a standards and labelling programme in South Africa

Types of intervention to be pursued, (labelling and/or mandatory minimum energy performance standards)

General criteria for selection of appliances (and products and processes), for labels and/or standards and market transactions, (covering both locally produced and imported products)

Envisioned implementation timeframes

Rules, procedures and deadlines

Monitoring and evaluation protocols to be used to track progress.

Incentives and financial issues

The *Energy Efficiency Strategy* stresses the element of finance, because the majority of energy efficiency improvements will lead at the end of the day to positive savings for both enterprise and customers alike. Furthermore, the Government has incurred substantial costs relating to the *(phase 1)* awareness campaigns and coordination requirements, as well as partial utilisation of existing subsidy schemes through the ESKOM (DSM) Fund. Under these circumstances, it is difficult to justify direct government subsidies for efficient appliances, e.g. in the form of direct rebates. However, in the longer term, fiscal reforms will be considered. The GEF-component of this initiative will support further analysis into what incentives can be built into the tax system, for example by reducing both import and export duties on energy-efficient appliances and/ or by applying higher duties on poor efficiency products, using the new appliance labeling scheme.

In principle, the higher investment cost of efficient appliances will be borne by the direct beneficiary, the customer, which is reasonable in view of the relatively short payback periods anticipated with the purchase of these initial products. In cases where payback periods are less favourable or where lower-income groups will shun higher initial investments due to their limited purchasing power, *'innovative mechanisms'* for financing are being considered. One such scheme could be the utilisation of customer credit schemes (many customers purchase on credit at various retail outlets throughout the country), to equalise the cost of poorer and more efficient equipment, possibly using funds from the Central Energy Fund (CEF).

Minimum energy performance standards for electric appliances

The introduction of labels will shift the distribution of models upward towards higher energy efficiency by providing information to customers, empowering them to make rational decisions about the products they buy, and by stimulating manufacturers to design products that achieve higher energy-rating levels. Minimum Energy Performance Standards (MEPS), are closely linked with labels. MEPS are usually set, to exclude the label categories with the lowest energy efficiency from the market. Various methods exist to determine these standards, e.g., statistical consideration, setting energy efficiency targets at the least life-cycle cost level, choosing the top runner model at the threshold or by adopting world's best energy efficiency practices.

Phase 1 of the programme will ensure that stakeholder consultations and the necessary engineering and market analyses are carried out in a systematic way, in order to develop a strong standards programme, as follows:

- Expert and stakeholder consultations
- Identification of product categories and key issues
- Engineering analysis to determine life-cycle cost and energy performance of models
- Defining principles and methods for setting the standards, (e.g., lowest life-cycle cost)
- Analysis of impacts (on manufacturers, consumers, competition, utilities, as well as economic and environmental impacts)
- Public comments and stakeholder negotiations
- Setting of final standards
- Introduction of relevant legislation.

Product Testing and Compliance

Developing a testing capability

The process of creating an energy testing capability must begin, before a labelling of standards programme is launched. The test procedure[1] describes the method used to measure the energy performance of a product and a testing norm that references the appropriate testing procedures. The testing procedure is the foundation for the energy standards and label of a product. Selection (adoption) of existing test procedures is strongly preferable to inventing the wheel by designing new test protocols, e.g., the International Standards Organisation (ISO) and International Electrical Commission (IEC) are two international entities responsible for formulating internationally recognised appliance test procedures.

Test facilities are needed to perform energy tests. In South Africa, various (commercial) independent testing facilities exist. SABS has a Test House and there are other test laboratories, as well as the 'in-house' test facilities of the manufacturers. Several independent test houses are in the process of

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[1] Test protocols, specifying: energy use metrics, product operating cycles and conditions, performance metrics, model categories, electricity input voltages and frequencies, allowable tolerances, measuring instrument specifications

being be accredited under the South African National Accreditation System (SANAS)[2] system to develop energy measurements, so that local manufacturers can have their products tested and accepted for energy efficiency performance.

Enforcement of labels and standards
The policing of the energy label scheme is critical in the implementation and maintenance of a mandatory energy label system. One option is that manufacturers sample and test their products in their own or third-party facilities, confirmed by a manufacturer's declaration (self-certification), or by an independent party, (certification). The controlling body is likely to be SABS, aided by a system of local / regional inspectors that monitor the energy efficiency label at the factories, distributors and retailers sites.

Capacity strengthening of main stakeholders
Carrying out standards and labelling programmes requires adequate institutional capacity in the form staffing, financial resources and skills. Since standards and labelling is a relatively new subject in South Africa, new teams are being trained in order to implement the standards and labelling schemes, and to make consumers aware of the system:
Strengthening of test laboratories so that these are fully equipped, staffed and accredited to carry out energy performance testing
Strengthening of the government agency responsible for developing, issuing and maintaining both labels and standards, e.g. by setting up a *'Standards and Labelling Unit'* within the Directorate for Energy Efficiency of DME and training of new staff through short courses and workshops.
Training of manufacturers, distributors and retailers, so that these crucial stakeholders actively (and accurately), support the programme.
The agency responsible for compliance monitoring must be adequately staffed (and funded), to perform its tasks, (product testing, retail inspections, etc.).

Monitoring and Verification

Rigorous monitoring, evaluation and reporting are vital to ensure the effectiveness of and public confidence in the labels and standards programme. Performance measurements and evaluation enable decision-makers, programme managers, staff, and ultimately, the taxpayers to ascertain whether the money is being well spent. *Phase 2* of the programme will support the following tasks:

- Monitoring of the market towards compliance and progress towards targets (monitoring of product testing according to the prescribed protocols, proper reporting, proper accreditation of laboratories, sampling and testing of products on energy consumption, national impact on load reduction, GHG-mitigation, etc.).
- Regular evaluations of the progress, (market trends and consumer preferences, consumer and manufacturer costs, energy and CO_2 savings).
- Programme evaluation, (administration costs and effectiveness).
- Review of programme results and, if necessary, revise programme elements.

Risks

Political, financial, institutional and/ or other factors in South Africa may contribute to the extended or delayed implementation for the introduction of energy labels and MEPS for end-use equipment in the country. However, the country's *Energy Efficiency Strategy,* as well as the *White Paper on Energy* firmly recommends mandatory labelling and standards as an ultimate goal.
Manufacturers, especially local, may object to the implementation of efficiency labels and standards. The implementation of new regulations resulting in additional costs to manufacturers is usually of great concern and a central issue in discussions between government and manufacturers.
Consumers fail to understand energy efficiency labelling and avoid purchasing energy-efficient models, as a result of the generally higher capital costs.

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[2] The South African National Accreditation System (SANAS) is recognised by the South African Government as the single National Accreditation Body that gives formal recognition (accreditation) to ensure that laboratories, certification bodies, inspection bodies, proficiency testing scheme providers and test facilities are competent to carry out specific tasks.

Conclusions

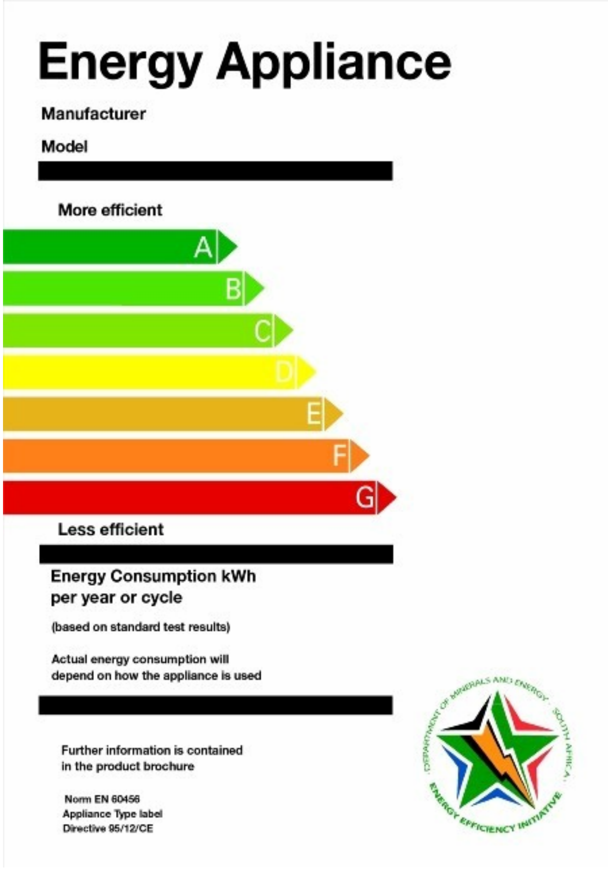
When properly introduced, implemented and managed, *Energy Efficient Appliance Labelling* can deliver tangible results, which are amongst the cheapest and least intrusive of policy instruments in this field.

Overall, the results provide a measurable and verifiable increase in the rate at which the average energy efficiency of all energy consuming appliance grows in the domestic and commercial sectors. Further implementation will have substantial economic benefits on a national level and will reduce the overall use of fossil fuel, hereby reducing GHG emissions accordingly. The potential for savings in South Africa through standards and labelling is high in terms of energy consumption. Initial estimates show a cumulative reduction in CO_2 emissions of 2 million tonnes over a timeframe of 10 years.

Since *Energy Efficient Appliance Labelling* has a strong capacity-building element, the main outputs of this project have not only been limited to new energy efficiency standards and labels, but has also enhanced institutional structural growth, with a capacity to effectively maintain and revise the energy efficiency standards and labelling programme over time.

Hence, the establishment of effective energy efficiency labels and/or standards leads to a more sustainable energy future.

The Label



The above graphic depicts the generic South African Energy Efficient Appliance Label.

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[1] Krause, M., and Glemarec, Y: "Project Development Facility". *Pipeline Entry and PDF Block B*, PIMS 3277, Rev No. 2, January 2006, pp.1-19

[2] Lebot, B., Newman, J. and Waide, P: "The European Appliance Labelling Programme" *Proceedings of an International Conference and associated references*, May 2002, pp. 1-15.

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Voluntary Agreements

Common Efforts between an Energy Authority and the IT Industry on Promotion of Energy Efficient Computers and Monitors

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Abstract

IT products are assumed to be a main factor of the increase in electricity consumption in the domestic and service sectors in Denmark. Before 2004, very few activities towards energy efficient IT equipment had taken place in Denmark. In 2004, the DEST (Danish Electricity Saving Trust) and partners in the IT sector took the initiative to establish a voluntary agreement for promoting energy-efficient computers and monitors.

The result today is that most of the computers and monitors from the IT partners, covering more than 80 percent of the Danish computer market, are declared according to power consumption in on, sleep, and standby modes. In addition, campaigning activities significantly have strengthened the attention on energy-efficiency of IT equipment and have focused on the advantages of efficient notebooks and flat panel LCD monitors. Furthermore, the manufacturer partners have also become more focused on power consumption at the design level.

This paper describes the content of the voluntary IT agreement, the campaigning activities, and summarises the results and the main factors for the results.

Increasing use of IT in homes and offices

The growth in the Danish electricity consumption in domestic and service sectors is assumed to be partly due to increased use of IT in the homes and at the offices. The number of IT appliances (computers, monitors etc.) is increasing and the appliances are supposed to be switched on during longer periods.

The total electricity consumption in the Danish public and private service sectors grew by 15 percent from 1995 to 2004. The consumption in the domestic sector grew by 1.8 percent in spite of many saving efforts for instance for white goods and lighting. The tendency of increased use of IT appliances is assumed to continue in near future.

The area had only little focus by the energy authorities before the IT activities described in this paper.

Efficient technologies available

There are large differences in electricity consumption of the computers and monitors on the market. The DEST has calculated that it is possible to save up to about 140 EUR in TCO (Total Cost of Ownership over the lifetime) per PC and per monitor. In offices, additional savings for air-conditioning and ventilation systems will be achieved.

Examples of possible large savings are:

- An inefficient 17” CRT monitor (170 kWh/year) is replaced with an efficient 17” TFT monitor (50 kWh/year) and savings of 70% are achieved.
- An inefficient desktop and monitor (total 350 kWh/year) are replaced with an efficient notebook (35 kWh/year) and savings of 90% are achieved.

Even though these selected examples show savings above average, they give a clear indication of the large variety of electricity consumption among the product types and the products. This makes it worth promoting the most energy efficient products.

The IT agreement between DEST and supplies

In 2004, the Danish Electricity Saving Trust (DEST) initiated a dialogue with Danish representatives of five larger IT manufacturers, Apple, Dell, Fujitsu Siemens, Hewlett-Packard and IBM (now Lenovo);

the IT industry organisation (IT-Brancheforeningen) and a public procurement organisation (SKI, National Procurement Ltd) regarding improvement of energy efficiency of computers and monitors.

The main idea was to establish a win-win situation between DEST and the IT industry by basing the agreement on a common goal of higher sale shares of efficient computers and monitors and particularly notebooks and LCD monitors, which was supported by the industry organisation and the public procurement organisation.

As a result of the dialogue, the DEST and the IT manufacturers entered a voluntary agreement [1] with these basic subjects:

- The energy declaration: All desktop computers, notebooks and monitors shall bear a declaration on power consumption in advertisements, brochures, web sites, technical information etc. showing the power consumption in on, sleep and standby and showing if the product is “energy-efficient” according to DEST requirements.
- Product lists: DEST maintains product lists of computers and monitors sold by the agreement partners and the partners shall update the list with available models on the market and power consumption of the products.
- Promotional effort of energy-efficient products: The IT industry carries out promotional efforts for the energy-efficient products.
- Campaigning activities: DEST carries out campaigning activities to support the agreement. In 2004 and 2005, two larger kick start campaigns were carried out.
- Public information: Information is provided on energy efficiency of computers and monitors, both regarding the purchase and the use of the products

The expected savings over three years amount to 100 GWh.

Power consumption levels and the declaration

Computers

When establishing the declaration and the power levels for “energy-efficient”, the DEST and the partners wanted to base the definitions, test methodology, and power levels on existing schemes internationally recognised.

Definitions and test methodology were therefore based on “Energy Star Computer Memorandum of Understanding (Version 3.0)”, which was the current version at the time of establishment of the agreement.

The Energy Star qualifying levels were, however, not sufficiently strict to be used as levels for “energy-efficient”. The DEST therefore agreed with the partners to use the values in the GEEA (Group for Energy Efficient Appliances) scheme for standby (2 W) and sleep (5 W after maximum 30 minutes without use).

In addition, the DEST and the partners wanted to include the active mode as part of the “energy-efficient” criteria and decided to use an idle-on definition. The main idea was to introduce the idle-on concept and to prevent the most energy consuming computers to achieve the “energy-efficient” stamp. Therefore the requirement was set at 80 W.

The idle mode was a new concept for energy specifications at that time and it was seen as the most practical way of including on mode consumption of computers. It was defined as the mode, in which the computer is immediately after it has been switched on and started the operating system, drivers, etc., which are delivered with the computer, and has reached a stable level for computer activity without other user activity. For notebooks with a rechargeable battery, no charging must take place.

Integrated desktop computers with monitor built-in were allowed in the on-mode to consume 80 W plus the corresponding level for the monitor.

About half of the computers on the market could comply with the requirements for “energy-efficient”.

Monitors

The Energy Star specifications had recently been revised and the DEST and the partners felt that the Tier II criteria of the specifications were sufficiently strict for the “energy-efficient” compliance of the IT agreement and they were therefore adopted.

The energy requirements are:

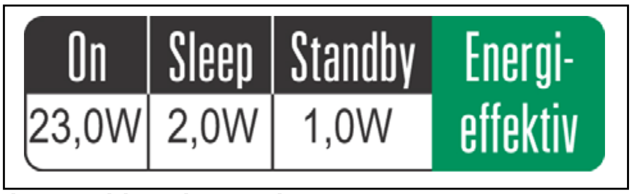
- Off/standby mode: Max. 1 W
- Sleep/low power which is achieved after 30 minutes without use: Max. 2 W
- Active mode: Max. 23 W for resolutions (megapixels) of less than 1 and max. 28 W * resolution (megapixels) W for resolutions greater than or equal to 1. The resolution is calculated as the horizontal resolution multiplied by the vertical resolution in megapixels.

About 25 percent of the monitors on the market could comply with the requirements for “energy-efficient”.

The declaration

The partners and the DEST agreed on a common format to declare the electricity consumption comprising a graphical or a text based declaration. The declaration is not a physical label to stick on the products. Instead the declaration should be included in publicity material aimed at potential buyers and points of sale, such as advertisements, brochures, retailer circulars and newsletters. Wherever possible, this also applies to web sites, electronic media, other technical information and other similar media where product data is given.

See examples in the following:



On	Sleep	Standby	Energi-effektiv
23,0W	2,0W	1,0W	

The graphical declaration

On/sleep/standby: 55W/5W/2W (energi-effektiv) (energy-efficient)

The text-based declaration

The power consumption data are provided by the manufacturers including a declaration of the accuracy of the data. Data are subject to possible spot checks by the DEST.

Partner declarations and activities

Partners in the agreement

The IT agreement was established between the DEST and seven partners:

- Five manufacturers: Apple, Dell, Fujitsu Siemens, Hewlett-Packard and IBM (now Lenovo)
- Danish SKI (National Procurement Ltd), which is an organisation that enters framework contracts with suppliers of products and services and offer them to their customers in the public sector. Typically, energy and environment considerations are part of the evaluation criteria.
- IT-B (IT-Brancheforeningen), which is an industry organisation for manufacturers and suppliers of IT products.

Since then, three more manufacturers (Acer, Philips, Samsung) have entered the IT agreement with the DEST.

In 2005, the DEST decided to open the activities for the retail sector with an agreement similar to the manufacturer agreement. Two retailers have entered the agreement: ComputerCity, which is a large retail chain and B.J. Trading, which is an internet shop.

Use of the declaration

The partners have actively participated in all the activities. They managed to get the power consumption data for their products even though data was not always available for the manufacturers and some of those had a difficult task to get the correct data from their main office.

The partners also managed to include the energy declarations in most of the advertisements, brochures, etc. Often, space is very limited and it is difficult to include more information.

The following figures show a sample of the declarations used.

IBM ThinkCentre A50 SFF

Funktionalitet og fleksibilitet til virksomheder

Systemspecifikationer:

- Intel® Pentium® 4 Processor 2.80 GHz
- Microsoft® Windows® XP Professional
- 256 MB RAM, 40 GB harddisk
- 48x cd-drev
- Ethernet
- Lille formfaktormodel (skærm ikke inkluderet)
- Garanti: 3 års service på kundens adresse

Varenummer: PZC77DK

Kr. 4.885 ekskl. moms

Kr. 6.107 inkl. moms

Leasingydelse kr. 136 ekskl. moms i 36 mdr. Kun gældende for virksomheder og ved køb for over 100.000 kr.*

On	Sleep	Standby	Energi-effektiv
59,2W	2,4W	1,3W	

On	Sleep	Standby	Energi-effektiv
18W	2W	2W	

***

Kan det hele, over det hele

AMILO Pro Edition V2000:
FAP:DAN-148250-003

- Intel® Centrino™ - mobil teknologi
  Intel® Pentium® M-processor 725
  (1,60 GHz, 2 MB cache, 400 MHz FSB)
  Intel® 855GME Chipset, Intel® PRO/Wireless 2200
- Microsoft® Windows® XP Professional MUI

HP COMPAQ BUSINESS NOTEBOOK nx9030

7.799 kr. ekskl. moms, ekskl. lev.*

9.749 kr. inkl. moms, ekskl. lev.* (Order ref.: PG570ET)

- **Intel® Centrino™ Mobile Technology**
  Intel® Pentium® M processor 725
  Intel® Pro/Wireless LAN 802.11b/g
  Intel® 855PM Chipset
- **Microsoft® Windows® XP Professional**
- 15" XGA TFT skærm
- 256 MB DDR RAM
- 40 GB harddisk
- Combo DVD/CD-RW
- Op til 64 MB grafik

HP Care Pack: 3 års totalsikring, afhentning og returnering (U4400A/E) 2.828 kr.

On	Sleep	Standby	Energi-effektiv
61,6W	0,13W	0,78W	

Sample of advertisement by three of the partners with the declarations.

Other partner activities

Many partners carried out additional activities as part of the campaigns, for example:

- Parallel campaign on the partner's web site towards the consumers
- Many information activities towards the retailers (direct mail, newsletters, tools, product information meetings etc.) in order to help them being better able to guide the consumers in finding the efficient products. The retailers are important because there have the direct contact to the consumers.
- Participating in press releases with the DEST
- Publishing information in newsletters

Some of the manufacturers also included the "energy-efficient" requirements as part of the design specifications for new computers and monitors. This does not have an immediate effect; however, when implemented in the new models, the effect is considerable.

One example is HP Denmark who noticed that the external power supplies for the notebooks had a much lower standby consumption level (under 1 Watt) than similar external power supplies for the monitors (above 2 Watt). After a dialogue with the main office design department, the specifications for the power supplies for monitors have been globally adjusted in order to achieve less than 1 Watt in standby.

Product lists and the web site

The web site www.it.sparel.dk established by the DEST is a focal point for the information. The web site contains:

- The product lists of the partners' computers and monitors with technical data and power consumption data. The technical data are provided by the company CNET Channel, which continuously update the models and the data. The partners' task is through a web interface to select the models on the Danish market and enter the consumption data. The web site users can personalise the data by changing default values for usage time and electricity price.
- A calculator that the consumers can use for calculating the savings by changing the current computer and/or monitor to one of the products on the product lists.
- Information on the declaration, financial benefits, advantages of notebooks and LCD monitors, technical details on energy efficient products, impact on working environment, energy efficient use etc.
- TV spots from the advertisement campaigns and a game.
- A partner section where the partners can log in and download material, declaration graphics etc.

The main goal of the DEST information on the web site and in the campaigns, is to inform consumers about the lifetime costs (ie. TCO: Total Costs of Ownership), which is the electricity costs during the assumed lifetime of the products.

Kick start campaigns

DEST and the partners carried out two kick start campaigns during the autumns of 2004 and of 2005 using TV spots, advertisements, web site, product lists, direct mails, PR activities, information at the retailers etc.

The main target groups were IT and financial officers in public and private institutions and consumers in the domestic sector.

The main objective of the 2004 campaign was to focus on the differences in power consumption of products and the use of the declaration as an easy tool for finding the efficient products. The differences in power consumption was narrowed down to a simple message of possible savings of up to about 1000 DKK (~ 140 EUR) during the lifetime of a computer or a monitor by selecting the most energy efficient types compared to the least efficient ones.

The main objective of the 2005 campaign was to clearly communicate that notebooks and LCD monitors are efficient products and that the consumers should consider buying notebooks next time instead of a desktop computer and consider changing the old CRT monitor to a new LCD type.

The possible savings and use of the declaration were underlying messages.

Public procurement

The DEST's definition of "energy-efficient" computers and monitors is part of the DEST Purchasing Guidelines [2]. During 2005, a Government circular [3] was issued stating that the Government institutions must only purchase energy-efficient products complying with the DEST Purchasing Guidelines.
This circular is assumed to support the IT agreement by allowing the Government only procuring computers and monitors complying with the requirements for "energy-efficient".

Results

Main results of the activities include:

- The partners are very active in using the declaration of the computers and monitors in advertisements etc. facilitating the identification of the efficient models by the consumers.
- The manufacturers in the agreement cover more than 80 percent of the computers sold at the Danish market. The partners' market share of monitors is not known, but it is assumed to be between 60 and 80 percent.
- During 2004 and 2005, the share of notebooks of the total computer sale has significantly increased from 37 percent in 2003 to close to 55 percent by end of 2005. CRT monitors have now very little share of the monitor sales. This is not only because of the DEST's and the partners' campaigns, but it is assumed that the campaigns have given an additional push in the right direction.
- Electricity savings for IT equipment were almost an untouched issue before the IT agreement was entered, but in less than two years, the attention has increased significantly by the consumers. After the 2005 campaign, 68 percent of the IT managers knew about the declaration and about 60 percent said that they would choose efficient models next time.
- The DEST and the partners have initiated a very fruitful collaboration that can be used in many other areas.

Main factors for the results

Main factors for the positive results are:

- Dedicated IT partners who went seriously into the work and allocated many resources.
- A close collaboration between DEST and the partners where flexibility was given from both sides and where a win-win situation could be established.
- The most efficient products, i.e. notebooks and LCD monitors give many additional advantages for the consumers and the employees.
- Being a public authority, DEST works as a rubber-stamp for the declaration and the campaign messages level setting.

Perspectives and future activities

The DEST and the partners will continue working with the declaration and energy-efficiency of computers and monitors and will include other related activities, such as:

- Energy-efficient power supplies
- Servers
- Thin clients
- Software for improved automatic power management of computers and monitors
- Development of a self-help web tool for analysing the electricity consumption of IT and office equipment (computers, monitors, imaging equipment and other office appliances).

About Danish Electricity Saving Trust

DEST, (Danish Electricity Saving Trust "Elsparefonden" in Danish), is an organisation under the Ministry of Transport and Energy. It is independent and with own board. It focuses on market transformation by influencing both supply and demand and uses often new and creative instruments.

It works primarily with the household and public sectors, however, the activities can be extended to the private sectors. The goal is to save 0.8 TWh/year over ten years with a budget of 12 millions EUR/year. A recent evaluation showed that the trust is 28 percent ahead of the planned savings.

References

[1] *Voluntary agreement between the Danish Electricity Saving Trust and Producers of IT equipment concerning electricity savings for standard computers and computer monitors 2006* . Can be downloaded from www.sparel.dk/english

[2] The Danish Electricity Saving Trust*: Purchasing Guidelines 2006.* Can be downloaded from www.sparel.dk/english

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CECED Cold Appliances Unilateral Industry Commitment - a Combination of „Hard” and „Fleet“ Targets for Efficiency Increase

Friedrich Arnold

Bosch and Siemens Hausgeräte GmbH

Abstract:

In 2004 the European Committee of Manufacturers of Domestic Appliances (CECED) presented an updated Unilateral Industry Commitment aiming at improving energy efficiency of domestic refrigerators and freezers. The target values of the commitment were expressed with reference to the values and formulas based on the new energy labelling classes A+ and A++.

The commitment sets quantified and staged targets in terms of energy efficiency thresholds and fleet consumption targets. In addition it provides a method for monitoring the evolution of energy efficient appliances diffusion into the market that allows to track progress and results.

The actual status and new developments will be presented. Market transformation mechanisms will be discussed.

CECED[1] Cold Appliances Unilateral Industry Commitment - a combination of „hard” and „fleet“ targets

Within the EU exists profound experience with both voluntary industry agreements and legal directives. In 1999, for example, a directive imposing an energy limit came into force and a voluntary agreement was adopted together with the revision of the energy label directive. The advantages and disadvantages of the two different approaches towards more efficient household appliances will be put up for discussion in the following paper.

For being able to compare, it is necessary to understand, what the results of the current voluntary agreements are. Thus, the first step will be to look at the development of the last few years:

In 2004 the European Committee of Manufacturers of Domestic Appliances (CECED) presented an updated Unilateral Industry Commitment aiming at improving energy efficiency of domestic refrigerators and freezers.

The market of household refrigeration appliances is currently governed by two directives on the energy side:

“Energy labelling of household refrigerators / Directive 94/2/EC(1994/2003)”
“Energy efficiency requirements / Directive 96/57(1996)”

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[1] Conseil Européen de la Construction Electro-Domestique

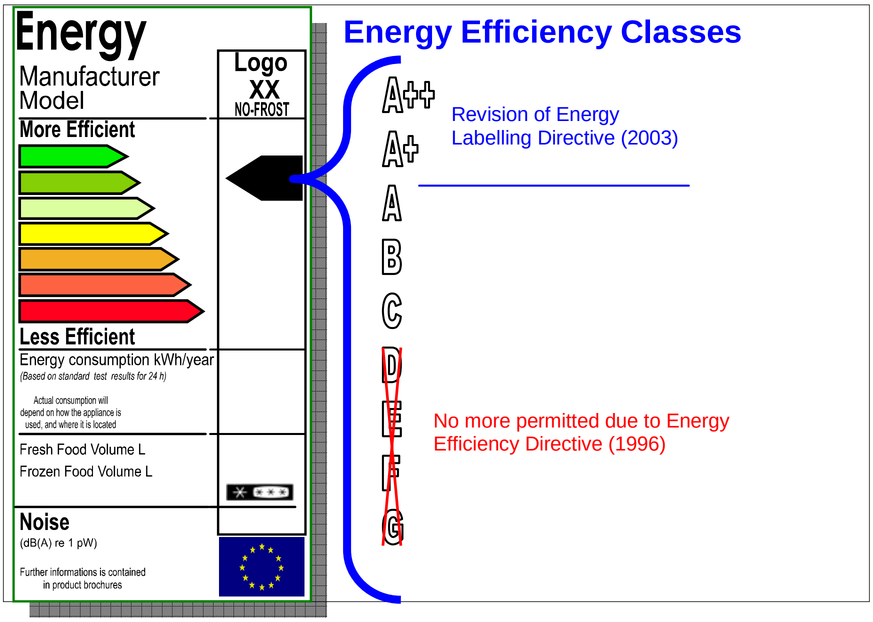

Figure 1: Energy labelling of household refrigerators

The following figure tries to estimate the effect of the energy labelling Directive extrapolating the trend in the percentage of saving from 95 to 97 onward.

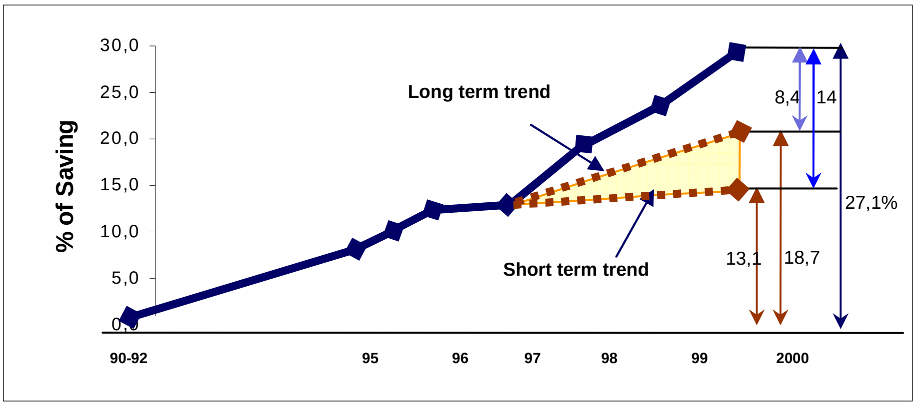

Figure 2: Saving on the overall average energy efficiency index [1]

The present Commitment is based on the following criteria:

Representativeness

The commitment covers almost the totality of the European household refrigeration appliances industry. CECED represents more than 95% of the market [2].

Quantified and staged targets

The commitments sets quantified and staged targets in terms of energy efficiency thresholds and fleet consumption targets. In addition it provides a method for monitoring the evolution of energy appliances diffusion into the market that allows tracking progress and results well beyond the time horizon of the commitment.

The commitment should result in a saving of about 4.5 TWh in year 2006 and 11.6 TWh in year 2010 [2]. This is in line with the TWh saving for household refrigerating appliances as indicated in the "SAVE II" Study.

Incentive compatibility

CECED recognises the need for a favourable political framework to be feasible and effective.

Two measures are fundamental:

- ⇨ The revision of the energy label Directive
- ⇨ The development of co-ordinated measures to improve the diffusion of energy efficient solutions in the market

Publication

CECED will give full evidence of the results achieved by the present commitment as well as of the monitoring results.

Commitments of the participants [2]

Withdrawal of less efficient household refrigerating appliances / "hard target"

Participants will stop producing for and importing in the Community Market household refrigerating appliances having an energy efficiency index 75[2] and above by December 31st, 2004.

Furthermore participants will stop producing for, and importing in the Community Market electric compressor based chest freezers having an energy efficiency index 90[3] and above by December 31st, 2004.

Reducing the fleet consumption / "fleet target"

Each participant will reduce its own production – weighted average energy efficiency index – to a value of 55 (LLCC) for production and importation into the EU market by the year 2006.

In the case the EU fails to develop frame effective market transformation tools, participants however commit to achieve a fleet target of 57 (weighted average energy efficiency index).

Notary based production weighted data collection and validation

Starting from the production year 2001 each participant will provide the independent consultant with production weighted energy efficiency data in each refrigeration energy class and for each product category during the previous calendar year until 2010.

Additional measures / "soft targets"

Starting from year 2004 all participants commit themselves to strengthen their overall activities to achieve energy savings and to educate consumer in the way of saving energy; in particular:

- ⇨ By giving information on the appropriate size of a refrigerator with regard to the household size
- ⇨ By co-operating with National Energy Authorities in view of common programmes to promote the efficient use of refrigerators (e.g. Energy Star)
- ⇨ By giving information about the rational use of the appliance in order to reduce energy consumption like:
  - proper thermostat setting
  - loading of food according to storage temperature
  - preparation of food to be refrigerated/frozen
  - correct location and installation (free ventilation openings)
  - proper cleaning and maintenance (frost removal)
  - reducing number and duration of door openings
  - prevent excessive frost by putting food into containers or envelopes
  - do not store food at high temperature

CEDED Commitments [2]

- ⇨ Listing of participants
- ⇨ Database for refrigerators, updated each calendar year
- ⇨ Starting from year 2001, a notary will monitor the overall production weighted average energy consumption
- ⇨ Yearly report based on the notary calculation

Reporting

Based on the data provided, CECED will submit a report each calendar year -starting from 2003- to the European Commission including the following information:

- ⇨ Base of notary summary
  - The overall production weighted energy efficiency index
  - A histogram of production weighted energy efficiency index for each efficiency classes and product category
  - The ranking of the production weighted energy efficiency indexes of the participants (in an anonymous way)

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[2] Equals efficiency class D or worse

[3] Equals efficiency class E or worse

- ⇨ Base of CECED technical database
  - The respective share of each product category
  - Charts showing technological trends

Reaction to Non-Compliance

- ⇨ If a participant produces or imports household refrigerating appliances belonging to a banned energy efficiency class, CECED will immediately issue to the participant a written warning of non-compliance and will request the participant to take appropriate corrective actions within a deadline of one month.
- ⇨ If the notary report for the year 2005 causes doubts whether the target of 55/57 could be achieved in time by a participant, CECED will issue to the participant a written warning and will request the participant to take appropriate corrective actions.
- ⇨ If the participant fails to comply within the set deadline or a participant is identified to fail to reach the average energy efficiency this participant would be deemed not to take part any more in the commitment. CECED will issue a press release indicating that the participant no longer takes part in the commitment.

Commitment monitoring and achievements

Since 1995 CECED collected all the data declared on the energy labels by manufacturers (technical data basis) on an annual base.

In 2002 CECED also launched a notary based data collection to report sales weighted data in EU 15 which is also going to be completed with an additional notary based data collection for sales in the EU25 countries.

These tools allow monitoring the development of the commitment.

When the analysis and monitoring activity was launched some ten years ago, 75% of the refrigerators and freezers sold in the EU15 had an efficiency class D or worse. Only few flagship models were in class A.

In 1999, the share of the “D or worse” appliances has already shrunk to 13% while the intermediate classes have grown to 70% at the same time.

This is the combined effect of the Directive 94/2EC (1994) on “Energy labelling of household refrigerators” (amended in 2003 by the new Directive 2003/66/EC) and the Directive 96/57 (1996) on energy efficiency requirements.

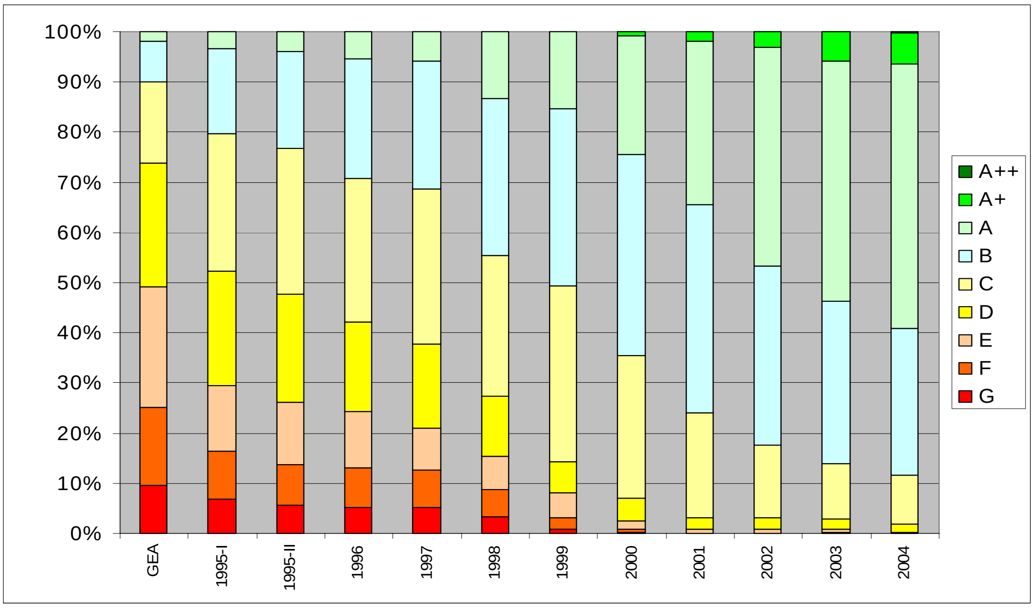

Figure 3: Energy label class distribution over the years [2]

Furthermore, the overall improvement includes the complementary result of a “natural” trend due to both the technological evolution and the market competition.

From 1999 to 2004, a new transformation in the profile of the appliances sold became noticeable: The market share of class A or better appliances increased from 15% to 53%. This outstanding development is resulting from the combined efforts of all the manufacturers who have developed new

solutions, which allowed the widespread use of environment benign gases, such as hydrocarbons, and the diffusion of highly efficient products. [2]
A list of the development potentials, discussed within SAVE II, is indicated below.
GEA study:

- increased door insulation
- increased cabinet insulation
- increased evaporator surface area
- increased condenser surface area
- increased evaporator heat capacity
- increased condenser heat capacity
- more efficient compressors
- decreased door leakage

Additional possibilities:

- higher quality insulation (vacuum insulation, alternative foaming agents)
- low-wattage fans
- variable-speed-, linear-, rated-speed-compressors
- optimized electronic control
- alternative refrigerants
- flow regulation valves
- compressor-run capacitors
- phase-change materials in the evaporator / condenser
- off-cycle migration valve to prevent pressure equalisation

Potentials of combinations:

- alternative cooling cycles
- optimized thermal balancing, reducing the need of thermal-compensation heaters
- two compressors
- two-way refrigerant control valves
- intelligent adaptive defrosting

Figure 4 shows the overall improvement achieved year after year[4], as recorded in the CECED technical data base. The improvement has been about 3% per year, with an apparently constant progress.
Also the target lines for 2006 fleet consumption are marked.

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[4] Fleet average value over all participants

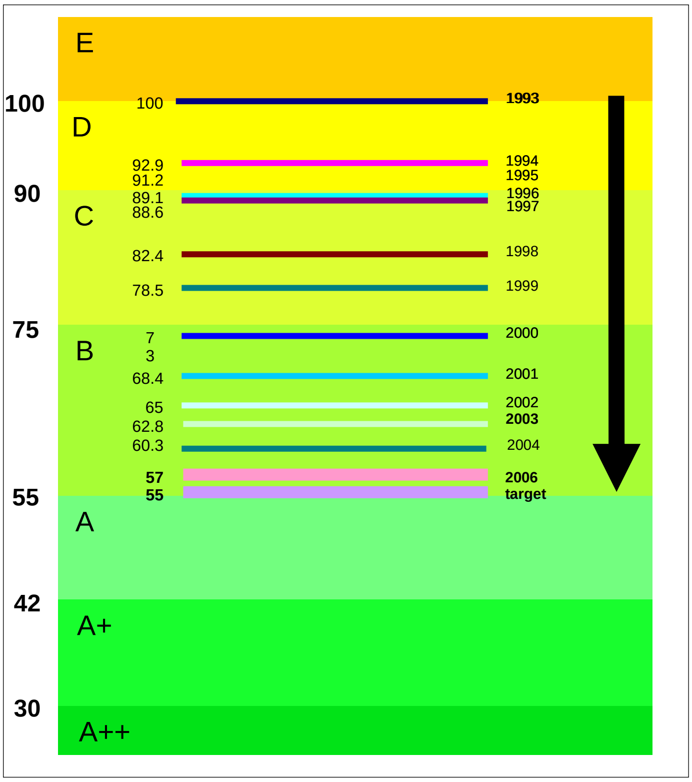

Figure 4: Energy efficiency progress achieved by manufacturers in the decade 1993-2003 [2]

The evolution of the product distribution within the different energy classes is shown in Figure 5. Class B products have steadily increased from 1993 to 2001. Since then they have started declining, while classes A and better started to increase. This is a sign of the ongoing transformation of the national market.

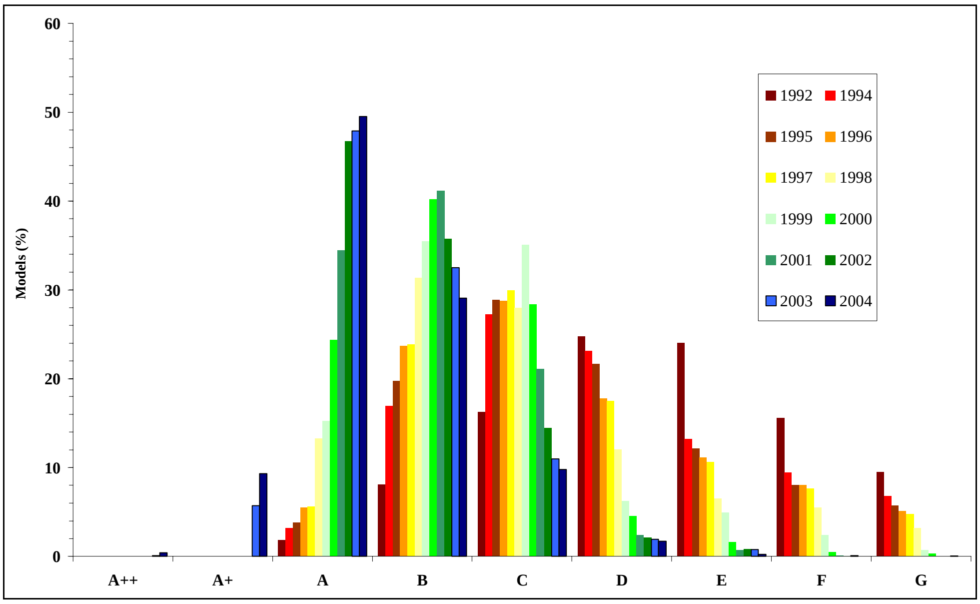

Figure 5: Evolution of the product distribution within the energy classes [2]

Figure 6 shows the product distribution according GEA, CECED technical and CECED notary database.

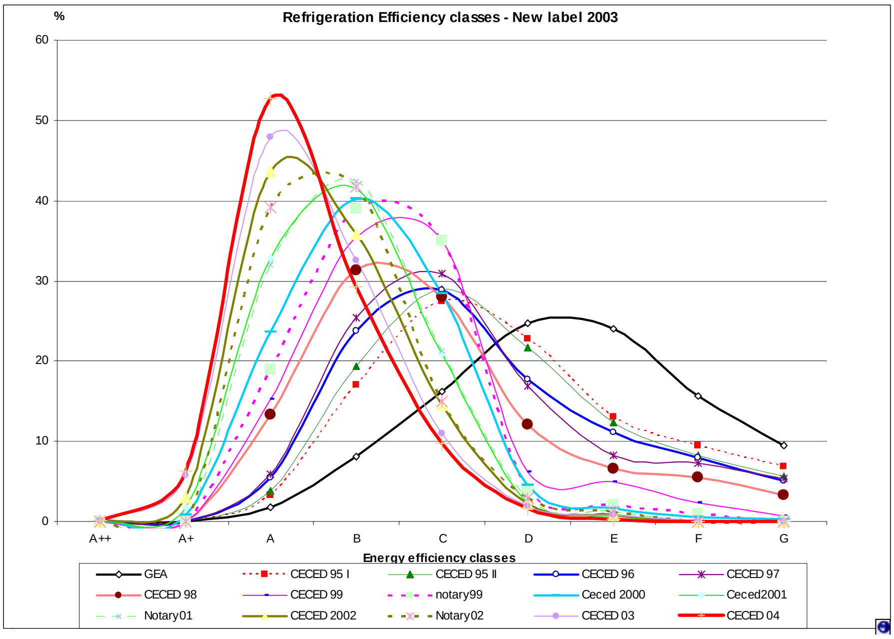

Figure 6: Evaluation of the product distribution according to different databases [3]

Manufacturers participating to the unilateral commitment already started to have an internal notary data collection on refrigerators and freezers before the unilateral commitment was launched. Therefore, the trend of 5 years can be offered, even though this is the second year reporting for the Unilateral Commitment. Figure 7 shows the trend of the production referred to the notary data collection

Table 1: Total weighted average energy efficiency index 1999-2004 [2]

	1999	2001	2002	2003	2004
Total weighted average energy efficiency index	74,11	69,58	67,26	64,38	60,35
Total production (x1000)	15,315	17,503	18,181	20,254	20,291

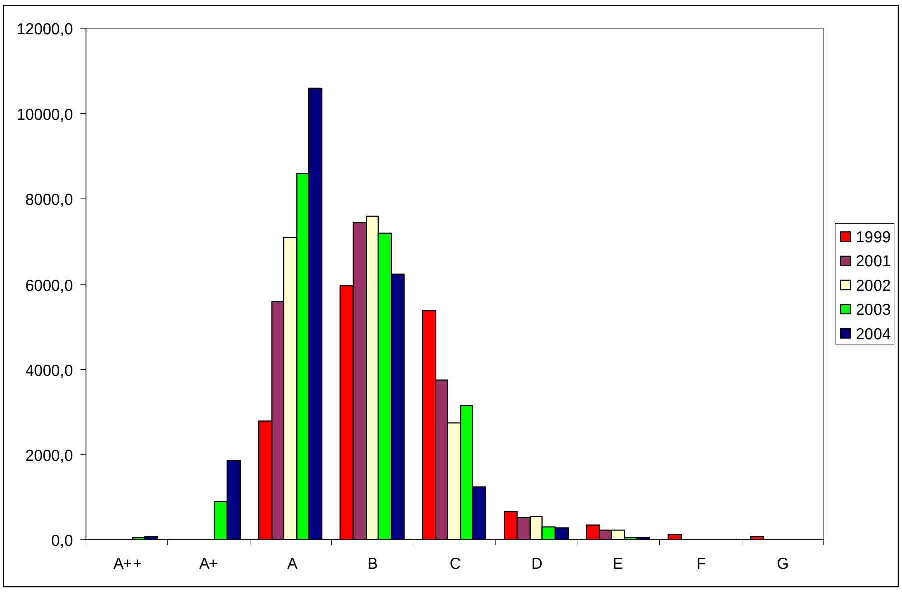

Figure 7: European production/imports – notary distribution [2]

Also in this case class B products have started declining from 2002, with a quite normal slight delay compared to the technical data base. The notary declaration in 2004 recorded first quantities and percentages of models sold in A+ and A++ energy label classes. From the following table it can be seen that A++ products are already available in categories 1, 6, 7, 8 and 9.

Table 2: Refrigerators and freezers produced/imported for EU market; Notary collected CECED data year 2004 (Directive 94/2) [2]

	Classes	Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7	Category 8	Category 9	Category 10	**Total**
Energy efficiency	A++	29.90	0	0	0	0	29.50	29.37	29.70	29.04	0	*29.42*
	A+	40.90	38.22	40.85	0	0	40.47	40.64	40.61	39.58	40.62	*40.47*
	A	53.00	53.75	54.17	53.88	54.62	50.34	53.40	54.09	47.11	54.12	*53.25*
	B	70.99	65.08	74.08	72.64	72.76	66.35	70.74	72.54	73.72	73.20	*71.35*
	C	84.02	81.30	88.08	84.85	87.87	87.55	86.60	86.40	88.92	81.60	*87.84*
	D	0	0	0	0	0	0	97.73	0	98.39	0	*98.33*
	E	0	0	0	0	0	0	0	0	104.77	0	*104.77*
	F	0	0	0	0	0	0	0	0	120.94	0	*120.93*

N° appliances x1000	A++	13	0	0	0	0	4	10	22	32	0	*81*
	A+	255	16	7	0	0	20	878	355	308	13	*1852*
	A	1759	41	116	6	38	131	6924	1265	239	72	*10591*
	B	662	12	247	105	185	64	3713	916	267	53	*6225*
	C	48	0	149	38	12	10	141	168	655	3	*1225*
	D	0	0	0	0	0	0	25	0	248	0	*274*
	E	0	0	0	0	0	0	0	0	42	0	*42*
	F	0	0	0	0	0	0	0	0	1	0	*1*
												20291

The fleet target commitment requires that the minimum target value of 55 (57 in absence of market transformation initiatives) is achieved individually by each participant during the year 2006.

The notary has also released the individual position for each participant in an anonymous form. Figure 8 shows the results in a random order.

As it can be seen, two participants have already reached the fleet target. Nine are close to the average; three have more than a one year gap to overcome. From this situation it appears evident, that the need exists for governments to approve measures supporting an accelerated replacement of obsolete appliances and a stronger penetration of the new efficient ones.

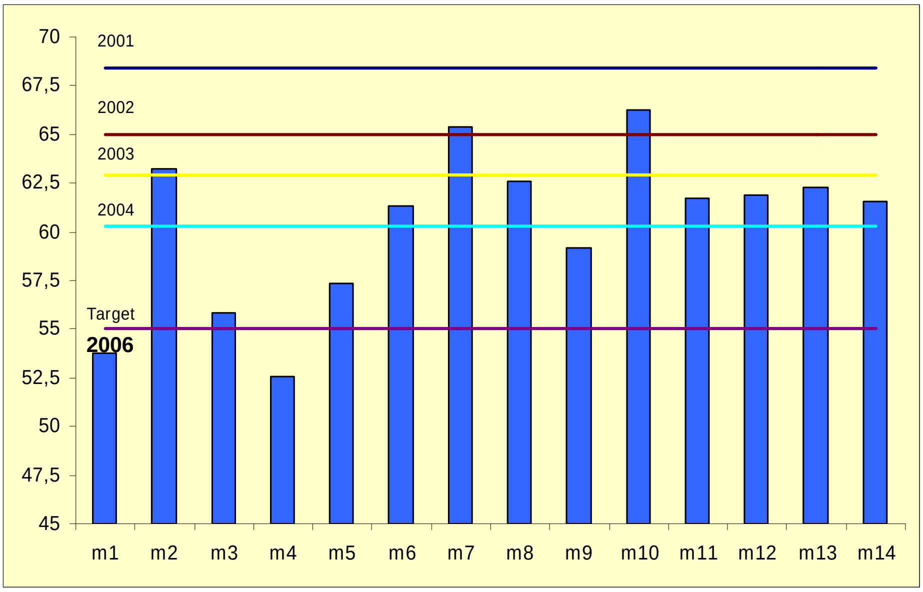

Figure 8: Fleet consumption of the participants [2]

During the first years of this unilateral commitment we registered a slowdown of the supporting measures such as rebate schemes. In 2005 the political debate has focused back to sustainable energy and the need to address market transformation.

We register in most of the markets that sales trends in value are lower than trends in units. This means that consumers are oriented towards cheaper products - in general less efficient ones.

88 million refrigerators and freezers more than 10 years old, are still in use in Europe. This means that their average consumption is at least 60% higher than today's average and three times higher than the most efficient appliances offered today by the manufacturers.

The replacement of obsolete units with top range appliances, from the energy standpoint, would provide the highest contribution for the next 10 to 15 years to the reduction of energy consumption.

In November 2005, as a result of the ongoing efforts in improving energy efficiency of household appliances, CECED has been accepted as an associate to the Sustainable Energy campaign 2005-228. We are confident, that this campaign may provide a good basis for a tight cooperation between the manufacturers and the national or local energy agencies for the development of market transformation initiatives.

Table 3: Participating manufacturers [2]

Manufacturers	HQ Country
AMICA WRONSKI	Poland
ANTONIO MERLONI	Italy
ARCELIK	Turkey
B/S/H	Germany
CANDY	Italy
ELCOBRANDT	France
ELECTROLUX	Sweden
FAGOR	Spain
GORENJE	Slovenia
INDESIT COMPANY	Italy
LIEBHERR	Germany
SNAIGE	Lithuania
VESTFROST	Denmark
WHIRLPOOL	Italy

Advantages and disadvantages of a voluntary agreement versus mandatory requirements

As we have seen, the effects of the unilateral commitments so far have been very positive. However, it might be a point for discussion, how the results of such a voluntary agreement are, compared to those of creating mandatory legal requirements. Looking closely, the effects generated on the market differ vastly, depending on which type of regulation is applied.

Implementation times and economical side-effects

Normally, it should be plausible that a legal requirement should be faster in showing effects on the market. Reality, however, shows a different picture. If a new directive is developed, a very time-consuming process is started in advance: Technical background, economical effects and many other factors have to be evaluated and verified before the final text is ready to pass legislation – which takes some time itself. Last, but not least, the legislation has to include some time window for the industry to react to avoid massive economical problems, during which no effect results (due to selling off stocks etc.).

Voluntary agreements in contrast do not need much technical consultation, as the participants already know very well about the technical possibilities and the time needed for certain progress. Likewise, they do only need a minimum of time for implementation, as the time for change-over in the market is automatically optimized not to affect the industry overdue: While not so advanced manufacturers naturally tend to slow the progress, technologically advanced participants will try to push the implementation because of economical advantages over their competitors; ending up in an compromise between minimum implementation time and minimum cost effects for the industry.

Technological gains

As the main target is raising the energy efficiency of the appliances, there is one point which is undoubtedly an advance for the legislative approach. As a result of a directive enforcing minimum standards, all appliances with a too high energy consumption can be prevented from being marketed any further, while within the voluntary agreement those appliances stay marketable, as only a median target value for the fleet consumption is defined.

However, the fleet consumption value as target does not necessarily mean that the effect is less big. Inefficient appliances can be marketed, but they have to be balanced out by highly efficient ones in order to reach the target = only limited amount tolerable. This leads to a different distribution of energy classes in the market, as shown in figure 9.

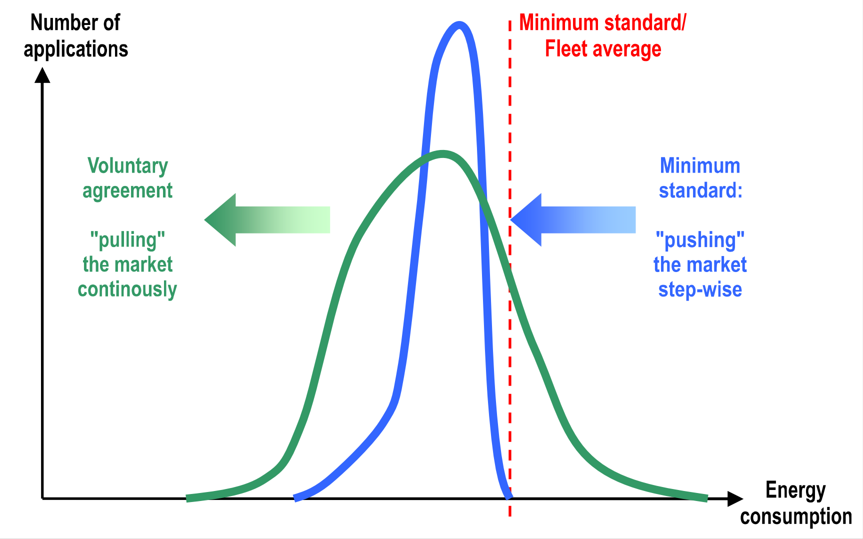

Figure 9: Different effects on the energy class distribution

A present minimum standard will be kept, but since higher efficiency means additional costs in research, development and production, there will be only a small number of appliances going significantly beyond the standard for economical reasons, leading to a concentration around the minimum, with only a weak trend towards significantly higher efficiency for every legislative step. A fleet consumption target, in comparison, leads to a broader range of improved applications and continuous improvements by the positive marketing feature of high efficiency.

Access to the market

The second point for setting minimum requirements by governments is the access to the complete market; no application may deviate from the set standard. Voluntary agreements, however, are only binding to their participants. Thus, non-participants can not be prevented from selling lower efficiency models and only agreements covering the majority of manufacturers on the market can be effective.

Implementation

Concerning best possible implementation, legal methods fall short of the voluntary approach. As the affected manufacturers take part in the development of the agreement, there is only a minimum of potential for problems: Everybody knows exactly how and what to do. This eliminates effectively disputes over e.g. possible interpretations of the legal texts, exemptions and so on.

Monitoring

Concerning monitoring, too, the voluntary agreement has some points ahead of the minimum standard. Voluntary agreements are not to be controlled by the state, thus not resulting in additional costs for the community – but still, the competitors are controlling each other effectively. All necessary information is provided (e.g. yearly report, qualitative data by the “soft targets”…).

Conclusion

Voluntary agreements show a significant effect on the market, which can be proven by the clearly measurable results over the last years. However, the voluntary nature is the source of both advantages and drawbacks, especially being not able to enforce the agreements on non-participants. For the future, it seems very promising to keep up the strategy of voluntary actions on one hand, but supplementing it with enforceable legal directives for getting a maximum of synergistic effect on the other.

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The Role of Voluntary Initiatives in Improving the Energy Efficiency of Appliances

David B. Calabrese

Association of Home Appliance Manufacturers

Abstract

The U.S. Department of Energy has been widely criticized for missing statutory rulemaking headlines to consider the revision of minimum energy efficiency standards for appliances. Despite these missed deadlines, there have been dramatic improvements in the energy efficiency of appliances through non-mandatory or voluntary means.

Voluntary efforts have played an important part of the trend towards energy efficiency in appliances. Representative examples include: (1) utility programs that provide rebates to consumers who purchase energy efficient appliances, (2) federal tax incentives, (3) the Energy Star Program, and (4) independent efforts by manufacturers to improve the efficiency of their products. These and other voluntary programs and efforts have helped to dramatically increase the overall energy efficiency of appliance products over the past decade. In fact, recognizing the importance of such voluntary initiatives, the U.S. Congress passed energy legislation in 2005 (i.e. the Barton-Domenici Energy Policy Act of 2005) that included support for such voluntary initiatives. While this law included new federal mandatory efficiency standards, it also authorized new voluntary incentive programs as well as financial support for existing voluntary programs. For example, the law authorizes business tax credits for the production of super-efficient clothes washers, refrigerators, and dishwashers that is expected to transform the market for these products. In addition, the law provides federal support for state-based incentive programs that are designed to encourage consumers to purchase energy efficient products. Even the mandatory efficiency standards included in the law were the result of voluntary consensus-based negotiations between industry and environmental organizations.

Introduction

Much of the focus of environmental advocates and government policymakers in the U.S. and internationally has traditionally been on the use of mandatory minimum energy efficiency standards to increase the efficiency of appliances. While this system has obvious benefits, voluntary initiatives have an essential, and frequently overlooked, role.

The purpose of this paper is to provide information on the different varieties of those voluntary initiatives currently in effect in the United States, including utility programs, tax credits, and the Energy Star program, and also to explain how they are an effective tool in improving the energy efficiency of appliances.

Background on Appliance Energy Efficiency Programs

Federal Minimum Energy Efficiency Standards

The National Appliance Energy Conservation Act ("NAECA") establishes federal minimum energy efficiency standards in the United States for covered appliance products, including clothes washers, clothes dryers, ranges and ovens, refrigerator-freezers, dehumidifiers, commercial clothes washers, room air conditioners, dishwashers.[1] The standards are established through rulemakings in which the Department determines the potential for energy savings from a standard, the consumer cost-benefit and the impact on manufacturers. Producers of these products must adhere to the minimum standards in order to sell their products in the U.S. market.

The cumulative impact of all the federal appliance efficiency standards enacted since 1987 has been over 60 quadrillion Btus of energy saved.[2] For example, standards for refrigerators are now in their third generation and have reduced the annual energy use of today's refrigerator to less than that of a 75 watt light bulb. In 1987, the average size home refrigerator was 20 cubic feet in size and

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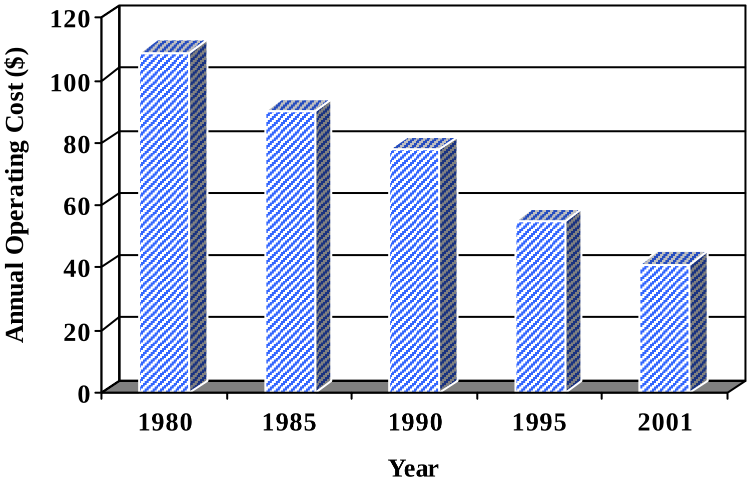
[1] 42 U.S.C. § 6291 et seq, Pub. Law 100-12 (1987)

[2] U.S. Appliance Efficiency Standards Overview, Bryan Berringer, U.S. Department of Energy, Oct. 3, 2003, p. 7

consumed 974 kilowatt hours of energy per year.[3] The average unit sold in 2004 was slightly larger, 21 cubic feet and consumed 500 kilowatt hours per year, a 49% reduction in energy use. The efficiency gain of the average refrigerator has increased 35% since 2000.[4]



Energy Trend of R/Fs
Source: AHAM Market Data Information

Voluntary Appliance Energy Efficiency Programs

As distinguished from federal minimum efficiency standards maintained by DOE, the voluntary initiatives in place today can take many different forms. They are, as their name implies, non-mandatory means to transform the market by encouraging consumers and manufacturers to manufacture and purchase energy efficient appliances. They can take the shape of consumer tax credits, manufacturer tax credits, retail tax rebates, and the Energy Star designation. In the U.S. these programs are becoming more prevalent and are being established as an accepted part of the marketplace.

State-Based Tax Rebates and Utility Programs

Some states and utilities provide rebates and tax incentives to consumers to incentivize them to purchase energy-efficient appliances. Rebates can take the form of reductions in the initial purchase price of certain high-efficiency appliances which make them more attractive for consumers to purchase. Many of these programs are in place for high-efficiency appliances such as dishwashers, refrigerators and clothes washers. In addition, utility companies may also offer rebates for high-efficiency products and water utilities offer rebates for certain highly efficient models of clothes washers that use low amounts of water.[5]

For instance Pacific Gas and Electric's program for 2006 include purchase rebates for certain Energy Star rated dishwashers. The rebate in the amounts of $30 or $50 can be claimed from the utility if the dishwasher meets certain energy efficiency specifications.[6]

Tax Holiday

Tax holidays are a popular means for individual states to encourage residents to purchase energy efficient products. For a specified period of time – a weekend, month or an entire year – the state sales tax is waived on purchases of certain energy efficient products. For example, legislation is currently being considered in the Maryland legislature, S.B. 265, which would provide a specific time of year when consumers who buy energy star appliances would not pay any state sales tax on those items.

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[3] AHAM Market Data Information

[4] Id.

[5] Found on the American Council for an Energy Efficient Economy website, <http://www.aceee.org>, last visited on February 23, 2006.

[6] Found on the Pacific Gas and Electric Website, <http://www.pge.com/res/rebates/dishwashers/index.html>, last visited on February 23, 2006.

In addition, the state of Iowa is considering legislation, H.F. 2141, which would exempt from sales and use taxes consumers' purchases of clothes washers, refrigerators, and dishwashers that meet Energy Star program specifications.

Tax Rebates/Deduction
In Hawaii, legislation is being considered, S.B. 2125, which provides consumers with a $50 tax credit/deduction from their income for the purchase of Energy Star Appliances. If enacted, this credit would be effective for tax year 2006 and beyond.

The Energy Star Program
The purpose of the Energy Star program is to increase the prevalence of energy efficient products in the marketplace by providing information to consumers that can guide their purchase decisions, and, in turn, by providing incentives to manufacturers to use its designation – the Energy Star logo. The program is described as a way to breakdown market barriers, and as a long term measure that provides information and incentives to consumers and businesses. Importantly, some attribute the program's success to the capital investments that manufacturers make, on a voluntary basis, in energy efficient products and technologies.[7] In addition, the program creates an important partnership that between manufacturer, DOE/EPA, retailers, and local/state jurisdictions. For those consumers who may wish to buy energy efficient products, the program reduces the costs – both transaction costs and the risk premium – for purchasing these goods. By providing "credible" and "objective" information the program aims to assist consumers in making more informed decisions.[8]
The Energy Star appliance program is designed to clearly identify those appliance products that are the upper tier of energy efficient products on the market. The program currently includes more than thirty-five product categories and it is estimated that a typical home, fully equipped with Energy Star products, would operate on average with 30% less energy use than a home without.[9]
The Department of Energy ("DOE") and the Environmental Protection Agency ("EPA") share responsibility for managing the appliance program in the United States. The specifications, which are set through interaction with the industry, advocacy organizations, and the public are set higher than the federal standards and are designed to identify only the most efficient products on the market.

Product	**Agency**	**Energy Star Specification**	**Federal Minimum Energy Efficiency Standard**
Dehumidifiers	EPA	2006 Specification: Pints/day L/kwh ≤25 ≥1.20 >25 to ≤35 ≥1.40 >35 to ≤45 ≥1.50 >45 to ≤54 ≥1.60 >54 to ≤75 ≥1.60 2008 Specification: Pints/day L/kwh ≤25 ≥1.20 >25 to ≤35 ≥1.40 >35 to ≤45 ≥1.50 >45 to ≤54 ≥1.60 >54 to ≤75 ≥1.80	Effective in 2007: Pints/day L/kwh ≤25 ≥1.00 >25 to ≤35 ≥1.20 >35 to ≤54 ≥1.30 >54 to ≤75 ≥1.50 >75 ≥2.25
Clothes Washers	DOE	Current Specification MEF ≥ 1.42 2007 Specification MEF ≥ 1.72 WF ≤ 8.0	MEF ≥ 1.26

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[7] Energy Star – The Power to Protect the Environment Through Energy Efficiency, Environmental Protection Agency, p. 2.

[8] Id.

[9] Id. at p. 3.

Product	Agency	Energy Star Specification	Federal Minimum Energy Efficiency Standard
Refrigerator/Freezers	DOE	R/Fs 15% more stringent than federal minimum efficiency standard Freezers 10% more stringent than federal minimum efficiency standard	Federal minimum efficiency standard is based upon the volume of the individual refrigerator which is applied to a set formulas.
Room Air Conditioners	DOE	8.8 to 10.5 EER depending upon product category	8.5 to 9.8 EER depending upon product category
Dishwashers	DOE	Current Specification 0.58 EF (Reg. Size) 2007 Specification 0.65 EF (Reg. Size) 0.88 EF (Compacts)	0.46 EF (Regular Size) 0.62 EF (Compact Size)
Appliance Battery Chargers	EPA	Schedule based on battery charger voltage	None, however, DOE is directed by law to establish a standard.

Federal Tax Credits

The U.S. Congress has considered legislation recently that encourages voluntary measures to improve energy efficiency. Legislation providing for tax credits for manufacturers of appliances and credits for consumers have been included as part of energy legislation that has been before both houses of Congress over the past several years.[10] This type of legislation is based on the recognition that an effective way to make energy efficient products more accessible to consumers is by incentivizing manufacturers to produce them and consumers to buy them.

Appliance Manufacturer's Tax Credit

The Barton-Domenici Policy Act was signed into law on August 8, 2005 and with it, the appliance manufacturers' tax credit became law. The credit provides a per-unit tax credit for manufacturers for their production in the United States of super-efficient clothes washers, refrigerator/freezers, and dishwashers in 2006 and 2007.

The appliance manufacturer's tax credit is designed to provide per-unit tax credits, of varying amounts, for the U.S. production of super-efficient clothes washers, refrigerator/freezers, and dishwashers that exceed a baseline production amount. This baseline is determined by taking the average of the preceding three years production of the particular "type" of appliance. Each super-efficient unit produced that exceeds this baseline amount is eligible for the credit.

Below is a breakdown of the applicable credit for each product type.

1. **Clothes Washers** – The credit amount is $100 for units produced in 2006 and 2007 exceeding the baseline that meet the 2007 Energy Star Clothes Washer specification.
2. **Refrigerator/Freezers** – The applicable credit amounts include $75, $125 and $175 for the production of R/Fs that meet corresponding levels of efficiency (i.e. those that exceed the DOE 2001 Standard by 15%, 20% and 25%). Note that the qualifying production is that which exceeds the three-year baseline by 10%. In addition, there is a $20,000,000 cap for the 15% R/F category.
3. **Dishwashers** – The dishwasher credit amount depends upon how much more efficient the 2007 Energy Star specification is compared to the current Energy Star specification (i.e. 0.58

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[10] The 2003 Energy Bill which passed the U.S. House of Representatives, but failed to pass the U.S. Senate contained an appliance tax credit.

EF). Utilizing a formula of $3 per each 1% increase in efficiency, this credit will equal approximately $32 for each unit produced over the baseline production amount.

In order to limit the fiscal impact of this provision, the tax credits provides for a $75,000,000 per company maximum benefit for the two-year term of the credit, effective for products produced after December 31, 2005.[11] Furthermore, the credit provides that the only production that would qualify is that which exceeds the production from previous years. This element provides that production must be incrementally better each succeeding year – in order to determine the level of production that qualifies for the credit, the law establishes a three-year average rolling baseline for clothes washers and dishwashers and a three-year average rolling baseline, with a 110% multiplier, for refrigerator/freezers.[12] A manufacturer must calculate the average of the production in the proceeding three years from the taxable year that it wants to claim the credit. For example, a tax payer claiming the credit in 2006 must determine the average of production in 2005, 2004 and 2003. In claiming the credit in 2007, the tax payer must determine the average of production in 2006, 2005 and 2004. For Refrigerator/Freezers, the tax payer must add an additional 10% to the average to determine the base amount. However, qualified production only includes those products produced in the United States.[13] The lifetime per company cap over the two-year period plus a limitation that the annual total tax credit cannot exceed in any taxable year two percent of corporate gross revenues ensures that neither small nor large companies unduly benefit from the credit program.

Below is a description of the tax credit's provisions, per product.

Product	Efficiency Level	Credit	Year(s) effective
Clothes Washers	2007 Energy Star Level	$100	2006-2007
Refrigerator/Freezers	15%	$75[14]	2006
	20%	$125	2006-2007
	25%	$175	2006-2007
Dishwashers	Energy Star Level effective in 2007 that is established through legislation that directs DOE to announce a new Dishwasher Energy Star Level in 2005 that is effective in 2007	Incentive amount equals $3 per 1% increase in efficiency from the 2007 Energy Star specification[15]	2006-2007

Consumer Tax Credit

A different tax incentives approach is the consumer tax credit. In 2005, Senator Ron Wyden considered legislation that would provide for credits for consumers for the purchase of energy efficient furnaces, air conditioners and clothes washers.[16] As distinguished from the manufacturer-based tax credit, as described above, this consumer credit would have provided purchasers of appliances a federal tax credit of varying amounts (i.e. $100 to $250) for the purchase of certain qualifying appliance products.[17]

The Success of Voluntary Initiatives

Energy Star Program Success

The Energy Star program has been a huge success in the United States. Through its 14 years of existence, the program has served to transform the market for home appliances to new levels of efficiency. Different from minimum efficiency standards, which require manufacturers to produce

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[11] Barton-Domenici Energy Policy Act of 2005, Pub. Law No. 109-58, Section 1334.

[12] Id.

[13] Id. (The law defines "produced" as meaning "manufactured.")

[14] Subject to a $20,000,000 cap for the term of the credit.

[15] Subject to a $100 per-unit cap.

[16] From draft Senate bill language.

[17] Id.

products at certain efficiency levels, Energy Star provides incentives for manufacturers to make products at much higher levels of efficiency by offering the use of the Energy Star logo on their products. This logo is recognizable by the consumer as a mark of efficiency and value. As a result, manufacturers strive to make a significant portion of their product line Energy Star-qualified. In fact, in 2005, the Energy Star logo was placed on over 85% of the dishwashers in the marketplace. Generally, the program's goal is to have the top 25% or so of the particular product be Energy Star qualified. Overall, since the program's inception, over 1,000,000,000 Energy Star appliances have been purchased and it is estimated that the logy has a recognition by 40% of the American pubic.[18]

As such, the federal mandatory regulatory program has been augmented in the marketplace by Energy Star which is designed to take appliances beyond the minimum requirements. For example, in the case of refrigerators, products must be at least 15% more efficient than those meeting the minimum efficiency standards to bear the Energy Star mark. Energy Star market penetration has increased dramatically in the past five years and provided manufacturers with incentives to put innovation into the task of efficiency. The U.S. Department of Energy estimates that from 2000 to 2005 there were approximately 62 million Energy Star qualified appliances sold and that they delivered an additional 110 trillion Btus of energy savings and over $3 billion in consumer savings above and beyond the minimum appliance efficiency standards.[19]

The success of the Energy Star program in California is also indicative of the overwhelming success of these programs. In a study conducted by California Edison, market share for Energy Star appliances was examined over time.[20] For instance, the study shows that sales of Energy Star rated clothes washers in the state represented 56% of total sales in 2004.[21] This is compared to the nationwide Energy Star market share of these products at approximately 30% in the same period. But most importantly, the data show that a majority of those clothes washer units sold had energy efficiency ratings that substantially exceeded the Energy Star specification. The average Modified Energy Factor ("MEF")[22] of those sold was 1.7 to 1.8 or at least 20% to 27% more efficient than the specification.[23] In fact, approximately 28% of those clothes washers sold exceed the level of the 2007 Energy Star clothes washer specification (i.e. 1.8 MEF).[24]

The data for Refrigerator-Freezers and Room Air Conditioners Energy Star rated products sales in California is likewise dramatic. In 2004, marketshare for Energy Star R/Fs was 61%, while the national average was approximately 10% and for Room Air Conditioners, the marketshare of Energy Star rated products was 75%.[25]

Overall the program also provides an important free market element – a "market pull" feature that provides and encourages manufacturers to increase production of these products. Different from mandatory federal or state efficiency standards, Energy Star provides incentives for manufacturers to make more and better efficiency products in order to be eligible for the logo. This logo has become an indicator of high efficiency products in the market. Manufacturers generally want to have some portion of their product line to include Energy Star product.

The Appliance Manufacturer's Tax Credit

Increased Market Share for Energy Star Appliances

The manufacturer's tax credit was created as a market transformation tool to incentivize manufacturers to produce more highly energy efficient products than they would absent such incentives. This is achieved through an incremental approach – qualifying production is only that which exceeds historical shipment amounts. Under the credit provisions, as described above, production must exceed a rolling base average of production. This pushes upwards the amount of

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[18] Energy Star Appliances: DOE Update, Presentation by Richard Karney, P.E. at 2005 Energy Star Appliance Partner Meeting, September 29, 2005, p. 3.

[19] Id.

[20] California Residential Efficiency Market Share Tracking – Appliances 2004, Richard Pulliam for Southern California Edison, Dec. 6, 2005, p. 3-10.

[21] Id at p. 3-4.

[22] MEF is the metric used to determine the energy efficiency of clothes washers. The current Energy Star specification for clothes washers is 1.42 MEF.

[23] California Residential Efficiency Market Share Tracking – Appliances 2004, Richard Pulliam for Southern California Edison, Dec. 6, 2005, p. 3-10

[24] Id. at p. 3-10.

[25] Id. at pps.5-6 and 6-4.

products that must be produced in each of the years of the credit. In fact, in the R/F category the rolling base average is accentuated with a 10% premium that also must be achieved.[26]

The most important element of the credit, however, is that it is designed to transform the market for these products, and firmly establish super-efficient appliance products in the marketplace. The rationale behind the credit is an understanding that the capital investments that manufacturers will make, in order to take advantage of the credit, will put them in an irreversible path towards higher production levels of super efficient products.

AHAM has conducted analysis that has shown that Energy Star shipments of Energy Star refrigerators will increase significantly in 2006 and 2007 due to the manufacturers' tax credits. These tax credit incentives will have a huge impact in transforming the market and we have conservatively estimated that shipments of top-freezer Energy Star products will increase to 45% of the market in 2007 (from a current level of 25% year to date), and side-by-sides will increase to 80% of the market in 2007 (from a current level of 60% in 2005 year to date).[27]

AHAM's analysis is neutral with respect to how the tax credits will be utilized in the market, but there is no doubt that they will have a significant impact in transforming the market. For simplicity, and to reduce conjecture, we have assumed the market penetration levels of Energy Star shipments will hold at the elevated levels mentioned above after the tax credits expire because manufacturers will have re-tooled their manufacturing to produce the more efficient products.

The value of the credit in transforming the market is recognized by both manufacturers and advocacy groups alike. The American Council for an Energy Efficiency Economy ("ACEEE") has recognized this point in public statements this year in support of the credit. In a May 13, 2005 press statement, Steven Nadel, Executive Director of ACEEE, acknowledged that the appliance manufacturers tax credit "will increase the market share of these advanced products, market share gains that we expect to continue even when the incentives end."[28] In addition, it is widely accepted that the appliance tax credit is designed to transform the market by making these super-efficient products more prevalent. In fact, in December of 2002 a joint industry/advocacy group letter acknowledged this fact in a joint declaration stating that the tax credit "…will be the catalyst for a major market transformation in which the long term cost savings of increased energy efficiency will lead to a dramatic change in consumer purchasing decisions."[29]

Provides significant benefit to consumers

Most importantly, AHAM's analysis shows that the appliance manufacturer's tax credit would produce significant energy and water savings for the entire nation by encouraging the production of super energy-efficient clothes washers and refrigerators.

Our analysis provides support for the proposition that such production tax incentives provide manufacturers incentives to increase their production and market share of super high efficiency clothes washers and refrigerators. As described above, these strong incentives can provide as much as a doubling of the market share of high efficiency machines even after the incentives are removed.

The expanded use of super energy-efficient appliances has significant long-term environmental benefits. For example, increased use of super energy-efficient clothes washers would result in a reduction of the amount of water necessary to wash clothes by almost 1.2 trillion gallons over a twenty year period.[30] This is approximately the amount of water necessary to meet the needs of every household in a city the size of Phoenix, Arizona for two years or every household in the state of Louisiana for four years.

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[26] The base amount for R/F production is the average of the proceeding three years plus 10%.

[27] Comments on the Department of Energy, Building Technology Program 2006 Appliance Rulemaking Priorities, December 15, 2006.

[28] Appliance Manufacturers and Efficiency Organizations Applaud Tax Credit For Super Efficient Appliances, May 13, 2005. (copy attached)

[29] The High Efficiency Appliance Incentives Provision Pending before the Senate Finance Committee, Alliance for Resource Efficient Appliances (AREA), February 2002. (Members of AREA included the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, the Association of Home Appliance Manufacturers, the Appliance Standards Awareness Project, the Business Council for Sustainable Energy, the California Energy Commission, the City of Austin, Texas, Friends of the Earth, the Natural Resources Defense Council, the Northwest Power Planning Council, Pacific Gas and Electric and the Sierra Club.)

[30] Cost/Benefit Analysis of Manufacturer Tax Credits for Efficient Clothes Washers and Refrigerators, Mike Rivest, Navigant Consulting, Inc., October 2003

Our analysis also shows that the cumulative energy savings over the same period to be 0.574 Quads or the approximate equivalent of four billions gallons of gasoline and twenty-four million short tons of coal.[31]

Consumers would also benefit dramatically through the enactment of these credits. Consumers would see savings in the cost of operating their clothes washers and refrigerators that would result in an approximate benefit of $1.27 billion dollars over the life of the appliances. It is estimated that these super-efficient appliances could save an average family $100 per year in utility bills or $1,400 over the lifetime of the appliance.[32]

Other Incentive Programs

Consumer Tax Credit

A consumer-based tax credit is sometimes considered to be superior to a manufacturer-based credit because it ostensibly provides the tax incentive directly to the consumer; however, there are a several practical problems that, in reality, severely its limit its effectiveness. First, as a federal tax credit it could only be claimed by tax payers in the year after purchase of the product, and would require that the consumer file tax returns that provide for itemization – something that a large majority of U.S. tax payers do not do. Even for those that do file, the $100 or $250 would be, at best, received many months after the purchase of the product, and because of the relatively small amount, might not fully incentivize consumers to purchase one.

Another difficulty is that due to the fact that the credit can only be claimed for purchases of selected super-efficient products, there would be an inherent difficulty in identifying these products at the retail level. For instance, if the credit were to be claimed only for purchase of R/F's operating at 15% higher efficiency than the current standard, the product would have to be appropriately labeled in order to provide the requisite information to the retail sales staff and consumers so that they could properly identify those that would qualify and those that would not.

State Tax Rebates

While there are no studies or analysis demonstrating the effectiveness of these programs directly, anecdotal evidence suggests that the most successful programs are those that provide for sustained periods of time for the tax waiver programs to be in effect. This is because consumers do not generally make appliance replacement decisions based on the mere existence of a tax holiday, but instead when they have determined that they need to replace a particular product. Once they are in the retail establishment and ready to make a purchase a tax waiver will frequently drive them to purchase the more energy efficient products.

Conclusion

The use of voluntary versus mandatory efficiency programs present a new set of tools for government policy makers to increase the efficiency of appliances. In some respect, these consumer market-based approaches rely upon the consumer to take responsibility for energy efficiency. And these market based systems allow the "pull" through of the marketplace to encourage more manufacturers to make investments and allows them companies to respond to consumer demands and desires rather than by reacting to government mandated policies that may not have economic justification.

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[31] Id. and U.S. Energy Information Administration

[32] Id.

Household Dishwashers Energy Consumption Reduction – a Success Story

Guenther Ennen

CECED

Abstract

In November 1999, the European Committee of Domestic Equipment Manufacturers (CECED) presented a commitment for energy savings on dishwashers to the European Commission. It was the second Commitment in the household appliance sector, following the good experience with a commitment on reducing the energy consumption on washing machines. By signing this agreement participating manufacturers committed to reduce the total energy consumption of dishwashers in Europe and thereby CO_2 emissions caused by power generation.

The participants in this Commitment represented more than 90% of the European market in the product group dishwashers. The number of brands affected by the voluntary commitment was around 200, the number of models affected about 4.100.

The commitment for household dishwashers started on 31. Dec 1999 and expired on 31. Dec 2004. It contained two elements:

1. A reduction of the European fleet consumption of dishwashers:

Each participant committed to contributing to the Commitment's objective of achieving a reduction of the overall European production weighted average energy consumption of dishwashers by 20% for the year 2002 compared to the standard base case. To document the attainment of this commitment each year starting with the year 2000 each participant provided the CECED notary consultant with the appropriate data in each place setting class for the previous calendar year.

2. A stepwise phase-out of less efficient appliances defined by their ranking in the energy label classes:

Step one: Participants stopped producing and importing in the Community Market dishwashers, which belong to the energy efficiency classes E, F and G (for ≥10 place settings) or F and G respectively (for < 10 place settings) by 31. December 2000.

Step two: Participants stopped producing and importing in the Community Market dishwashers, which belong to the energy efficiency class D (for ≥10 place settings) or E respectively (for < 10 place settings) by 31. December 2003.

Results: All targets were fulfilled, some of them even ahead of schedule.

1. Introduction

In 1995 the EU Commission decided to introduce an Energy Label for dishwashers after the introduction of energy labels for cold and washing household appliances. It was clear at that time that a pure energy label without performance data would make no sense. As there was no European standard for measuring performance data at that time a mandate was given to CENELEC to develop such a standard.

A working group of CLC TC 59X then worked out the EN 50242 which describes a method for measuring the cleaning and drying performance and energy and water consumption of household dishwashers. Then it was proven in a ring test that this standard was able to fulfil the requirements with the necessary reproducibility for declaring the intended data on an energy label. A scheme for the classes and the class widths were developed on the basis of these ring test results in a way to give enough room for improvements.

In November 1999, the European Committee of Domestic Equipment Manufacturers (CECED) presented a commitment on energy saving for dishwashers to the European Commission. It was the second Commitment in the household appliance sector, following the good experience that had been made with a similar commitment on reducing the energy consumption on washing machines. By signing this agreement, participating manufacturers committed to reduce the total energy consumption of dishwashers in Europe and thereby CO_2 emissions caused by power generation.

The participants in this Commitment represented more than 90% of the European market in the product group dishwashers. The number of brands affected by the voluntary commitment was around 200, the number of models affected was about 4100. The commitment was open to the participation of any manufacturer or importer.
On 14 November 2001, the European Commission's DG Competition issued a letter to CECED clearing the Commitment notified. This was the conclusion of the investigation made by the European officials on the relevance of the environmental aim, in the light of the principles laid down in the guidelines on horizontal cooperation.
The commitment for household dishwashers expired on 31. Dec 2004.

The Commitment combined to elements:
1. A reduction of the European fleet consumption of dishwashers – as calculated by a notary
2. A stepwise phase-out of less efficient appliances ranking in certain energy label classes

The overall target of the commitment was to reduce the specific energy consumption of household dishwashers by 20% until 31 December 2002 related to the base case figures of 1996 [1].
The commitments in terms of clearly specified and quantified targets are supported by additional measures – so called soft targets – which contribute to the energy saving as well, such as active promotion of consumer awareness to save energy when using a household dishwasher.
Essential for any voluntary commitment is a sufficient and transparent monitoring and reporting system. Therefore CECED committed itself to monitor the progress and to issue a status report – once a year – to the European Commission on the basis of a notary report and a technical data base of household dishwashers. This technical database is also updated yearly and it lists 4159 models in 2004.

First Target: Reducing the fleet consumption (”fleet target”)

Each participant will engage himself to contribute to the Commitment's objective of achieving a reduction of the overall European production weighted average energy consumption of dishwashers by 20% for the year 2002 compared to the standard base case.
Starting from the year 2000 each participant will provide the CECED notary consultant with production weighted energy consumption data in each place setting class for the previous calendar year.

Second Target: Phase out of less efficient dishwashers (“hard target”)

Step one: Participants have stopped producing for and importing in the Community Market dishwashers which belong to the energy efficiency classes E, F and G (for ≥10 place settings) or F and G respectively (for < 10 place settings) by 31 December 2000.

Step two: Participants has stopped producing for and importing in the Community Market dishwashers which belong to the energy efficiency class D (for ≥10 place settings) or E respectively (for < 10 place settings) by 31 December 2003.

Table 1 – Elimination of less efficient dishwashers; x = stop production and import

Target Date	**Capacity**	**EC Directive 95/12/EC “Energy label classes”**						
		A	**B**	**C**	**D**	**E**	**F**	**G**
by 31 Dec 2000	for ≥ 10 place settings					x	x	x
	for < 10 place settings						x	x
by 31 Dec 2003	for ≥ 10 place settings				x			
	for < 10 place settings					x		

The monitoring system of the present commitment supervises both the fulfilment of the conditions described above and the progress in energy saving caused by this commitment.

2. Achievements reached by 31.12.2004

2.1 Reduction of the fleet energy consumption

Following the provisions of the Commitment, a notary calculates the production weighted specific energy consumption of all dishwashers produced by the participants of the commitment.

The notary report shows an overall saving of 35,9% compared to the base case. Thus the achievement went beyond the 20% improvement in the fleet-target: the implementation of the manufacturers' commitment has created a dynamic on the market and improvements in production of most energy-efficient dishwashers were fostered by synergies with the energy labelling and other industries commitments.

The progress is also monitored by the technical (model based) database. The situation in the year 2004 is illustrated in table no. 2. Dishwashers with 8, 9 or 12 place settings represent more than 95 % of the total number of models.

Table 2: average energy consumption of technical models in kWh/cycle and energy saving 1998 – 2004 to base case 1996 (Source: CECED technical database)

Standard place settings	KWh/ cycle 1996 (base case)	1998	1999	2000	2001	2002	2003	2004	Saving 2004 to base case 1996
8	1,416	1,139	1,044	0,981	0,940	0,886	0,872	0,971	31,4 %
9	1,485	1,248	1,066	1,055	0,962	0,917	0,878	0,850	42,7 %
12	1,692	1,483	1,393	1,307	1,236	1,162	1,107	1,087	35,8 %

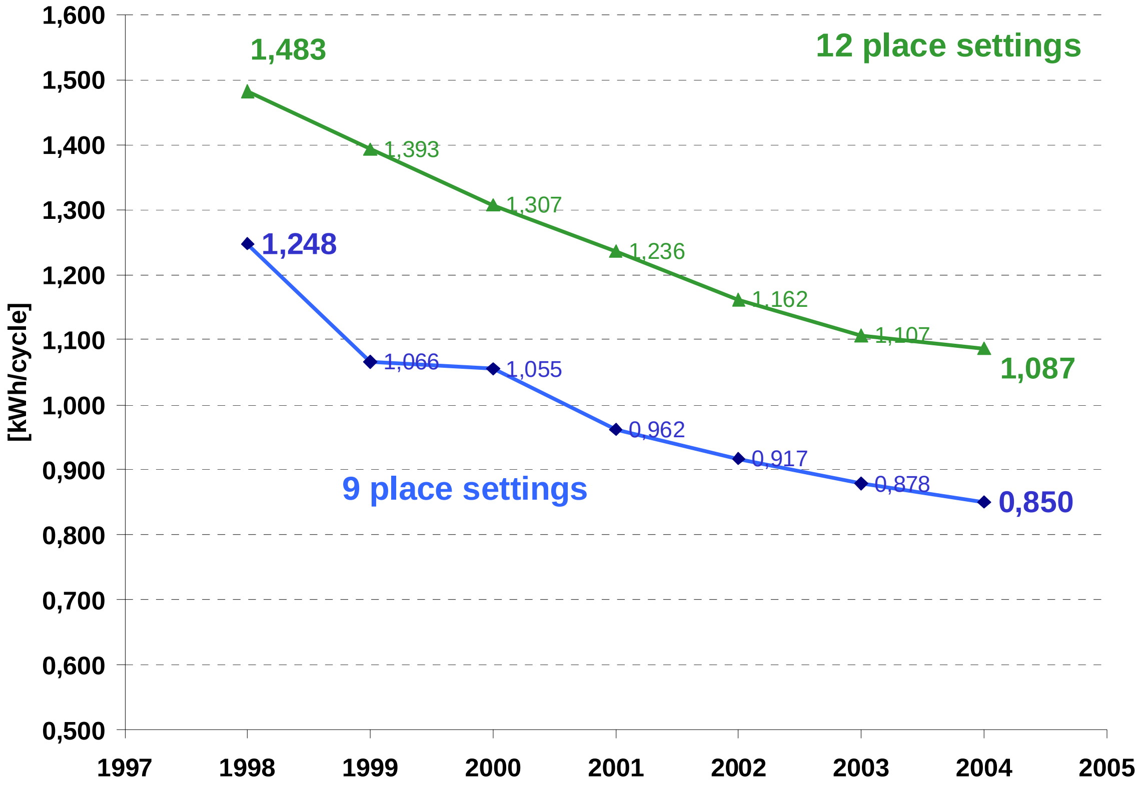
These figures show a significant correlation with the notary data collection (2004 energy savings compared to base case: 35,9%).

This means that weighting averages by number of units sold does not modify excessively the average energy consumption based on simple average from CECED data base.

Table 2bis: average energy consumption of technical models in kWh/cycle and energy savings in 2004 production compared to base case 1996 (Source: notary report)

Standard place settings	KWh/ cycle 1996 (base case)	Outcome notary kWh (weighted average) 2004	Number of units produced in 2004	Savings 2004 to base case 1996
8	1,416	0,791	82.586	44,1 %
9	1,485	0,859	898.890	42,2 %
12	1,692	1,098	6.551.491	35,1 %

The specific energy consumption (weighted average) from the notary also shows a very good correlation – as well as the percentage of energy savings – with the figures from CECED technical database (cf. table 2 above) for these 3 main categories representing 95% of the market.



Graph 1 – Energy consumption 1998 – 2004 (Source: CECED technical database)

2.2 Phase out of less efficient dishwashers

The phase out of less efficient dishwashers is based on the energy labelling scheme (EU directive 97/17/EC) and the monitoring on the technical CECED database of dishwashers, which contain all dishwasher models produced or imported by the participants.

The table 3 below shows the distribution of dishwashers <10 and≥ 10 place settings within the energy efficiency classes from A to G in 2004. The commitment to phase out all F and G machines with < 10 place settings and E, F and G machines with ≥ 10 place settings was already achieved in 2002. The last machines of efficiency class D (>=10ps) and E (<10ps) were taken out from production and import in 2003.

It should be underlined here how much EU Energy Labelling Directives are catalyst for marketing competition on energy: class A provides the benchmark for all.

Table 3: Distribution of energy efficiency classes based on the total number of 4159 models in the CECED database 2004

Standard place settings	**Energy Efficiency Class**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
< 10	68,5 %	12,1 %	16,1 %	3,3 %	0,0 %	0,0 %	0,0 %
≥ 10	84,4 %	12,2 %	3,4 %	0,0 %	0,0 %	0,0 %	0,0 %

3. Energy-efficiency and performances information

To give a transparent picture of the market offer, CECED committed to provide additional information - to the energy consumption of dishwashers calculated by the notary from a data collection of number units sold -, based on the CECED technical model database, especially figures on the development of the cleaning and drying performance.

It has to be pointed out that energy saving must not result in a lower performance. Consumer would not accept an energy saving process at the expense of the cleaning and drying performance.

3.1 Share of dishwashers related to their number of place settings

Table 4: based on the total number of 4159 models in the CECED database 2004

Standard place settings	4	5	6	8	9	10	11	12	13	15	Total
Share [%]	0,6	0,3	0,6	1,0	12,6	0,6	0,5	81,5	0,7	1,7	100,0

The notary report in annex 2 shows corresponding figures in units sold: the obvious correlation is a statistical confirmation of the soundness of our market data.

Table 4bis: based on the total number of models produced during year 2004 (source: notary report for 2004 in annex 2 hereafter)

Standard place settings	4	5	6	8	9	10	11	12	13	15	Total
Share [%]	0,8	0,3	0,6	1,0	11,2	0,6	0,5	81,5	1,3	0,7	100,0

3.2 Percentage of models in the technical model data base per energy efficiency classes for dishwashers with 8, 9 and 12 place settings

Table 5: based on the total number of appliances in the respective place setting category (CECED database 2004)

Standard place settings	Energy Efficiency Class						
Unit = %	**A**	**B**	**C**	**D**	**E**	**F**	**G**
8	16,7	19,0	28,6	35,7	0,0	0,0	0,0
9	75,3	12,5	11,4	0,8	0,0	0,0	0,0
12	84,4	12,0	3,6	0,0	0,0	0,0	0,0

The seemingly high share of class D in 8 place setting category (exception in phasing-out for small capacities models) is actually allocation of the energy label classes within 1% of the market only, as showed here above by table 4.

3.3 Percentage in the technical model data base per cleaning efficiency classes for dishwashers with 8, 9 and 12 place settings

Table 6: based on the total number of appliances in the respective place setting category (CECED database 2004)

Standard place settings	Cleaning Efficiency Class						
Unit: %	**A**	**B**	**C**	**D**	**E**	**F**	**G**
8	31,0	69,0	0,0	0,0	1,0	0,0	0,0
9	69,2	30,8	0,0	0,0	0,0	0,0	0,0
12	86,7	12,4	0,9	0,0	0,0	0,0	0,0

It is remarkable that the classes of the EU energy label corresponding to the quality levels of functional performance of the dish washer concentrate in the higher classes A and B.
As the drying efficiency classes show the same clustering in top classes (table 7 here after), one can conclude that the reduction of electricity used by the dishwashing cycle has not been achieved at the expense of performances for the consumer.

3.4 Percentage in the technical model data base per drying efficiency classes for dishwashers with 8, 9 and 12 place settings

Table 7: based on the total number of appliances in the respective place setting category

Standard place settings	**Drying Efficiency Class**						
Unit = %	**A**	**B**	**C**	**D**	**E**	**F**	**G**
8	11,9	19,0	61,9	7,2	0,0	0,0	0,0
9	40,7	39,0	20,3	0,0	00,0	0,0	0,0
12	54,3	35,7	9,2	0,8	00,0	0,0	0,0

So the “average European dishwasher with 12 place settings capacity “ in the year 2004 had energy class A, cleaning performance class A, drying performance class B and a water consumption of 14 L.
These considerable improvements in each regard became possible through a lot of technical developments for dishwashers without an increase in the consumer prices. In fact consumer prices decreased during this period and making machine dishwashing for consumers more affordable today then ever. Some of these new techniques were: improved pump and motor efficiency; electronic control, which allows more sophisticated cleaning processes than before; better filtering elements to remove particles from the water; and actively vented drying processes.
In addition, modern dishwashers operate today at a much lower noise level than 1999.

4. Participants

Participants to the voluntary agreement on reducing energy consumption of household dishwashers are the following manufacturers:

Table 8: List of manufacturers committed to the voluntary agreement

No.	Manufacturers	Country
1.	ANTONIO MERLONI	Italy
2.	ARCELIK	Turkey
3.	ELCOBRANDT	France
4.	B/S/H	Germany
5.	CANDY	Italy
6.	ELECTROLUX	Sweden
7.	FAGOR	Spain
8.	MERLONI ELETTRODOMESTICI	Italy
9.	MIELE	Germany
10.	SMEG	Italy
11.	V-ZUG	Switzerland
12.	WHIRLPOOL	Italy

5. Additional measures (“soft targets”)

“Hard-targets” as described before result in concrete figures like kWh or percent, or can be expressed into these concrete figures. In contrast to that, “soft-targets” characterize different technical and as well marketing related measures. The implementation of defined “soft-targets” will have additional positive aspects on energy consumption of domestic household dishwashers. However, the impact can hardly be quantified.

The “soft targets”, as specified in the voluntary commitment, are both aimed at technical improvement and at changing consumer behaviour.

Without any doubt all consumers can contribute largely to energy saving and as well to water saving simply by bearing some elementary rules in mind when operating a dishwasher. Therefore CECED manufacturers have been developing a more or less standardized instruction to be inserted in manuals how to save energy and water by means of a proper use of dishwashers. It contains instructions as well as tips concerning correct loading, use of pre-cleaning and proper temperature settings.

The washing temperature is another determinant factor regarding energy consumption. Therefore the manufacturers are working intensively to improve the performance of the low temperature cycle and switching the temperature level from 65^0 C down to $50/55^0$ C for one-temperature dishwashers.

When speaking about energy and water saving on dishwashers, it is important to note that there is a strong interdependence between the technology of the washing process and the available and actually used detergents. Based on that knowledge CECED established a close cooperation between manufacturers of dishwashers and manufacturers of detergents.

Therefore, energy consumption reduction of dishwashing machines in Europe over the last several years is a success story and is very well verified in each regard.

References

[1] Studies”Technical (economic analysis of dishwashers”; Delft/NL 1996; van Holsteijn en Kemna “Energy consumption of dishwashers (4-16 settings)”; Delft/NL 1997; van Holsteijn en Kemna

European Commission

EUR 22317 EN – DG Joint Research Centre, Institute Environment and Sustainability
Title: Energy Efficiency in Domestic Appliances and Lighting – Proceedings of the 4th International Conference - EEDAL'06, Volume 1
Authors: Paolo Bertoldi, Bogdan Atanasiu
Luxembourg: Office for Official Publications of the European Communities
2006 – 460 pp. – 21 x 29,7 cm
EUR - Scientific and Technical Research series; ISSN 1018-5593
ISBN 92-79-02750-6

Abstract

This book contains the Proceedings of the 4th International Conference on Energy Efficiency in Domestic Appliances and Lighting, London (UK), 21-23 June 2006. The EEDAL'06 conference has been very successful in attracting an international audience, representing a wide variety of stakeholders involved in policy implementation and development, research and programme implementation, manufacturing and promotion of energy efficient residential appliances and lighting. The international community of stakeholders dealing with residential appliances and lighting gathered to discuss the progress achieved in technologies and policies, and the strategies to be implemented to further this progress.
EEDAL'06 has provided a unique forum to discuss and debate the latest developments in energy and environmental impact of residential appliances and installed equipment, and lighting. The presentations were made by the leading experts coming from all continents. The presentations covered policies and programmes adopted and planned in several geographical areas and countries, as well as the technical and commercial advances in the dissemination and penetration of energy efficient residential appliances and lighting.

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LB-NA-22317-EN-C

ISBN 92-79-02750-6
9789279027505

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