Energy efficiency services for residential buildings: market situation and existing potentials in the European Union

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ABSTRACT

Although a substantial economic energy saving potential exists in the residential sector of the European Union, the energy efficiency service (EES) market is much less developed in this market segment than in other demand sectors (e.g. the industry or the public/service sector).

This paper presents an analysis of the current situation and existing potentials for future expansion. A specific analysis methodology has been developed and applied by a research consortium in 18 EU countries. This methodology has mostly built upon an extensive review of the existing literature and on interviews of a large number of acknowledged experts. Its application has allowed identifying encouraging development trends in specific market segments where the possibility of aggregating the EES demand or of exploiting good relationships with customers have created interesting investment opportunities. These trends have been observed in particular in Germany, Denmark, France, Flanders (BE), Hungary, Romania and UK. The assessment performed has also allowed discussing a series of strategies and policy measures that can be adopted to overcome existing barriers to market development. The general conclusion drawn in the paper is that energy efficiency policies supporting EES markets in the residential sector are highly needed. Although EU policies have typically a limited direct impact, they can increase trust into EESs and EES providers. At the national level, a stronger collaboration of governments or local administrations with banks to finance EESs is still very necessary in many EU countries.

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1. Introduction

Comprehensive overviews of the development status of the Energy Efficiency Service (EES) market for the residential sector in the EU Member States are still missing in the literature. The main references for an analysis of the EU EES market are the reports prepared by Bertoldi and Rezessy (2005), Bertoldi et al. (2006b, 2007, 2014) and Marino et al. (2010). A specific overview of the development status and existing potential for an EES market in the residential sector in European countries is however still missing. Despite its relevant economic energy saving potential (FhG-ISI et al., 2010), the EES market in the residential sector is much less developed than in the industry, tertiary and public sectors of the European Union. Given the existing market conditions and barriers, market experts generally appear quite sceptic about the possibility of a real and significant development in the EU countries (Ürge-Vorsatz et al., 2007). Besides sectors cross-cutting barriers (e.g. low level of energy prices in some countries, long investment

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payback periods, lack of information and awareness, lack of appropriate forms of finance), there are specific barriers which make a large scale application of the EES concept to residential buildings particularly difficult. These barriers typically are:

1. The particularly high transaction costs (Dahlin, 1979) for EES providers compared to the small amount of energy costs and the potential cost savings per single EES supplied.
2. The high fragmentation of the mass-market and the need to individually look at every building or building block. This makes the supply of standardised EESs difficult (Labanca, 2010).
3. The so-called landlord/tenant dilemma due to the fact that, although the tenant basically has an interest to reach energy savings through energy efficiency improvement (EEI) actions, the landlord typically receives no benefits from these investments or can hardly pass on investment costs to the tenant (Economidou, 2014; IEA, 2008).
4. The legal requirement existing in some countries that the landlord of a multifamily building is allowed to pass on EEI action investment costs to tenants only if all tenants agree on this investment (Rezessy and Bertoldi, 2010).
5. The privatisation process in multi-apartment buildings (which usually means that the most interesting investments for EES suppliers and financiers) in many Eastern European municipalities. This process has led in many cases to property situations where every flat in a building has a different owner, which makes decisions on the building shell and building technology more difficult. Decision rules are different in different countries. Typically, at least one half or even all apartment owners need to agree to a refurbishment (Tigchelaar et al., 2011; Grim, 2005).
6. The fact that the energy consumption in the residential sector is more closely related to individual needs and behaviours than in other sectors (EEA, 2013). This can make it particularly difficult to define a consumption baseline and induces high risks when setting energy saving guarantees. Moreover, individual energy consumption meters for heat and hot water are sometimes lacking in multi apartment buildings impeding energy efficiency investment decisions by single households.
7. Difficulty for potential customers to get oriented among existing EES offers due to a lack of information on the available offers and services and the difficulty in understanding the EES concept, financing and contract. Moreover, terms like energy services and EES are sometimes used for services without the clear aim of improving energy efficiency (Economidou, 2011).
8. The lack of credibility on EES providers due to the often lacking legal framework for their accreditation and bad experiences of some household (Bertoldi et al., 2007).
9. The fear to become too much dependent on the EES contractor (Bertoldi et al., 2006a) and that the service offered would be more expensive compared e.g. to the case when the supplier is not (partly) paid by the energy savings.
10. The present economic crisis and related economic and political uncertainties.
11. The scarce or difficult accessibility of public subsidies and financing capital for EES implementation (Rezessy and Bertoldi, 2010; Economidou and Bertoldi, 2014).

The presence of the above barriers and the existing literature pointing to very scarce possibilities for an actual market development have so far discouraged the accomplishment of thorough analyses concerning the actual advancement status of the market and existing potentials in the EU countries. This paper aims to contribute to fill the existing knowledge gap and to highlight possible future development trends.

After a brief description of the adopted analysis methodology, the paper presents analysis results concerning the development status of the European EES market in the residential sector and quantitative estimates performed in relation to existing potentials. Subsequent to that, analysis results concerning existing energy efficiency policies affecting the EES market are presented. Two possible development models — a so-called community model and a household model — for a future EES market in the residential sector are then illustrated. Moreover, a short discussion on strategies and energy policy measures that could be adopted to overcome the existing barriers to EES market growth and stimulate the diffusion of the models identified is presented at the end of the paper. Finally, a series of promising case studies reflecting the models outlined are briefly illustrated. The salient points emerged from the study are summarised in the flow chart reported in Fig. 1 below.

The definition adopted in this paper for energy efficiency services is equivalent to that provided by the European standard on Energy Efficiency Services (CEN, 2010) defining an EES as an agreed task or tasks, designed to lead to an energy efficiency improvement and other agreed performance criteria. This standard also requires that EESs include an energy audit as well as identification, selection and implementation of actions and verification of energy efficiency improvements over a contractually defined period of time through contractually agreed methods.

In the analyses presented a distinction is made among the following EES activity types that are also referred to as EES value chain stages or partial services connected to EES: (1) awareness raising, (2) information and advice, (3) identification of measures, (4) technical planning, (5) financing and subsidies, (6) implementation (operation and or supervision), (7) optimization of technical operation, and (8) measurement and verification of savings.

An Energy Service Company (ESCO) is any company delivering EESs or partial services connected to EESs, accepting some degree of financial risk in doing so and being wholly or partially paid for EES delivery based on the achievement of energy efficiency improvements (EEIs) and/or on the meeting of other performance criteria. Moreover, an energy company is defined in this paper as any company whose core business is related to energy carriers, whether this company is an energy distributor, or a distribution system operator, or a retail energy sales company. Finally, an EES provider is defined as any entity that delivers EESs (including ESCOs and energy companies).

2. Methodology of analysis

The methodology adopted to analyse the development status of the EES market in the EU countries has consisted of a literature review and of interviews of 4–5 acknowledged EES experts in 18 EU countries as performed by researchers participating in a European

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1 Most of these barriers do exist also in countries outside Europe since many years. See e.g. McKinsey (2009) and Lang (2004) for an overview of these barriers in US and China.

2 Although important, this paper will not discuss existing obstacles and opportunities for EESs focused on the utilization of low waste technologies and materials in the construction of residential buildings. A proper market of these EESs is far from being existent. For information on the current situation concerning the utilization of low waste materials for residential buildings in European and non-European countries see e.g. COM (2014) and Zhang et al. (2012).

3 However the situation is different where the privatisation process has resulted into a common ownership of a multi-apartment building or building bloc (where e.g. a co-operative, with the general assembly of the owners or the CEO on behalf of the assembly of owners decides on a refurbishment).

4 The 18 EU countries are AT, BE, BG, CZ, DE, DK, EL, EE, ES, FR, IT, LV, NL, PL, PT, SE, SK, SL.
The interviews and the literature review have been performed based on a common questionnaire developed by the researchers involved. Data and information gathered have been summarised in national analysis reports by following a same analysis template focussing on the identification of the national market size, number and typology of market players, existing market offers, EES providers positioning in the EES value chain, financing typologies and potential for new EESs. A cross-country analysis has then been performed based on the various national analysis reports. This approach has allowed covering a very large geographical area while gathering quantitative estimates about EES market sizes and number of EES providers. Such quantitative figures are missing in national statistics and in the existing reference literature.

The estimate of the existing market potential in the EU Member States is mainly based on the assessment of the economic and technical energy saving potentials in 2020 presented in FhG-ISI et al. (2010), on final end-user energy prices6 as reported in the EUROSTAT database and on estimates concerning the payback time of investments on specific EE technologies as performed by the ChangeBest project researchers.

3. The development status of the European EES market in the residential sector

This section presents an overview of the existing development status of the European EES market in the residential sector by answering the following research questions: How advanced is the EES market in the EU countries, which types of EES providers are active and which EES types are offered in these countries? Which technologies and fields of applications are mainly addressed by EES supplied? What common EES financing and contract types are adopted in the EU?

3.1. Market advancement, market actors and types of services provided

The development status of EES markets varies widely among EU countries mainly due to the market barriers described in the introduction to this paper. Based on survey information from national experts, different EES market developments could be identified in the 18 EU countries8 covered by the ChangeBest project researchers.

Promising models for a future EES market development in the residential sector have been identified based on a collection of business cases of new and promising EESs realised in the framework of the ChangeBest project and on the analysis of existing literature. Effectiveness in overcoming the main EES market barriers related to the residential sector and reproducibility in different countries have been considered as the main selection criteria for these business cases.

The inventory of existing policies presented in the paper is finally based on the results of the ChangeBest national analysis reports complemented with additional information sources like the MURE-database,7 the national energy efficiency action plans (NEEAPs) produced by EU Member States in the framework of the European Directive 2012/27/EU on Energy Efficiency (EED), the results of the surveys performed by the Joint Research Centre of the European Commission (Bertoldi et al., 2007, 2014).

5 See www.changebest.eu for further information on this project.
6 All energy prices considered are net of taxation and expressed in 2007 € values.
7 Database on energy efficiency policy measures in European countries, IEE project Odyssee-MURE, ISIS (www.mure2.com).
8 See Labanca et al. (2010) for more detailed information.
preliminary development stage or not existent in Portugal, Spain, Bulgaria, Czech Republic and Greece.9

The country analysis also allowed concluding that the market addressed by ESCOs when assessed in terms of number of EESs offered is generally less developed than the market of EESs offered by energy companies. The typically smaller projects implemented in the residential sector are indeed offered especially by retail energy sale companies or energy distributors, often to increase customers’ loyalty or to comply with a possible energy saving obligation in place in the country where they operate.

EES providers are mostly energy companies also in the surveyed countries or regions where the EES market in the residential sector has been depicted as quite well developed (i.e. in Germany, Denmark, Flanders, France). In Germany, energy companies (very often heating oil companies in competition with gas companies) offer EESs mainly addressing EEIs concerning space and water heating, buildings insulation and air conditioning. Such EESs are mostly offered to the housing industry, where a number of apartments or even houses can be covered.10 In addition, there are heat supply services for single households (house owners) that include EEIs of the heating system. Moreover, there are some governmental programmes supporting energy agencies, some NGOs and other market actors in making EESs related to building refurbishment or to electricity saving measures in low-income households financially viable. The German government-owned development bank KfW is finally particularly active in promoting energy efficient housing for owner-occupied houses.

In Denmark, Flanders and France energy companies address basically the same technologies and fields of application as in Germany. In these countries and regions an energy saving obligation is in place and energy companies are hence stimulated to supply EESs to their customers. The white certificate scheme and the tax deduction scheme in force in France have seemed so far particularly effective in fostering the supply of EESs related to the installation of individual and collective condensing boilers, high energy performance boilers, heat pumps and insulations measures (Giraudet et al., 2012; Duplessis et al., 2012; Suerkemper et al., 2012). In Denmark most of the EESs relate to the installation of efficient boilers and efficient ventilation and heating systems in general (Ea Energianalyse, 2008), whereas in Flanders the most common actions include installation of highly-insulated glazing, condensing and high-efficiency boilers, insulation of roofs in existing buildings (Bertoldi et al., 2010).

Concerning the EU countries not covered by the ChangeBest project survey (i.e. Cyprus, Finland, Hungary, Ireland, Lithuania, Luxembourg, Malta, Romania, United Kingdom) the JRC ESCO market surveys performed by Marino et al. (2010) and Bertoldi et al. (2014) indicate that the EES market in the residential sector is especially emerging in Hungary, Romania and UK. In Hungary the complex refurbishment of residential block houses (including heating, insulation, windows renovation) has become a fast emerging market area for ESCOs mainly due to state and municipal grants available for the refurbishment of panel block houses (Czakó, 2012). In Romania thermo-rehabilitation of existing buildings has been increasingly performed as of 2005 mainly due to a public funding programme covering up to 80% of building rehabilitation costs. Although the ESCO market in the UK is probably one of the most developed in the European Union, ESCO activities have mostly concentrated in the commercial and industrial sector so far. Existing energy saving obligations for energy suppliers in the UK stimulate to a certain extent the provision of EESs in the residential sector. Nevertheless the market of this country remains dominated by a few EES providers belonging to larger energy suppliers, with a number of managing agents aggregating small energy efficiency projects and selling the package to obliged suppliers.11 Energy companies often provide only partial services for the residential building sector (e.g. information or energy audits) in order to increase customer loyalty.

The analysis performed has also shown that actors different from ESCOs and energy companies often provide EES, especially in countries such as Austria with a long tradition of public subsidies in the housing sector:12 Social housing corporations, project developers, architects, investors, building companies and installers of energy using systems in the construction sector are other important EES market actors. Energy consultants, auditors and engineers play also an important role in this market, especially in those countries where this market relies on regulations related to energy certification of buildings and/or energy audits.

Some of these company types offer integrated services and cover the whole EES value chain. However, most of them decide to focus on specific value chain stages. ESCOs for example rarely concentrate on information and awareness raising on EESs. Additionally, their activities related to EES financing is often limited to the identification of third parties available to finance EES investments for energy end-users. Moreover, the provision of energy saving measurement and verification by ESCOs and energy companies is often considered only as a consequence of the stipulation of Energy Performance Contracts (EPCs) or the need to achieve some mandatory and measurable energy saving target (e.g. in Denmark, France, Flanders, Italy).

Information and awareness raising activities are often performed by energy agencies, e.g. in Portugal, Germany and Austria. Energy agencies can be interesting partners for other EES providers, both in the stage of information and awareness raising and in the saving measurement and verification stage, as they increase the credibility and transparency of the EES provided. In some countries (e.g. in Austria) banks are active in providing information and advice on EESs. This represents part of their marketing activity related to the credit lines they offer for EES. The provision of energy supply in combination with an EES by energy companies seems to be a common practice in countries where a quite well developed EES market exists (e.g. in Denmark, Germany, Flanders). In countries where the EES market is still in a preliminary development stage (e.g. Slovakia, Poland) this combination is rare or not provided at all.

3.2. Technologies and fields of application

The available data allowed providing only indications about the main sector cross-cutting technologies and fields of applications for EESs in the industrial, residential, commercial, public/service and agricultural sectors. Table 1 shows that building envelope insulations and heating systems are the sector cross-cutting technologies and fields of application mainly addressed by EESs in 18 EU countries.13

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9 These indications should be taken with caution because quantitative information was not always available to the experts who performed the assessments.

10 However, such EES have become more difficult in recent years due to a legal decision that house owners are not allowed to transfer payment of the EES contract to the tenant. Existing political proposals to overcome this barrier by changes in tenant law have not been implemented yet.

11 See for example Hannon et al. (2013) for further details.

12 Leutgeb and Varga (2010).

13 Notice that the information related to the different preference degrees for the various technologies and field of applications registered in the various countries refers to all possible sectors and could hence not actually indicate the actual variation in the preferences existing in the residential sector. For further information, see Labanca et al. (2010).

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3.3. Financing and contracting

Concerning EES financing and contracting, successful pure business models addressing EES supply in the residential sector without relying on governmental subsidies or incentives are very rare in Europe. For this reason, the EES financing and contract types adopted seem also not very evolved. Whereas a quite good level of market activity has been identified (e.g. in Germany, Denmark, Flanders and France), EES financing and contracting are typically supported by energy efficiency policy measures like energy saving obligations, tax deductions, tax credit schemes or subsidies. It is quite unlikely that these business models would continue to exist on a pure commercial basis without any form of economic support provided through these policy measures. As already mentioned, energy companies decide in some cases to provide these services for commercial reasons in order to increase customers’ loyalty or to gain competitive advantage. Third Party Financing (TPF) is typically more common for larger investments (e.g. in case of EES implemented by housing associations or real estate companies) or in those countries where banks have developed sufficient expertise and confidence in the EES business (e.g. Austria), or where international agencies have activated credit facilities to finance energy efficiency projects (e.g. the European Bank for Reconstruction and Development in Bulgaria and Romania).

EESs are often provided in combination with energy supply or contracts for operation and maintenance of energy systems at the energy end-users sites. Contract types stipulated in the EES business in several countries analysed are leasing, Build-Own-Operate-Transfer (BOOT) contracts,14 chauffage.15 Energy performance contracts (EPCs) are still very rare. Some examples of EPCs stipulated in the residential sector exist in Sweden (Lindgren, 2009; Soroye and Nilsson, 2010), Flanders (Coolen, 2010), Latvia (Rochas and Blumberga, 2010) and Italy (Milin et al., 2012).

4. EES market potentials in the residential sector

This section shows an assessment of the potential market volume, which can be addressed by future promising EESs in the residential sector. The market volume estimates have been mainly derived from assessments of the economic and technical energy saving potentials in 2020 as available in FhG-ISI et al. (2010). Energy saving potentials considered in the analysis refer only and exclusively to EEI actions related to space and water heating in existing residential buildings.

Following the approach already adopted in Duplessis et al. (2010), the paper authors have first performed they estimates by indicating a range of variability for the potential economic energy savings that can be assessed by considering a baseline scenario, a low policy intensity scenario (LPI) and a high policy intensity scenario (HPI) related to the implementation of energy efficiency improvement (EEI) actions. The baseline scenario extrapolates past autonomous EEI rates, including the impact of early energy savings (adopted through 2006). The LPI scenario assumes high barriers to energy efficiency, an increase in the policy effort to overcome these barriers compared to current policies and considers the implementation of EEI actions which are cost-effective for the whole country. Finally, the HPI scenario assumes a removal of the barriers to energy efficiency achieved by a high policy effort and considers actions whose implementation is cost-effective for the consumer.16

The overall economic energy saving potentials in EU-27 by 2020 correspond to 140 TWh of final energy under the LPI scenario and

14 These Build-Own-Operate-Transfer contracts may involve an EES provider designing, building, financing, owning and operating the EE equipment for a defined period of time and then transferring its ownership to the client. These are long-term supply contracts where the service charges include capital and operating costs recovery as well as project profit.

15 The EES provider takes complete responsibility for the provision of an agreed set of energy services. This arrangement is an extreme form of energy management outsourcing. Where the EES market is competitive, the EES provider also takes over responsibility for fuel/electricity purchasing. The fee paid by the client is calculated on the basis of its existing energy bill minus a percentage saving so that the client is guaranteed immediate savings. More efficient the EES provider is, the greater its earnings. If well designed, chauffage contracts provide strong incentives for EES providers to supply effective and efficient services.

16 See FhG-ISI et al. (2010) for further information and details. Cost-effectiveness has been calculated in FhG-ISI et al. (2010) from the sum of annualized investment costs, annual operation and maintenance costs minus the annual financial savings from lower energy bills. Capital costs have been annualized over the technical lifetime of the actions with a discount rate of 8% under the LPI scenario, and a discount rate of 4% under the HPI scenario. Energy prices are net of taxation and expressed in 2005 € values.
to 379 TWh of final energy under the HPI scenario. Of these, 125 TWh are fuel savings and 15 TWh are electricity savings under the LPI scenario, whereas 358 TWh are fuel savings and 21 TWh are electricity savings under the HPI scenario. The annual economic energy saving potentials (estimated for each EEI action considered in each of the EU-27 countries) have been multiplied by the corresponding country specific end-users energy prices to estimate the EU-27 additional annual potential market volume. This potential corresponds to 527 M€ under the LPI scenario and of 1438 M€ under the HPI scenario.

The huge difference between additional electricity and fuel savings is mainly due to the fact that a) electricity savings from most of the energy efficient appliances are not considered because the installation of these appliances could hardly be part of EESs; b) electricity represents on average a small part (about 10%\(^{17}\)) of households final energy consumption for space heating; c) the energy performances of installed direct electric heating systems are assumed as hardly improvable; d) heat pumps, which are responsible for a significant amount of the estimated energy savings, are assumed to be mostly installed in substitution of existing oil or gas fuelled heating systems as the cost of duct and plumbing works to replace direct electric heaters with heat pumps is prohibitive.

The big variation between the economic energy saving potential estimated under the LPI and HPI scenarios derives mainly from the marked energy performance improvements of buildings envelopes assumed under the HPI compared to the LPI scenario.

Although it could be roughly assumed that the actual EU-27 economic energy saving potential that will be exploited by 2020 lies somewhere between the potentials estimated respectively under the LPI and HPI scenarios, it should be also considered that these potentials include the possible implementation of EEI actions with a long investment payback time that could be hardly considered for the stipulation of EES contracts. For this reason, the energy saving potential that might be in principle exploited by EESs has been also estimated starting from the technical scenario (TECH) estimated in Duplessis et al. (2010)\(^{18}\) and by considering only those additional EEI actions having reasonably short payback times. The technical energy saving potential due to EEI actions related to space and water heating systems in the existing residential buildings of the countries of the EU-27 has been therefore analysed with respect to the payback times of actions, which are different in each of these countries. Fig. 2 reports the cumulated technical energy saving potentials estimated for the various EEI actions considered in each of the EU-27 countries vs. the average payback times of the related investments. These national technical potentials have been sorted by increasing payback time and cumulated in order to represent the EU-27 “supply curve” of technical energy savings. This type of approach is a new development compared to analyses of the existing EES market potential in the residential sector that may have been performed in the past.

Fig. 2 indicates that the largest potential could come from wall and roof insulation. These EEI actions can be implemented with short investment payback times in the countries with moderate or warm climates. This potential is less exploitable in colder climates because of the better quality of existing insulation solutions. The replacement of boilers has on average a short payback time and represents hence a very accessible EES market potential, mostly in multi-family buildings where payback times are shorter (less than 5 years in most of the countries). Heat pumps have also short payback times, but their energy saving potential is smaller. Finally, double glazing\(^{19}\) and ground insulation represent a not negligible potential but their payback times are comparably long (more than ten years).

The overall technical energy saving potential of all EEI actions considered for the residential sector and represented in Fig. 2 corresponds to around 555 TWh in 2020. The additional annual potential market volume that can be estimated based on these figures is around 2440 M€ up to 2020. By ordering the technical potentials according to their payback times, it can be estimated that the yearly additional potential market accessible to EESs could reach 194 M€ if the investment payback times (and hence the corresponding EES contract durations) were shorter than 3 years. The annual additional market potential accessible to EESs rises to 1644 M€ if payback times shorter than 8 years are considered. A less accessible market potential of 795 M€ is instead made of investments with payback times over 8 years (see Table 2 below).

These results are conservative estimates of the potential market volume actually available in the EU-27 due to the following reasons: (1) only investments needed to install energy efficient solutions are included in the estimates; (2) many additional services can in principle be aggregated to the installation of the solutions considered; (3) only EESs in addition to the business as usual scenario have been considered for the potential market volume assessment.

\(^{17}\) See Economidou (2011).

\(^{18}\) This scenario implements EEI actions to a level that is assumed to be technically achievable and takes into account also measures that are not cost-effective and whose related investment payback time is hence longer than measure lifetimes, although it does not include extremely costly measures. It has been based on a simplified thermal model of existing buildings stocks and national average values related to climate indicators and EEI actions economic and energy impacts. For more information see Duplessis et al. (2010).

\(^{19}\) A discount rate of zero is assumed in the payback time calculations.
5. Promising EES models in the residential sector

Despite the difficulties often met by EES providers in approaching the residential sector, the existing energy saving potential and the success cases registered in some European countries indicate that interesting investment opportunities can exist for energy end-users and EES providers. The objective of this section is to characterise and analyse promising EES models for the residential sector that can in principle be reproduced in different countries and by further EES providers and that are suited to overcome the main market barriers. Based on best practices registered in European countries, two potentially suitable business models for EESs in the residential sector have been identified: the community model and the household model. These two models have been already generally outlined by one of the paper authors in previous studies (see Bertoldi et al., 2006a). The analysis presented here represents a further elaboration and a more detailed characterisation based on concrete application best practices observed.

In the community model, 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 in new build and social housing21). The community model gives the chance to realize economies of scale by installing energy efficiency solutions in several homes in one go. Key sectors like local government or social housing organizations can e.g. take the lead in stimulating the diffusion of this model in such a way that, in case of buildings housing organizations can e.g. take the lead in stimulating the diffusion of this model in such a way that, in case of buildings retrofit or in case of new build developments, the whole energy related infrastructure on a site can be contracted out e.g. to an ESCO that could be in charge of energy efficient measure design, implementation, operation, maintenance and energy billing. In case of new build developments, ESCOs could in some cases even install the electrical network to each community home instead of the distribution network operator. Moreover, they could play the role of facilitators since energy efficiency investment decisions require the agreement of a large part of the community members. On the other hand, difficulties that may arise should not be underestimated for this market segment. Such difficulties include the need for coordination between ESCOs and housing developers, consumer preferences for individual rather than communal solutions and high investment upfront costs.

The household model can instead represent an interesting opportunity especially for energy suppliers, who typically need to differentiate their offerings in liberalised energy markets in order to attract new customers and can use EES supply to increase customers’ loyalty. Also small firms providing maintenance, breakdown repairs, equipment supply for residential buildings can contribute to the diffusion of household models, as they are particularly sensitive to maintaining good customer relations and do not have to provide saving guarantees to convince customers of their capabilities. In this case, 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. However, the risks due to high transactions costs involved, the need for a strategic and structured marketing approach, the difficulties linked to the identification of potential customers and the lack of confidence in EES providers represent important barriers that should not be underestimated under this model.

A series of best practice case studies for the two business models are briefly described in the appendix of this paper. They represent useful examples and lessons learnt about how profitable business cases can be developed. The conditions for the development of an actual market are, however, context and country dependent and the best practices described are not necessarily replicable in all EU countries. The most interesting cases reproducing the community model are those developed for social housing and multi-apartment buildings mainly due to the possibility of realising economies of scale, higher investment opportunities and lower transaction costs compared to EES supplied for single houses.

In case of social housing, substantially different EES supply approaches can in principle be adopted depending on tenure (e.g. social houses provided for rent, for sale or with shared ownership as in UK), providers (e.g. public authorities, non-profit or limited profit associations and companies, private for profit companies, etc.), beneficiaries (e.g. most vulnerable households, low-income households, all citizens), funding arrangements (e.g. social housing financed by public money, by a regulated or deregulated private rental market, etc.). The social housing operator (SHO) typically contracts an ESCO (by applying public procurement rules in case it is a public entity or an entity with a mission of public interest) and pays for the EES, whereas tenants pay the SHO a fixed rate including energy consumption costs for the contract duration. This rate usually does not exceed the average amount paid for energy consumption before EES implementation and covers part of the EES supply costs. The support by a third party financing part of ESCO or SHO investments is also often needed. Considering that social housing represents 35 million homes across Europe and accounts for about 18% of European greenhouse gas emissions (Builler, 2010), and given the size of the housing stock typically managed by social housing operators, the potential of this market segment is worth being considered. An interesting example of EES implementation in this market segment is illustrated in the paper appendix describing a case of EPC implementation for social houses in France.

EESs for privately owned multi-apartment buildings also represent a promising market segment. Compared to EESs for social housing, the main differences are that public procurement rules do not have to be applied and contracts can be directly stipulated with EES beneficiaries, as beneficiaries are not necessarily low-income or vulnerable households. However, especially in case of comprehensive renovation of buildings, a certain level of subsidy is often needed in order to implement EESs without additional payments by flat owners. Challenges for EES providers are to create transparency and trust22 to flat owners in order to stimulate collective action, to co-ordinate all professional partners involved in EES supply and to establish a good co-operation with the local housing managers. Contracts need to be explained in detail to beneficiaries by showing profit margins and economic simulations, especially in case of EPCs. Interesting EES examples for multi-apartment buildings exist in Latvia and Hungary (for more details see the paper appendix).

The household model is mainly adopted by market actors whose core business is not EES provision like energy suppliers, contractors or equipment suppliers. This market model is characterized by the implementation of much smaller projects with relatively high transaction costs. The market segment addressed is characterized by more standardised products/contracts and a better knowledge of customers’ needs and priorities that allow to design marketing concepts fitting to the target groups. Several practical applications of this model are nowadays available in Europe. Some particularly interesting cases are summarised in the final part of the paper appendix.

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21 It is worth reminding that central heating system should always be installed with individual heating control systems in single dwellings in order to minimise the energy consumption.

22 See Backlund and Eidenskog (2013) for further details on this aspect.
All in all, the case studies described in this paper and the many other cases for which information starts being available in the literature indicate that an EES market in the residential sector can in principle develop at least in some European countries. However, it must be admitted that information and evidences related to the profitability of EESs so far implemented are typically lacking and it is not yet evident which EES types in the residential sector could exist on a pure commercial basis without any form of public subsidy or incentive.

6. Policies affecting EES market development in the residential sector

Several types of policy measures can affect the EES market development in the residential sector. The aim of the following section is to analyse how policy measures affect the supply of EESs in countries by using a specific analysis structure distinguishing among five different categories of policy measures:

(1) Policy measures specifically targeting EES providers: a distinction can be made for this category among (a) measures for accreditation/certification of ESCOs or EESs, (b) measures for the creation of platforms for ESCOs with common interests, (c) measures providing specific support for ESCOs (e.g. financial) and (d) legal arrangements often regarding the removal of barriers for ESCOs. Clearly the potential for EES market development in a country cannot be directly correlated to the number of measures in place targeting EES providers. However, the overview performed highlights that only a few countries (i.e. Latvia, the Netherlands) have no measures in place specifically devoted to directly improve EES providers position, whereas few countries have implemented more than two of the above mentioned policy measure types (i.e. Italy, Poland, Spain, UK). Support is given in various ways, sometimes through extra subsidies for ESCO projects, a few times as preferred partner (Czech Republic) in energy saving projects. Financing of investments by ESCOs is generally part of policy on third party financing, which is however not always related to projects implemented by ESCOs.

(2) Policies creating or supporting a general mechanism for EES: policy measures like white certificate schemes (WCS), other types of energy saving obligations, energy efficiency funds or policies supporting energy performance contracting (EPC) and third party financing (TPF) can in principle create ample opportunities for EES providers. Policy measures stimulating EPC and TPF have been identified in 8 EU countries, although EPC is rarely adopted in the residential sector. The above mentioned mechanisms create opportunities but they do not lead by definition to a thriving EES market because of the market barriers in the residential sector and the absence of a level playing field for EES providers. For example, WCS can bring additional cash flow for EES providers and shorten payback times for the actors involved in EES implementation. Nevertheless, EEE actions so far mostly implemented under WCS could hardly be part of a self-sustaining long term EES market because they typically are the easiest and cheapest to implement (e.g. they relate to CFL or low flow showerheads distribution and installation). However, the situation might change in the coming years considering also the stimulation to WCS implementation represented by the article 7 of the recently implemented Directive 2012/27/EU on Energy Efficiency (EED).

(3) Policy measures that stimulate one or more EES activities in the value chain: many types of policies aiming at raising awareness, providing information, advice on saving measures, or supporting technical planning and monitoring of energy savings have so far been implemented in the EU Member States. However, only single policy measures are typically in place. There is hence a need for a complete sets of policy measures (‘policy packages’) that stimulate simultaneously all the key EES activities that are necessary in order to realise and verify energy savings (i.e. policy packages stimulating at least the combination of activities related to energy audits, EE improvement action implementation and energy saving measurement and verification).

(4) Policy measures stimulating energy savings and hereby EES activities indirectly: all the countries surveyed deploy policy measures with the objective to achieve energy savings in the residential sector such as energy performance standards for new dwellings/buildings, minimum efficiency standards for appliances, labelling of buildings and appliances, subsidies or favourable loans or tax-deductions, voluntary agreements, taxes on energy consumption or on CO2 emissions. Whether these policy measures stimulate the demand for EESs or not depends on the complexity of solutions. The promotion of simple solutions, such as efficient refrigerators, does not lead to significant demand for various EES activities. The promotion of complex solutions, such as renovation of buildings or installation of micro combined heat and power (CHP) generation systems, does instead provide more opportunities for EES providers. Further on, some policies only create a temporary market for EES, such as those for very efficient new dwellings that will become common building practice in time.

(5) Policy measures restricting the (commercial) EES market: a distinction can be made between legislation that restricts EES companies in their operation and policy measures that restrict the commercial market for EESs. Legislations restricting EES providers’ activity relate for example to the requirement that all tenants of multifamily buildings must agree on investments by ESCOs (e.g. in Germany and Slovenia), to the low and regulated heat prices not leaving room for ESCO investments in Poland, to the restricted transfer of district heat costs to the consumers in the Netherlands. Most of the legislative problems are not related to energy savings but regard arrangements between parties in general. In a number of countries, policy measures have been formulated to lift the legislative barriers, as demanded in the EED. However, the observed problems show that in many countries this demand has not yet been met. Policy measures stimulating public supply of EESs, which compete with commercial offers, can actually restrict the commercial EES market in countries with an already quite well developed EES market. Examples are free energy checks/advises by energy agencies, government

\[23 \text{ See Boonekamp and Vethman (2010) for further information.}\]

\[24 \text{ Article 7 requires each Member State of the EU to set up an energy efficiency obligation scheme ensuring that retail energy sales companies and/or energy distributors designated as obligated parties achieve a pre-defined annual end-use energy savings target of 1.5% annually in the period between 2014 and 2020. Member States are also allowed to choose alternative measures to achieve the annual 1.5% energy saving target.}\]

\[25 \text{ However, free energy checks/advises received from independent third parties can increase customers’ trust on the service received and avoid the suspect that more expensive solutions are unnecessarily proposed by an EES provider having an interest in their installation.}\]
supported/erected ESCOs and subsidies that are only available for energy end-users. Whether the public offering of EESs restricts the commercial EES market or not also depends on the targeted end-users, the type of EES activity (awareness raising is generally a public EES activity), the terms for public EES offering and the EES market development status in the residential sector of a country. In particular, public offering of, or public economic support for EESs in the residential sector can surely serve to stimulate the commercial market for EESs in markets that are in an initial development stage, this being the case in most of the countries of the EU-27.

Also EU policy (EED, EPBD, CHP, Ecodesign Directive, Labelling and ETS) transposed into national policy measures can in principle stimulate the EES market in the residential sector. However, EU policy, as e.g. highlighted in the EED, has generally a large indirect effect on the EES market, whilst its direct effect is usually very limited.

7. Discussion of results

The results presented in the previous paper sections show a relevant EU market potential for EESs supplied in the residential sector. At the same time, they indicate a high heterogeneity among EU countries regarding the development status of national EES markets, the types and number of market players, the types of EES provided, the EES financing and contracting models adopted and supporting policies implemented. A series of specific barriers still impedes the exploitation of the existing potential in the residential sector. These barriers mainly include the high transaction costs relative to the amount of energy costs, the high fragmentation of this mass market, the existing situations of split incentives, the rules regulating the decision processes in multi-apartment buildings, the lack of credibility on EES providers, the lack of standardised procedures for measurement and verification of energy savings.

Nevertheless, existing experiences and case studies indicate for example that the high transactions costs (relative to the amount of energy costs) can be sometimes reduced by EES providers by initiatives aiming at creating district community groups and pooling together a number of buildings and apartments to implement EEI measures. Such strategies are however limited to relatively homogeneous buildings and energy efficiency service types. Suitable strategies can in principle be developed also to address residential market segments characterized by smaller projects with relatively high transaction costs (see the household model described in a previous paper section). These strategies however require more standardised products/contracts and a better knowledge of customers allowing to design marketing concepts that fit to the target groups.

The problems due to the high fragmentation of the market can in particular be effectively addressed by standardised inspection and advice, as part of the energy performance certification of dwellings to be sold or rent. In many of the EU-10 countries that have joined the EU in 2004 (e.g. Slovakia, Latvia, Hungary, etc.) the huge amount of existing prefabricated multifamily buildings constructed between 1960 and 1990 and currently in need of refurbishment represents for example a very interesting opportunity for providing highly standardised EESs on a large scale. However, again, such strategies are limited to relatively homogeneous buildings or building blocks. In addition, it is of great importance to ex-ante verify that a standardised EES leads in practice to the implementation of the optimal EE measures for each specific building in order to avoid lost energy saving opportunities in the long term. To address the barrier of split incentives between building renters and owners, EES providers could act as a broker and allow meeting the interests of all parties while realising the saving measures. Moreover, EPC can serve to stipulate contractual arrangements allowing building owners to recover energy efficiency investment costs through renters’ energy bills without charging these renters with extra costs compared to the before investment situation (see examples provided in the annex). Large scale installation of smart meters at households may then contribute to better define a consumption baseline and may allow EES providers to stipulate energy saving guarantees. In some countries (e.g. in Italy) almost all households are now equipped with electricity meters endowed with remote reading capabilities. The challenge will be to make all relevant information readily available to energy end-users and EES providers for the verification of the energy savings.

With respect to energy efficiency policy, it is not possible to identify or recommend a common EU policy approach to kick-start a market for EESs in the residential sector given the significant heterogeneity of national situations. However, the Energy Efficiency Directive (EED) adopted in 2012 contains a range of measures that Member States (MSs) have to implement to foster the provision of energy services, to develop an ESCO market and to help financing energy efficiency. Article 18 of the EED contains a list of measures that MSs shall adopt in order to promote energy service markets including the ESCO market. Also, Article 19 of the EED asks MSs to adopt measures to remove the split incentive barrier. Existing financing barriers could be reduced at the EU level by specifically addressing banks and/or by arranging guarantee funds for EES, e.g. through the European Investment Bank or the European Energy Efficiency Fund. In addition, in most EU MSs there is a need for an integrated and centrally co-ordinated approach to EES implementation because of the many intermediates acting involved (e.g. agencies, housing corporations, installers and manufacturers of efficient systems, etc.). There is also a need for a common understanding of EESs, EPC, etc. when designing EU and MS policies (see for example the EN 15900). EU policy in particular, but also national policies, can increase trust into EESs and EES providers by supporting information, qualification, certification, accreditation as well as training programmes and by supporting platforms and networks for exchange of experiences, standardised EES contracts and measurement and verification procedures.

At the MS level, national policies hindering the implementation of EESs (e.g. the recently revised, but only partly improved tenant law in Germany) should be revised or removed. This should happen also for policies being a barrier towards the development of a level playing field (e.g. policies and support programmes that do not allow energy companies to offer specific EESs). Moreover, a mechanism allowing the financing of EE actions offered through EESs in the domestic sector should probably be implemented in every MS. For example an energy efficiency fund and/or an energy efficiency obligation scheme could be created, national governments or local administrations could collaborate with banks to offer low interest rates or financial guarantees or revolving funds could be established to finance EES providers. Unwanted competition to the commercial provision of EESs at the national level should also be avoided. For example, in countries where the EES market is already well developed, free audit schemes of energy agencies could be replaced with subsidies for energy audits that are valid for

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26 For example, public EES offering may be necessary for single dwellings, which are typically very difficult to address by EES providers, whereas this offer might in principle restrict the commercial EES market for multifamily buildings.
all EES providers.\textsuperscript{27} In general policy packages stimulating simultaneously demand and supply of EESs would be highly beneficial. Especially policies stimulating the supply of EESs are rare at the moment.

Although the provision of financial subsidies and/or financial incentives for EESs can effectively trigger energy savings, they should be considered as temporary policy measures to be implemented only during the initial EES market development stages. In the long-term, policy measures facilitating the development of competitive EES business models in the residential sector should have the priority.

8. Conclusions

The conservative estimate presented in this paper for the EES market potential in the residential sector indicates the presence of an additional annual market volume of about 190 M€ in the EU-27 for investments with payback times below 3 years (or of about 1640 M€ for investments with payback times below 8 years). The largest part of this potential comes from EESs related to wall and roof insulation and installation of energy efficient boilers in multifamily buildings. Although specific barriers in the residential sector still hinder national EES markets development in important ways, positive market signals have been registered in Germany, Denmark, France, Flanders (BE), Hungary, Romania and UK. The characteristics of these markets are however largely different either in terms of types of active market actors and services provided, or in terms of technological solutions addressed and financing and contracting typologies adopted. In general, evidences start being available concerning the possibility of developing an interesting market by initiatives aiming at creating district community groups and pooling together a number of buildings and apartments to implement EEI measures, as may happen e.g. in case of social housing or privately owned multi-apartment buildings. Positive trends are also registered in market segments characterized by smaller projects addressing single households, although this market segments require more standardised products/contracts and better knowledge and relationships with potential customers. The implementation of energy efficiency policies supporting these development trends is highly needed. EU policies have generally a limited direct effect on the national EES markets, although they can increase trust into EESs and EES providers by supporting information, certification and capacity building initiatives and can contribute to arranging guarantee funds for EES. At the national level, the collaboration of governments or local administrations with banks to offer low interest rates and financial guarantees for EESs or to create revolving funds to finance EES providers is still necessary in many EU countries.

Although the paper provides a comprehensive overview of the current EU market situation for EESSs in the residential sector, there remain some research challenges that need to be addressed in future research. Considerably more work will need to be done in evaluating the effectiveness and efficiency of energy efficiency policies directly or indirectly affecting the supply and demand of EESSs targeting this sector. Continuous market observations in terms of market barriers and existing potentials will also be necessary in order to identify emerging opportunities and derive suitable recommendations for policy makers. Further research might also in particular explore the development of emerging EES business models that will be suitable for a wider deployment in EU countries.

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Appendix

Description of promising EES examples in the residential sector

Energy Performance Contract (EPC) for social houses in France

The first EPC with third party investment in social housing in France was stipulated in 2011 for 64 social dwellings in the Strasbourg suburb of Schiltigheim (Builler and Lefèvre, 2011). The EPC between the social housing operator (a private limited company) and the ESCO guarantees a primary energy consumption reduction of 47% (from 239.5 to 126.1 kWh/year m\textsuperscript{2}) for 19 years over the 6781 m\textsuperscript{2} of gross area covered by the 64 dwelling units concerned. Renovation activities planned consist of classic refurbishment works related to common areas, comfort upgrading as well as to deep energy renovation of building shells and electric heat and ventilation systems. Annual adjustments of the guaranteed energy saving targets are envisaged based on possible variations observed in the estimated degree days, indoor maximum temperature, number of dwellings occupants and DHW volumes consumed per occupant. Buildings energy performances are measured based on a measurement and verification plan and on metering devices installed to record the electricity consumption for heating and ventilation, the amount of hot water consumed, the indoor temperature. The total investment for the EPC amounts to about 4,050,000 Euros, but only about 60% of this will serve to cover EEI measure costs. Funding for total investments will be provided by grants (20%), loans (9%), ESCO equity (12%) and third party financing (59%). Besides local authorities’ contribution (4%) and private companies’ contribution (1%), the grants to be received will consist of a rebate on property tax and VAT reductions (7%) envisaged in France for investments on energy conservation. The amounts received by the sale of the white certificates that will be awarded under the French white certificate scheme for the energy saving measures implemented (8%) will also contribute to repay investment costs. Energy efficiency investments will not cause rising rents of building tenants. The only revenue generated by these investments will be obtained through the energy bills paid to the social housing operator (SHO) for 15 years after energy efficiency measures implementation. Total economic savings generated by these measures during this period are estimated to be around 22,400 Euros/year and will be shared at 50% between the tenants and the SHO. The decision to implement the project could not be taken without the approval of the majority of tenants. They voted for it once the ESCO responsible for project implementation had been selected by applying the public procurement rules established in France for companies having a mission of public interest (as it is the case for social housing companies). This selection was based on a competitive dialogue leaving participating ESCOs the freedom to choose the most suitable technical options to achieve pre-established energy performances. The EPC establishes that the ESCO has to pay financial penalties in case the total consumption of the 64 dwellings exceeds the expected overall target. These penalties are supposed to be apportioned among all tenants. Each tenant pays for the amount of energy consumed. The less

\textsuperscript{27} At least when this does not prevent from the possibility of receiving energy checks/advises from independent third parties not biased towards recommending unnecessarily expensive solutions.
energy he consumes, the higher the amount he receives in case of ESCO penalization. All risks of default on ESCO payments are taken by the SHO.

**Energy Performance Contract (EPC) for multi-apartment buildings in Latvia**

In 2009 an EPC has been stipulated for the EEI actions implemented in a multi-apartment building in Valmiera, Latvia (Rochas and Zogla, 2010). Since 1980 a district heating system supplies thermal energy for space and water heating to 36 apartments distributed over the 9 floors of the building, covering a heated area of about 1914 m² and consuming on average 214 kWh/m²/year (162 kWh of which due to space heating) between 2006 and 2008. EEI actions implemented related to insulation of outer walls, insulation of attic and basement ceiling, repair of windows openings, improved insulation of heat distribution pipes, modernization of the heat substation, improvement of the DHW distribution system. A monitoring system measuring temperature (outdoor, in the attic, in the basement and in all flats) and energy consumption for space and water heating has been installed and allows the remote reading of monitored data as collected by a central data logger. Additional measures to improve visual and aesthetic aspects and solve operational and maintenance issues (e.g. refurbishment of the building entrance and staircase, etc.) have been also implemented. Data monitored during the first months of 2010 indicated that energy savings achieved thanks to the measures implemented were already around 50% of the ex-ante consumption. Services included in the EPC were supplied by a network of companies with an ESCO responsible for supervision and quality control taking financing and technical risks. The EPC guarantees that no extra costs will be borne by apartment owners because of the measures implemented. During the whole contract period (20 years) they will pay for energy consumption the same amount paid before building renovation. Total project implementation costs amounted to around 144,000 Euros. A part of this amount was covered by subsidies. The building manager pays the ESCO for the service supplied (including heating) whereas flat owners do not keep any relation with the ESCO and continue paying their building manager for building maintenance and energy services.

**Government stimulating ESCO project implementation for multi-apartment buildings in Hungary**

In 2001 the Hungarian Government launched a program called “Panel Program” providing support in the form of grants for the renovation of prefabricated buildings (Grosser Lagos, 2010). Government, municipalities and home owners were supposed to contribute to the energy efficient renewal of prefabricated buildings by providing roughly one third of total investment costs each. ESCOs performing building renovations stipulated an EPC with the housing co-operatives representing apartment owners and guaranteed the energy savings. The housing co-operatives typically took a loan to finance energy efficiency investments on behalf of apartment owners. A loan agreement involving the financing institution, the apartment owners, the ESCO and the local government was stipulated based on apartment owners’ bank guarantee and ESCOs guarantee. Loans are typically repaid in a period between 65 and 105 months by apartment owners. About 380,000 flats were partly or totally renovated thanks to this initiative in the period between 2001 and 2005. Their total energy consumption was in some cases reduced by up to 40–50%. Total investment needed per apartment oscillated between 6000 Euros (in case of comprehensive renovation) and 2000 Euros (in case of partial renovation). Energy savings achieved were in some cases less than expected due to the fact that apartment owners sometimes preferred to install low-cost solutions. Moreover, the financial crisis caused a credit slowdown and a contraction of ESCO investments in this initiative, starting from 2009.

**Examples of household EES models in Europe**

In **Germany** a municipal utility supplying electricity and gas has started offering to their customers the replacement of old and inefficient circulation pumps with efficient models saving up to 80% of electricity. All customers are supposed to pay via their electricity bill a same amount of about 300 Euros for each circulator installed over a period of four years. Customers can easily understand what they are paying and what they are saving by their electricity bills. They can be reduced by up to 10% thanks to the efficient solution installed. Economic margins for the utility are low but higher customer retention has been achieved thanks to this EES.

A similar EES is also supplied by an energy company in **Slovakia** which, besides circulator replacement, provides also an energy audit of the house.

In **Germany** an energy supply company started to install gas condensing boilers controlled by ambient temperature at single and multiple family houses under full service contracts for heat supply. The company carries out hydraulic adjustments of the heating systems, informs its clients about the functioning of the new system and maintains ownership of the boilers until the end of the contracts (i.e. for 10 years). An important demand for this EES seems to exist in Germany, but the contracts have to be simple and transparent, otherwise customers are not available to sign them.

In **Denmark** an energy supply and distribution company engaged in a strategic dialogue with its customers and organised a series of campaigns whereby the implementation of EESs is stimulated by offering infra-red photography, mini energy audits, devices to reduce standby consumption, EE circulators, LEDs, complete building refurbishment within an EPC. Eight hundred customers were reached with the first campaign organised and each of them achieved on average energy savings around 650 kWh/year.

In **France** an ESCO provides a service consisting in assessing whether an energy efficiency project fits into the conditions for getting white certificates that can be sold to energy suppliers having to comply with an energy saving obligation. Customers implementing EE projects pay the ESCO a fixed amount or a pre-established percentage of the certificate market price for this specific service.

In **Italy** benefits from the combined installation of EE solutions and renewable energy sources are exploited by an ESCO offering free of charge PV panels combined with heat pump installations. This EES may allow ESCO clients to achieve zero energy bills and benefits from a feed-in tariff incentive mechanism in place in Italy for PV panel installation.

More information on the examples reproducing household EES models reported here is available in Renner et al. (2012).

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