EPS energy efficiency – comparison among present and proposed values

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CoC V.4

Table 1.1: No-load Power Consumption (excluding external power supplies up to 8 W for mobile handheld battery driven applications)

Rated Output Power (P_{no})	No-load power consumption from 1.1.2009
≥ 0.3 W and < 50 W	0.30 W
≥ 50 W and < 250 W	0.50 W

Table 1.2: No-load Power Consumption for external power supplies up to 8 W for mobile handheld battery driven applications

Rated Output Power (P_{no})	No-load power consumption
≥ 0.3 W and ≤ 8.0 W	0.25 W from 1.1.2009 to 31.12.2010
≥ 0.3 W and ≤ 8.0 W	0.15 W from 1.1.2011

Table 2.1: Energy-Efficiency Criteria for Active Mode (excluding Low Voltage external power supplies)

Rated Output Power (P_{no})	Minimum Four Point Average Efficiency in Active Mode (expressed as a decimal) 2 from 1.1.2009
0 < W ≤ 1	≥ 0.48 * P_{no} + 0.140
1 < W ≤ 49	≥ [0.0626 * ln(P_{no})] + 0.622
49 < W ≤ 250	≥ 0.870

Table 2.2: Energy-Efficiency Criteria for Active Mode for Low Voltage external power supplies[3]

Rated Output Power (P_{no})	Minimum Four Point Average Efficiency in Active Mode (expressed as a decimal) 4 from 1.1.2009
0 < W ≤ 1	≥ 0.497*P_{no}+0.067
1 < W ≤ 49	≥ [0.075*ln(P_{no})]+0.561

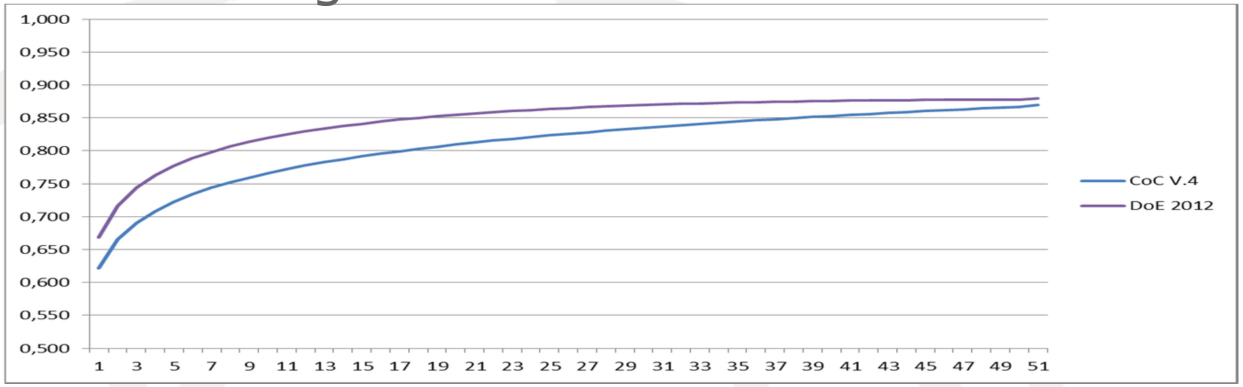
DoE BCEPS 2012

Table I-1. Proposed Energy Conservation Standards for Direct Operation External Pow Supplies

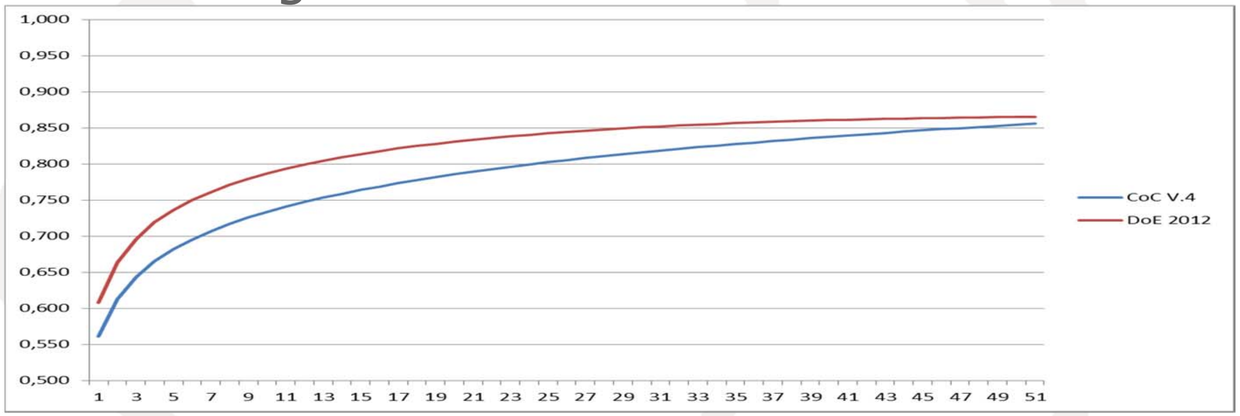
AC-DC, Basic-Voltage External Power Supply		
Nameplate Output Power (P_{out})	**Minimum Average Efficiency in Active Mode** *(expressed as a decimal)*	**Maximum Power in No-Load Mode [W]**
0 to ≤ 1 watt	≥ 0.5 * P_{out} + 0.16	≤ 0.100
> 1 to ≤ 49 watts	≥ 0.071 * ln(P_{out}) - 0.0014 * P_{out} +0.67	≤ 0.100
> 49 watts to ≤ 250 watts	≥ 0.880	≤ 0.210
> 250 watts	0.875	≤ 0.500
AC-DC, Low-Voltage External Power Supply		
Nameplate Output Power (P_{out})	**Minimum Average Efficiency in Active Mode** *(expressed as a decimal)*	**Maximum Power in No-Load Mode [W]**
0 to ≤ 1 watt	≥ 0.517 * P_{out} + 0.087	≤ 0.100
> 1 to ≤ 49 watts	≥ 0.0834 * ln(P_{out}) - 0.0014 * P_{out} + 0.609	≤ 0.100
> 49 watts to ≤ 250 watts	≥ 0.870	≤ 0.210
> 250 watts	0.875	≤ 0.500

CoC V.4 vs. DoE BCEPS 2012

Basic voltage



Low voltage



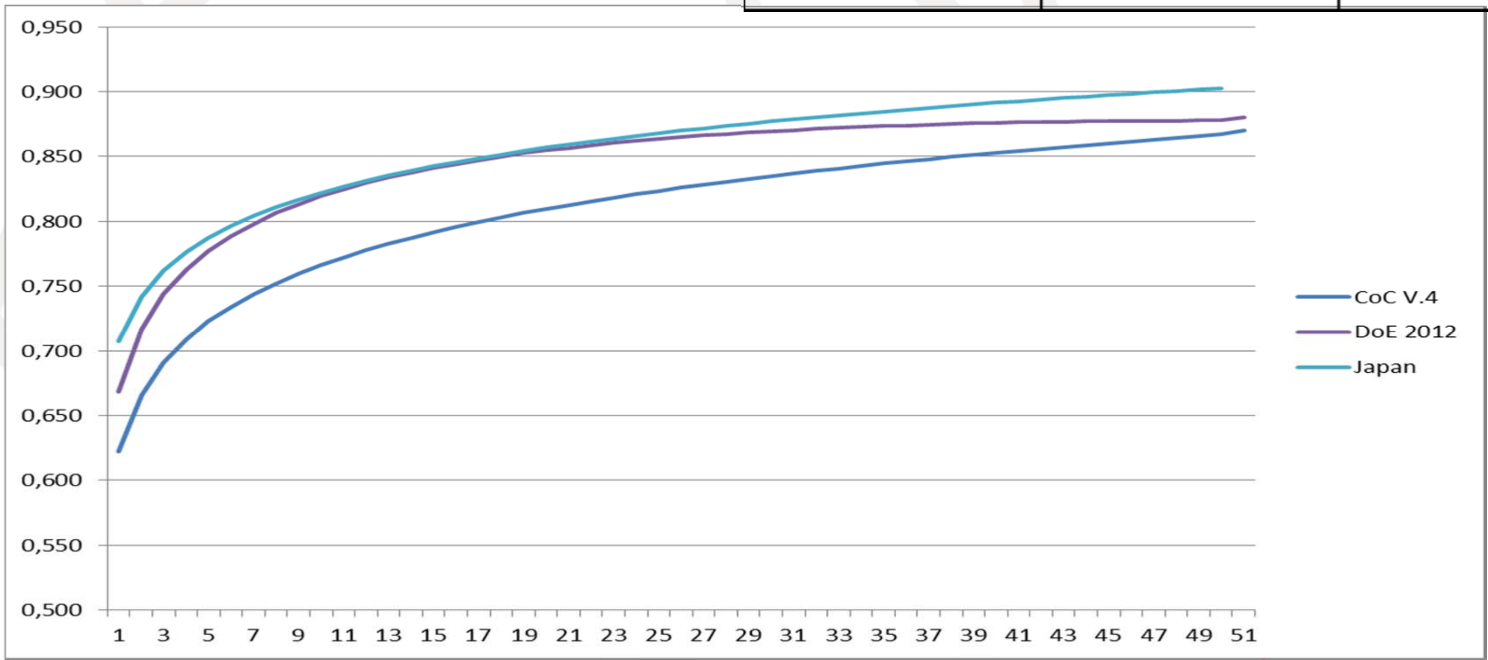
Note – Low voltage EPSs are considered only those <6V @ ≥550mA
Which rule applies for those <6V @ <550mA?

CoC V.4- DoE BCEPS and Japan Ecology Guide

Table : Assessment scale of the Japanese Ecology Guideline for the ICT industry in Japan. All external power supplies should comply with the five stars by 2012.
Revision planed at the end of 2012.
Figure of merit: Average conversion efficiency η = (η25＋η50＋η75＋η100)/4
Pno: nameplate output (W)

Assessment scale	Rate of reduction vs power consumption at NR	Average conversion efficiency η (See formula (＊))
★★★★★	n≧30%	η≧70.7＋5.00ln(Pno)
★★★★	20%≦n＜30%	67.7＋5.46ln(Pno)≦η＜70.7＋5.00ln(Pno)
★★★	10%≦n＜20%	64.8＋5.88ln(Pno)≦η＜67.7＋5.46ln(Pno)
★★ (includes NR)	0%≦n＜10%	62.2＋6.26ln(Pno)≦η＜64.8＋5.88ln(Pno)
★	(Normative reference not achieved)	η＜62.2＋6.26ln(Pno)

Basic voltage



Proposal from Salcomp and Nokia

Proposal for CoC 2014 limits, Standard models

Rated Output Power (Pno)	Minimum Average Efficiency in Active Mode (expressed as a decimal)
0 < W <= 1	≥ 0.5 * Pno + 0.145
1 < W <= 50	≥ [0.0626 * Ln (Pno)] + 0.645
50 < W <= 250	≥ 0.89

Proposal for CoC 2014 limits, Low voltage models (< 6 V, => 550 mA)

Rated Output Power (Pno)	Minimum Average Efficiency in Active Mode (expressed as a decimal)
0 < W < 1	≥ 0.5 * Pno + 0.085
1 <= W <= 50	≥ [0.0755 * Ln (Pno)] + 0.585
50 < W	≥ 0.88

Proposal for CoC 2014 limits, No load power consumption

W < 50	<= 0.15
W >= 50	<= 0.25
W < 8 Mobile hand held	<= 0,075

CoC V.5 starts Jan 1st 2014

- Basic voltage → = CoC V.4 + 2,3% efficiency
- Low voltage → = CoC V.4 + (about) 2,4% efficiency
- Efficiency at 10% load = mean efficiency -10%

ITU-T standardization

Worldwide applicability to ICT EPSs and beyond
Defining a limited set of «standardized solutions»
Energy and environmentally friendly

Two tiers have been proposed:

Transitional solution → valid at the date of publication:

No load
- @ Low and Basic voltage is <150mW

Efficiency
- Same as Energy Star / CoC V.4

Target solution valid after 3 (or 2) years:

No load
- @ Low voltage is <30mW - @ Basic voltage is <75mW

Efficiency
- Same as DoE 2012

Standardization is being finalized at next SG5 / WP3 meeting (October – Geneva)

ITU-T efficiency and no load DRAFT

Table 2 –

No load power and efficiency requirements of the adapter block in the UPA solutions

Category	Voltage	Current	Power	Transitional solution			Target solution		
				No-load power (W)	Average efficiency at 25, 50, 75 and 100% load	Efficiency at 10% load	No-load power (W) (Note 2)	Average efficiency at 25, 50, 75 and 100% load	Efficiency at 10% load
1a	5V	1A	5W	0,15	68.2%	58.2%	0,03	75.7%	70,7%
1b	5V	2,4A	12W	0,15	74.8%	64.8%	0,03	81.7%	76,7%
2a	12V	0,5A	6W	0,15	73,4%	63,4%	0,075	78,9%	73,9%
2b	12V	1A	12W	0,15	77.8%	67.8%	0,075	83%	78%
2c	12V	2A	24W	0,15	82.1%	72.1%	0,075	86,2%	81,2%
2d	12V	3,3A	40W	0,15	85,3%	75.3%	0,075	87,6%	82,6%
2e	12V	5A	60W	0,15	87.0%	77%	0,075	88%	83%

The Target values will come in force three years after the official publication of this Recommendation.

Efficiency at 10% load

Standby regulations, eco efficiency requirements and energy aware developments are driving ICT equipment to ever more variable energy consumption, ideally proportional to the service volume delivered.

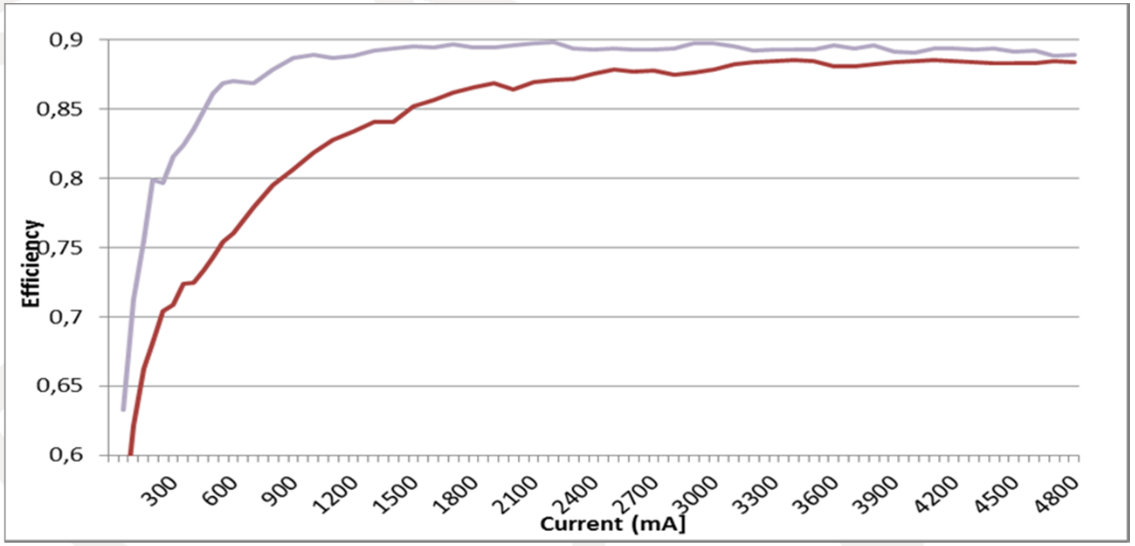
Most ICT, when in normal operation, delivers few per-cent of their capabilities and thus is expected to draw only a minor part of the maximum rated power.

Laptops as an example, when in normal operation draw only between 15 and 30% of their maximum rated power.

The «four points mean» calculation method is not suitable in relation to the new modes of operation.

Efficiency at 10% load

Efficiency curves of two EPSs showing similar "mean efficiency", (less than 2% difference) but quite different efficiency at lower loads.
Example from ITU-T Document "T09-SG05-C-0459!!MSW-E" – source: Telecom Italia



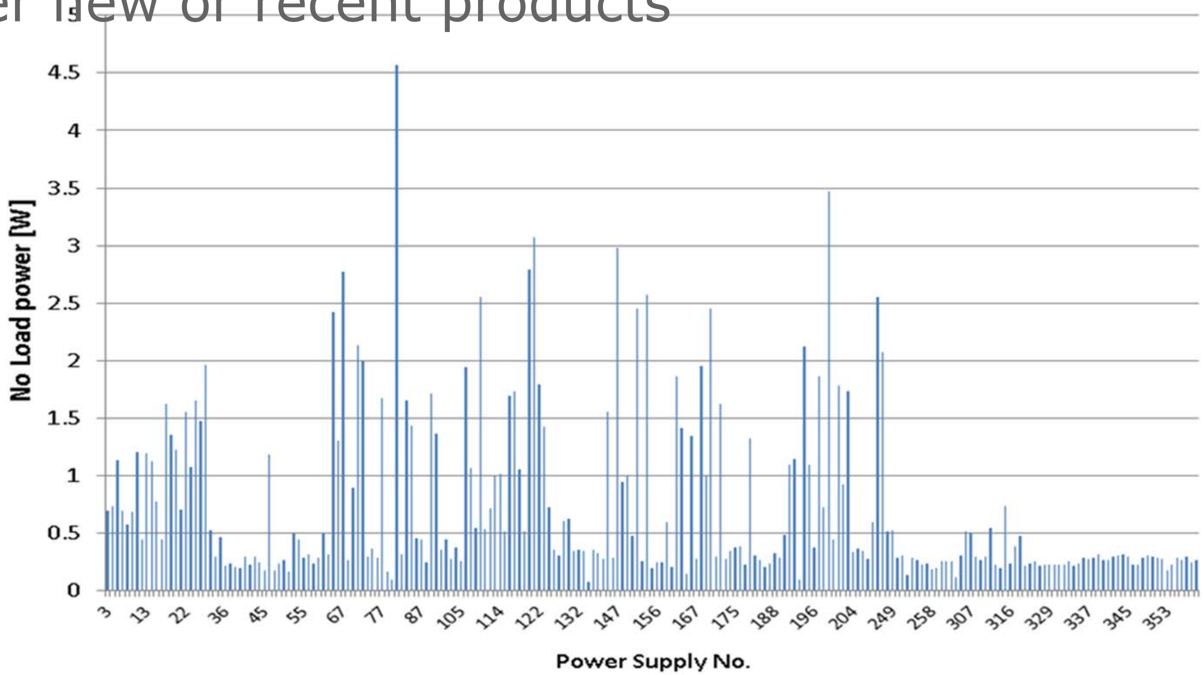
<u>ITU-T and ETSI have defined efficiency targets at 10% load:</u>

- ETSI → about 7% lower than the mean efficiency
- ITU-T:
  - Transitional solution → 10% lower than the mean efficiency
  - Target solution → 5% lower than the mean efficiency
  - The efficiency must not drop below these targets in the whole 10 to 100% load

<u>Efficiency at 10% load is expected to play a major role</u>

ITU – GeSI study – No Load

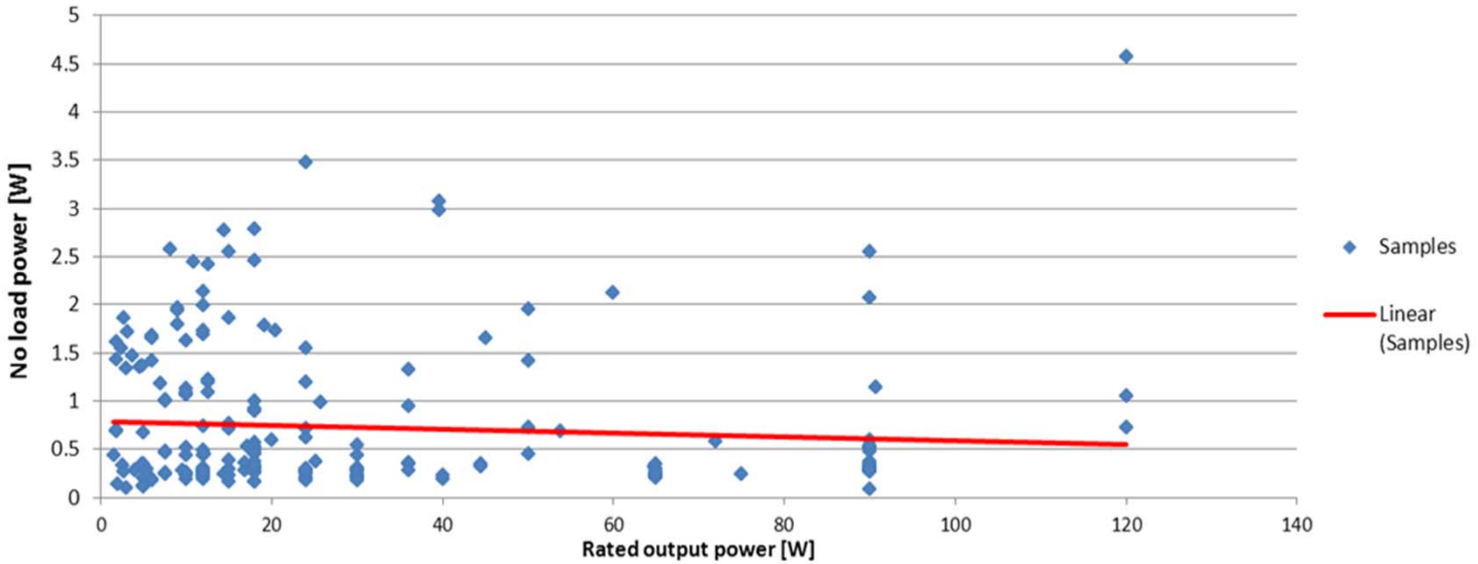
Study developed by the Genoa University
Electrical measurements on more than 200 commercial EPSs either new or recent products



The range of efficiency is quite wide. Many very good (low) values below 0.1–0.15 W, but very inefficient equipment (even higher than 2W) are frequent too.

Mobile charger have shown it is possible to have even better efficiency (< 30 mW).

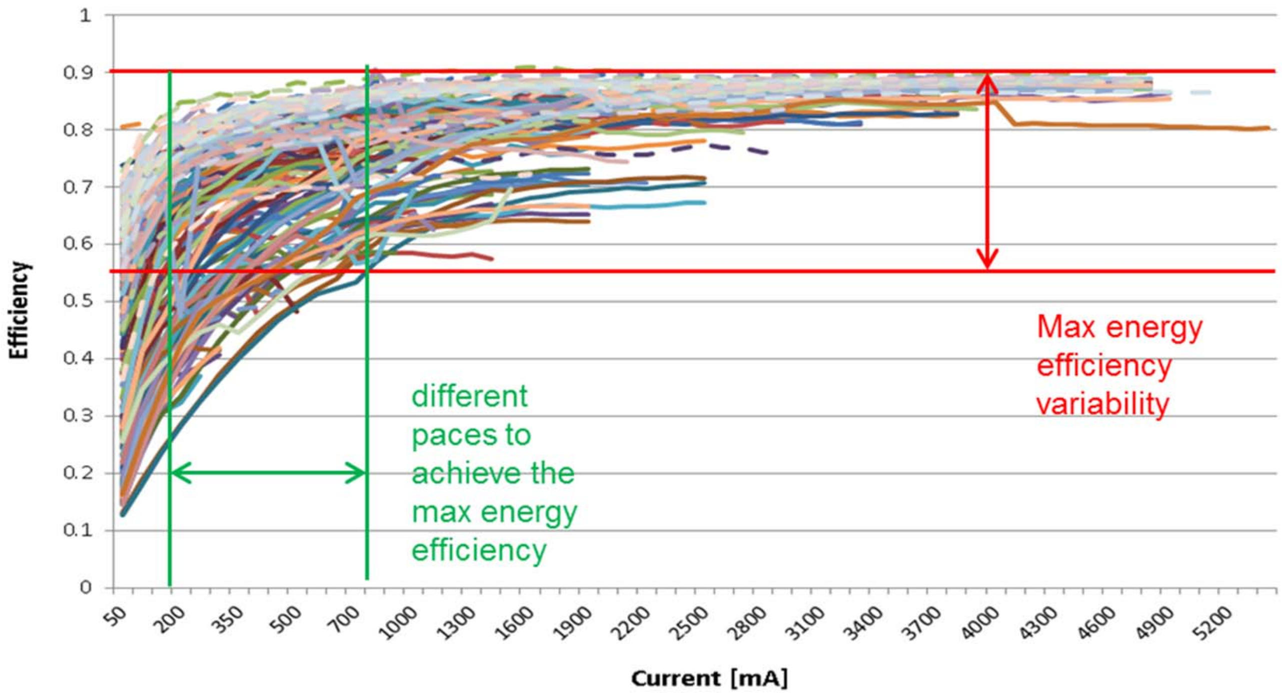
ITU – GeSI study – No Load vs Rated Output Power



- No correlation between no-load performance and output power.
  - It can be noted how many 90W adapters show very good no load consumptions and one of them is among the best of the tested equipment.
  - On the contrary, high no-load absorptions are present at low/medium power rates.

- The **no-load efficiency is mainly independent from output power**, but mostly depend on the design and internal components' quality.

ITU – GeSI study – Energy Efficiency at Variable Loads



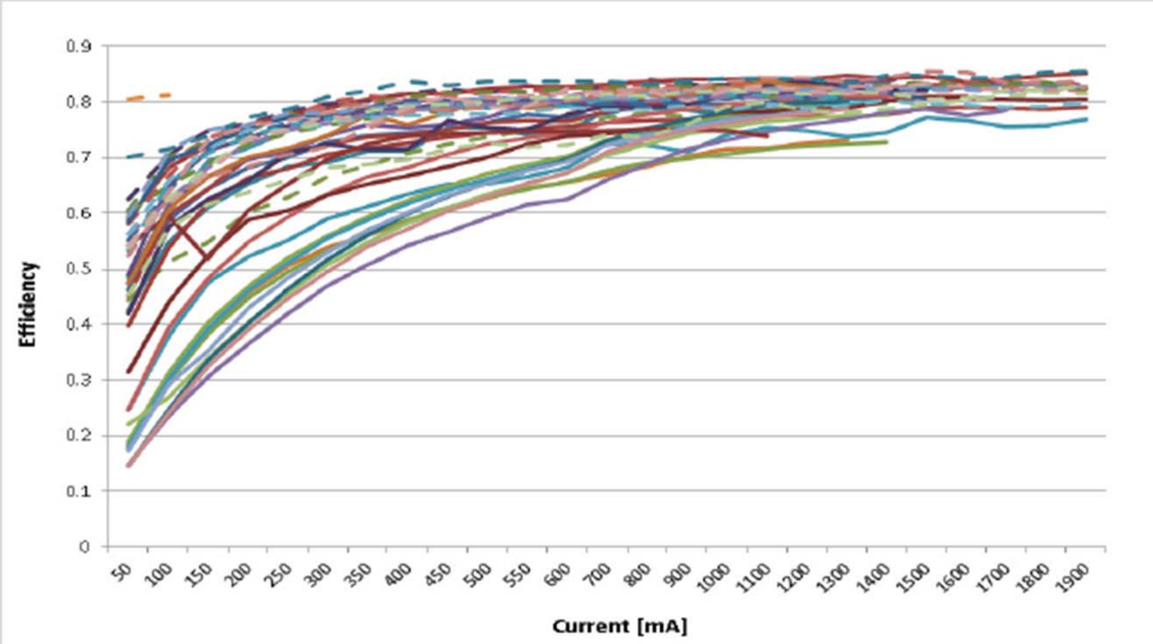
Energy efficiency curves with variable loads for all the analyzed adapters.

Each power supply has been tested up to its declared maximum value of DC current.

ITU – GeSI study – Energy Efficiency at Variable Loads

Figure 26: Energy efficiency curves with variable loads for the analyzed adapters. Each device has been tested up to its declared maximum value of DC current (Category C).

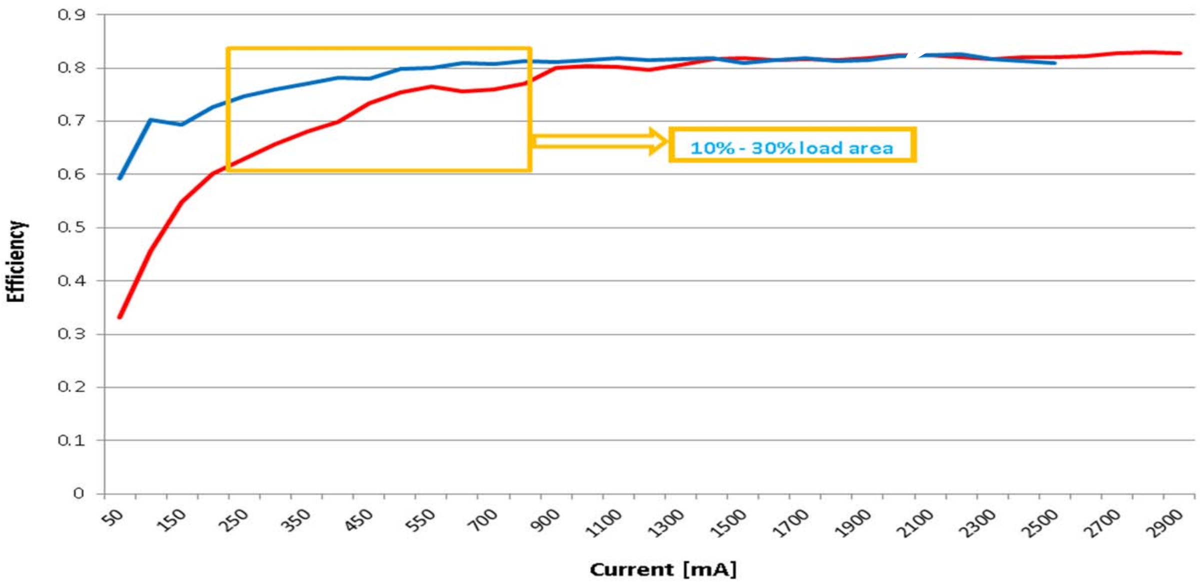
Voltage = 12V, 1 A < Current ≤ 2 A, Power: any;



The study highlights that lots of poorly efficient EPSs are still introduced in the market

ITU – GeSI study – Comparison among equivalent equipment

Two EPSs with the same average ES efficiency

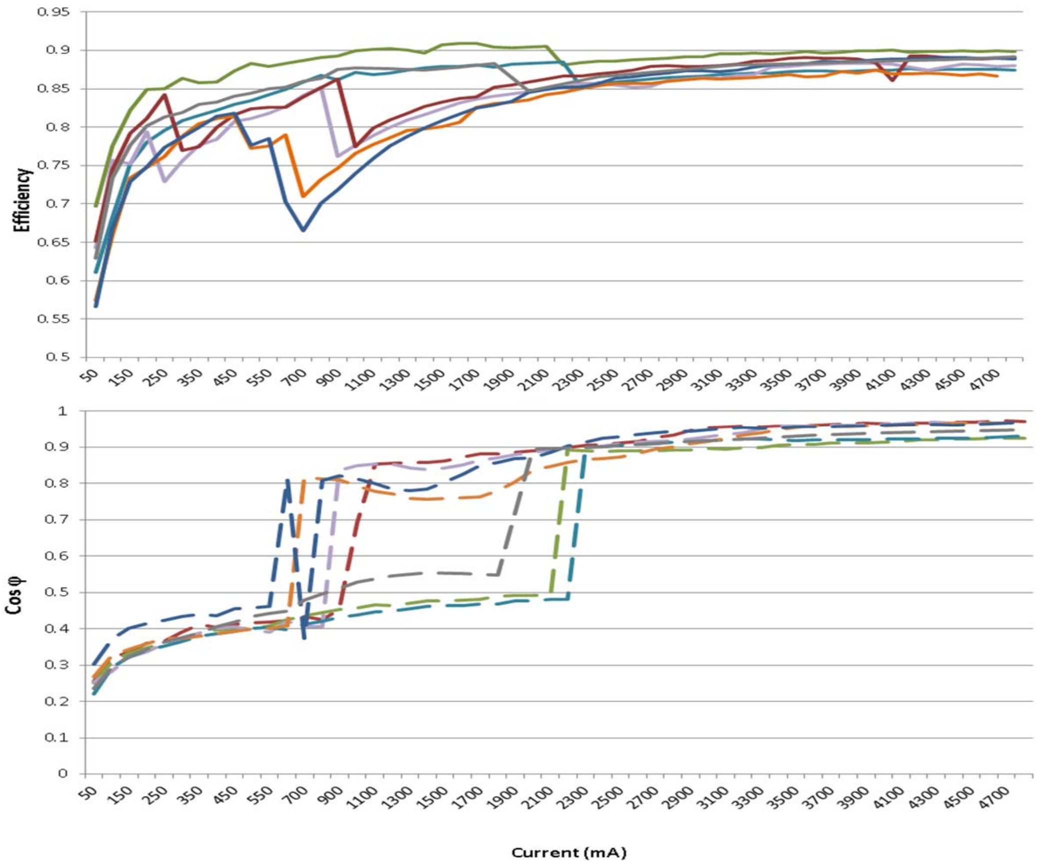


Even if the Energy Star calculation of the average energy efficiencies (mean of the efficiencies at 25%, 50%, 75% and 100% of the rated load) gives very similar results, the differences in the efficiency behavior are often clearly noticeable.

The gap in the range up to the 20-30% of the maximum load can be quite noticeable (5%-15%). This results in a significant increase in the overall energy consumption as several devices draw only a limited amount of energy for most of their operating time.

ITU – GeSI study – Power factor vs. load and efficiency

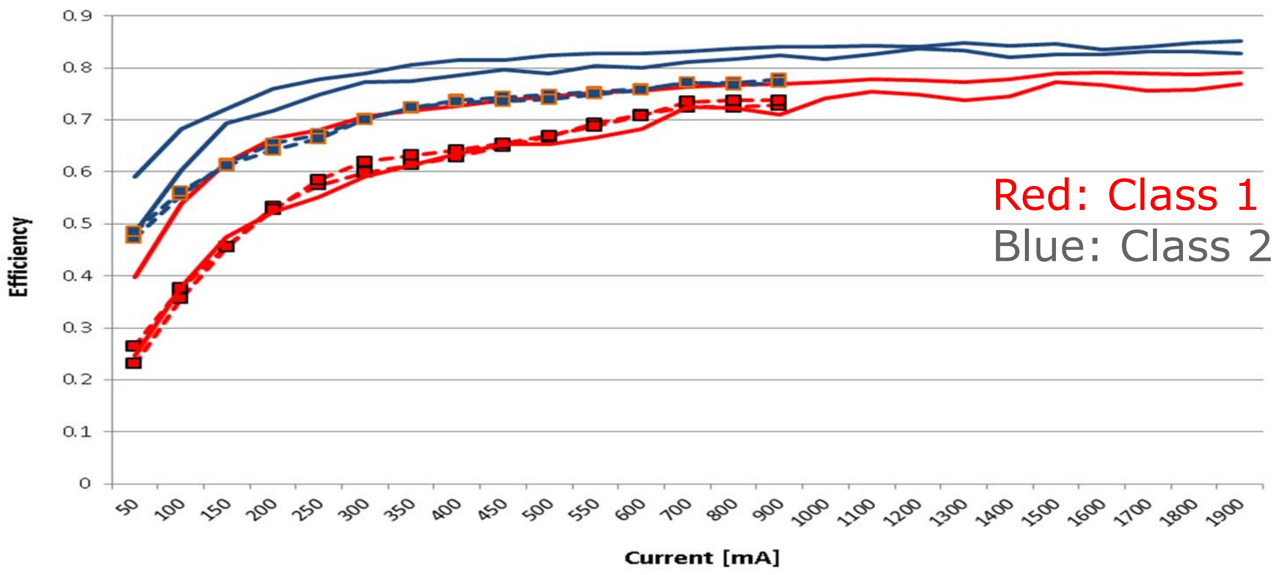
- Regulation require power factor correction for higher power EPSs (>75-100W). The power factor is verified in full load condition.
- Almost every EPS with a high power factor (more than 0.8) has a much poorer power factor when operating at lower power.
- Efficiency and Cos φ have been coupled to show the correlation between them
- Increased power factor comes at a cost of reduced efficiency (3-10%)



As several devices (e.g., laptops) for most of the time draw only a minor amount of the rated energy of their power supplies, the above described behavior implies that, in real life, those EPSs will not benefit the electrical network with good power factor.

Power Factor Correction shows to reduce the EPS's efficiency. The cost (less efficiency) / benefit (higher power factor) should be evaluated.

ITU – GeSI study – Correlation between safety class and efficiency

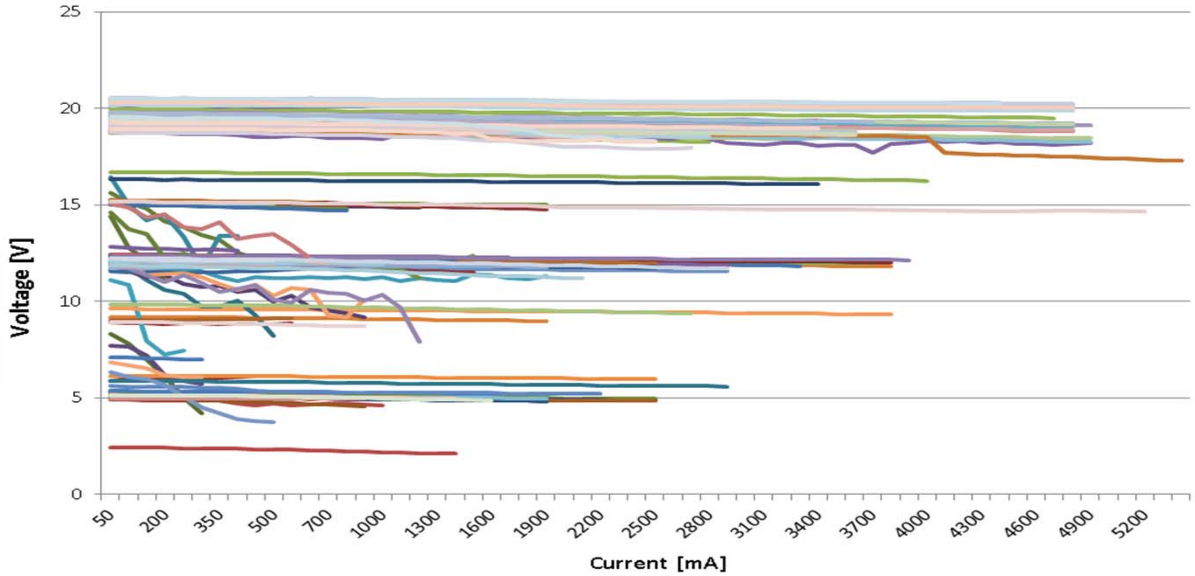


- The vast majority of the equipment analyzed belongs to safety class 2.
- Safety Class 2 EPSs have shown better efficiency.

Considering the: savings of material, increased efficiency, better compatibility of the class 2 mains connectors (2 pins) and increased safety for clients, it might be advisable the complete switch-over to this kind of solution/connectors/cables.

ITU – GeSI study – Output voltage

DC voltage measurement at variable output load



- A subset of the analyzed adapters shows, low loads voltages much higher than what declared.

This could create troubles for the connected devices, especially when the voltage value is far higher than the declared. In general, the ratings declared in the nameplate are expected to be accurate, and represent the real features of the power supply.

Further analysis in ITU on no load

This analysis has taken as basis the power supply data list released by the **Energy Star Program (ESP)**, a spreadsheet named **"External Power Supplies AC-DC Product List; December 16, 2010".** It lists 3782 models of power supplies and gives, for each EPS: brand, name, voltage, current, rated power, efficiency and no load at 115V and 230V and, finally, the full load power factor.
Out of that very long list, 611 EPSs fall around the EPS classes that have been proposed for standardization **(5V 12W, 12V 12W, 12V 24W, 12V 40W, 12V 60W, 19V 40W, 19V 65W, 19V 90W and 19V 120W)** and the mean efficiency (at 115V and 230V) and no-load has been calculated for each of such classes.
ITU-T Document "T09-SG05-C-0460!!MSW-E" – source: Telecom Italia

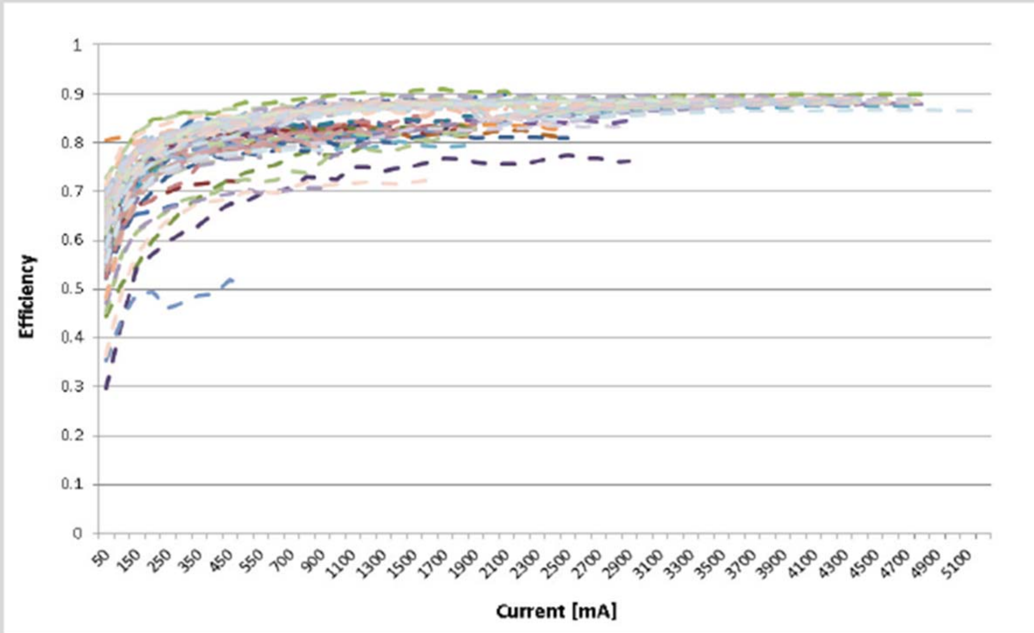
Results:

- Little difference on efficiency depending on the mains voltage
- Significant difference on no-load depending on the mains voltage
- Evident relation between output voltage and efficiency
- At and above 40W the efficiency remains about the same
- The efficiency difference between "best" and "worst" equipment, per each rated power, ranges between 4% and 8%
- Below 40W there is no dependency between rated power and no-load
- At and above 60W the no-load increases slightly, but without a clear trend
- Market seems able to easily outperform the most stringent Energy Star requirements

			115V		230V	
Voltage	Power	number	mean eff	no load	mean eff	no load
5V	12W	53	77,04	*0,11*	76,69	*0,19*
12V	12W	138	81,11	*0,15*	79,90	*0,20*
12V	24W	99	84,13	*0,13*	83,58	*0,20*
12V	40W	11	86,65	*0,15*	86,12	*0,23*
12V	60W	11	87,71	*0,17*	88,15	*0,24*
19V	40W	57	87,95	*0,16*	87,63	*0,20*
19V	65W	103	88,52	*0,19*	88,40	*0,24*
19V	90W	99	88,99	*0,22*	88,74	*0,29*
19V	120W	40	88,98	*0,19*	88,18	*0,27*

Efficiency of Energy Star marked equipment

Figure 23: Energy efficiency curves with variable loads only for the analyzed adapters with the Energy Star mark. Each device has been tested up to its declared maximum value of DC current.



Many Energy Star marked EPSs show very poor efficiency, sensibly lower than their declared class.

This seems due to lack of market sampling and control

<u>Regulation and even voluntary standards effectiveness is at risk if proper market surveillance is not put in place</u>

Thank you for your attention

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The full ITU-GeSI report is available at:

http://www.itu.int/ITU-T/climatechange/
http://www.gesi.org/