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Electricity Consumption and Efficiency Trends in the Enlarged European Union

- Status report 2006-

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Introduction

Electricity consumption in the EU-27 Member States and Candidate Countries has continued to grow in the last years despite numerous energy efficiency polices and programmes at EU and national level. Total electricity consumption in the residential sector in the EU-25 has grown by 10.8% in the period 1999-2004, at almost the same rate as the economy (GDP). Similar trends are also observed in the tertiary sector and to a lesser extend in industry. The electricity consumption in the tertiary sector has grown by 15.6% in the period 1999-2004 and by 2.0% in the period 2003-2004. Despite this increase and the consequent impact on CO2 emissions, there is little knowledge at European level, where the electricity is uses, what is the status of efficiency of the installed and sold equipment and what is the likely impact of the past, present and planned policies. For the tertiary sector there is even much less data available for individual electricity end-uses than for the residential sector, and only a few sources or countries attempted to split the total electricity consumption among the different end-uses.

The energy consumption of the industrial sector has continued to grow in the period 1999 to 2004 in the EU-25 with an increase of 6.6%, while the yearly growth rate in the period 2003-2004 has been 1,3. The electricity in the industrial sectors has grown by 9.5% in the period 1999-2004 and by 1.7% in the period 2003-2004.

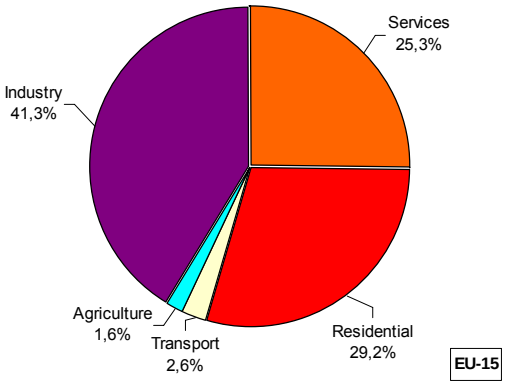
This report summarises the result of a 2006 in-depth survey on the electricity consumption in buildings in the enlarged EU and Candidate Countries, together with the present market share of efficient appliances and equipment. One of the aims of this report is to show the present status of electricity consumption for the main appliances and equipments, and on the base of the best available data estimate the saving potential for electricity in buildings in EU Member States and Candidate Countries. It also describes the policy actions introduced at EU level and some of the national policies. The report focuses also on motor driven systems, a horizontal technology present in all types of industry. In particular electric motors are responsible for 10 to 20% losses of the above indicated electricity consumption in the process of converting electrical energy into mechanical energy.

Electricity end-use in the residential sector

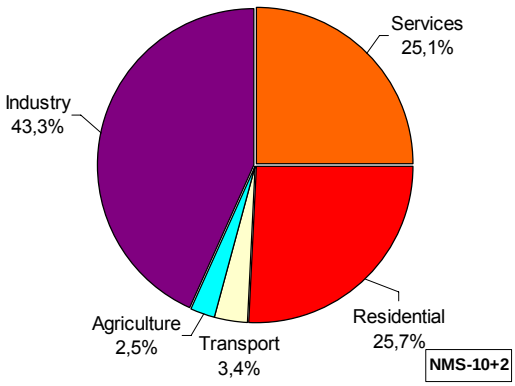
Gas and electricity consumption in the EU-25 Member States, Candidate and Accession countries has continued to grow in the last years, despite numerous energy efficiency policies and programmes at EU and national level.

The gas consumption in the residential sector has continued to grow in the period 1999 to 2004 in the EU-25 from 4721 PJ to 5399 PJ with an increase of 14%, while the yearly growth rate in the period 2003-2004 has been 2.2%. Total electricity consumption in the residential sector for the EU-25 has grown by 10.8% in the period 1999-2004, from 690 TWh in year 1999 to 765 TWh in year 2004 and by 1.8% in the period 2003-2004. Electricity use grows at almost the same rate as the economy (GDP). Increasing electricity demand is due to many different factors, including:

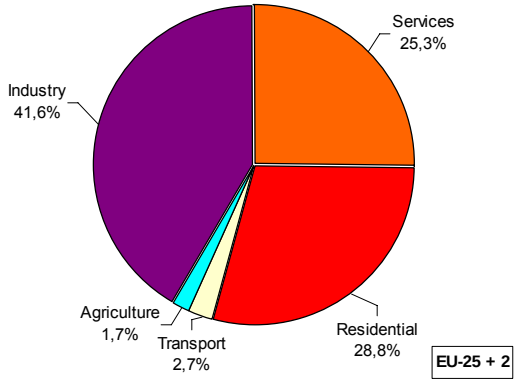
- more penetration of "traditional" appliances (e.g. dishwashers, tumble driers, air-conditioners, personal computers, which are all still far away from saturation levels); introduction of new appliances and devices, mainly consumer electronics and information and communication technology (ICT) equipment (Set Top boxes, DVD players, broadband equipment, cordless telephones, etc.) many with standby losses.
- Increased use of "traditional" equipment: more hours of TV watching, more hours of use of personal computer (driven by some tele-working and increased use of internet), more washing and use of hot water.
- Increased number of double or triple appliances, mainly TVs and refrigerators-freezers.
- More single family houses, each with some basic appliances, and larger houses and apartments. This results in more lighting, more heating and cooling, and last but not least, older population demanding higher indoor temperatures and all-day heating in winter and cooling in summer, and spending more time at home.

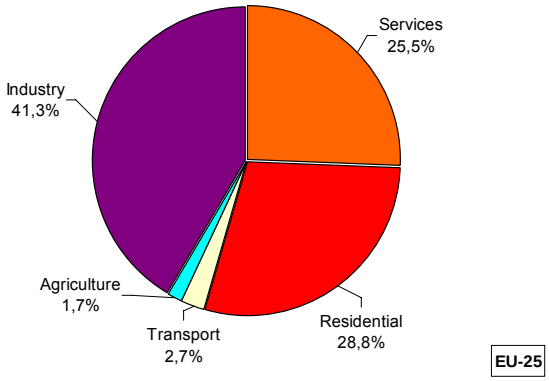


a) electricity consumption: EU-15



b) electricity consumption: NMS-12





c) electricity consumption: EU-27 d) electricity consumption: EU-25

Fig 1.: a), b), c), d): Breakdown of electricity consumption between sectors in 2004 (source Eurostat and JRC survey)

On the basis of recent enquiries, the total residential electricity consumption is apportioned to the different end-uses devices. As it can be seen in figure 2 and 3 there is still a substantial difference between the former EU-15, where the largest electricity use is still space heating, followed by refrigerators and freezer and lighting, and the new Member States where refrigerators and freezer and lighting are more or less on the same level and are the largest electricity end-use, and where very little electricity is used for space heating and cooling.

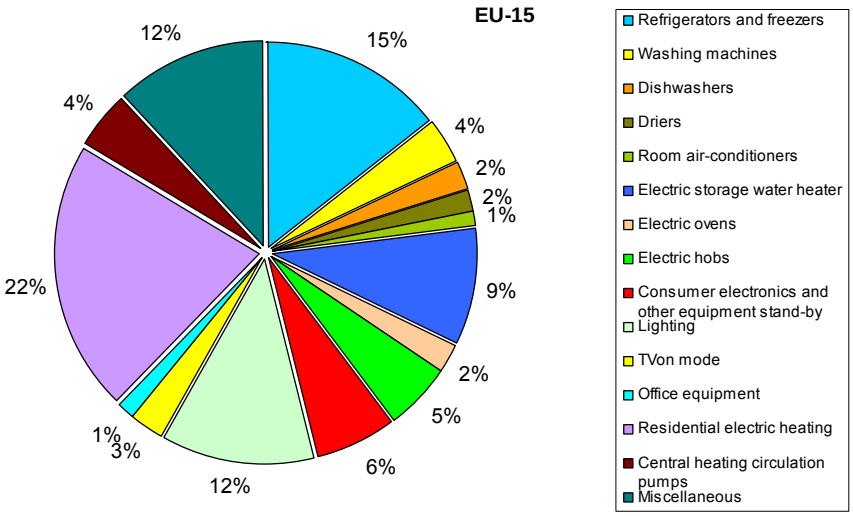


Fig 2.: Breakdown of electricity consumption among residential end-use equipment in EU-15, yr. 2004 (source JRC and [IEA 2003], [Wai 2004], [Wai2004a)

Table 1.: Breakdown of residential electricity consumption in EU-15 [TWh] (source JRC and [IEA 2003], [Wai 2004], [Wai2004a])

Breakdown of residential electricity consumption in EU-15 [TWh]	
Refrigerators and freezers	102
Washing machines	26
Dishwashers	14
Driers	13
Room air-conditioners	7
Electric storage water heater	65
Electric ovens	15
Electric hobs	37
Consumer electronics and other equipment stand-by	45
Lighting	85
TV-on mode	20
Office equipment	10
Residential electric heating	150
Central heating circulation pumps	30
Miscellaneous	85
Total	704

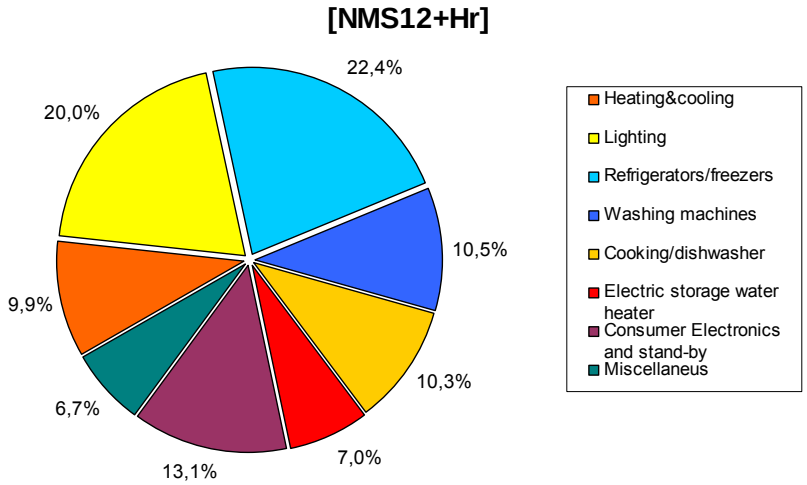


Fig 3.: Breakdown of electricity consumption among residential end-use equipment in NMS12+Hr, yr. 2004 (source JRC and [Ata2004])

Table 2.: Breakdown of residential electricity consumption in NMS12+Hr (source JRC and [Ata2004])

Breakdown of residential electricity consumption in NMS10+2AC+Hr [TWh]	
Heating&cooling	8,61
Lighting	17,32
Refrigerators/freezers	19,36
Washing machines	9,08
Cooking/dishwasher	8,90
Hot water	6,06
Consumer Electronics and stand-by	11,36
Miscellaneous	5,84
Total	86,53

Some equipment, e.g. electric storage water heater, room air-conditioners, electric direct resistance heating, electric hobs, are present only in a limited number of dwellings, and concentrated in some specific Member States (e.g. electric hobs in Germany and France). Space heating, although present only in a limited number of households in particular in some countries (mainly present in Sweden and France, and to a lesser extend in Germany and UK), still represents the largest single electricity end-use equipment in the residential sector (about 20% of the total electricity consumption in the residential sector) followed by refrigerators and freezers, lighting and water heating. Direct resistance heating, electric and storage water heating are decreasing their market share due to strong competition from natural gas. Only in a few Member States heat pumps are replacing fossil fuel boilers or direct resistance heaters for heating purposes.

Table 3. : EU Residential Sector Electricity Consumption (source: Eurostat, JRC)

	Residential [TWh]			
	Eurostat data			JRC survey
	2003	2004	2004 vs. 2003 [%]	2004
	EU-15			
AT	15,08	15,11	0,21	16,03
BE	26,03	26,54	1,99	18,2
DK	10,26	10,33	0,68	9,72
FI	20,41	20,36	-0,20	12,2
FR	141,55	146,74	3,67	141
DE	139,55	140,40	0,61	140,4
GR	16,44	16,85	2,48	16,88
EI	6,97	7,40	6,23	7,35
IT	65,02	66,60	2,44	66,6
LU	0,75	0,75	0,00	0,75
NL	23,30	23,50	0,86	23,5
PT	11,84	12,43	5,04	11,4
ES	57,23	60,67	6,01	60,2
SE	42,00	41,38	-1,48	43,5
UK	115,76	115,50	-0,23	115,5
EU-15	**692,17**	**704,57**	1,79	**683,216**
	New Member States			
CZ	14,51	14,53	0,15	14,53
CY	1,29	1,32	2,01	1,32
EE	1,59	1,62	1,63	1,62
HU	11,06	11,03	-0,28	11,1
LV	1,42	1,47	3,24	1,47
LT	1,90	2,07	9,02	2,07
MT	0,63	0,62	-0,96	0,6
PL	22,05	22,80	3,42	22,4
SK	5,04	4,82	-4,41	5,1
SI	3,01	3,01	0,13	3,01
NMS10	**62,50**	**63,29**	1,26	**63,22**
	Candidate and Accession Countries			
BG	9,31	8,77	-5,81	9,21
RO	8,24	8,04	-2,43	7,9
HR	5,69	6,07	6,60	6,07
TR	25,20	27,62	9,62	27,62
AC&CC	**48,44**	**50,50**	4,25	**50,8**

	Residential [TWh]			
	Eurostat data			JRC survey
	2003	2004	2004 vs. 2003 [%]	2004
EU-25	754,67	767,85	1,75	746,44
EU-15	692,17	704,57	1,79	683,22
NMS-10	62,50	63,29	1,26	63,22
NMS-10+2	80,05	80,10	0,06	80,33
EU-25 + 2	772,22	784,67	1,61	763,55

Electricity consumption per appliance in households in “real” situation (through monitoring of consumption) has not yet been very well documented. Some past monitoring campaigns have collected data (France, Italy, Denmark, Portugal) [Sid2006]. On average measurements of some households' electricity consumption in Italy and Denmark - without the space and water heating uses are 3358 kWh/year for Denmark and 3157 kWh/year for Italy [Pag2003]. In France, an average electricity consumption excluding water and space heating is about 2500 kWh/year [Sid2006]. Moreover the observed mean electricity consumption of electric water heaters amounts to 2364 kWh/year. The average consumption in he EU-15 (total electricity consumption of the residential sector divided the number of households) is 4343 kWh/year. More recent monitoring campaigns in Sweden, based on a statistical sample, monitored 400 households covering both single family houses, and apartments, excluding electric heating and water heating. The preliminary results of the survey are 5034 kWh/year on average for the single family's households, and 2954 kWh/year for the apartments [Ben2006]. Recently a new SAVE project, REMODECE, has been started to carry out additional monitoring survey in several EU Member States, the results will be available in 2007.

1.1. Air-conditioning appliances

In the ‘southern’ countries (Italy, Spain, Portugal, Greece and Southern France) one of the main drivers to increases in electricity consumption and more important to electricity peak demand is the fast penetration of small residential air-conditioners (less then 12 kW output cooling power) and their extensive use during the summer months. Due to the heat wave in the summer of 2003 in Italy during that year all small air-conditioners available on the market were sold and installed. For Italy, the manufacturer trade association reported the following sale trends:

Table 4.: Sales of small air-conditioners Italy (source [Coa 2005])

Year	Sales (thousand)	Annual increase
2001	950	
2002	1067	12%
2003	1550	45%
2004	2100	35%
2005	1367	-35%

The impact of 2003 summer heat wave had also a big effect on sales for year 2004. Cooler summers in 2004 and 2005 reduced the sales levels in 2005. There is also some saturation effect as almost 20% of Italian household own an air-conditioner. Although at European level the penetration of small air-conditioners is still small (about 4% of residential space), in some countries such as Italy and Spain the penetration of small air-conditioners reached in 2005 significant penetration levels similar to the US where there is a penetration of about 20%. Total residential air-conditioners’ electricity consumption in EU-25 in year 2005 was estimated to be between 7-10 TWh per year.

For room air-conditioners (up to 12 kW output power), the Labelling Directive (2002/31/EC) has been adopted by the European Commission and was published in March 2002. [EU 2002a]

The full mandatory application of this Directive was fixed for 30 June 2003. However the relevant test standard needed to serve as the reference document was missing; the new revised standard EN 14511 covering all products in the scope of the Directive has not been finalised before May 2004. The European Commission in agreement with the Labelling Committee decided to postpone the application till just before the summer 2004. The A class limit for the split, non ducted, air-cooled air conditioners up to 12kW is set at EER[1] of 3,2; some new models have been introduced on the market with EER above 4, the best models on the market having an EER of 5,51. This indicates that the A class level is not very ambitious. In addition, there are still several E and D class models on the European market, with EER at around 2,5. [EU 2002a]

For room air-conditioners (up to 12 kW) the improvement of the EER can be attributed to the technological development and transfer (mainly from Japan, where there are very ambitious energy efficiency targets) and to the publication of the EER (and last year also of the energy label) in the Eurovent Certification Scheme (available at: www.eurovent-certification.com). Eurovent-Cecomaf has also self-committed to withdraw from the market the models in G class. Implementation of this proposal started in January 2004 with the elimination of Class G products. [Sah2006]

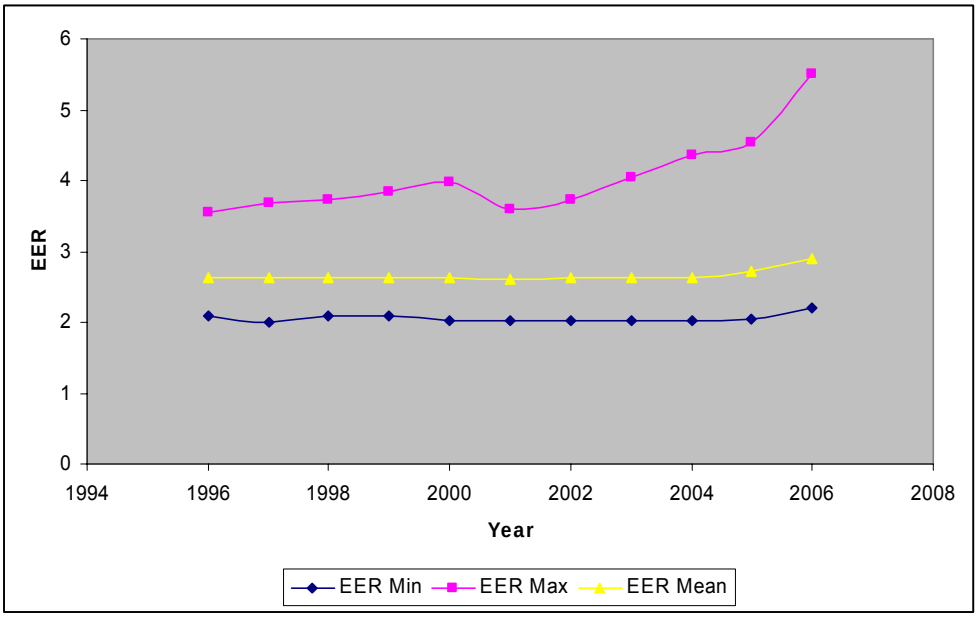


Fig. 4.: Evolution of the EER (minimum, maximum and model weighted average) for split, non ducted, air-cooled Air conditioners up to 12 kW (source Eurovent [EU2006], [Bec2006])

[1] EER = Energy Efficiency Ratio. This is the ratio between the output cooling (thermal) power and the input electrical power in the cooling mode. The EER is used to define the energy classes for the energy labelling. For reversible air-conditioners (working as heat pump) the efficiency indicator is the COP (coefficient of performance) which is defined as the EER during the heating mode.

1.2. Major Household appliances

Sales of major domestic appliances (MDAs) in 2005 (refrigerators, freezers, washing machines, dishwashers, tumble driers, ovens, cookers and hobs) were about stable compared to 2004 in the EU-15. For the following 10 countries (SE, UK, BE, NL, IT, DE, AT, FR, ES, PT) a total of about 52,7 million MDAs were sold in year 2005: about 12 million refrigerators, 12 million washing machines, 5 million dishwasher, 3 million driers, 3 million freezers, 12 million cooking appliances [Sor2006].

Table 5.: Sizes and trends in Major Domestic Appliances[2] in Europe [Sor2006a]

	10 countries from EU-15[3]	6 countries from NMS-10 & CC[4]	Russia and Ukraine
Size (th. units)	52716	6817	4732
Market trend	0,2	2	24,8

CECED (European Committee of Domestic Equipment Manufacturers) reported a production for the EU market including import for the companies who have signed the unilateral commitment of about 20, 2 millions cold appliances, and 15,4 millions washing machines for the EU-15.

Another important information is the current penetration of appliances in households. While the penetration of MDAs in the former EU-15 Member Sates has been well documented in previous reports, the below table 6 show the current penetration levels of the four most common appliances in New Member States:

Table 6.: Major appliances penetration in households from NMS and CC in 2004 (source JRC[5] [Ata2004])

	Refrigerators	Freezers	Clothes washing machines	Dishwashers
	[%]	[%]	[%]	[%]
Czech Rep	110,0	50,0	85,0	10,0
Cyprus	100,0	19,0	95,0	37,0
Estonia	91,0	10,0	78,0	2,0
Hungary	75,0	53,0	70,0	4,0
Latvia	90,0	15,0	80,0	n.a.
Lithuania	96,0	17,0	82,0	1,0
Malta	108,0	30,0	103,0	8,0
Poland	97,8	38,1	73,8	2,4
Slovak Rep.	99,1	99,1	60,3	2,3
Slovenia	98,0	69,0	95,0	39,0
Bulgaria	84,0	25,0	42,0	2,0
Romania	70,0	30,0	49,0	2,0

[2] Major domestic Appliances (MDA) means: washing machines, tumble dryers, dishwashers, cooling, freezers, cooking, hobs, cooker hoods

[3] 10 countries from EU-15: Se, UK, Be, Nl, De, At, Fr, It, Es, Pt

[4] 6 countries from NMS-10 & CC: Pl, Cz, Hu, Bg, Ro, Hr

[5] from JRC survey on electricity end-use in NMS and CC

Average NMS12	89,2	39,8	67,0	4,1
Turkey	97,38	n.a.	78,97	14,49
Croatia	99	85	96	18

1.2.1. Refrigerators and freezers

The efficiency improvement trend continued for refrigerators and freezers. For domestic refrigerators the energy efficiency index (EEI)[6] is defined in the "Cold Appliances" labelling Directive and the EEI was set at 102 for the average model on the market in year 1992, as reported by the GEA study.

Among the combined refrigerator-freezer, the best models on the market in the year 2005 were models rated A++ with an EEI below 30; as example a model with 215 fresh food volume and 60 l of freezer (4*) volume has an annual consumption of 137,0 kWh/year . For the same size a C class model just meeting the efficiency requirements would use 522 kWh/year (a factor four energy reduction!). There are still a limited number of models in A++ class (EEI below 30), and still difficult to find them in shops, while there is already several models in A+ class.

The graph from Figure 5 shows the improvement of the EEI from year 1992 to 2005. On average the efficiency improvement over 13 years has been a remarkable 40%.

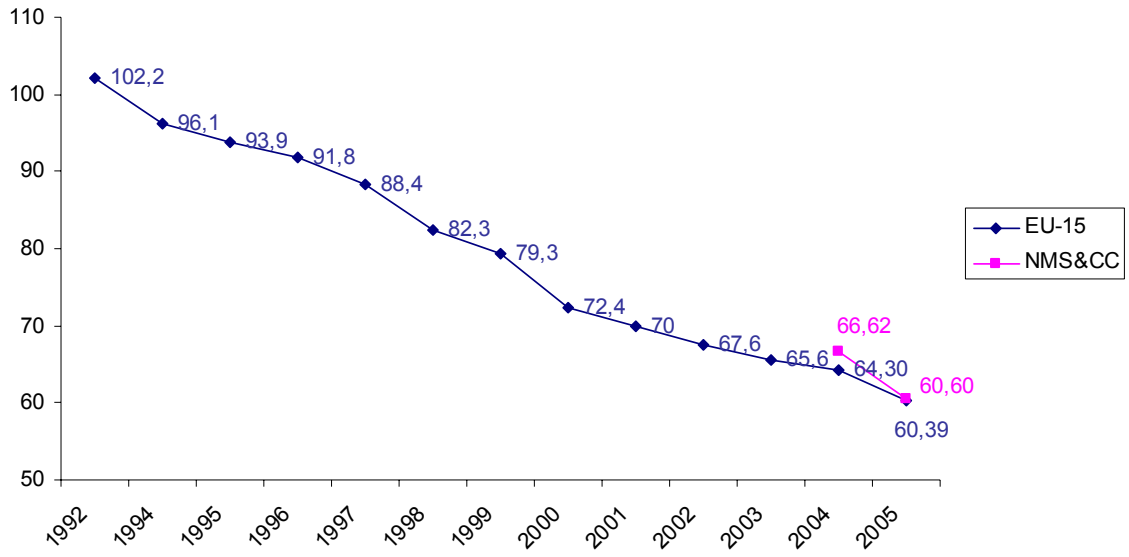


Fig. 5: Evolution of the EEI (new model sale weighted average) for cold appliances (source: JRC, [Wai 2004a])

It is interesting to notice that in 2005 new cold appliances average efficiency in NMS and CC are almost identical to the EU-15 in term of efficiency index.

[6] The EEI is defined as the ratio between the energy consumption of the sold appliance compared to the one of reference appliance as defined in Directive 94/2/EC.

CECED calculated the following values as part of their Unilateral Commitment [CEC2005] reporting mechanism.

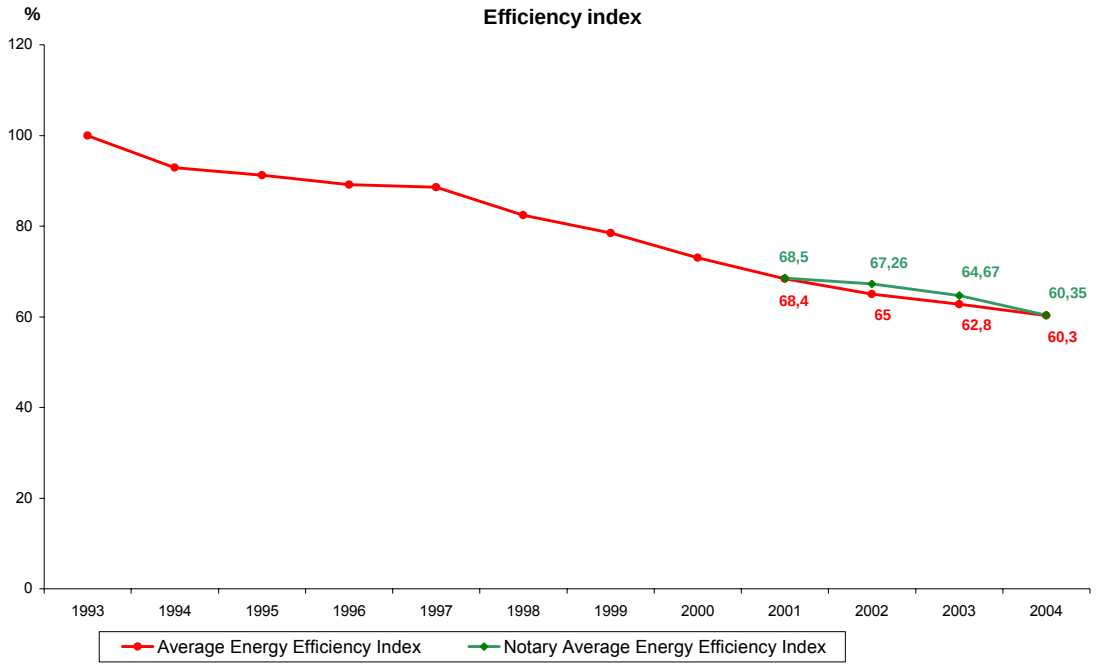


Fig. 6.: Evolution of the EEI (new model sale weighted average) for cold appliances according to CECED notaries system [CEC2005]

The sale data for 2005 for cold appliances show that in some markets (and in particular in the Netherlands and Germany) the A+ appliances are starting to have an important market share (14.8 % market share of A+ class in Germany), while at European level the share of A class has reached 60 % of the sales, with 9% in A+ class. In all countries the share of A and A+ appliances has strongly increased in 2005 compared with previous years. Large differences still exist between countries due to different national and regional policies and programmes. The lowest share of sales of A class appliances is in the west European countries covered by the GfK panel 2004 is in Spain (36.1%), and the highest share in the Netherlands (71.1% in A class plus 19.2% in A+ class) , this remarkable high share is due in particular to incentives for very high efficient appliances. Also worth noticing is that the share of A class appliances in new refrigerators sales is higher in the New Member States (again comparing only among the countries covered by the GfK panel). The strongest progress in the period 2002 to 2005 happened in the UK mainly due to the Energy Efficiency Commitment[7] under which about 1 million efficient cold appliances have been sold per year.

[7] Energy Efficiency Commitment (EEC) runs in 3-year cycles from 2002 to 2011. 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.

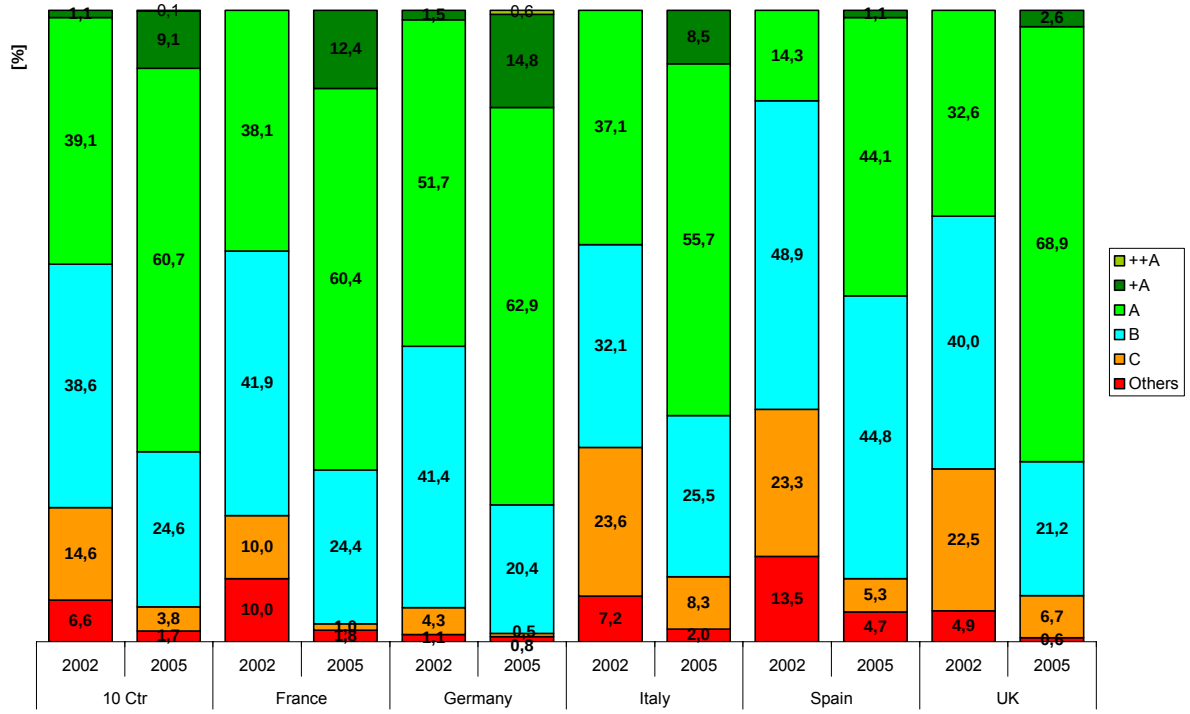


Fig. 7.: Sales of cold appliances: comparison for the 5 large countries of sales in 2002 and 2005 by energy class (Source GfK, [GfK 2004], [Sor2005])

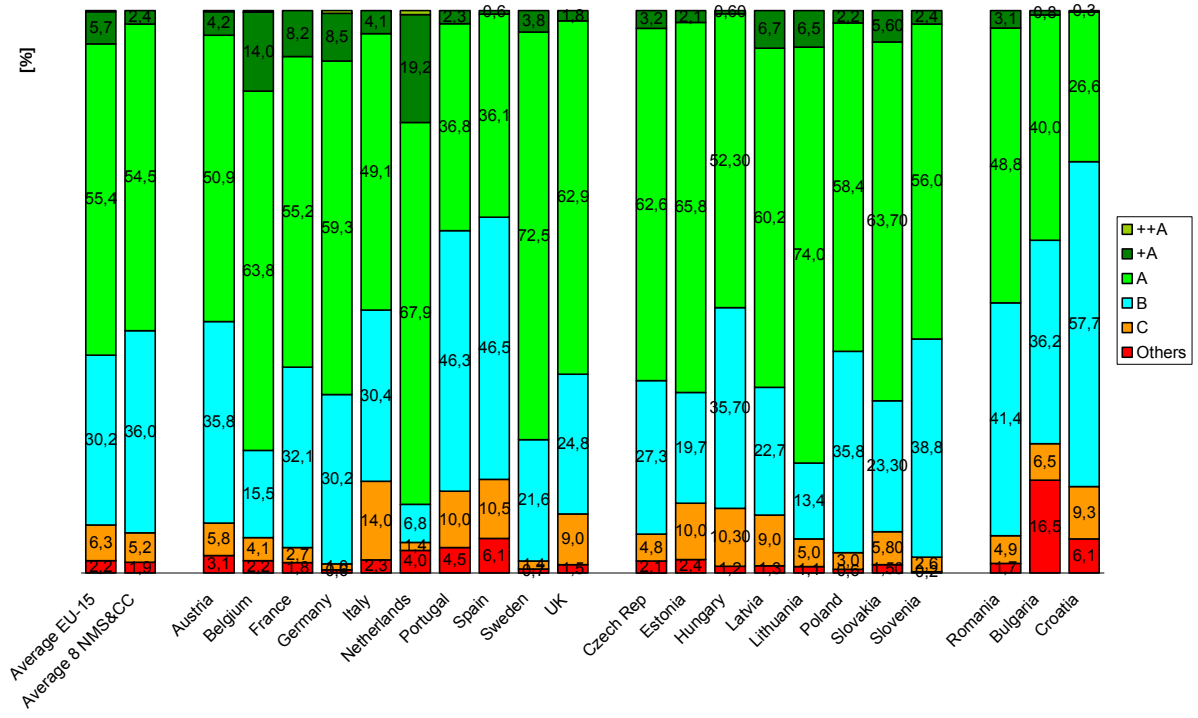


Fig. 8.: Sales of refrigerators in 2004 by energy class (Source GfK, [Sor2005])

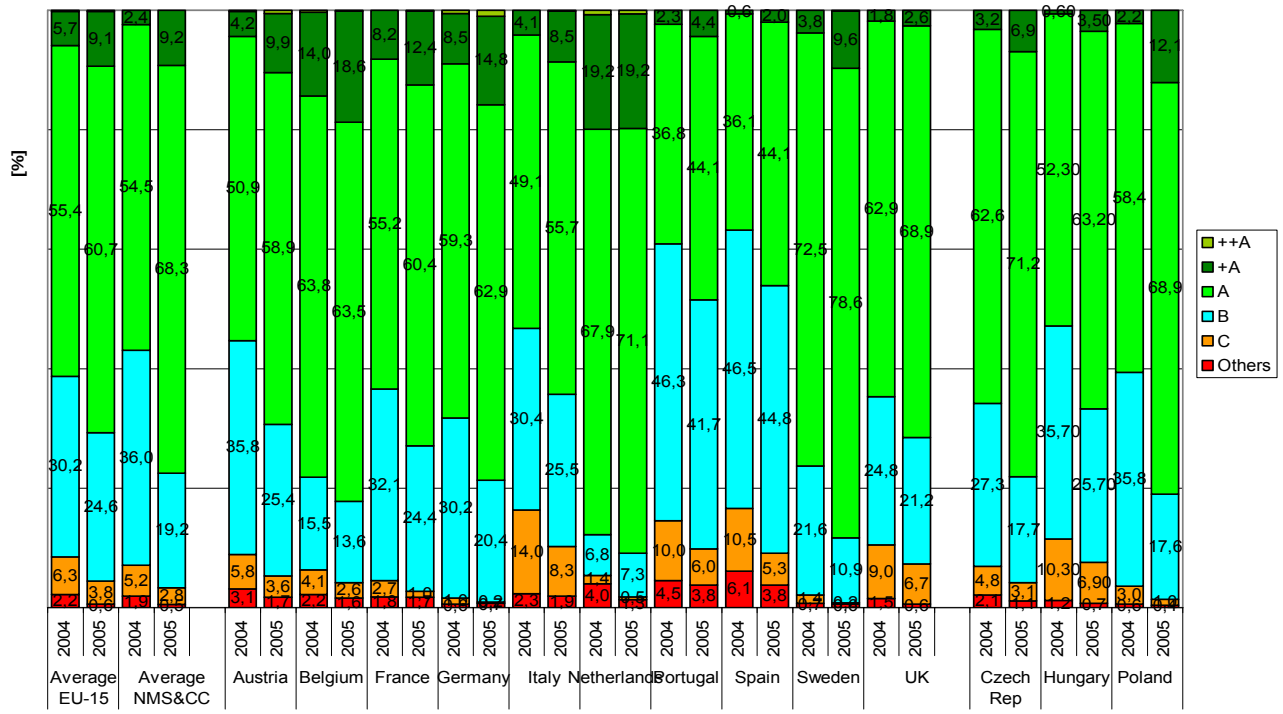


Fig. 9.: Sales of refrigerators: comparison between 2004-05 by energy class (Source GfK, [Sor2005])

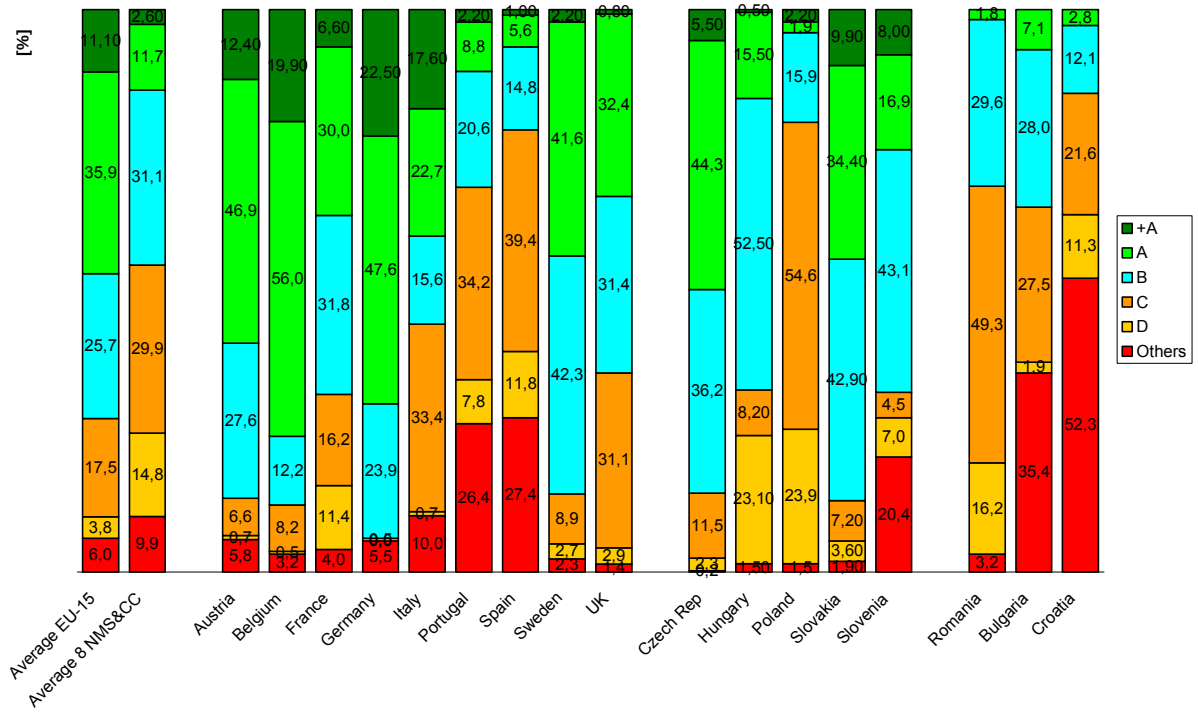


Fig. 10.: Sales of freezers in 2004 by energy class (Source GfK, [Sor2005])

The major European policy measures already in place are the mandatory energy labelling (Directive 94/2/EC), including the Amended Directive of 2003 (2003/66/EC) to introduce the A+ and A++ classes [EU 2003], and the CECED unilateral agreement [CEC2005].

The CECED unilateral agreement contains the following commitments. Participating manufacturers have stopped producing for, and importing in, the Community Market electric compressor based household refrigerating appliances having an energy efficiency index 75 (corresponding to energy label class C) and above (except for chest freezers), and for electric compressor based chest freezers having an energy efficiency index 90 (corresponding to energy label class D) and above, by 31st December 2004.
The agreement also includes a ”fleet target”: Each participant will reduce its own production - weighted average energy efficiency index- to a value of 55 for production and importation into the EU market by the year 2006. [Arn2006]

1.2.2. Washing machines

As far as the sales of washing machines are concerned, the share of A class appliances was already above 50% in 2002, in 2005 in some Member States (Germany, the Netherlands, and Belgium) there is a large penetration of A+ appliances (not defined in the labelling Directive but agreed among CECED manufacturers), and the combination of A and A+ in these markets is approaching the 100% market. The most remarkable market change from 2002 for washing machines has happened in the UK due to the Energy Efficiency Commitment (about 800000 washing machines have been subsidised each year under EEC). It is also interesting noting that the class B is almost disappeared from the market, but there is an increased share of not labelled appliances. Class A appliances are seen by consumers as a high quality product (most of A class appliances are AAA, associating to the low energy consumption, high spin speed and good washing performances).
For washing machines the EEI is expressed as the energy used per kg of soiled cloths in a standard 60ºC cotton cycle (kWh/kg).

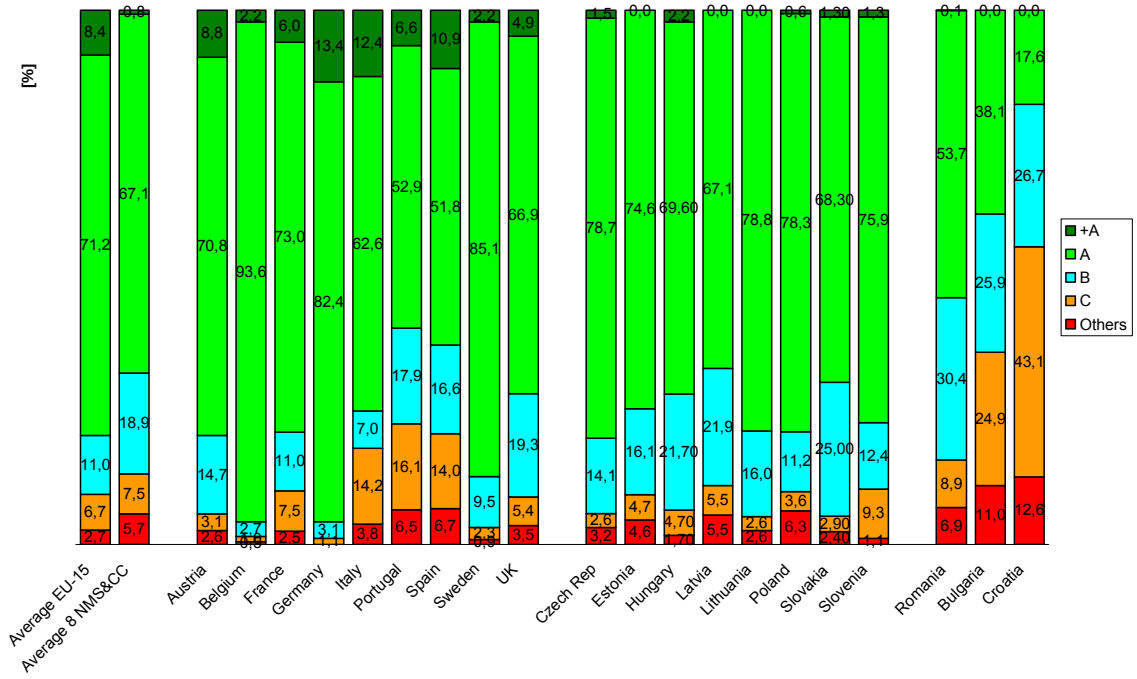


Fig. 11.: Sales of washing machines in 2004, by energy class (Source GfK, [Sor2005])

In 2005 there was not any improvement in the share of sales of A and A+ washing machines in the EU-15 (only in the countries covered by GfK), while in the New Member Sates the combined share of A and A+ models continued to grow.

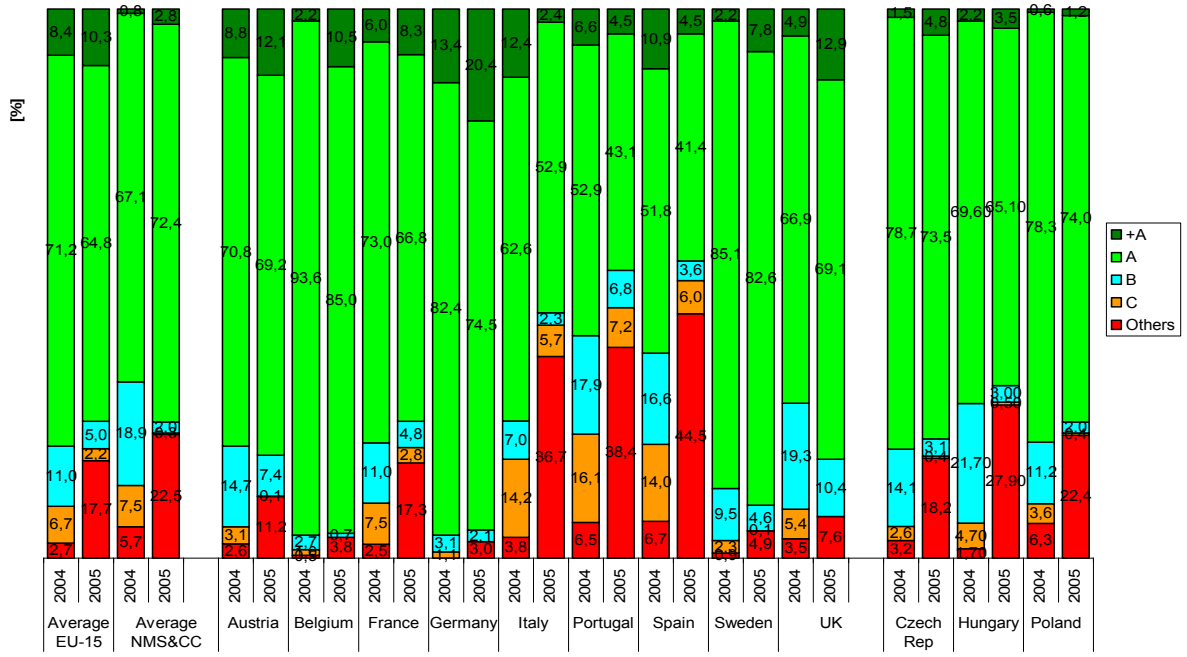


Fig. 12.: Sales of washing machines: comparison for 2004-2005 sales, by energy class (Source GfK, [Sor2005])

The production weighted average consumption of washing machines was 0,95 kWh/kg in the year 2004 per wash for a 5 kg cotton load at 60ºC cycle. The best model on the market (already for several years) has an EEI[8] of 0,85 kWh. This indicates that even with the present technology there is a large energy saving potential of about 12%, between the average model on the market and the best model.

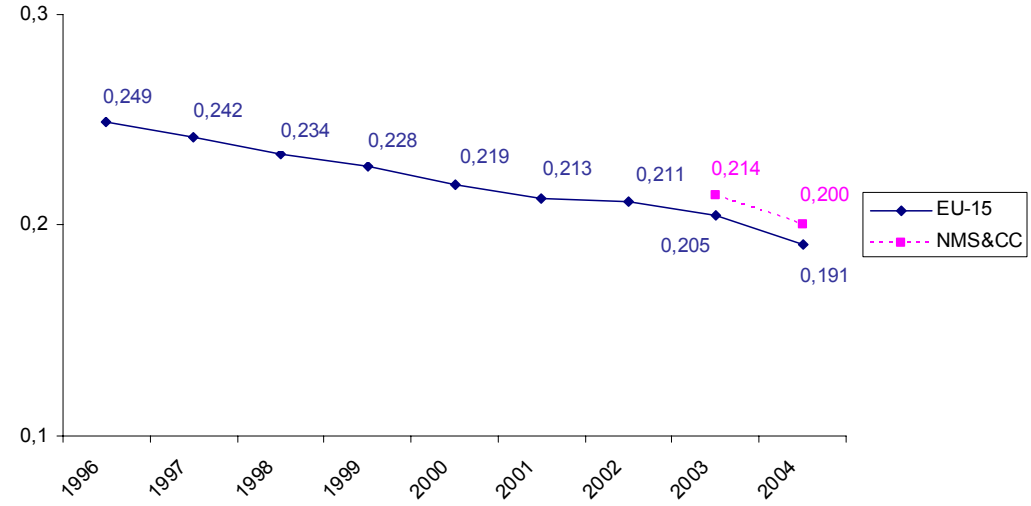


Fig. 13.: EU-15 and NMS&CC washing machines energy efficiency index progress (in kWh/kg), based on production weighted average (source [CEC2004] and JRC)

[8] For washing machines the EEI is expressed as the energy used per kg of soiled cloths in a 60ºC cotton cycle (kWh/kg)

The major European policy measures already in place are the mandatory energy labelling Directive (95/12/EC amended by Directive 96/89/EC) [EU 1996] and the CECED Unilateral commitment [CEC2004]. The central element in the 2nd CECED commitment is a reduction of the fleet energy consumption (this is the production weighted mean value of the energy consumption of all washing machines produced by the participants). The commitment calls for achieving a European production weighted average of 0,20 KWh/Kg for the year 2008. [CEC2004]. In addition at the latest by 31 December 2003 the participant manufacturers have stopped production and import in the Community Market domestic washing machines, which belong to energy efficiency class D.
The CECED notary report of 2004 shows an average mean value of 0,195 kWh/kg. The value 0,195 kWh/kg of the notary report corresponds very well with the value of the CECED technical database, which in 2004 was 0,192 kWh/kg for the old Member States (EU15) and as well 0,192 kWh/kg for the NMS-10.

Table 7.: Distribution of models in 2004 [CECED technical database; EU-15]

	EC Directive 95/12/EC energy label classes							
	A	B	C	D	E	F	G	Total
No. of appliances	3515	262	308	12				4097
	85,8%	6,4%	7,5%	0,3%				

A+ models have started to be significantly placed on Community market. There are already 1042 A+ models in a total of 4097 models in the CECED EU-15 database, and already 290 A+ models in new Member States, for a total by 1066 models put on EU-10 markets.
The relative proportion of A+ is thus quite similar between ‘old’ and ‘new’ Member States (EU10). In the period 1996 to 2004 there has been an efficiency improvement of about 20%.

1.2.3. Dishwashers

For dishwashers there was only a relatively small efficiency progress between year 2001 and 2005. In the year 2003 the average consumption per test cycle wash of a 12 place setting dishwasher was 1,197 kWh down 10% from the average consumption in 2001. The best model on the market (already for some years) has an EEI of 1,05 kWh per wash cycle. This indicates that even with the present technology there is not anymore large energy saving potential (this also means that there is no possibility to introduce an A+ class).

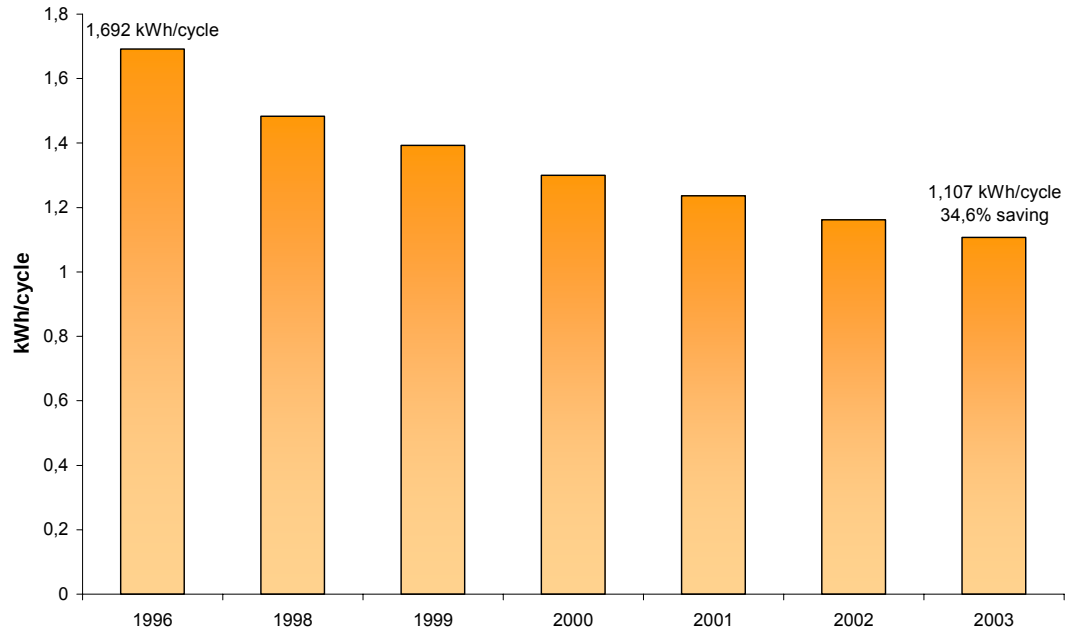


Fig. 14.: EU-15 Dishwasher energy efficiency index progress, in kWh/cycle (source CECED)

The sales of dishwashers by energy class follow a similar patter to the one of the washing machines, with the class A already above the 50% threshold. The lowest share of sales of A class appliances in 2005 was in Spain 69% (still up from 31 % in 2002), with the highest share 94% in Belgium.

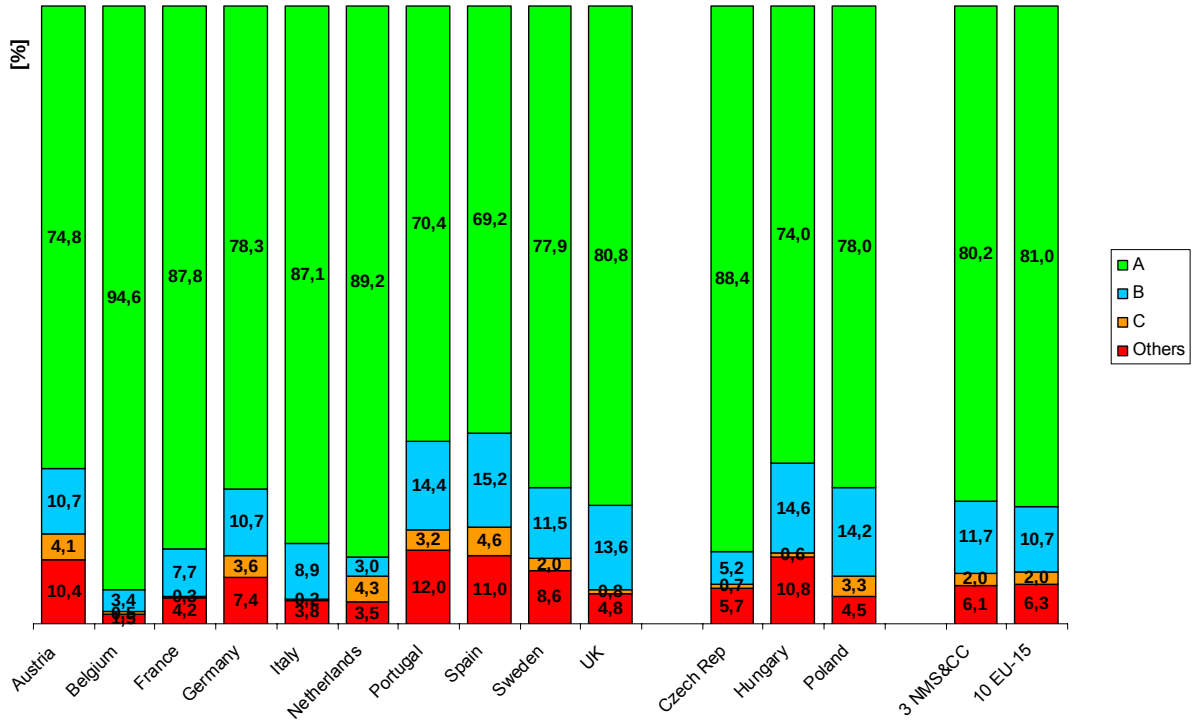


Fig. 15.: Sales of dishwashers in 2005, by energy class (Source GfK)

Remarkable progress in energy efficiency of new models took between 2002 and 2005 in all EU-15 countries, especially in the UK and Italy. Very impressive also is the high A class market share in some of the New Member States.

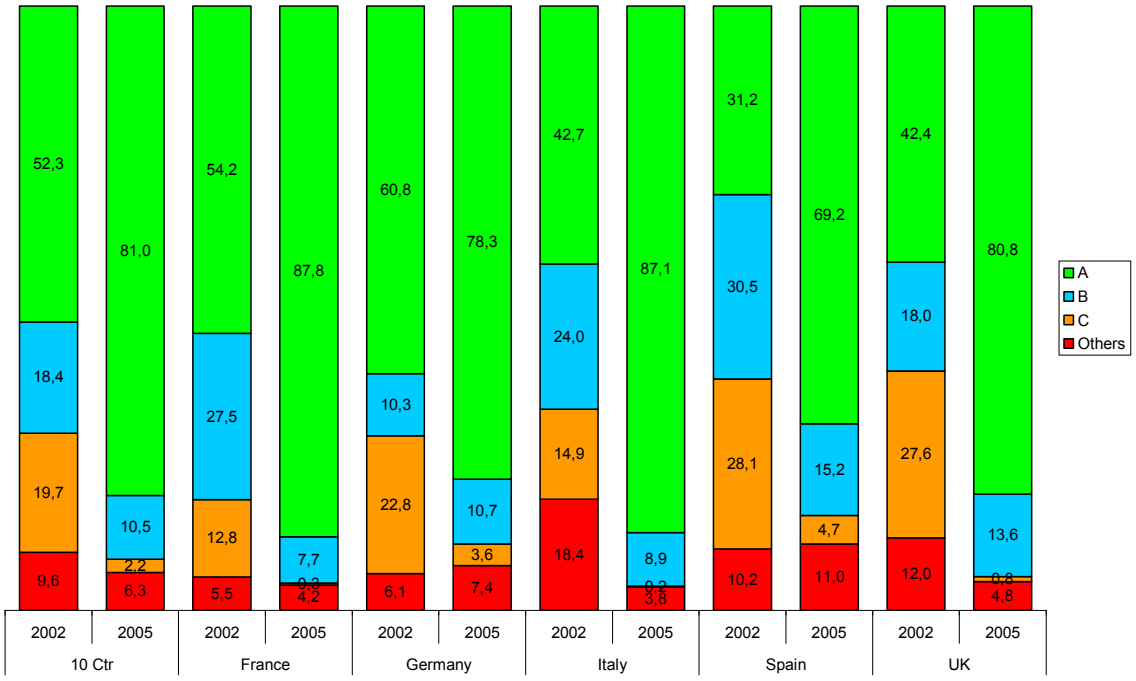


Fig. 16.: Sales of dishwashers: comparison between 2002 and 2005 for the 5 major EU-15 countries, by energy class (Source GfK, [GfK2004], [Sor2004])

The major European policy measures already in place are the mandatory energy labelling (Directive 97/17/EC amended by Directive 1999/9/EC) [EU 1999] and also the CECED Unilateral Commitment [CEC 2004], which is now expired.
The CECED agreement foresaw that participating manufacturers commonly agreed to stop producing and importing in the EU dishwashers which belong to the energy efficiency class D (for >10 place settings) or E respectively (for <10 place settings) from 31 December 2003. On 31 December 2004 the dishwasher unilateral agreement expired.

1.2.4. Cooking Appliances

Electric ovens represent 97% of the ovens sales in the EU-15 in 2005, with similar trends in the 10 New Member States. For free standing cookers the share of electric one is 34,5% and for gas ones is about 44%; interesting to notice also that for hobs the share in sales among electric and gas is 58,4% electric and 37,4% gas models, with almost 100% electric hobs in Germany and Sweden, and almost 100 % gas hobs in Italy. Hobs represent 43% of total sales in the EU-15 and about 20% in the New Member States, followed by ovens with 26% and 13% respectively, and with 26% and 66% for free standing cookers. This does not include microwave ovens which have an increasing penetration, but are not yet used to cook major meals. Total electricity consumption for electric cooking is estimated to be 52 TWh (around 37 TWh electric hobs and 15 TWh electric ovens). There is a mandatory energy label (Directive 2002/40/EC) [EU2002b] only for electric ovens, which covers also the electric ovens in free standing cookers. The impact of the energy labelling is starting to be visible on the market. The best electric oven models on the market just meet the A class level (0,8 kWh for the test cycle), while a typical model has an energy consumption in the test cycle of 1,2 kWh. There is still a long way before the class A appliances will dominate the market as for dishwashers. [Sor2006]

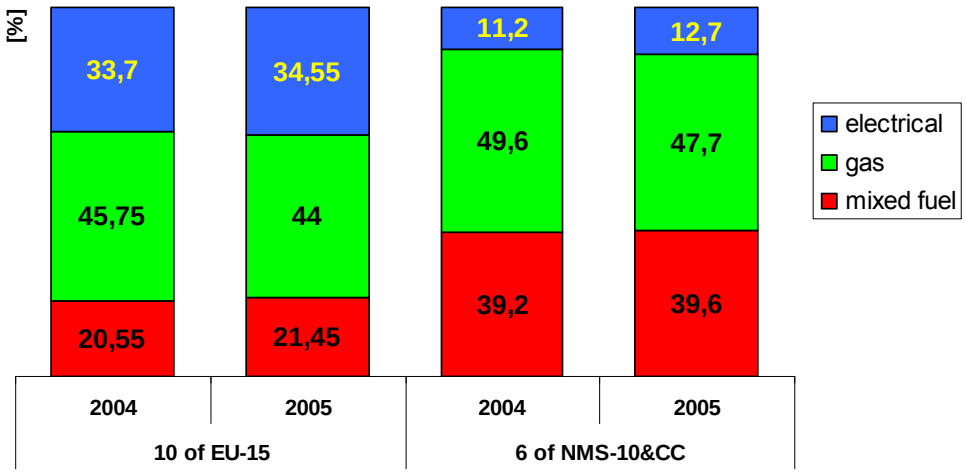


Fig. 17.: Sales of free standing cookers, by type of fuel; comparison between yrs. 2004 and 2005 (Source GfK, [Sor2006])

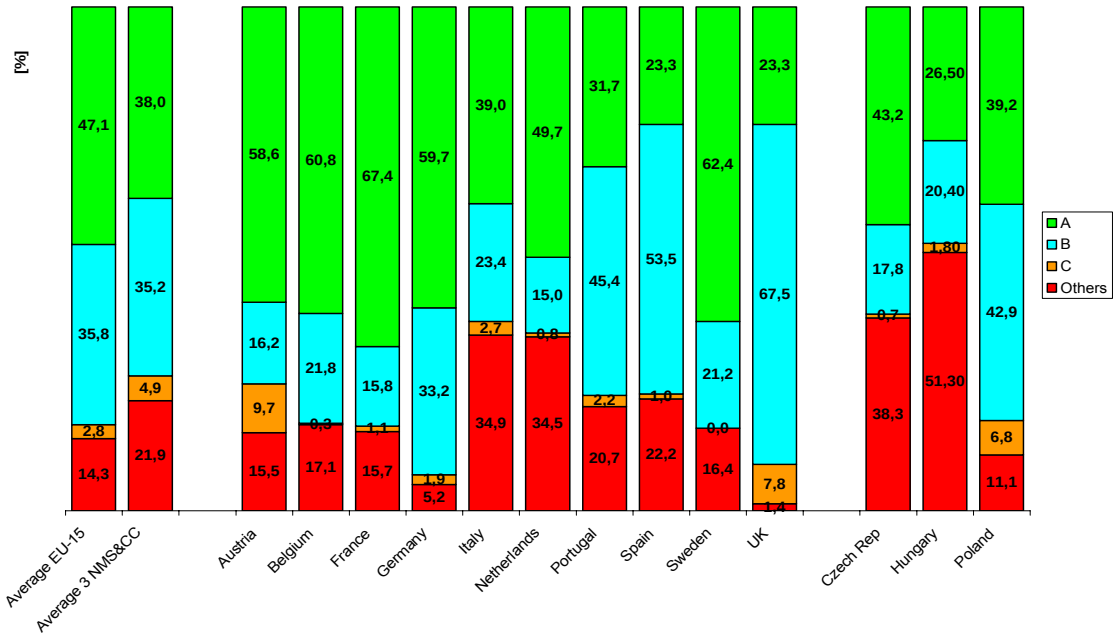


Fig. 18.: Sales of ovens in 2005, by energy class (Source GfK, [Sor2006])

1.2.5. Dryers

Dryers are the appliance where little progresses in energy efficiency have been achieved with the mandatory energy label (Directive 95/13/EC) [EU1995]. In theory, gas heated (which are not labelled) and heat pump dryers (most of them are in A class and tend to be much more expensive than conventional models), which use much less primary energy[9], are already on the market, but have almost no market share (with the exception of gas dryers in the UK). Transforming the dryer market to A-label machines will save a lot of energy: for the Netherlands alone calculated savings would be in the magnitude of 0,8 PJ per year.

[9] For gas driers, this statement is based on the average European fuel mix and efficiency for power generation

1.3. Electric Water Heaters

Electric water heaters are responsible for a considerable share of the total residential electricity consumption (9% in EU-15 and about 7% in EU-10+2). Electric storage water heaters with a capacity over 30 litres represent about 28,8 % of the installed park for primary water heaters [ECW2006], with an additional share of 7% for instantaneous electric water heater. In term of sales about 6 million of storage model where sold (or about 34,3% of total water heaters sales), with 2,4 millions instantaneous models. Until today there has been little EU level policy to improve efficiency of electric water heaters, due to the lack of suitable measurement standards, the many different types of water heaters (gas, district heating, solar, electric). Past activities for electric water heaters have concentrated on storage (tank) models and in particular on the reduction of the standing losses, through increased insulation. The only real policy action was a unilateral agreement by the main European manufacturers through their trade association, CECED. The agreement was concluded by the manufacturers at the end of 1999, and lasted till the end of 2003.The main terms of the agreement where: 1) a standing losses declaration in the form of additional and clearly visible data; 2) a stepwise phase-out of less efficient appliances ranking in certain draft energy label classes; and 3) a reduction of the European fleet consumption of appliances, as calculated by a notary system heaters [CEC1999]. The first report published in year 2003 [CEC2003] and covering the year 2001 reported successful implementation by manufacturers, reaching the agreed target as show in the figure 19.

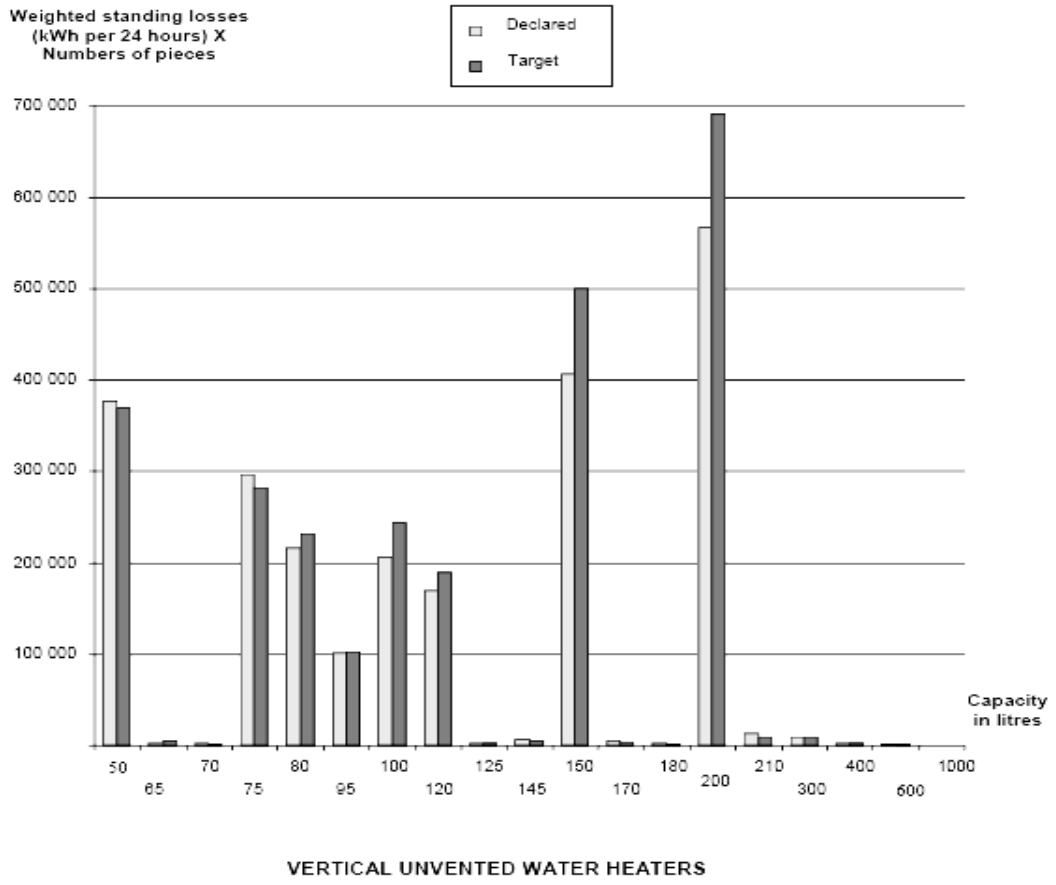


Fig. 19.: The standing losses for water heaters (target and declared one)

1.4. Consumer Electronics and Information. Communication equipments. Televisions

This is the fastest growing electricity end-use in the residential sector. It includes more "traditional" equipment such as TVs and Hi-Fi, and "new" devices such as MP3 players, PVRs etc.. The below table shows the large increase of equipment sold, considering the general trend of price decrease. CRT TVs and VCRs are also sharply reducing their sales in favour of flat TVs and DVDs. In this sector there is a fast turnover and technological development which could change the energy consumption in a rather fast way (Table 8).

Table 8.: Western European consumer electronics market, sales in million Euro (source EITO, [Lam2006])

Western Europe*	**2002**	**2003**	**2004**	**2005**	**2006**	**2003/02**	**2004/03**	**2005/04**	**2006/05**
		[million EUROs]				[%]	[%]	[%]	[%]
Cathode ray tube TV	11957	10159	8520	6041	3630	-15,04	-16,13	-29,10	-39,91
Advanced TV	3085	4821	8440	12864	17410	56,27	75,07	52,42	35,34
Plasma display TV	955	1720	2924	4097	5209	80,10	70,00	40,12	27,14
Liquid-cristal display TV	250	1174	3515	7095	10635	369,60	199,40	101,85	49,89
Rear and front projection TV	1880	1927	2000	1673	1566	2,50	3,79	-16,35	-6,40
Digital versatile disks	3172	4010	4290	4498	4474	26,42	6,98	4,85	-0,53
Video cassette recorders	1777	1089	604	330	182	-38,72	-44,54	-45,36	-44,85
Analogue camcorders	442	263	132	50	19	-40,50	-49,81	-62,12	-62,00
Digital camcorders	2176	2270	2256	2100	1938	4,32	-0,62	-6,91	-7,71
Digital still cameras	3526	5566	7299	7785	7879	57,86	31,14	6,66	1,21
Analogue set-top boxes and kits	183	162	98	95	42	-11,48	-39,51	-3,06	-55,79
Digital set-top boxes and kits	344	821	1193	1674	2446	138,66	45,31	40,32	46,12
Digital personal audio	1088	1300	2013	3110	3426	19,49	54,85	54,50	10,16
MP3-format-based digital personal audio sets	83	320	1285	2631	3097	285,54	301,56	104,75	17,71
Analogue personal audio sets	1385	1258	1145	1011	899	-9,17	-8,98	-11,70	-11,08
Home cinema systems	1216	1572	1487	1204	1115	29,28	-5,41	-19,03	-7,39
Audio home systems	2273	1777	1445	1199	986	-21,82	-18,68	-17,02	-17,76
Separate HI-FI elements	2108	1759	1473	1306	1180	-16,56	-16,26	-11,34	-9,65
Game consoles	2487	2169	1767	2230	3355	-12,79	-18,53	26,20	50,45
All other categories	6320	6715	7790	9325	9783	6,25	16,01	19,70	4,91
Analogue recording media	1028	822	702	562	408	-20,04	-14,60	-19,94	-27,40
Digital recording media	1750	2596	3751	4797	5253	48,34	44,49	27,89	9,51
Total CE	43539	45710	49949	54822	58764	4,99	9,27	9,76	7,19

**Western Europe includes Austria, Belgium, France, Germany, Italy, Netherlands, Sweden, Spain, Switzerland and UK. Note: These market estimations and forecasts result from GfK manufacturers' collaboration. Data published for the previous years are as of November, anticipating Christmas trade. As a result, GfK revises these data the following March, after data for the previous year have been confirmed.*

1.4.1. TVs, VCRs and DVDs

TVs are the largest electricity consuming appliance in this sector. According to GfK total sales of TV continues to grow, and reached 30 million in 2005. In addition in 2005 non CRT models gained a considerable market share.

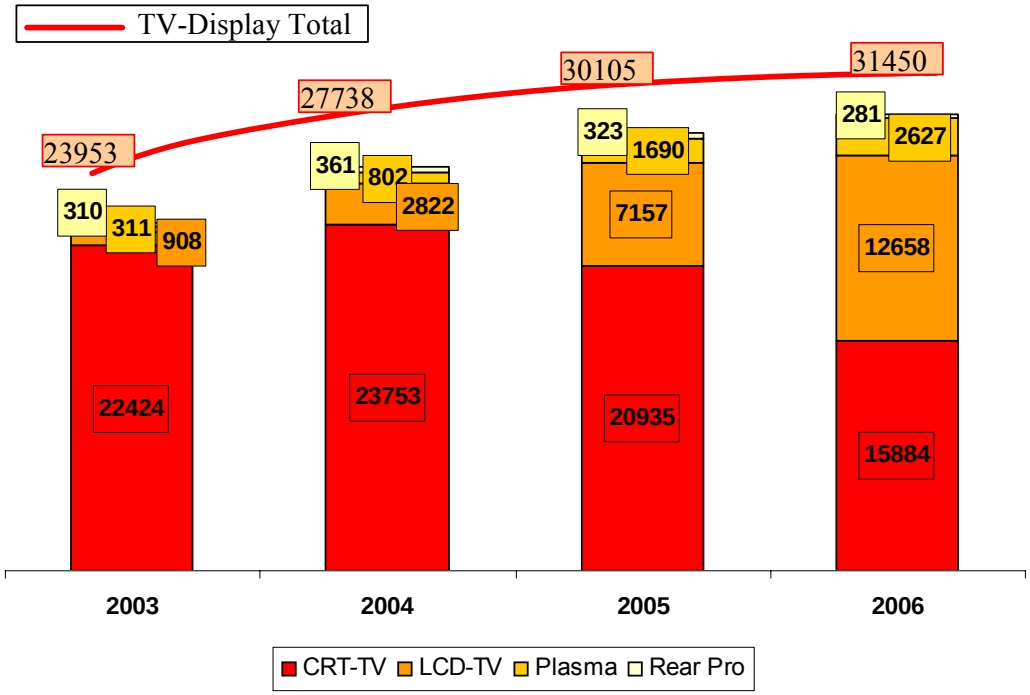


Fig. 20.: Sales of TVs (source GfK)

GfK presented at the EEDAL'06 conference [Boy2006] data for a selected number of EU-15 Member States that confirmed the increased penetration of TV in households (more TVs per household, often old TVs moved to a different room), and the increased number of viewing hours.

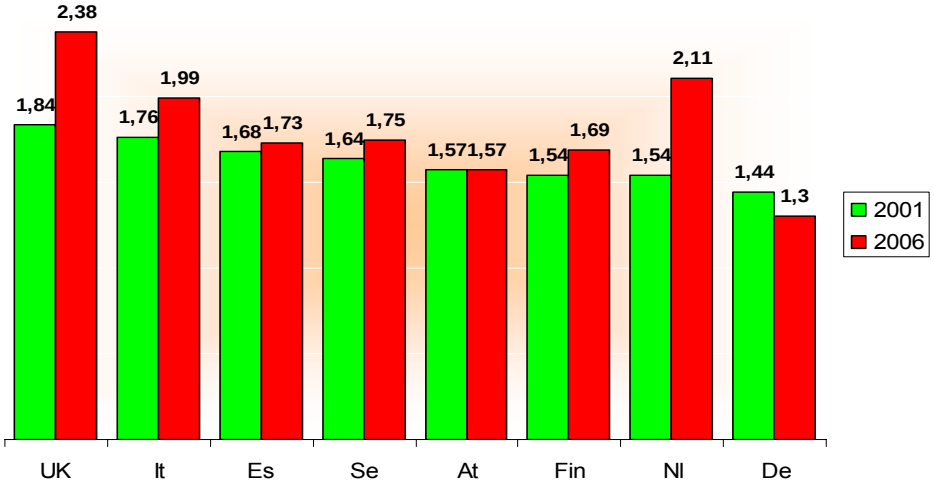
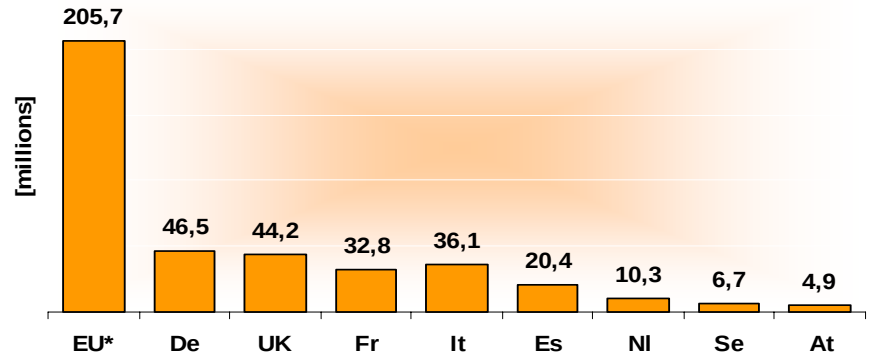


Fig. 21.: increased number of TV per Household (source GfK)



**this is the sum of the TV set in use in the above mentioned countries and not for the overall EU countries.*

Fig. 22.: TV set in use (source GfK)

GfK also investigated the average number of viewing minutes at the global level, as shown in the figure 23. Referring to the year 1995 the number of viewing minutes on TVs increased with 13% (27 minutes more per day) till 2005.

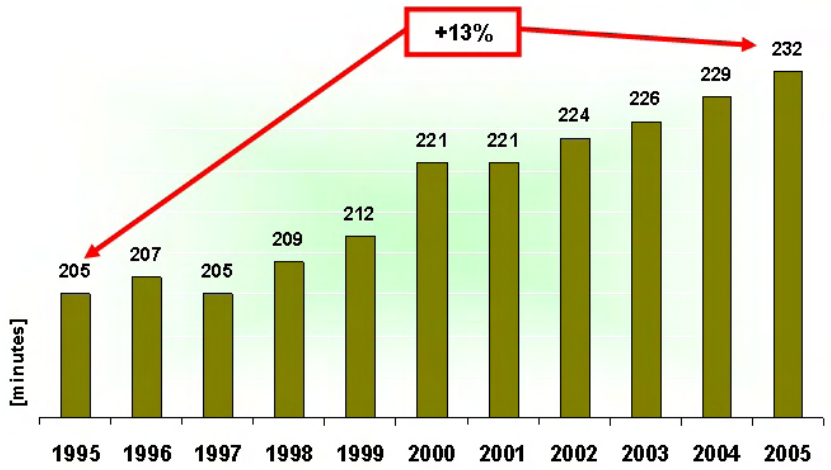


Fig. 23.: Average use of Color-TV in minutes per day (source GfK, [Boy2006])

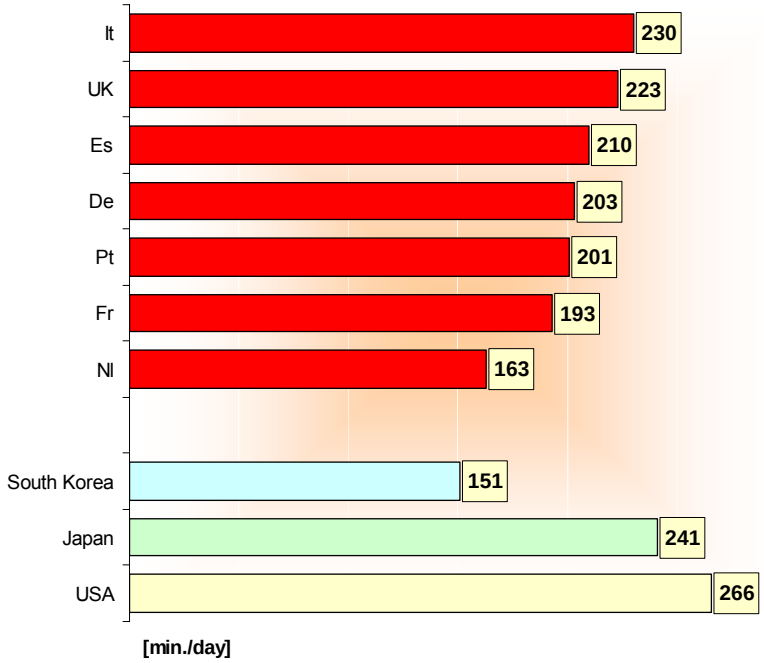


Fig. 24.: Average Daily Viewing Time (source GfK, [Boy2006])

The study in the frame of the Eco-design Directive [ECT2006] calculated for the EU-25 an average penetration rate for TV set of 1,48, which is expected to grow to 2,08 by 2010.

Table 9.: Data on CRT, LCD, PDP and RP television sales, stock and penetration for EU-25

Status Quo 2003 EU-25	**CRT**	**LCD**	**PDP**		**Total**
Sales [no. of TV sets per year]	29681130	769943	223928		30675001
Share of technology in sales [%]	96,76	2,51	0,73		100,00
Annual sales growth rate 2001-2002 [%]	-1,48	605,62	207,83		1,20
Replacement sales [no. of TV sets per year]	29681130	286167	-		30305605
New sales [no. of TV sets per year]	-	286167	83228		369395
Stock [no. of TV sets per year]	269971292	903458	318250		271193000
Share of technology in stock [%]	99,55	0,34	0,12		100,00
Penetration rate [no. of TV sets per household]	1,48	0,005	0,002		1,48
Prospect 2010	**CRT**	**LCD**	**PDP**	**RP**	**Total**
Sales [no. of TV sets per year]	4907000	25889000	5518000	215000	36530000
Share of technology in sales [%]	13,4	70,9	15,1	0,6	100,00
Annual sales growth rate 2009-2010 [%]	-22,1	-8,9	-4,9	0,5	-2,80
Accumulated sales 2001-2010 (100%) [no. of TV sets]	186243000	112595000	25260000	2159000	326256000
Accumulated sales 2001-2010 (120%) [no. of TV sets]	223491000	135114000	30312000	2591000	391513000
Stock [no. of TV sets per year]	251499000	112595000	25260000	2159000	391513000
Share of technology in stock [%]	64,2	28,8	6,5	0,5	100,00
Penetration rate [no. of TV sets per household/188 million]	1,34	0,59	0,13	0,02	2,08

European policies to improve TV efficiency were introduced staring from 1996 and initially covered only standby losses. The first measure was the TVs and VCRs standby losses unilateral agreement which was signed in 1997 by 16 companies and notified to the competition authorities by the consumer electronic trade association (at the time EACEM, now EICTA). Manufacturers agreed that the company sales-weighted average would be progressively reduced towards 3W by 2009. The target refers to the company *sales-weighted* TVs and VCRs stand-by consumption. Models with standby consumption over 10 W were to be phased out. In 2003 already sale-weighted average power consumption of 2.21 W and 3.53 W was achieved for TVs and VCRs respectively.
More recently EICTA (the European Industry Association for Information Systems, Communication Technologies and Consumer Electronics) submitted in 2003 to the European Commission a new Self Commitment (unilateral commitment), signed by the a large number of the their member companies, to reduce the energy consumption of consumer electronics by continuously seeking to improve the energy performance per appliance.
According to the new EICTA unilateral commitment the following targets for CRT TVs, non-CRT TVs and DVD' players were established:

1. For Analogue CRT based television receivers:
   - Achieve a sales weighted average of 3,0W standby passive in 2005 with the target for new chassis of analogue TVs for 2005 is 1,0W;
   - Achieve maximum power consumption in standby passive to 1W by 2007;
   - Improve the sales-weighted energy efficiency index by a target of 10%, with a minimum of 5%, improvement in energy efficiency by 2007, with a longer-term objective of achieving a target of 15%, with a minimum of 10%, improvement in energy efficiency by 2010.
   - For all new models introduced after the 1st of June 2004 manufacturers will provide information on the power consumption of the equipment in the ON, standby modes and estimated annual energy consumption (kWh to potential purchasers on, or alongside, the product at the point of sale.
2. For non-CRT based analogue television receivers:
   - Achieve a sales weighted average of 3,0W, for power consumption in standby passive by 2005;
   - Set maximum power consumption in standby passive to 1,0W by 2007.
   - For all new models introduced after the 1st of June 2004 manufacturers will provide information on the power consumption of the equipment in the ON, standby modes and estimated annual energy consumption (kWh to potential purchasers on, or alongside, the product at the point of sale**.**
3. For DVD stand alone players:
   - Achieve 1W for power consumption in standby passive by 2005;
   - Report on an annual base the market share of DVD players, and the standby power consumption.

12 participating manufactures have provided the data which represents approximately 51% of the EU (15+ Switzerland and Norway) for the CRT TV market in 2004.
The sales weighted average stand-by consumption is higher in 2005 (2,2 W) compared to the equivalent 2003 figure (1,75 W, which was the lowest achieved), it is well below the target set for 2005 of a sales weighted average of 3,0W standby passive.

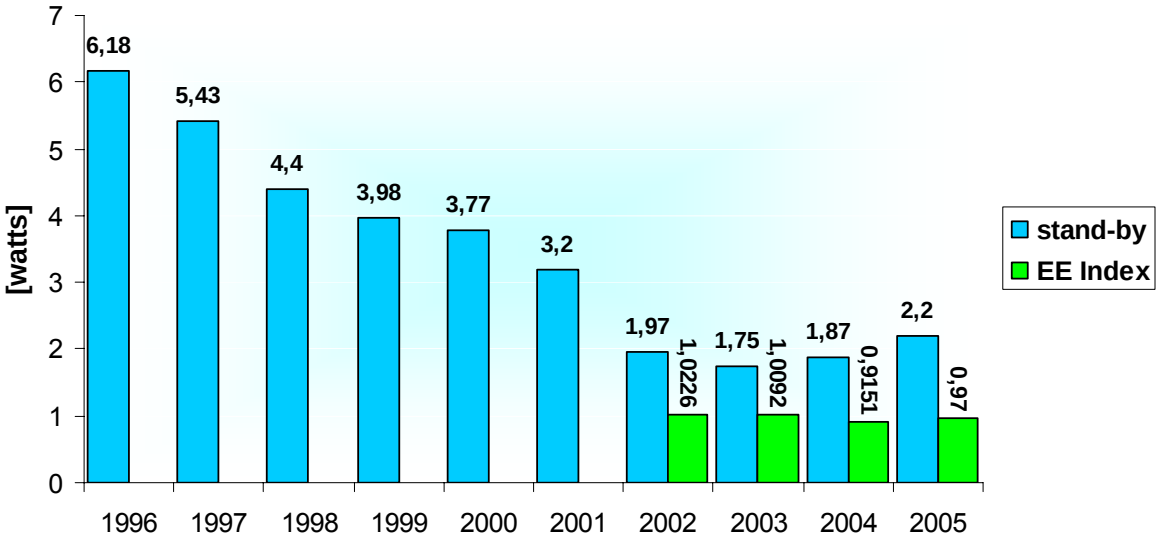


Fig. 25.: Analogue CRT TV receivers average stand-by power consumption and EE Index (source EICTA, [EIC2005])

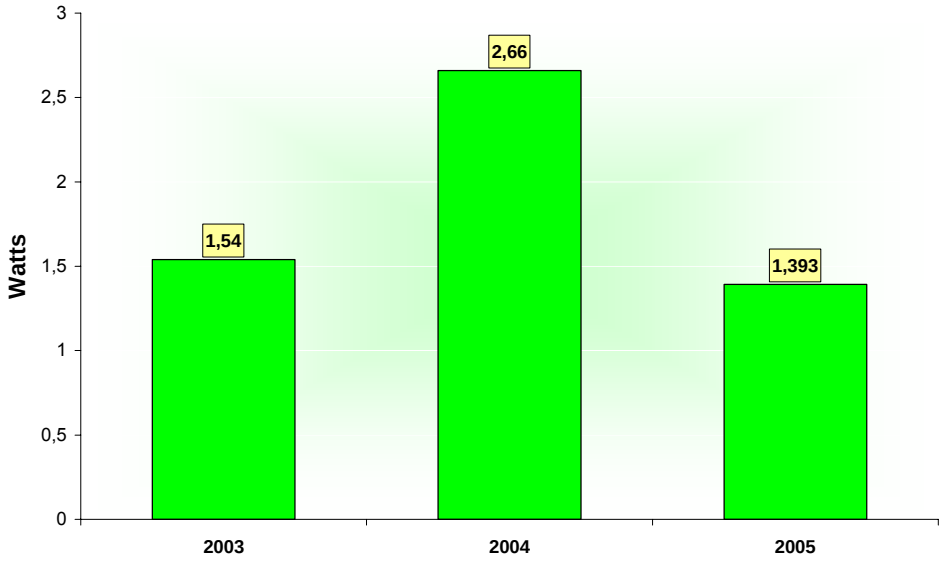


Fig. 26.: Non CRT TV receivers average stand-by power (source EICTA, [EIC2005])

Many new TV models have now standby consumption well below 1 W, some companies have introduced a company policy to have all their models below 1 W. For VCRs the best appliances have a standby consumption around 1 W (eco-mode), many have standby consumption around 2W, however, it must be noted that VCRs sale are decreasing very rapidly. For DVD- players (which take the place of VCRs on the market and are experiencing a boom in sales) standby passive of best appliances is below 0,5 W. More recently policy makers' attention has been drawn to the television on-mode consumption, due to the increase in the viewing hours and the size of the TVs. In order to compare on-mode consumption of TVs having the same size and features (TV consumption is strongly related to the size), an EEI has been developed by industry EICTA and experts.
The data on TVs' EEI is still very limited because most manufacturers do neither indicate the energy efficiency index nor the power consumption in the on-mode. New trend on the market having an important impact on energy consumption are larger screen sizes and plasma TVs,

which use considerable more energy (350-400 W, but new developments can decrease this to less than 300). Smaller LCD TVs typically have an EEI of 0,4, larger LCD TVs tend to have the same consumption as CRT TVs. The best CRTs on the market have an EEI of 0,995. Finally, prospects for improving efficiency in LCD TVs are better than for improving efficiency in CRT TVs, in particular by introducing solid state lighting in the backlighting systems. [Sid 2004].
A similar unilateral agreement was introduced in year 2000 by EICTA to reduce consumption of audio equipment. The targets for this agreement are as follows: maximum allowed stand-by consumption of 5 W for all equipment marketed after 1/1/2001; maximum allowed stand-by consumption of 3 W for all equipment marketed after 1/1/2004; maximum allowed stand-by consumption of 1 W for all equipment marketed after 1/1/2007. No report on the implementation of this agreement has been made available till present.

1.4.2. Digital TV services

Another major driver for the increase in electricity consumption is the move to digital TV and broadband communication. The European Union is rapidly moving toward the switch to digital TV and the phase-out of analogue broadcasting. This means that the current stock of analogue TVs will need converter boxes in order to function. In 2004 and 2005 millions of these boxes were be sold in Italy, the UK and other European countries. At the same time, pay-TV is competing on the market with more sophisticated services and offers, resulting in even more complex set-top boxes, which show a worrying trend in rising energy consumption levels.
In addition to the digital TV services supplied through satellite, terrestrial and cable (fibre or coax), there are new service providers starting to offer digital TV and video-on-demand through the telephone lines with DSL modems or using power line technology. These trends will accelerate the convergence between Information Communication Technology equipment and consumer electronics and have a big impact on energy consumption (more than one system always on in each dwelling, and increasing electricity demand for each device as it gets more powerful).
According to the Canalys research company the number of households with digital TV in Western European countries was already over the 50 million during the first half of 2005. This high number has been reached through the switch from analogue to digital by pay-TV providers and the set up of free-to-air services in many Member States. The European Commission has indicated a switchover target of 2010, and the stronger than anticipated success of digital TV in several countries - including France, Germany and Sweden - means that many European countries would be meeting the target. [Til2005]
The UK has the highest household penetration of digital TV in Europe, primarily driven by Sky and Freeview. Finland is second with the combination of both free-to-air and cable companies. In terms of overall number of households the UK leads too, while Germany is only on the same level as Italy and France. Germany's pay-TV cable providers still serve most of their customers by multi-channel analogue transmission. Germany has taken a regional approach to analogue switch-off, with the last region not scheduled to make the move until 2010. These dates, much more than consumer demand, will shape digital TV adoption in Germany [Til2005].
France is the European leader today in IPTV (TV offered through internet). Free-to-air services were launched in March 2005.
In Italy, free-to-air digital TV had a strong growth, partially due to the former government subsidies available on terrestrial digital set-top boxes.

Canalys estimates that 50% of digital TV households in Western Europe today receive service by satellite, with 24% using terrestrial broadcast, followed by 22% on cable and 4% via IPTV. Although the majority of European digital TV viewers are still paying for the service, free services are growing quickly and already account for more than one-fifth of the market. Canalys expects over 40% of European digital TV households to be using only the free services by 2008 [Til2005].
Subscription digital satellite TV at the end of 2005 reached about 15 % of Western Europe household [LMP2006].
There are different digital technologies in the national markets. Cable is dominating the market in Belgium and Switzerland while satellite is predominated in Austria and Spain. Among the broadcasters, Sky leads due to its large installed base in the UK, and is followed by Canal+, Premiere, Digital Plus and Mediaset. Across Europe, however, the various free-to-air providers as a group already have more customers than Sky [LMP2006].
According to 'European Switchover Strategies', a report from market research firm Informa Telecoms & Media, 44,9 million European households will have access to DTT signals on their main TV set by 2011 [Til2006].
Sweden, which was one of the first countries to launch a digital terrestrial service and has just under half a million subscribers, is expected to be one of the first to switch off analogue transmissions in 2008. The UK, with 5,78 million subscribers, is still aiming for analogue switch-off in 2012.
Other recent reports announced that 10 million Digital Terrestrial Transmission (DTT) set-top boxes have been sold in the United Kingdom. Together with cumulative DTT set-top boxes sales in the rest of Europe, it is estimated that over 20 million DTT set-top boxes have now been sold. The number of DTT households in Europe increased from 8,2 million at the end of 2004 to 11,6 million by mid 2005. [Mou2006]
Of the five largest western European markets, those with established DTT markets, the United Kingdom, Italy and German, showed continued growth while two potentially large markets, France and Spain, launched DTT services in 2005. In both France and Spain, set-top box sales exceeded initial industry estimates.
In France approximately 1,7 million DTT receivers were sold as of the end of 2005. In Spain at the end of 2005, 1 million households could access DTT services.
Italy it is estimated that over 3 million set-top boxes have been sold in 2004 and 2005. In Germany over 60% of the population can now access DTT services. It is estimated that over 4,5 million DTT receivers have been sold in Germany (other reports quote about 3.5 millions).
The United Kingdom has one of the highest DTT penetration rates in Europe with over 6 million households relying on the DTT platform as their main television reception platform.
The DTT platform has also progressed strongly in the Nordic countries. Finland and Sweden. Finland currently holds the highest DTT penetration rates in Europe with nearly 30% of its population accessing DTT services. In Sweden, DTT is currently the fastest growing digital platform and is expected to become the largest digital platform in 2006. Nearly 600,000 households access the available free-to-air and pay DTT services. DTT growth has been slower in Belgium, the Netherlands and Switzerland where cable reception dominates the television market. The Czech Republic launched its DTT services in October 2005 and 150,000 DTT set-top boxes have been sold. DTT launches have been announced in Estonia, Slovakia and Lithuania. Ongoing DTT trials are in place in Croatia, Estonia, Hungary, Lithuania, Macedonia, Poland, Serbia-Montenegro, Slovakia and Slovenia.

In 1997, a working group lead by the European Commission identified the digital service system STB as the domestic electronic device with one of the largest potential to increase energy consumption in European households.
Research into proposed development showed that by 2010, the STB could push domestic electronic energy consumption in Europe above that of refrigerators and freezers. With potentially over 200 million of these boxes across the EU - equivalent to one per household – the annual electricity requirement for digital service systems with full functionality and poor power management could be around 60TWh.
To limit the potential growth in energy consumption a voluntary programme was introduced, the European Code of Conduct for Digital TV Services[10], developed by a working group which includes all the stakeholders. The Code of Conduct sets out the basic principles to be followed by all parties involved in digital TV services, operating in the European Community in respect of energy efficient equipment.
The two below graphs shows the power consumption of new Set Top Boxes (STBs) sold in the EU by companies that have signed the Code of Conduct requirements. STBs not designed to be efficient may always be on with a power consumption of 20W or more. It is also important to notice that both the standby and on-mode power have decreased in the period 2001 to 2005 despite a strong improvement in performance and features.

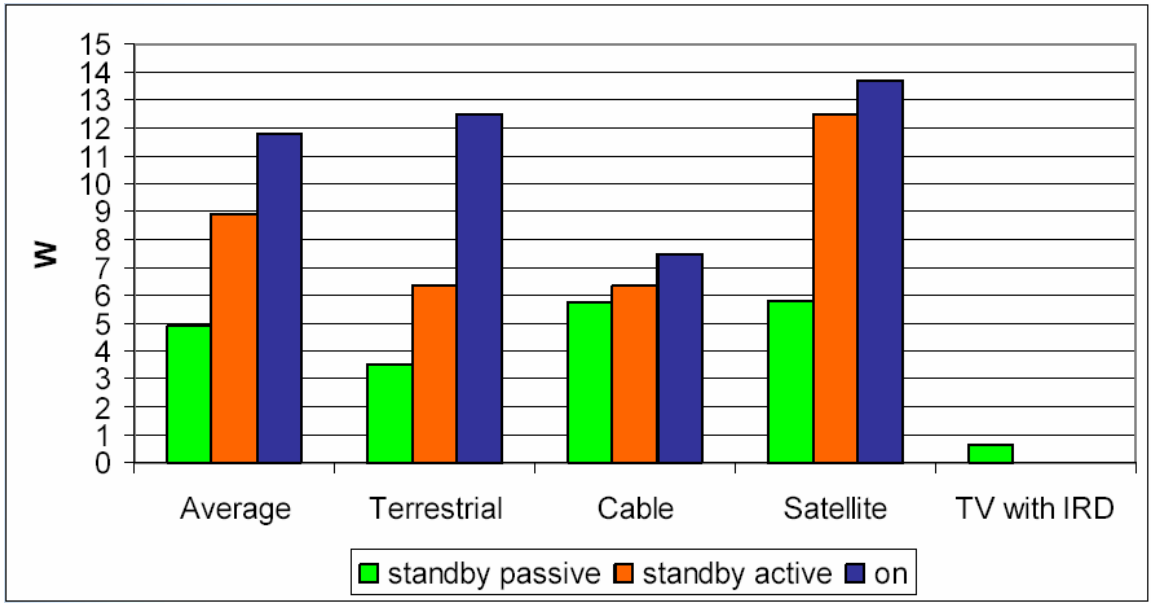


Fig. 27.: Power consumption for individual set-top boxes in year 2005 (source [Har2006])

[10] All the information can be found at http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_digital%20tv%20services.htm

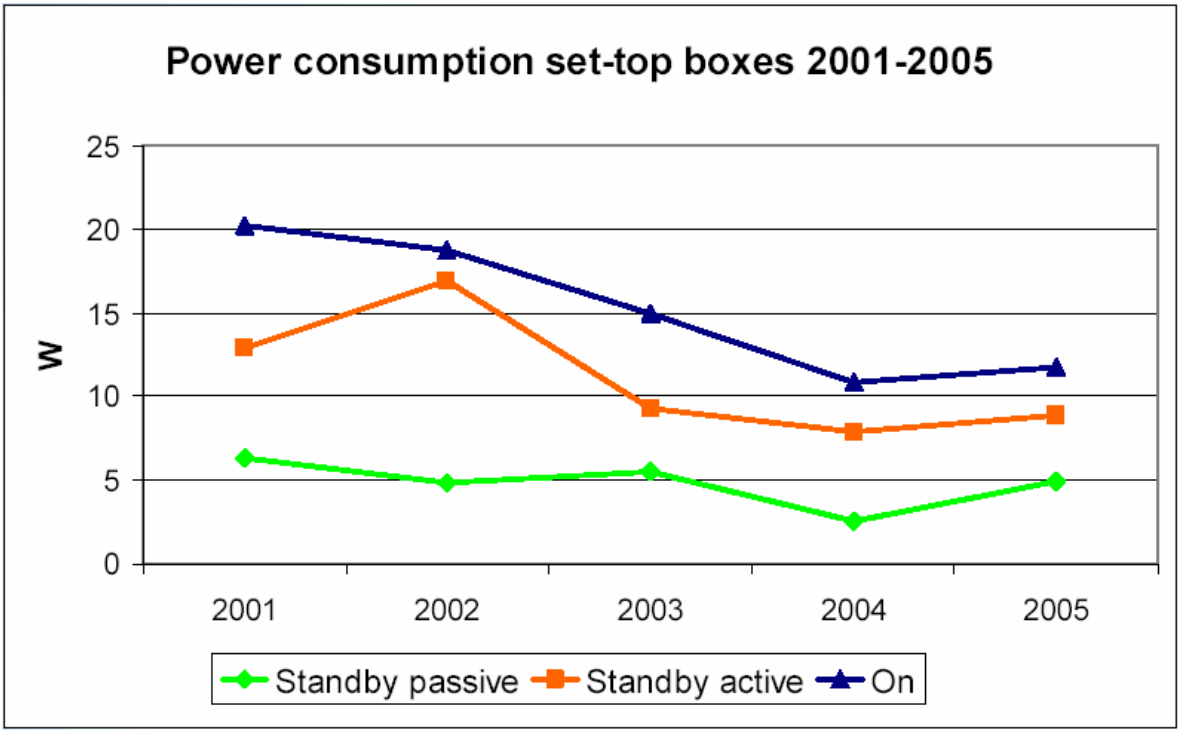


Fig. 28.: Power consumption for set-top boxes between 2001-2005 (source [Har2006])

1.4.3. Broadband Equipment and office equipment

Another driver in the increase of consumption in households (and also in the service sector in the network infrastructure and data centres) has been broadband communication and office equipment (PCs, printers, scanners, monitors, etc.). According to the Eco-design study on Personal Computers and Monitors [ECC2006] in 2005 there were about 105 millions desktop, 24 millions laptops and 104 million monitors (of which 47 where flat panel) installed in household in the EU-25. The only policy measure in place for office equipment is the voluntary quality labelling Energy Star[11].

Broadband is one of the fastest among new communication technologies in Europe. The total number of broadband lines in the EU has quadrupled in just three years. Detailed data on DSL usage in Europe is still in compilation.

In October 2005, 80% of broadband subscribers in the 25 EU Member States used DSL to connect to broadband Internet. Cable modems currently account for about 16% of all broadband connections in the EU-25 [Com2006].

In January 2006, broadband reached almost 60 million subscriber lines in the EU-25 and had a penetration rate of about 25% of households. Growth in broadband is mainly market-driven.

Broadband growth is uneven across Member States. The best performers on broadband penetration have been and are the Netherlands, Denmark and Finland, with a penetration rate above 20%. Belgium and Sweden follow closely, and the U.K. and France have achieved 15%. Most new Member States, plus Ireland and Greece, lag behind, with Greece, Poland, Slovakia, Cyprus, Latvia, Hungary and Ireland at penetration rates below 5% in October 2005 [Com2006].

In terms of broadband coverage, the Benelux countries and Denmark do not suffer any urban/rural gap mainly because they are relatively small, flat countries. However, large gaps

[11] For more information http://www.eu-energystar.org

can be found in France, Germany, Austria, Italy, Ireland and Greece. As DSL in Europe is currently the most common technology and tends to overlap with cable modem, its coverage is a good approximation of broadband deployment.
Current projections show that the predicted uptake of the two key broadband WANs (wide area communication networks), DSL (digital subscriber line) and digital cable, will have a large potential impact on European household energy consumption. Even with the unlikely application of best practice in energy efficiency for all the network and end-user hardware, a simple broadband terminal for, say, 200 million EU households by 2010 would increase annual domestic electricity demand by an estimated 6,6 TWh. This could effectively be doubled by associated LAN equipment.

Table 10.: Countries with more than one million DSL subscribers, 31 March 2006
(Source: data provided for the DSL Forum by Point Topic)

Ranking (ranking in the world)	**Country**	**Total DSL Q1 2006**
1 (4)	Germany	11 100 000
2 (5)	France	10 214 000
3 (6)	UK	7 921 500
4 (7)	Italy	7 024 300
5 (9)	Spain	4 294 800
6 (13)	Netherlands	2 587 000
7 (17)	Poland	1 429 429
8 (18)	Sweden	1 382 500
9 (19)	Belgium	1 344 252
10 (21)	Finland	1 088 935

Figures on energy consumption for DSL modems vary significantly. In the UK, the largest national telecommunication provider, BT, has, through energy efficient procurement policy, provided basic, self-powered external DSL modems with a 4,0W power requirement. More typical devices in the open market and supplied by some other European telecommunication groups have a power requirement of about 10 W. With the latter, up to 87 kWh per annum could be added to a household's energy overheads.

Table 11.: Penetration of ADSL lines in 2004-2008, in thousands (source [Lam2006])

ADSL Lines	2004	2005	2006	2007	2008	CAGR% 2004-2008
Eastern Europe	1,378	2,205	3,087	4,383	5,698	42,6
Western Europe	31,464	47,503	62,019	75,02	85,178	28,3
Total Europe	32,842	49,708	65,106	79,403	90,876	29

The EU added in 2005 more than 17 million new DSL subscribers in the period to reach 52.8 million – at a growth of 48% – extending its global share of the DSL subscriber market to almost 35%.

Table 12.: DSL penetration of phone lines, 31 March 2006. Countries with DSL population of more than one million (Source: data provided for the DSL Forum by Point Topic)

Ranking (ranking in the world)	**Country**	**Penetration (DSL/100 phone lines) Q1 2006 [%]**
1 (1)	Finland	38,3%
2 (2)	France	30,0%
3 (5)	Belgium	26,2%
4 (6)	Netherlands	25,9%
5 (7)	Italy	25,6%
6 (9)	Spain	23,0%
7 (10)	UK	22,5%
8 (12)	Sweden	21,0%
9 (13)	Germany	20,7%
1 (1)	Finland	38,3%

Expectations are that broadband equipment will contribute to the electricity consumption of households in European Community in the near future. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, a total European consumption of up to 50 TWh per year can be estimated for the year 2015. To address the issue of energy efficiency whilst avoiding competitive pressures to raise energy consumption of equipment all service providers, network operators, equipment and component manufacturers helped the European Commission to develop the Code of Conduct for Broadband equipment[12].

The Code of Conduct sets out the basic principles to be followed by all parties involved in broadband equipment, operating in the European Community, in respect of energy efficient equipment.

The Code of Conduct covers, both on the consumer side (end-use equipment) and the network side (network equipment), for services providing a two way data rate of 144kb/s or above. With the general principles and actions resulting from the implementation of the new Code of Conduct on energy consumption of broadband equipment the (maximum) electricity consumption in this sector could be limited to 25TWh per year.

1.4.4. External Power Supplies

Another component that is contributing to the increase of the electricity consumption are the external power supplies. These external power supplies are used for many different types of electric and electronic devices, such as mobile telephones (the fast penetration is shown in the table below), digital cameras, cordless phones, notebook PCs, modems, kitchen tools, power tools, etc.

[12] all the information can be found at
http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_broadband%20communication.htm

Table 13.: Mobile subscriptions, 2004-2008, in thousands (source EITO Task Force, [Lam2006])

Mobile subscriptions	2004	2005	2006	2007	2008	CAGR % 2004-2008
Denmark	5120	5251	5377	5498	5618	2,3
Finland	4937	5344	5483	5609	5717	3,7
France	44544	46221	47422	48659	49828	2,8
Germany	71437	78104	81618	84385	86917	5
Italy	62751	69032	72208	75396	78748	5,8
Spain	38716	42226	44126	45935	47936	5,5
Sweden	9529	9923	10101	10266	10451	2,3
United Kingdom	61835	65914	68814	71153	72913	4,2
Western Europe*	411444	441111	459511	476101	490633	4,5
Eastern Europe**	180082	255716	311973	358769	394646	21,7
Total Europe	591526	696827	771484	834871	885279	10,6
USA	181243	205219	225420	240482	253446	8,7
Japan	90273	94730	97539	100231	102851	3,3
Rest of the world	857564	1153982	1400436	1618680	1804172	20,4
World	1720606	2150757	2494879	2794264	3045748	15,3

**Includes also Turkey, **Geographical demarcation*

The above table show the large increase in mobile phone users. Similar trends are also observed for other new electronics devices using external power supplies for charging the batteries. The study on External Power supplies in the frame of the EcoDesign Directive [ECH2006] assumed sales in the EU for external power supplies and battery chargers of about 500 millions with mobile telephone representing about 50% of these sales. The study estimated the current stock of external power supplies to be in the order of 2 billions, which correspond to an average of about 12 external power supplies per household, however the stock includes the external power supplies in the non residential sector. A better estimate will be to have 5 to 8 external power supplies per household.

For external power supplies, the only energy efficiency policy in place at the moment is the European Code of Conduct[13], which was introduced in year 2000 to reduce the no-load losses, and recently also to improve the on-mode efficiency. In the graph below are shown the results achieved by the participating manufacturers in the CoC. Before the introduction of the Code of Conducts many external power supplies had no-load power consumption above 1 W, and low efficiency in operational modes.

[13] all the information can be found at http://energyefficiency.jrc.cec.eu.int/html/standby_initiative_External%20Power%20Supplies.htm

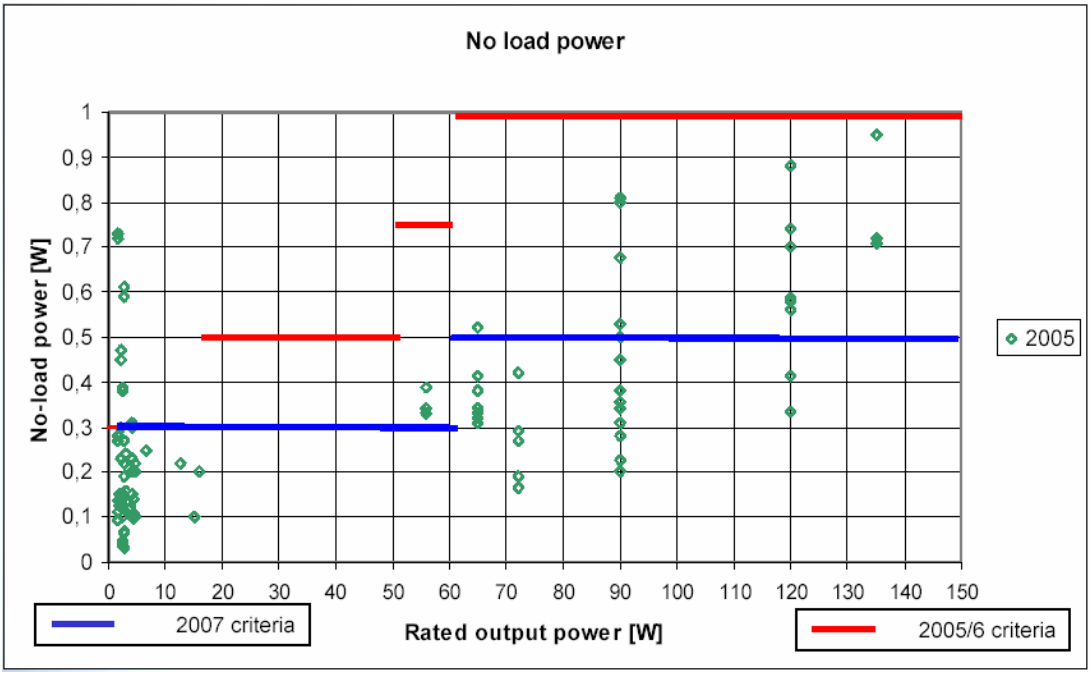


Fig. 29.: No-load power new criteria for external power supplies and results achieved by participating companies(source [Har2006])

By 2005 many of the external power supplies in the European market have no-load losses below 1 W.

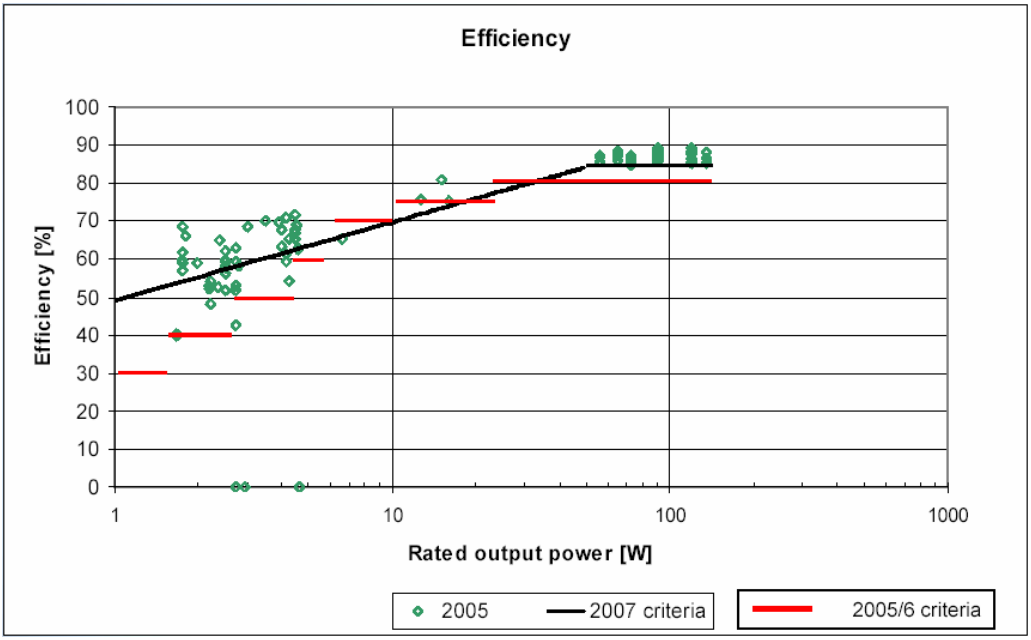


Fig. 30.: New efficiency criteria for external power supplies and results achieved by participating companies (source [Har2006])

1.5. Residential Lighting

Compact Fluorescent Lamps (CFLs)[14] represent one of the most efficient solution available today for improving energy efficiency in residential lighting. The recent drop in price to together with several information and promotion campaigns had a positive impact on sales. In particular, two different types of CFLs are marketed: the short life (average life around 6000 hours) and the professional models (average life around 12000 hours). The first type is mainly marketed for the residential sector. Direct sales comparison between incandescent and CFLs and incandescent is not meaningful as CFLs have a longer life time (6 to 12 times or more). Moreover it is difficult to gain access to sales data, and sales data available includes lamps not destined to the residential sector.

Table 14.: Sales of CFL lamps (Source [ELC 2004, Str 2004])

Product	**Market (million units)**					
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Western Europe						
CFL-I	101	109	119	131	145	146
CFL-NI	72	78	80	82	87	92
Central & Eastern Europe						
CFL-I	14	21	27	34	41	
CFL-NI	9	10	12	13	15	

The below table gives a more accurate picture of the present status of lighting consumption and CFL penetration in households in the EU-25 countries, as well as the new Member States Romania and Bulgaria and Croatia as a Candidate Country.

The table shows that there are still a large number of households in the EU-25 which do not own a CFL, moreover only a few countries show a number of CFLs close to the cost-effective saturation level (about 25% of lighting points per households using a CFL).

[14] CFLs are of two types, with an integral ballast (ballast inside the package) or pin-based. The first type dominates the market for the residential sector. Recently some pin-based CFL luminaires have appeared on the EU market for residential lighting, however, no sales figures are available. Of particular interest are the CFL based “torchieres”, which could replace halogen based upright floor lamps, the latter using light sources up to 500W. There is also a certain use of linear fluorescent lamps, especially in some countries, e.g. the UK, and in specific rooms such as kitchens and garages. For the residential sector any linear fluorescent lamps even with a magnetic ballast could be considered an efficient solution if it replaces an incandescent lamp.

Table 15.: national lighting consumption and CFL penetration data (data supplied by national experts, source [Ber2006])

	no. of hslhlds [milions]	residential electricity cons. [TWh]	Lighting consumption [TWh]	Lighting consumption from total residential electricity consumption [%]	Average cons lighting/HH [kWh]	Number of HH with CFLs [%]	CFL's/HH [including HH without CFLs]	Lighting points/HH	CFL/ Lighting points [%]
AT	3,08	15	1,1	7,3	357,14	70	4	26	15,4
BE	3,90	18,20	2,23	12,23	343,22	70,50	2,50	26,00	9,6
DK	2,31	9,71	1,36	14,00	589,00	65,00	4,90	25,40	19,3
FIN	2,30	12,20	1,7	13,93	739	50	1	23,5	4,3
FR	22,20	141,06	9,07	6,43	409	52	2,26	18,9	12,0
GR	3,99	16,87	3,04	18	761	50	1	12	8,3
DE	39,10	140,00	13,2	9,43	337,6	70	6,5	32	20,3
EI	1,44	7,33	1,32	18	920	38	1,5	18	8,3
IT	22,50	66,67	8	12	370	60	0,8	18	4,4
LU	0,20	0,75	0,098	13	487,5	70	2	20	10,0
NL	6,73	23,75	3,8	16	524	60	4	40	10,0
PT	4,20	11,40	1,7	14,91	404,8	54	1,7	11,4	14,9
ES	17,20	61,11	11	18	639,5	15	2	25	8,0
SE	3,90	43,50	3,4	16	872	55	3,3	32	10,3
UK	22,80	111,88	17,9	16	785	50	2	20	10,0
CZ	3,83	14,53	1,74	12	455,37	70	2,9	14	20,7
CY	0,32	1,32	0,24	18	749	79	2	16	12,5
EE	0,60	1,62	0,45	28	753,81	20	0,25	15	1,7
HU	3,75	11,10	2,775	25	740,48	60	1	18	5,6
LV	0,97	1,47	0,41	28	424,16	19	0,42	17	2,5
LT	1,29	2,07	0,62	30	479,72	20	0,25	10	2,5
MT	0,13	0,62	0,0806	13,00	630	50	1	15	6,7
PL	11,95	22,80	6,38	28	534,4	50	0,5	20	2,5
SK	1,90	4,90	0,4	8,20	240,05	50	1	15	6,7
SI	0,68	3,01	0,33	11	480	70	2	19	10,5
BG	2,9	9,31	0,9	10	310	34	0,5	13	3,8
RO	8,13	8,04	2,911	35,18	356,75	40	0,2	10	2,0
HR	1,42	6,07	1,1	18,11	773,76	39	1	14	7,1

Table 16.: EU summary

	no. of hslhlds [milions]	residential electricity cons. [TWh]	Lighting consumption [TWh]	Lighting from total residential electricity consumption [%]	Average cons lighting/HH [kWh]	Number of HH with CFLs [%]	CFL's/HH [including HH without CFLs]
EU-15	155,85	679,43	78,91	11,61	506,33	54,59	3,15
New EU-10	25,41	63,42	13,42	21,16	528,20	51,97	1,01
EU-25	181,26	742,85	92,33	12,43	509,40	54,23	2,85
Bg+Ro	11,03	17,35	3,81	21,97	345,54	38,42	0,28
EU-27	192,29	760,20	96,14	12,65	500,00	53,32	2,71

2. Tertiary Sector Building Electricity Consumption

Total electricity consumption for the tertiary sector for the EU-25 was 628 TWh in year 1999 and 726 TWh in year 2004. The electricity in the tertiary sector has grown by 15.6% in the period 1999-2004 and by 2.0% in the period 2003-2004. The gas consumption in the tertiary sector has continued to grow in the period 1999 to 2004 in the EU-25 from 2070 PJ to 2362 PJ with an increase of 14%, while the yearly growth rate in the period 2003-2004 has been 1.9%.

For the tertiary sector (in this report it is the public sector, education, healthcare, services and commerce)[15] there is much less data available for individual electricity end-uses than for the residential sector, and only a few sources attempted to divide the total electricity consumption among the different end-uses.

[15] This is also know as the 'commercial sector' and represent non-residential buildings in the service sector. Most of the statistics and researchers do not specify whether the buildings belowto the industrial sector companies (i.e. car manufacturer headquarters, office buildings etc.) are included

Table 17.: EU Tertiary Sector Electricity Consumption (source: Eurostat, JRC)

	Services [TWh]		
	2003	**2004**	**2004 vs. 2003 [%]**
EU-15			
AT	14,38	14,85	3,30
BE	11,91	11,93	0,18
DK	10,11	10,35	2,37
FI	14,66	15,30	4,39
FR	113,92	115,63	1,50
DE	110,26	110,26	0,00
GR	14,98	15,85	5,84
EI	7,84	8,10	3,29
IT	67,43	69,96	3,75
LU	1,11	1,26	13,36
NE	30,93	32,60	5,40
PT	13,19	13,71	3,94
ES	57,23	60,67	6,01
SE	27,26	27,56	1,08
UK	95,05	95,14	0,09
EU-15	**590,24**	**603,15**	2,19
New Member States			
CZ	12,59	12,90	2,45
CY	1,63	1,68	2,88
EE	1,64	1,82	10,77
HU	8,65	9,11	5,38
LV	1,87	1,99	6,60
LT	2,40	2,57	7,05
MT	0,63	0,63	-1,10
PL	27,26	26,20	-3,90
SK	6,47	7,35	13,63
SI [16]	1,80	2,63	46,22
NMS	**64,94**	**66,88**	2,98
Candidate and Accesion Countries			
BG	5,99	5,82	-2,81
RO	4,75	3,59	-24,49
HR	3,48	3,72	6,66
TR	27,10	29,33	8,22
CC	**41,32**	**42,45**	2,73

	Services [TWh]		
	2003	**2004**	**2004 vs. 2003 [%]**
EU-25	655,18	670,03	2,27
EU-15	590,24	603,15	2,19
NMS-10	64,94	66,88	2,98
NMS-10+2	75,68	76,29	0,80
EU-25 + 2	665,92	679,44	2,03

[16] from JRC survey on electricity consumption

The European Climate Change Programme (ECCP) in year 2000 agree on the following breakdown that was endorsed by the all the ECCP experts [ECC2001].

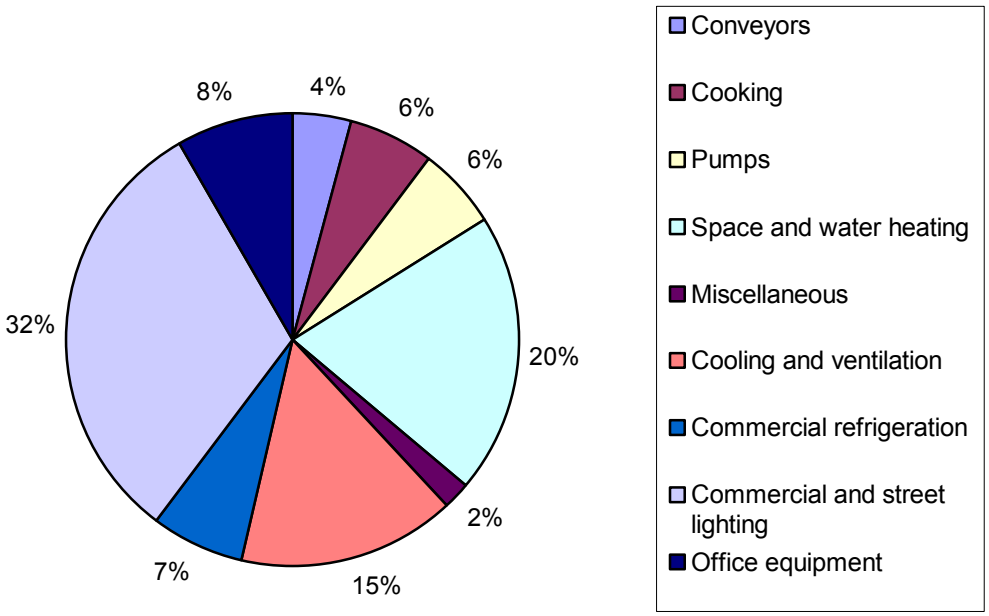


Fig. 31.: Breakdown of the Tertiary Sector Consumption (Source [ECC2001])

The difficulty to arrive to the individual end-use consumption is due to the fact that both sales and stock data for the different end-use equipment are difficult to find, that the type of buildings and the associated energy consumption are much different (ranging from data centres to primary schools), and for many type of equipment there is not yet an energy efficiency indexes or label to track the penetration of efficient equipment and the market share among new sales.

2.1. Lighting

Lighting is by far the major end-use category in tertiary sector consumption, responsible for about 175 TWh or 26% of total electricity consumption in the tertiary sector (this is slightly lower than the EECP findings in the above figure). As far as non-residential buildings lighting is concerned, this is dominated in lumen and energy terms by linear fluorescent lamps. T12 fluorescent lamps are the oldest technology of fluorescent lamps. These lamps have an efficiency of less than 75 lumens per Watt (lm/W). In the majority of cases there exists a T8 lamp that can be retrofitted into the same lighting point. Depending on whether this T8 lamp is a halo phosphor or a tri-phosphor the lamp efficiency can be improved to between 80lm/W (halo phosphate) and 90lm/W (tri phosphor).

The T8 lamp now dominates the linear fluorescent market. The existing mix of lamps is still two-thirds halo phosphate lamps with the remaining third being three-band rare earth phosphor lamps which are currently increasing their market share year by year. Barrier coat technology has allowed the mercury content in current tri-phosphor lamps to be reduced to below 5mg[17].

The average lamp wattage for T12 lamps is 65 W (1500 mm long). The average energy saving per lamp when switching from T12 (65W) to T8 (58W is 12%). The total annual sales figure for T12 lamps in the European Union is 16 million lamps. This is more or less a stable replacement market. The total sale of linear fluorescents is estimated to be 350 million lamps per year [Str2004]. There is a relatively new technology, T5 which has a higher efficiency and is designed to be fed only by electronic ballasts (in addition these lamps perform best at a temperature of about 35 C, which is often the case in luminaires, while T8 perform best at 25C). However, the market penetration of T5 lamps is still limited, though slightly increasing overtime.

About 207 millions are new installed lamps in 2004 [CEL2005], which tends to be of higher efficiency compared to already install lamps.

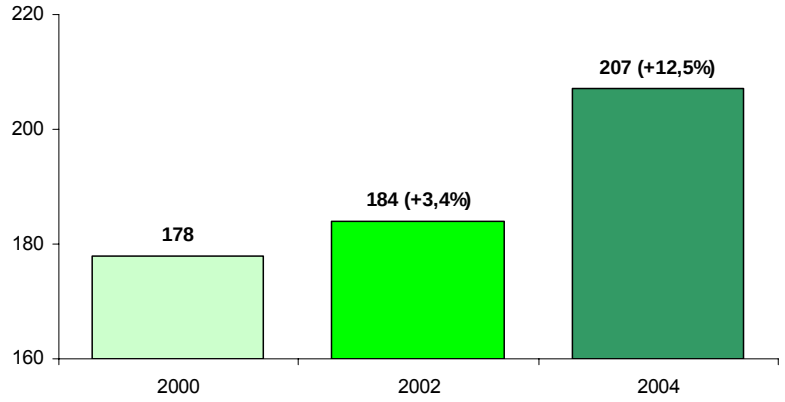


Fig. 32.: Number of new installed lamps (in millions) [CEL2005]

[17] According to the RoHS directive (2002/95/EC), which will enter into force 1 July 2006, tri phosphor lamps may contain 5 mg of mercury per lamp and halo phosphate lamps may contain 10 mg mercury per lamp. The tri phosphor lamps on the European market contain 3 mg of mercury per lamp. These lamps are more expensive, but they have significantly longer life-time than the halo phosphate which gives a total price per hour approximately the same. Thus, there is a great potential of lowering the consumption of mercury in florescent tubs in EU if the tri phosphor lamps containing less than half the amount of mercury as the halo phosphate was used instead. It is also possible to lower the content of mercury in the tri phosphor lamps even further (below 3 mg) and to increase the life-time, but that needs some time for technical development.

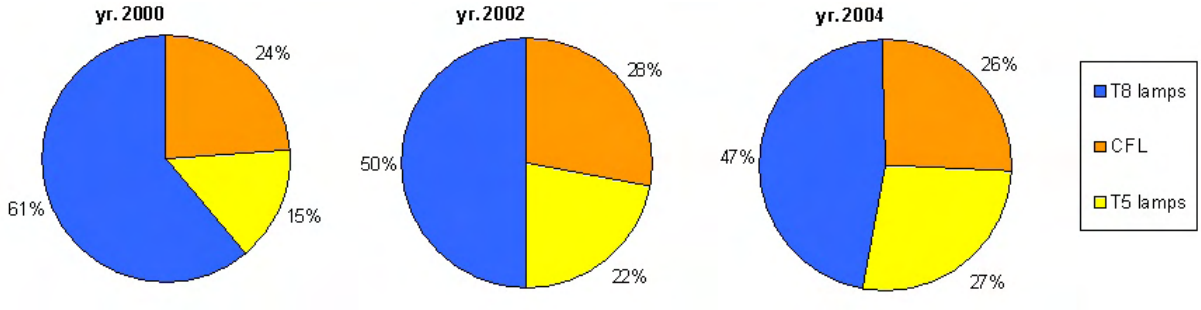


Fig. 33.: Share of ballast for lamps [CEL2005]

The above figure confirms that in new installations the share of T5 is gradually growing.

Ballasts are needed to run every fluorescent or discharge lamps. There are two very different technologies for ballasts: the magnetic type and the electronic type. The latter lowers power losses and also allows operating the lamp at lower wattage for the same light output. There is a voluntary classification scheme for the combination of lamp ballasts introduced in the year 1998 by the lighting equipment manufacturers' trade association, CELMA [CEL2005]. The classifications scheme[18] together with the minimum efficiency requirements for ballasts (Directive 2000/55/EC), which came into effect in 2002, have resulted in a gradual market transformation. The Directive foresees two gradual steps for phasing out low and medium efficiency ballasts. The first steps took place in year 2002 and phased out low efficiency magnetic ballasts (class D). The second steps took place in November 2005 and phased out Class C ballast representing the largest shared of the market. The EU Directive 2000/55EC aims to reach a market transformation by 31.12.2005 with the following values:

- **class A** ballast 55%,
- **class B** and C (sold until 01.11.2005) ballasts 45%.

At the moment there are, however, no sale data available for 2005 to evaluate the impact of the second phase. The below graphs show the ballast market evolution up to 2004, when electronic ballast reached a market share of 31%. In figure 1.36 also the predicted trends in the ballast market are shown [CEL2005].

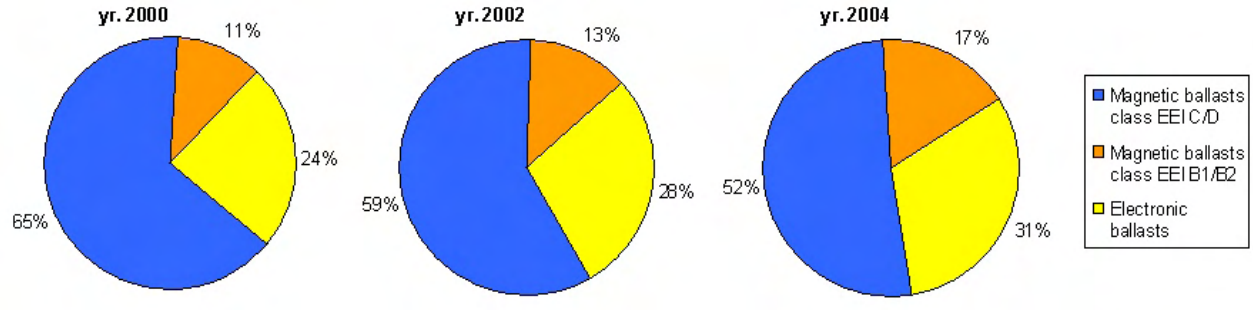


Fig. 34.: Ballast Sales (Source [CEL2005])

[18] The classification scheme is available at http://www.celma.org/pdf_files/BallastGuideEN200212.pdf

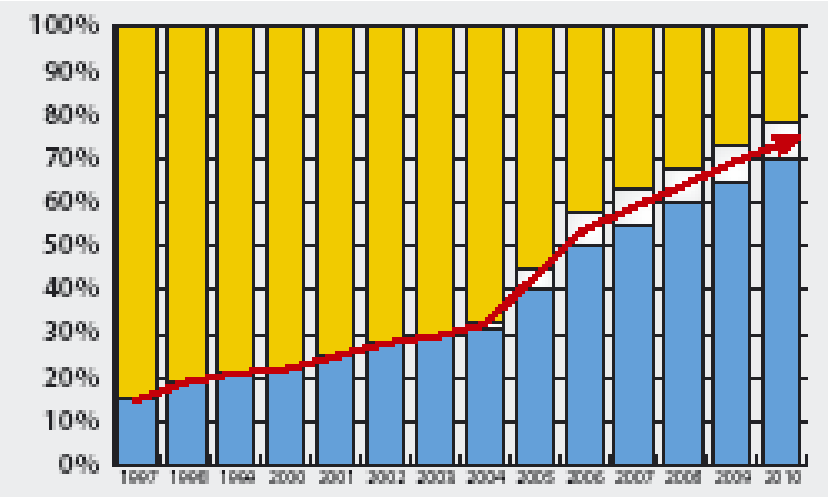


Fig. 35.: Expected trends in Ballast Sales (Source [CEL2005])

Lighting equipment energy consumption is not only determined by the lamp, ballast and luminaire efficiency, but also by the running hours and the output light provided. In order to save energy of particular interest is the introduction of technologies to reduce the light quantity (dimming) as function of day lighting, and the operating hours in functions of the occupancy. There are no data on the present penetration of occupancy sensors, and day-light sensors, and other control systems associated with dimmable ballasts.

A recent survey by the IEA has identified the following parameters for the OECD Europe [IEA2006]: average lighting power density 15,6 W/m^2, average energy consumption 27,5 kWh/m^2 per year, average operating hours 1781. Some examples of advanced lighting for office buildings from the GreenLight[19] programmes have reported for office buildings lighting power densities in the range of 7 to 10 W/m^2, and annual power consumption density of 19 kWh/m^2.

[19] All the information are available at www.eu-greenlight.org

2.2. HVAC and Refrigeration in tertiary sector

For other tertiary sector end-use equipment (e.g. central air conditioners, chillers, commercial refrigeration, pumps, etc.) there is even less information on market penetration of efficient equipment. *Air-conditioners* in non residential buildings are estimated to consume about 70 to 80 TWh of electricity [Adn2003]. In the UK the MTP has calculated approximately 14.4 TWh for non-domestic and domestic air conditioning (the residential share being almost negligible) [MTP2006a]. Eurovent established classification for full load Energy Efficiency Ratio of each type of chillers. The classification follows the A to G approach used in the European Energy Label for household appliances but the limits between classes have been defined for the existing chillers as listed in Eurovent directory, see Table18 for cooling mode.[Sah2006a].

Table 18.: Chillers Energy Classification in Cooling Mode

EER Class	Air Cooled	Water cooled	Remote condenser
A	EER≥3.1	EER≥5.05	>=3,55
B	2,9≤ EER< 3,1	4,65≤ EER<5,05	3,4≤ EER<3,55
C	2,7≤ EER< 2,9	4,25≤ EER<4,65	3,25≤ EER<3,4
D	2,5≤ EER< 2,7	3,85≤ EER<4,25	3,1≤ EER<3,25
E	2,3≤ EER< 2,5	3,45≤ EER<3,85	2,95≤ EER<3,1
F	2,1≤ EER< 2,3	3,05≤ EER<3,45	2,8≤ EER<2,95
G	<2,1	<3,05	<2,8

The classification has been implemented in February 2005; the distribution of number of units in each class is shown in Table 19.

Table 19.: Distribution of units in each class

Class/ kW	0-50	50-100	100-150	150-200	200-500	500-1000	>1000	Total
A	85	12	4	7	72	85	115	380
B	114	51	46	21	142	179	112	665
C	203	75	76	40	206	229	137	966
D	244	143	106	80	295	213	80	1161
E	383	131	121	84	432	246	98	1495
F	287	62	54	52	125	68	29	677
G	152	14	10	8	41	31	19	275
Total	1468	488	417	292	1313	1051	590	5619

It is too early to see the influence of this classification on energy efficiency. However, the distribution shows that 7% of certified chillers are in Eurovent Class A and in total only 5% of the certified chillers are in Eurovent Class G.

Another important share of electricity is consumed by fans for *ventilation systems* (including fans).which results in about 94 TWh in the [FRA2001]. For the time being there are no existing European polices to improve efficiency of ventilation systems.
A similarly important sector in term of consumption is commercial refrigeration. Estimate for the total European consumption range from 70 to 100 TWh per year. Only s a few national data are available, in Germany it has been estimated a consumption of 13TWh for commercial refrigeration in the service sector by one expert, while another estimate that is around 8TWh

in the wholesale, retail trade, hotels and restaurants. In the UK, the MTP estimates that the consumption of commercial refrigeration equipment represent 8.5 % of the total non domestic energy consumption. The specific refrigeration products covered by commercial refrigeration equipment, are: process chillers, refrigerated display and service cabinets, cellar cooling, ice making machines (non domestic), walk-in cold stores, refrigerated vending machines, refrigeration compressors, air-cooled condensing units, heat exchangers (process/industrial applications) [MTP2006b].

2.3. Office Equipment

For office equipment there are no much data available on the total energy consumption. According to the Ecodesign study [ECC2006] in 2005 there where 44 Million desktop computers installed in non residential applications, and another 36,5 million laptops, and about 44 million monitors, of which 45% were flat panel. In 2003 a rapid penetration of LCD screens occurred, ad was sustained in 2004 and 2005, which should have led to a decrease of the total monitor consumption. A German survey has identified the ICT electricity consumption in the tertiary sector buildings to be 11% of total electricity consumption in this sector [Sch2006] [Gru2006]. This is in good accordance with the ECCP finding. The ICT sector is predicted to increase its share in total electricity consumption (more equipment and more use of the equipment, in particular data centres are large electricity using buildings). The UK Market Transformation Programme in its Policy Brief dedicated to Information and Communication Technology (ICT) Equipment [MTP2006] indicates that "Non domestic ICT equipment was responsible for over 7% (16.5 TWh) of non domestic energy consumption in 2004 (excluding servers and data centres). Non-domestic electricity use by ICT equipment has increased by over 70% between 2000 and 2006. Non-domestic ICT consumption is expected to continue to increase by almost 40% between 2006 and 2020. Risks include expected increases in ICT equipment functionality and networking capabilities, and barriers to the ability of the PC to enter low power consumption modes such as sleep." [MTP2006c] However it is important to notice that the UK figure includes also the ICT consumption of the industrial sector. It also important to notice that in the UK the residential energy consumption of office equipment is estimated to be 7 TWh (or 6% of total residential consumption). It is assumed by the authors that office equipment (ICT equipment) is responsible for about 60 to 80 TWh per year in the tertiary sector. More research is needed to arrive at a more precise evaluation. In the residential sector ICT is responsible for about 10 to 20 TWh. [MTP2006c]
Other experts calculated that office equipments consumption in the commercial buildings was only in France about 4 TWh.
The only policy in place at European level to reduce energy consumption of office equipment is the Energy Star label (more at: www.eu-energystar.org). However there are no data on the market share of the equipment meeting the Energy Star levels or on the rate of equipment with the power management enabled.

For commercial buildings another interesting energy efficiency indicator is the total primary energy consumption (or the total electricity consumption) per square meter. Although again there are no official statistics, some data have recently been collected by some experts especially for Germany. From a monitoring exercise carried out in Germany the following data has been compiled [The2004] [Her2006]. A number of office and educational buildings have total primary energy below 100 KWh/m^2 per year, with lighting at about 10 kWh/m^2 and ventilation at 10 kWh/m^2. [NEU2005] To reach this low energy consumption values such a building use natural or passive cooling technologies (including ground loop heat pumps).

Table 20.: Building Specific Consumption of Primary Energy [NEU2005]

Type of building	Primary Energy Consumption [kWh per m^2 gross usable floor space and year]
Average old office building constructed before 1990	591
Average office building	502
Average office building constructed after 1990	421
Average new office	400
Best practice	150-50

3. Industrial Sector Electricity Consumption

The energy consumption of the industrial sector has continued to grow in the period 1999 to 2004 in the EU-25 from 299 Mtoe to 319 Mtoe with an increase of 6,6%, while the yearly growth rate in the period 2003-2004 has been 1,3%. Total electricity consumption for the industrial sector on the EU-25 was 792 TWh in year 1990 and 1042 TWh in year 2000 [EC 2004b] and reached 1089 TWh in 2004. The electricity in the industrial sectors has grown by 9,5% in the period 1999-2004 and by 1,7% in the period 2003-2004. Of this consumption, 707 TWh, or 65%, was consumed by motor driven systems [EC 2003a, Eci 2004], which includes compressors, refrigerators systems, pumps, ventilations, conveyors and other equipment.

This report focuses on motor driven systems, a horizontal technology present in all types of industry. In particular electric motors are responsible for 10 to 20% losses of the above indicated electricity consumption in the process of converting electrical energy into mechanical energy. For electric motor there is been a policy at European level to improve efficiency. The unilateral motor agreement by the European Motor Manufacturers Association (CEMEP) was based on a new system of efficiency classification: motors are divided in 3 categories, according to their efficiency with EFF 1 being the highest efficiency motors, and EFF 3 the lowest efficiency ones. The agreement goal has been to reduce the market share of motors in the lower efficiency class by 50% of what was in 1998. By 2005 EFF3 motors (new sales) represented less than 5% of the market. The motor sale and the relative efficiency classification have been monitored through the CEMEP unilateral agreement, which has provided sales data for the most recent years on 4 and 2-poles three-phase industrial motors in the power range 1 to 90 kW. These are the motor responsible for the largest share of energy consumption, and are sold in large numbers. The existing CEMEP classification scheme allows for classification of motors into three classes[20].

The European motor manufacturers represented by CEMEP are selling about 2 millions 4 poles motors and 1 million 2 poles motor per year. Through the unilateral commitment described above CEMEP manufacturers have managed to increase the market share of medium efficiency motors (class EFF 2) and almost phased out the low efficiency motors (class EFF 3) as can be seen in the graphs below.

[20] The European Motor Classification Scheme; http://energyefficiency.jrc.cec.eu.int/motorchallenge/tools.htm

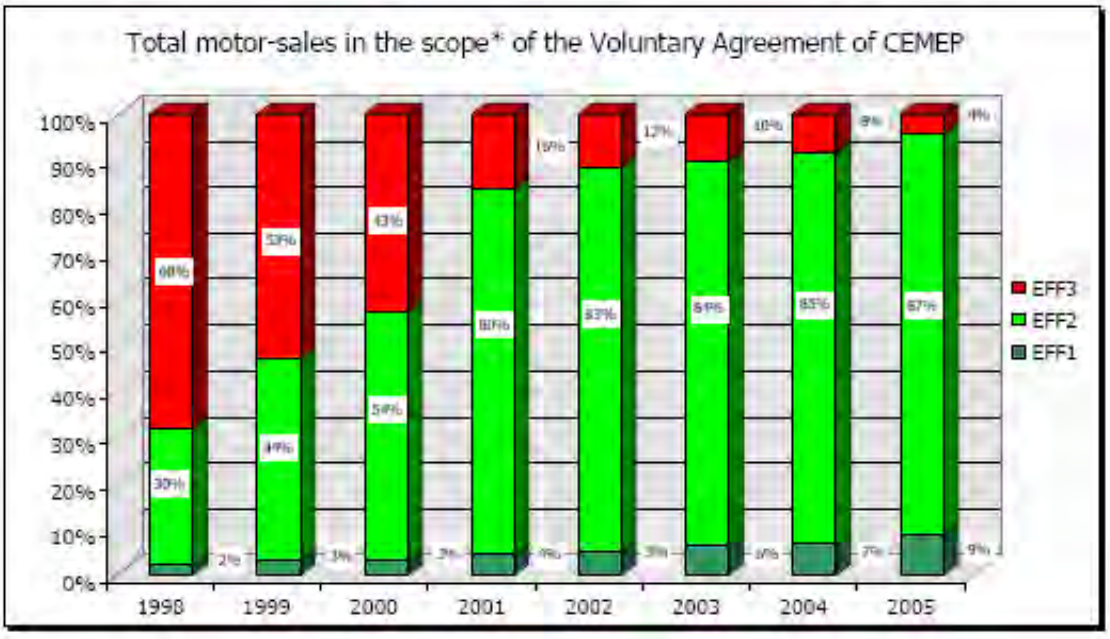


Fig. 36.: Change of market share among the 3 motor classes (Source CEMEP [Cem 2004])

Another important piece of equipment to save energy in motor systems is the Variable Speed Drive (VSDs), especially in all the fluid and motion applications where there is no constant flow or speed. It would be important to collect sales data for VSDs for future reports.
Detailed data on the efficiency of other end-use equipment in motor systems such as fans, compressors and pumps are not available. Moreover, the energy consumption depends more on the overall systems design and operation than on the efficiency of the individual components. For some types of water pumps[21] a simple assessment system to verify the efficiency of the pump at the operation duty point has been developed and made available. This is based on the best efficiency points of the available efficiency of pumps of the market. With this instrument pumps can be classified in three categories for the specific operation point.
A new report published by the European Copper Institute in year 2004 reports the following energy savings in motor systems:

Table 21.: Energy savings in motor systems (Source [Keu2004])

	Savings potential (billion kWk/yr.)					
	EU-15	EU-25	France	Germany	Italy	UK
High efficiency motors	24	27	4	6	4	3
Variable speed drives	45	50	8	10	7	6
Application part of the motor systems (pumps, fans, compressors)	112	125	19	26	17	15
Total electricity savings potential	181	202	31	42	28	24

[21] The European Guide to Pump Selection and the Basic on Pump Efficiency; can be downloaded at http://energyefficiency.jrc.cec.eu.int/motorchallenge/tools.htm

4. Conclusions

The energy efficiency policies and programmes (standards and labels, unilateral agreement by trade associations, utility DSM programmes, incentives, white certificates, etc) implemented at EU level and national level have resulted in the market transformation described in the previous sections These actions are evaluated on the basis of the annual electricity savings they have delivered and will continue to deliver in the coming years. While the various energy efficiency indicators for end-use equipment described in the previous sections are somehow 'relatively' easy to evaluate, it is necessary to build a detailed and dynamic stock model in order to evaluate the annual energy savings. Important information needed to create the stock model is the present stock of installed appliances and equipment, and their energy consumption (in real life conditions not in the energy consumption test mode), the average life of a appliances and equipment, annual replacement rate and any change in ownership penetration, patterns of use, size, together with the key demographic indicators (e.g. number of households, people per household).
Since only a percentage of the installed equipment is replaced each year, the impact of energy efficiency polices tends to be relatively slow and modest at the beginning, though continually increasing over time. However, in a time span of 10 to 15 years, when almost the whole stock has been replaced and the full effect of the policy measure has taken place, annual electricity savings in the order of tens of TWh will be achieved for several types of appliances and equipment described in the previous sections. The annual savings resulting from each individual policy are calculated against the Business as Usual (BaU) scenario, which correspond to the most likely trend in consumption, if the policy was not introduced. The BaU scenario includes the natural efficiency improvements (due to the autonomous market and technology developments), and the autonomous trends in sales.

The follow table show the potential savings till 2015, according with JRC estimation compared to BaU Scenario.

Table 22.: Potential electricity savings till yr. 2015 (JRC estimation)

	Electricity Consumption 2005 [TWh/year]	Realistic Saving Potential by 2015 compared to BaU Scenario [TWh/year]	Ambitious Saving Potential by 2015 compared to BaU Scenario [TWh/year]
DESWH [22]	**65**	**3**	**20**
Office Equipment	**60**	**10**	**20**
Standby	**44**	**20**	**30**
Residential Lighting	**95**	**16**	**44**
Main Domestic appliances	**165**	**44**	**60**
Electric motor systems	**707**	**60**	**200**
Commercial lighting	**185**	**36**	**72**
Total	**1321**	**189**	**446**

One of the possible policy actions is to accelerate the *replacement rate* of "old" installed equipment, thus reducing the time for the complete turn over of the installed stock. CECED in a recent report [CEC2005a], [Rud2006] presented at the EEDAL'06 conference claims that

[22] Domestic Electric Storage Water Heaters (DESWH), the saving potential indicated is only related to the reduction of the thermal stand-by losses due to thicker insulation. Additional saving will come from control strategy (thermostat and timer). Larger electricity saving will be achieved by introducing solar thermal panel.

by replacing the 188 Million existing appliances older than 10 years with the best on the market 44 TWh could be saved. Of course attention must be paid that old appliances are withdrawn from household and "scrapped", as well as appliances are replaced with models of the same size.
For some appliances although there is a positive impact due to the policy action resulting in energy savings compared to the BaU scenario, there could still be a net increase in the electricity consumption, due to a larger penetration rate (this is the case for example for residential room air-conditioners, dishwashers, dryers). Another element to evaluate the result from a given policy is the possible competition between gas and electricity, and possible energy savings in terms of primary energy or CO2 emission reduction. For example electric storage water heaters are decreasing their total electricity consumption, due to the fact that are being replaced by instantaneous gas, thus resulting in CO2 emission savings. The substitution of electric water heaters (on average 30% of households in Europe) by combined electric-solar or gas-solar systems would contribute on energy saving as well as to reduce CO2 emissions. Calculations have been carried out for several households that would substitute electric water heaters by an electric supported solar hot-water system in several Member States [BLO2006]. Similar benefits could be achieved by replacing electric hobs (resistive type) with efficiency gas hobs, and replacing conventional driers with gas models.
As already indicated in previous reports standby energy consumption in entertainment electronic and ICT equipment is growing at a worrying rate. This because a lot of new equipment is added to the present stock (STBs, DVD players new TVs and surround sound systems, mobile telephones, broadband communication including home network). In addition some old replaced equipment may still stay in use in different locations in houses (e.g. older TVs moving to children's bedrooms together with the old VCRs). Some equipment which did not "traditionally" have any standby consumption such as traditional white goods, start to have AC/DC converters, displays, modems, microprocessors, all devices that are likely to be always on and to add a few watts of standby consumption. While these additional features may be desirable and even useful to save energy in the operation modes, every step during the design phase has to be taken by designers and manufacturers to make sure that while in standby the added electronic devices draw as little power as possible and power management is always implemented to switch off all the devices not needed. Moreover, although new TVs, use significantly less standby power than older models as results of the EICTA unilateral voluntary agreement introduced first in 1997, and new TVs models are beginning to lower in-home standby power use, the simple number of appliances with standby power mode continues to increase. The net effect of these trends is likely to be a continuing increase in standby power use.

TV reception platforms are rapidly moving toward digital broadcasting technology. As a result, set-top boxes (STBs) will be the source of significant new standby and on-mode power demand in the near future. Some STBs introduced on the market stay in on-mode all the time, consuming up to 20–30 W of power (this consumption tends to increase as more functionality is added to STBs). With the assumption of about 50 millions advanced STB (accessing pay per view services with recording and time shift capabilities) in household by 2010, this is an additional electricity consumption of **10 TWh** per year in the EU-25. In addition, with the phase out of the analogue TV signal, simple converter boxes will be required by the legacy of the old analogue TVs. Converter boxes now on the market tend to consume about 10 W all the time. With the assumption of one converter boxes per household this will result in an additional **16 TWh** per year. The EU Code of Conduct for Digital TV Systems, if successfully implemented halves this predicted consumption and thus will deliver about **13 TWh** of annual electricity savings by 2010 compared to the business as usual

A similar trend is also observed for broadband communication (mainly through DSL, but could also be implemented through cable and satellite STB, G3 mobile phones, and PLC) a number of new devices such as modems, routers, switches are introduced and are often always on. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, a total European Union consumption of up to 50 TWh per year can be estimated for the year 2015. With the general principles and actions resulting from the implementation of new Code of Conduct the electricity consumption could be limited to 25 TWh per year, i.e. a savings of **25 TWh** against the BaU scenario.

As far as the traditional white goods and other residential sector appliances and equipment are concerned electricity savings per year in the order of **24 TWh** to **30 TWh** have been achieved in the last decade (CECED in the same period estimate an energy savings of 34 TWh). In particular it is worth to notice that **65 TWh** to **75 TWh** will be saved per year by **2010 compared to 1995** in total by the current polices already in place (appliances labelling, efficiency requirements, unilateral voluntary agreements, Code of Conducts, etc.). It is important to highlight that there is still a huge saving potential available if further cost-effective[23] measure are implemented. In particular larger saving potentials exist for reducing **stand-by losses (20 TWh)**, which is also the sector with the highest consumption growth with the current polices (+50%). Large saving potential is also available in residential **refrigeration appliances (16 TWh)**, and **residential lighting** (**16 to 44 TWh** - in lighting with the current policies there will be a consumption increase of about 10%, the cost-effective technology CFLs is already in the market, but not yet used in all the cost-effective lighting points in households, a possible mandatory ban on incandescent lighting will deliver the largest savings).

Equally important to mention is the fact that with a prompt introduction of additional polices based on least life cycle cost and accelerated replacement of additional appliances and lighting the electricity of the residential sector could be reduced by an additional **60 TWh** to **90 TWh** per year by year 2015 compared to the current policies scenario.

Another important piece of equipment for electricity consumption and potential savings are **electric motors**, in particular the three phase industrial motors. Through the CEMEP unilateral agreement started in 1999 about **2 TWh** was already saved until 2005. The saving potential of the current agreement when most of the motor stock will be replaced (around 2012) will be about **6 TWh**. The economic saving potential is still much larger and estimated to be at about **20 TWh** by 2015. To achieve this cost-effective potential, a new policy action to phase out motors in efficiency classes EFF 2 is needed. The recent report [ECI 2004] has calculated the total electricity cost-effective savings in motor systems to **200 TWh**, this will be achieved with the optimisation of the whole motor systems.

[23] Most of the energy efficiency measures are cost-effective. This means that they will results in net money savings for the users, as the reduced electricity cost over the life time of the appliances will be bigger than any additional purchasing cost for the more efficient model. In many cases there is an increase in manufacturing cost to manufacturers, which can be passed on the users or can be compensate by productivity gains (and in many case will decrease over time when the most efficient components will be mass produced). Over the last ten years the EU white goods manufacturers have become more profitable, appliances cost less, and the efficiency has improved, this despite fears by manufacturers that the policy action introduced in the 90ies could have had a negative impact. Therefore it can be concluded that energy efficiency measures and in particular standards and labels are cost effective for society and reduce CO_2 emissions at a negative cost.

The "Ballast" Directive will deliver electricity savings of about **5TWh** by year 2010, while the economic potential for **non-residential lighting** will be at least **20 TWh** if the whole lighting system is considered. The European GreenLight programme (www.eu-greenlight.org) is promoting this concept and has already achieved remarkable savings (in the order of 100 – 200 GWh) [Gre 2004]. Other important electricity savings in the non-residential building sector **could come in office equipment** (hence the need of a more effective implementation of the Energy Star programme), and in the cooling and ventilation systems (through the use of natural ventilation, and free cooling, as well the introduction of energy efficient compressor based cooling and tri-generation).

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Abstract

This report summarises the result of a 2006 in-depth survey on the electricity consumption and efficiency of equipment in buildings in the enlarged EU and Candidate Countries, together with the present market share of efficient appliances and equipment. One of the aims of this report is to show the present status of electricity consumption for the main appliances and equipments, and on the base of the best available data estimate the saving potential for electricity in buildings in EU Member States and Candidate Countries. It also describes the policy actions introduced at EU level and some of the national policies. The report focuses also on motor driven systems, a horizontal technology present in all types of industry. In particular electric motors are responsible for 10 to 20% losses of the above indicated electricity consumption in the process of converting electrical energy into mechanical energy.

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