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Electricity Consumption and Efficiency Trends in European Union

- Status Report 2009 -

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Summary

1. Introduction

Over the period 2004-2007 the final energy consumption in the EU-27 Member States decreased, while electricity end-use consumption in EU-27 continued to grow, but at a lower rate than the economic growth.

In 2007 the final energy consumption of EU-27 was 1,31% lower than it was in 2004, decreasing in the residential (-7,12%), industry (-2,82%), agriculture (-6,24%) and tertiary (-0,92%) sectors but continuing to grow in the transport sector (4,58%).

The EU-27 final electricity consumption grew by 4,46% between 2004 and 2007 as compared to economic growth[1] of 8,23% over the same period.

Over the same period 2004-2007, the EU-27 electricity end-use consumption had a negative trend only in the transport sector (-1,6%), increasing in industrial (2,06%), residential (2,11%), tertiary (10,45%) and agriculture (14,45%). The growth rate of the final electricity consumption in tertiary was much higher than in the previous period surveyed (6,96% over 2001-2004 as compared to 10,45% over 2004-2007) due to the strong development of this sector. After years of decreasing trends (-5,1% from 2001 to 2004), the agriculture sector registered a strong increase in only three years (14,45%).

For the NMS-12 economies, the growth rate of the final energy and electricity consumption was higher in the period 2004-2007 than in 2001-2004 (respectively 1,83% and 7,91%), but in the context of a stronger economic development of 19,69% GDP growth in 2004-2007, as compared to 13.11% in the period 2001-2004. In 2007, the NMS-12 share in final energy and electricity consumption of EU-27 was 14,4% and 12% respectively, much lower than the share of NMS-12 in EU-27 population (21%) but much higher than the GDP contribution of NMS-12 (5,74% in 2007, market prices).

Energy and electricity consumption trends over 2004-2007 seem to indicate that residential energy efficiency policies and measures start to be effective. Nevertheless, it is too early to conclude this positively due to the impact of warm winters that influence heating energy consumption. There is still a huge saving potential that could be exploited. EU energy efficiency policies were significantly reinforced from 2005 on, with new important legislation coming into force or under assessment. The 2007-2012 Action Plan for Energy Efficiency "Realising the Potential" sets the new reinforced energy efficiency policy. The main objective of the Action Plan is to control and reduce energy demand and to take targeted action on consumption and supply, in order to save 20% of annual consumption of primary energy by 2020 (compared to energy consumption forecasts for 2020). This objective corresponds to achieving approximately a 1,5% additional saving per year up to 2020. The Action Plan

[1] GDP market prices (2000 exchange rates)

indicates all measures presenting the best cost-efficiency ratio, i.e. those with the lowest environmental cost over the life cycle.

The Eco-design of the Energy-Using Products Framework Directive 32/2005/EC (Eco-design Directive), the end-use energy efficiency and energy services Directive 32/2006/EC (ESD), the Energy Performance of Buildings Directive 91/2002/EC (EPBD, under recast) as well as the Labelling Directive 75/1992/EC (under recast) will contribute significantly to realise the energy-saving potential in the European Union.

Accompanying and completing the EU legislation, many energy efficiency measures concerning financial incentives, supplier obligations, information, etc. have also been adopted by the Member States.

This report summarises the outcome of the results of an in-depth survey of electricity consumption in buildings in the EU-27 conducted by the JRC, the main findings of the first preparatory studies for implementing the Eco-design Directive, as well as other recent analyses and studies on different aspects of the electricity final consumption in EU27.

One of the aims of this report is to show the present status of electricity consumption of the main appliances and equipment, the energy efficiency progress and estimates of the saving potential in the EU-27 electricity sector. The report summarises the policy actions introduced at EU level and some of the national policies for the building sector and for the electric motor systems.

2. Energy and Electricity end-use in EU-27

EU-27 final energy consumption grew by 8,4% between 1990-2007 and by 4,37% from 1999 to 2007. In 2007 the final energy consumption was 1,31% lower than it was in 2004. The largest share in final energy consumption is taken by EU-15, with 85,5% (table 1). The NMS-12 contribute with only 14,5% to the final energy consumption of EU-27, lower than the NMS-12 share in total EU-27 population (21%), but higher than the GDP contribution of NMS-12 (5,74% in 2007, market prices, 2000 exchange rates).

However, the growth rate of final energy consumption in the NMS-12 economies was higher than in EU-15, 45,5% over the period 1999-2007, comparing to 19,31% in EU-15 over the same period. Over the last decade, the EU-27 energy consumption decreased in residential (-1,55%) and agricultural (-7%) sectors and grew significantly in the transport (6,47%) and tertiary (11,5%) sectors.

Table 1: EU-27, EU-15 and NMS-12 final energy consumption trends (source Eurostat)

EU-27	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	1068084	1109214	1114360	1140322	1126807	1159718	1173009	1172258	1175579	1157654
Residential	263423	289031	286901	300000	292572	304698	306375	307487	304688	284553
Services	107302	122087	117239	124037	121036	129489	131191	132102	136317	129985
Industry	365731	316934	327757	330380	325655	331589	332217	325775	319494	322846
Transport	280733	338382	340167	343921	346824	352267	360728	363232	371144	377249
Agriculture	32998	29941	29889	29686	29026	29124	29678	29939	28345	27826
EU-15	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	861797	953011	962085	984753	972202	998480	1008237	1007045	1006008	989867
Residential	216596	239675	240613	251872	245579	255476	258319	258474	254871	238026
Services	89364	105458	101013	106108	103800	110979	111597	112931	115924	110599
Industry	266645	265009	274898	278843	273979	278543	278387	273633	266813	270112
Transport	253447	308842	311883	314059	316056	319219	325036	326267	331561	334827
Agriculture	21342	22359	22630	22671	22290	22627	23133	23257	22402	22179
NMS-12	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	206287	156203	152275	155569	154605	161238	164772	165213	169571	167787
Residential	46827	49356	46288	48128	46993	49222	48056	49013	49817	46527
Services	17938	16629	16226	17929	17236	18510	19594	19171	20393	19386
Industry	99086	51925	52859	51537	51676	53046	53830	52142	52681	52734
Transport	27286	29540	28284	29862	30768	33048	35692	36965	39583	42422
Agriculture	11656	7582	7259	7015	6736	6497	6545	6682	5943	5647

Table 2: Final energy consumption trends in EU-27 (source JRC based on Eurostat)

	EU-27			EU-15			NMS-12		
	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]
Final cons.	8,39	4,37	-1,31	14,86	3,87	-1,82	-18,66	7,42	1,83
Residential	8,02	-1,55	-7,12	9,89	-0,69	-7,86	-0,64	-5,73	-3,18
Services	21,14	6,47	-0,92	23,76	4,87	-0,89	8,07	16,58	-1,06
Industry	-11,73	1,87	-2,82	1,30	1,93	-2,97	-46,78	1,56	-2,04
Transport	34,38	11,49	4,58	32,11	8,41	3,01	55,47	43,61	18,86
Agriculture	-15,67	-7,06	-6,24	3,92	-0,81	-4,12	-51,55	-25,52	-13,72

Final electricity consumption in the EU-27 Member States has continued to grow in the last years, despite numerous energy efficiency policies and programmes at EU and national level. One possible explanation for this growth in electricity consumption is the increased number of electricity-using household equipment and more operation hours, mainly the ICT technologies and entertainment equipment, but also other traditional electricity-using equipment. The strong development of the tertiary sector (the economies are moving towards the service sector) contributed also significantly to the growth of the electricity consumption. In 2007 final electricity consumption in EU-27 represented around 21% of final energy consumption, with almost identical share in EU-15 (21,75%), but slightly different in NMS-12 (17,39%, see figure 1).

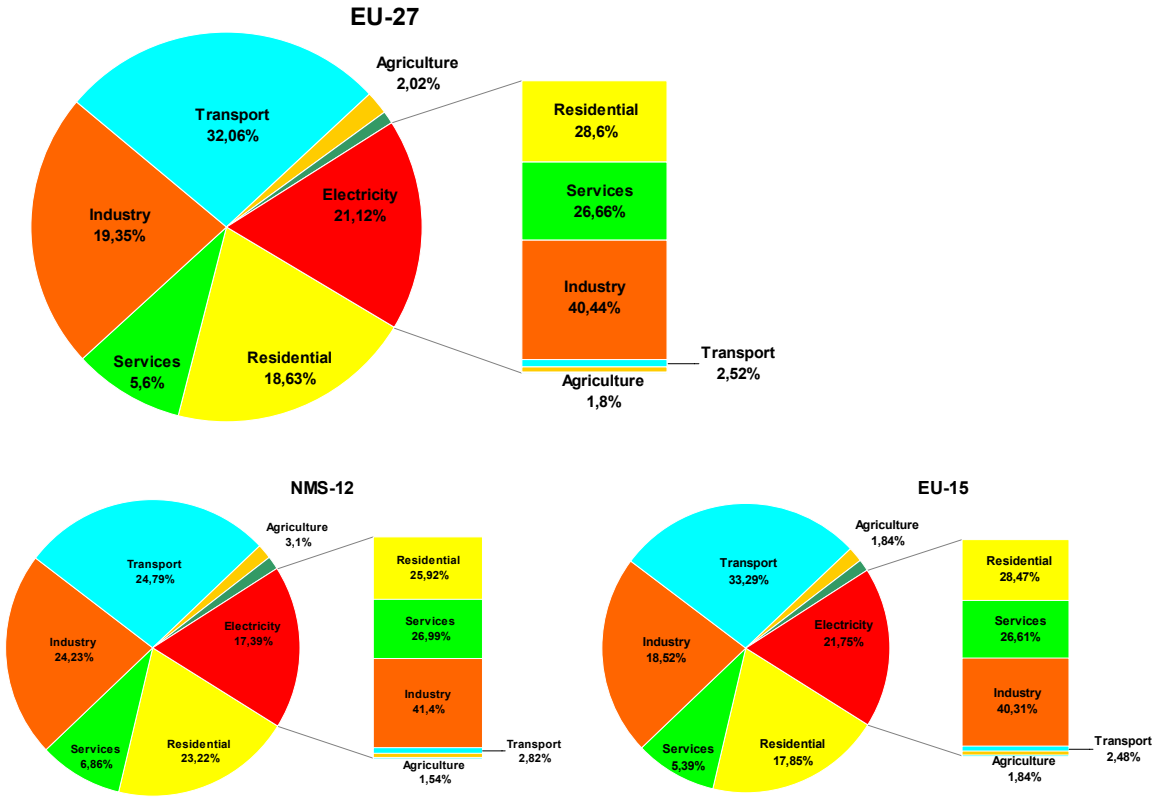

Figure 1: Breakdown of final energy consumption between sectors and final electricity consumption, in 2007 (source Eurostat and JRC survey)

Final electricity consumption grew more than final energy consumption over both the 1990-2007 and 1999-2007 periods (by 32,8% and by 16,47% respectively).

EU-27 final electricity consumption grew by 32,8% between 1990-2007 and by 16,47% from 1999 to 2007. In comparison to 2004, final electricity consumption in 2007 was 4,46% higher. Over the last decade, electricity consumption in transport (-12%) and agriculture (-46%) sectors of NMS-12 decreased, the highest growth of the electricity consumption being registered in the tertiary sector in both EU-27 (10,45%) and in NMS-12 (17,7%).

Table 3: EU-27, EU-15 and NMS-12 final electricity consumption trends (source Eurostat)

EU-27	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	184066	209899	216409	222880	223537	229403	234032	237547	242998	244475
Residential	50164	60836	61127	63212	63500	66280	67426	68361	69349	68850
Services	37241	50728	52795	55159	55122	57649	59001	60514	64899	65169
Industry	84136	87702	91880	93602	93901	94787	96882	97648	97395	98876
Transport	5390	5923	6109	6126	6157	6216	6262	6352	6088	6162
Agriculture	4766	3927	4034	4056	3969	3831	3849	4096	4354	4405
EU-15	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	155813	185519	191659	197451	198138	203130	206988	210205	214418	215293
Residential	44536	54249	54574	56562	56828	59155	60310	61120	61823	61287
Services	33673	44882	46740	48596	48934	51068	52309	53510	57299	57294
Industry	69247	77664	81694	83268	83414	83950	85340	86191	85566	86794
Transport	4001	4987	5127	5191	5213	5268	5374	5507	5300	5339
Agriculture	2608	3094	3256	3312	3253	3377	3403	3665	3896	3955
NMS-12	1990 [ktoe]	1999 [ktoe]	2000 [ktoe]	2001 [ktoe]	2002 [ktoe]	2003 [ktoe]	2004 [ktoe]	2005 [ktoe]	2006 [ktoe]	2007 [ktoe]
Final cons.	28253	24380	24750	25429	25399	26273	27044	27342	28580	29182
Residential	5628	6587	6553	6650	6672	7125	7116	7241	7526	7563
Services	3568	5846	6055	6563	6188	6581	6692	7004	7600	7875
Industry	14889	10038	10186	10334	10487	10837	11542	11457	11829	12082
Transport	1389	936	982	935	944	948	888	845	788	823
Agriculture	2158	833	778	744	716	454	446	431	458	450

Table 4: Final electricity consumption trends in EU-27 (source JRC based on Eurostat)

	EU-27			EU-15			NMS-12		
	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]	1990-2007 [%]	1999-2007 [%]	2004-2007 [%]
Final cons.	32,82	16,47	4,46	38,17	16,05	4,01	3,29	19,70	7,91
Residential	37,25	13,17	2,11	37,61	12,97	1,62	34,38	14,82	6,28
Services	74,99	28,47	10,45	70,15	27,65	9,53	120,71	34,71	17,68
Industry	17,52	12,74	2,06	25,34	11,76	1,70	-18,85	20,36	4,68
Transport	14,32	4,04	-1,60	33,44	7,06	-0,65	-40,75	-12,07	-7,32
Agriculture	-7,57	12,17	14,45	51,65	27,83	16,22	-79,15	-45,98	0,90

Over the period 1999-2007, EU-27 population increased by 2,8%, reaching some 495,1 million in 2007.

Over the same period of time. EU-15 population grew by 4,21% (more than the EU-27 average) and the NMS-12 population decreased by -2,23% (figure 2).

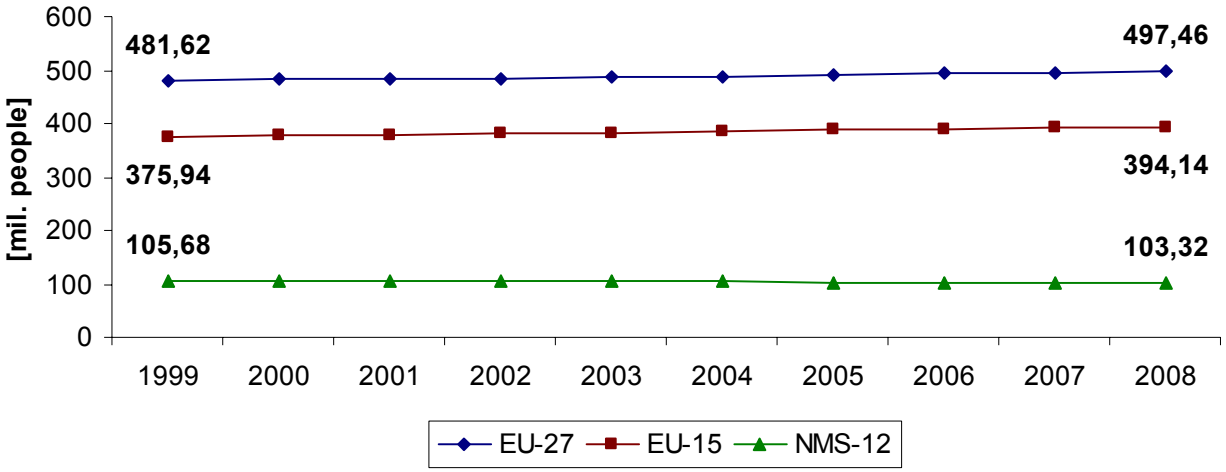

Figure 2: EU-27 population trends (source Eurostat)

The number of EU-27 households increased by 8% in the period 2002-2007, reaching 203,75 million. Over the same period, the number of households grew by 6% in the NMS-12 and by 10% in the EU-15 (figure 3).

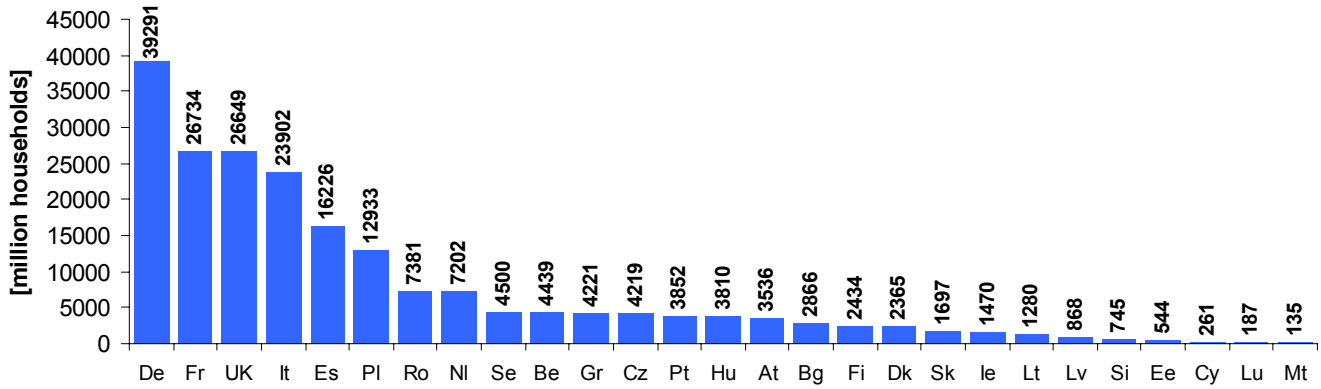

Figure 3: EU-27 households in 2007 (source Eurostat)

3. Energy and gas consumption in the EU-27 residential sector

Final energy consumption in the EU-27 residential sector started to decrease from 1999, going down by -1,55% in 2007 (-7,12% lower in 2007 than in 2004), but still 8% higher in 2007 than it was in 1990 (figure 4).

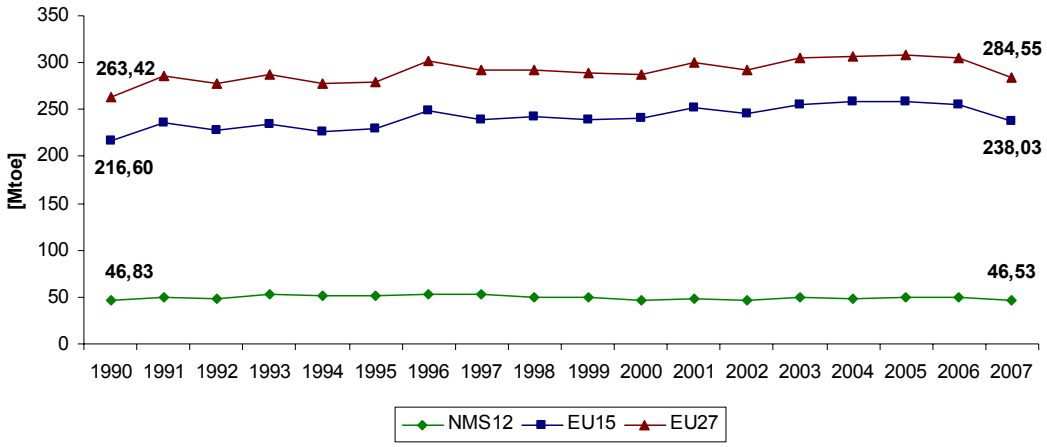

Figure 4: Trends of EU-27 final energy consumption in residential sector (source Eurostat)

The gas consumption of the residential sector has continued to grow in the period 1999 to 2007 in the EU-27 from 103,822 Mtoe to 113,176 Mtoe (9% growth), but the trend changed from 0,24% increase over the period 2004-2005 to -5,73% decrease over the period 2006-2007 (figure 6).

The NMS-12 gas consumption grew constantly: by 21,8% between 1990 and 2007. In the EU-15 gas consumption increased more significantly, by 45% between 1990 and 2007[2].

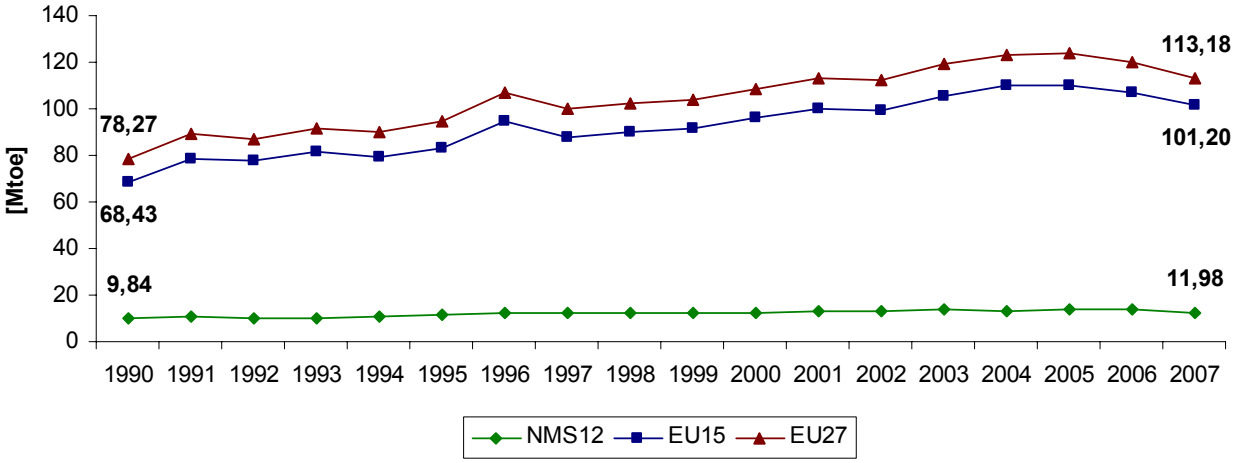

Figure 6: Trends of EU-27 gas consumption in the residential sector (source Eurostat)

[2] Over the last decades, the heating sector was characterised by fuel switch form heating oil to gas, with a positive impact on the heating efficiency.

Final electricity consumption of the residential sector for the EU-27 has grown by 13,17% in the period 1999-2007, from 707,52 TWh in 1999 to 800,72 TWh in 2007 and by 2,11% in the period 2004-2007 (figure 5). However, the consumption growth was lower than the economy growth of 20,57% during the period 1999-2007 and 8,23% in the period 2004-2007 (GDP market prices, 2000 exchange rates).

For the very first time, in 2007 EU-27 electricity residential consumption went down, decreasing by 7,5% as compared to 2006 (table 5).

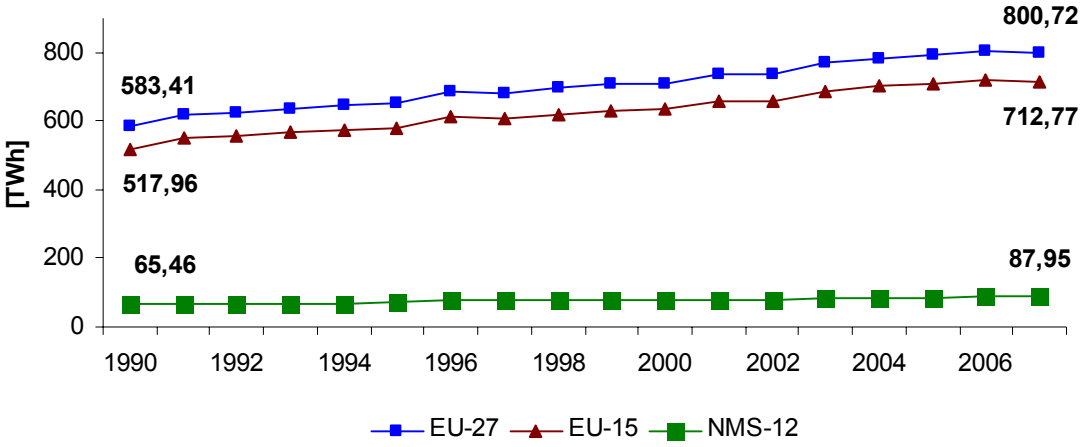

Figure 5: Trends of EU-27 final electricity consumption in the residential sector (source Eurostat)

Table 5: EU-27 Member States final electricity consumption in residential sector

	1999 [TWh]	2000 [TWh]	2001 [TWh]	2002 [TWh]	2003 [TWh]	2004 [TWh]	2005 [TWh]	2006 [TWh]	2007 [TWh]	1999-2007 [%]
EU-27	707,52	710,91	735,16	738,51	770,83	784,17	795,04	806,52	800,72	13,17
EU-15	630,92	634,70	657,81	660,91	687,98	701,41	710,83	719,01	712,77	12,97
NMS-12	76,61	76,21	77,34	77,60	82,86	82,76	84,22	87,52	87,95	14,81
At	13,38	13,58	13,70	13,82	14,02	14,22	14,56	14,74	14,16	5,85
Be	23,48	23,74	24,40	25,92	26,03	26,54	26,01	22,72	21,86	-6,93
Bg	10,12	9,86	9,75	9,31	9,31	8,77	9,05	9,31	9,38	-7,31
Cy	0,95	1,06	1,04	1,16	1,29	1,32	1,43	1,50	1,61	68,91
Cz	14,05	13,82	14,24	14,12	14,51	14,53	14,72	15,20	14,65	4,26
De	131,28	128,91	132,87	131,17	139,55	140,39	141,80	141,50	140,10	6,72
Dk	9,72	9,90	10,12	10,18	10,12	10,33	10,40	10,66	10,90	12,14
Ee	1,36	1,47	1,59	1,58	1,59	1,62	1,62	1,68	1,77	30,08
Es	45,44	43,62	49,69	50,64	54,24	58,05	63,82	70,73	71,59	57,54
Fi	18,45	18,14	19,37	19,94	20,41	20,36	20,58	21,14	21,49	16,51
Fr	126,93	128,72	133,89	133,00	141,55	147,09	144,55	147,10	145,76	14,83
Gr	13,48	14,21	14,55	15,78	16,44	16,85	16,88	17,68	17,96	33,17
Hu	9,83	9,79	10,13	10,44	11,06	11,03	11,12	11,45	11,25	14,41
Ie	6,01	6,38	6,73	6,58	6,97	7,35	7,51	8,08	8,06	34,18
It	60,72	61,11	61,55	62,96	65,02	66,59	66,96	67,64	67,22	10,71

Lt	1,89	1,77	1,82	1,81	1,90	2,07	2,14	2,35	2,46	30,65
Lu	0,68	0,70	0,72	0,74	0,75	0,81	0,81	0,84	0,83	23,01
Lv	1,15	1,19	1,24	1,32	1,42	1,47	1,57	1,73	1,79	56,41
Mt	0,52	0,56	0,54	0,57	0,63	0,62	0,62	0,66	0,66	26,30
Nl	21,35	21,80	22,10	22,80	23,30	23,50	24,23	24,83	24,29	13,79
Pl	20,80	21,03	21,38	21,66	24,85	25,48	25,06	26,02	26,37	26,77
Pt	9,52	10,06	10,63	11,38	11,84	12,43	13,24	13,41	13,86	45,57
Ro	7,88	7,65	7,72	7,77	8,24	8,04	9,23	10,00	10,39	31,79
Se	40,16	42,02	42,18	41,47	42,00	41,38	42,66	41,49	39,64	-1,31
Si	2,39	2,60	2,68	2,70	3,01	3,01	2,95	3,06	3,02	26,61
Sk	5,67	5,42	5,22	5,16	5,04	4,82	4,70	4,58	4,60	-18,86
UK	110,31	111,84	115,34	114,53	115,76	115,53	116,81	116,45	115,05	4,30

The largest electricity consumers in EU-27 households are electric heating systems (18,8%), cold appliances (15,3%), lighting (10,8%) and water heating systems (8,6%). Home appliances stand-by consumption accounts for 5,9% or 47,5 TWh/yr, being the eighth main consumer, more than air-conditioning, almost the same share as home computers and dishwashers together (figure 7, table 6).

Table 6: Breakdown of residential electricity consumption in EU-27 in 2007 (source JRC)

EU-27 residential electricity consumption	**[TWh]**
Cold appliances (refrigerators & freezers)	122,0
Washing machines	51,0
Dishwashers	21,5
Electric ovens & hobs	60,0
Air-conditioning	17,0
Ventilation	22,0
Water heaters	68,8
Heating systems/electric boilers	150,0
Lighting	84,0
Television	54,0
Set-top boxes	9,3
Computers	22,0
External power supplies	15,5
Home appliances stand-by	43,0
Others	60,6
Residential electricity consumption	800,72

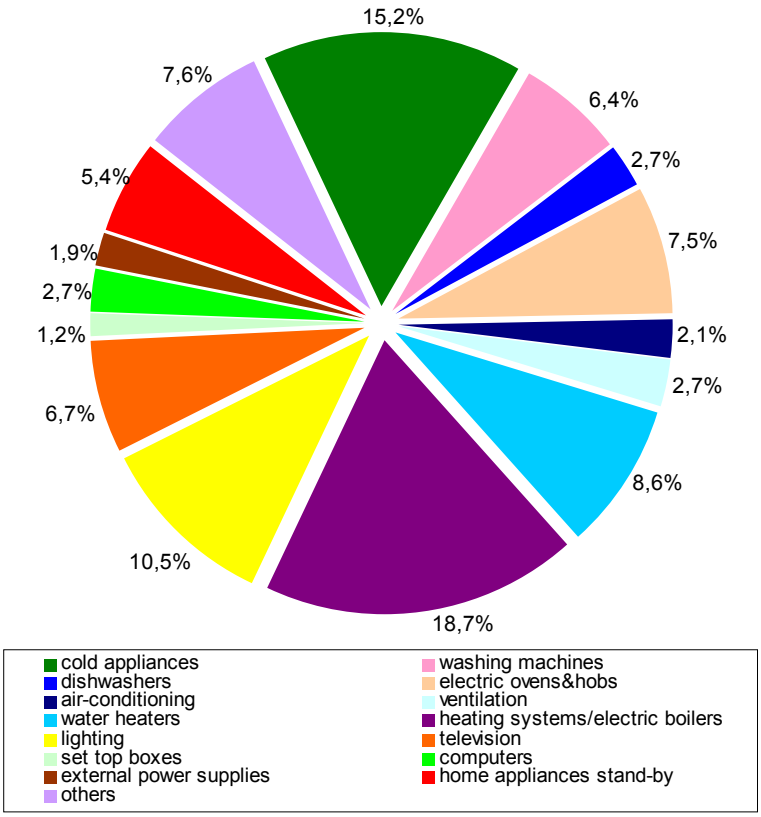

Figure 7: Breakdown of EU-27 residential electricity consumption, year 2007 (source JRC)

3.1. White appliances

White appliances present an example of sizeable energy efficiency improvement due a combination of EU legislation (energy labelling and minimum energy performance standards), national programmes (for example tax incentives in Italy, price rebate schemes in Spain, supplier obligations and White Certificate schemes in France, Italy and the UK) as well as the voluntary agreements of manufacturers (CECED).

Within the framework of the Eco-design Directive, preparatory studies for cold appliances, washing machines and dishwashers are already finalised and others for ovens, hobs and grills will start soon in June 2009. The implementation of the Eco-design Directive is expected to further boast the efficiency of these product groups.

3.1.1. Cold appliances (refrigerators and freezers)

Over the last years, the refrigerator stock reached the saturation level with penetration rates of around 100% in almost all EU-27 countries. At the same time, the freezer market registered a significant decrease tendency, due to the increased use of combined refrigerator/freezer appliances.

The EU-27 refrigerator stock in the residential sector was estimated to be around 190,577 million units and the freezer stock at around 84,292 millions units [PRE2008].

In 2005 the estimated energy consumption of the cold appliance stock in EU-27, considering also the extra-consumption due to the positioning (built-in appliances or without the required surrounding space), ambient temperature and the operation losses (opening of door, storage quantity), was around 82 TWh/yr for refrigerators and 40 TWh/yr for freezers [PRE2008]. The overall cold appliances consumption remained almost the same as in 2004 [BER2007]. Our evaluation indicates that with saturation levels reached, the consumption was almost the same in 2007.

In 2007, the combined refrigerator/freezer appliances (2 door appliances) accounted for the greatest share of cold appliance sales with 59,3% and 79% on both EU-15 and NMS-12 markets (figure 8).

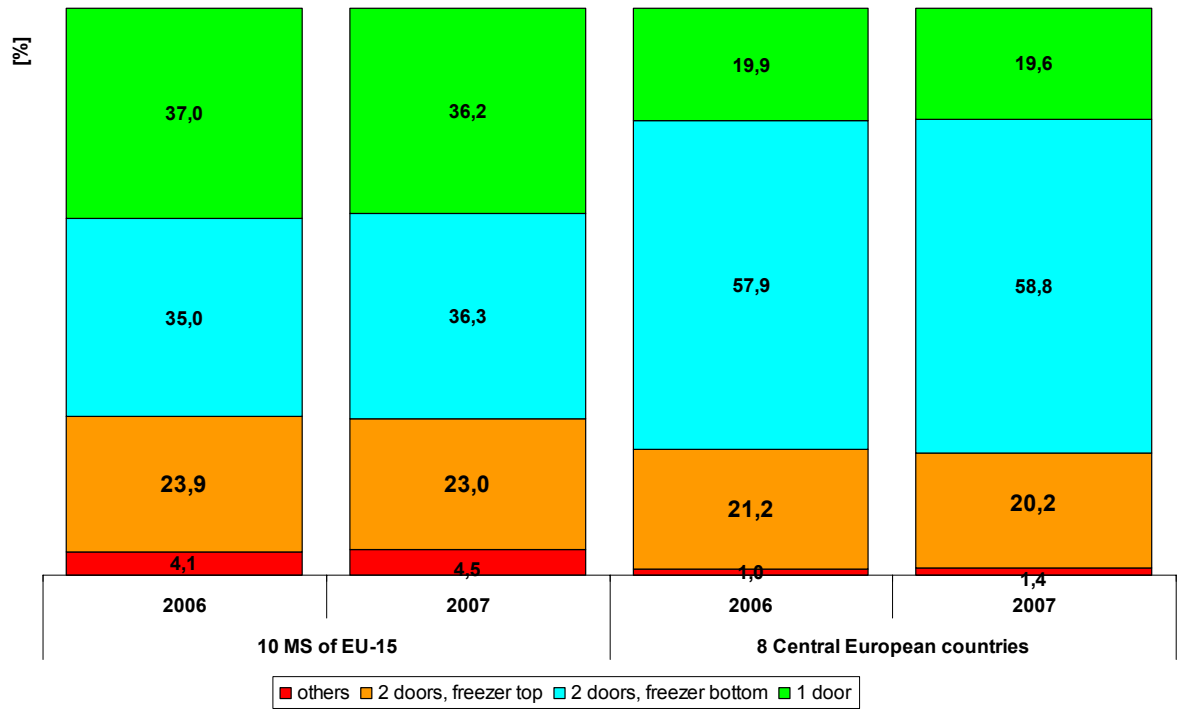

Figure 8: Sales of cold appliances: the market importance of models in 2006 and 2007 (Source GfK)

The cold appliance market is characterised by a high level of substitution of old appliances rather than the increase of the household stock. The efficiency improvement continued,

mainly due to the increased awareness about energy consumption and with the energy labelling scheme contributing to a real market transformation across EU-27.

The sales for refrigerators are at around 13,8 million units per year and the market registered the tendency to shift to bigger capacities, from 120 litre refrigerators to 161-180 litres and from 200 litres to 251-300 litres. The freezer sales decreased over the last years arriving to some 4 million units per year because of the higher market penetration of the combined refrigerator/freezer appliances. The freezer sales slowly shift to bigger capacities (as in the case of refrigerators), the great majority of the sales being in the range of the 81-300 litre capacity. [PRE2008].

From 2002 to 2007, cold appliance sales showed a strong tendency of 'greening', with A and A+ appliances becoming dominant on the market, together taking a share of 85,6% and 88,1% in EU-15 and NMS-12 respectively (figure 9). In the countries observed by GfK panel[3], the A class share grew by 72% in EU-15 and by 69% in NMS-12 from 2002 to 2007 and the A+ class share registered a more than 100% growth in overall market sales of cold appliances. The appliances below B class almost disappeared from the market, registering only a 2,4% and 1,4% market share in EU-15 and NMS-12 respectively. The current minimum energy performance standards (MEPS), entered in force in 1999, banning D class or below.

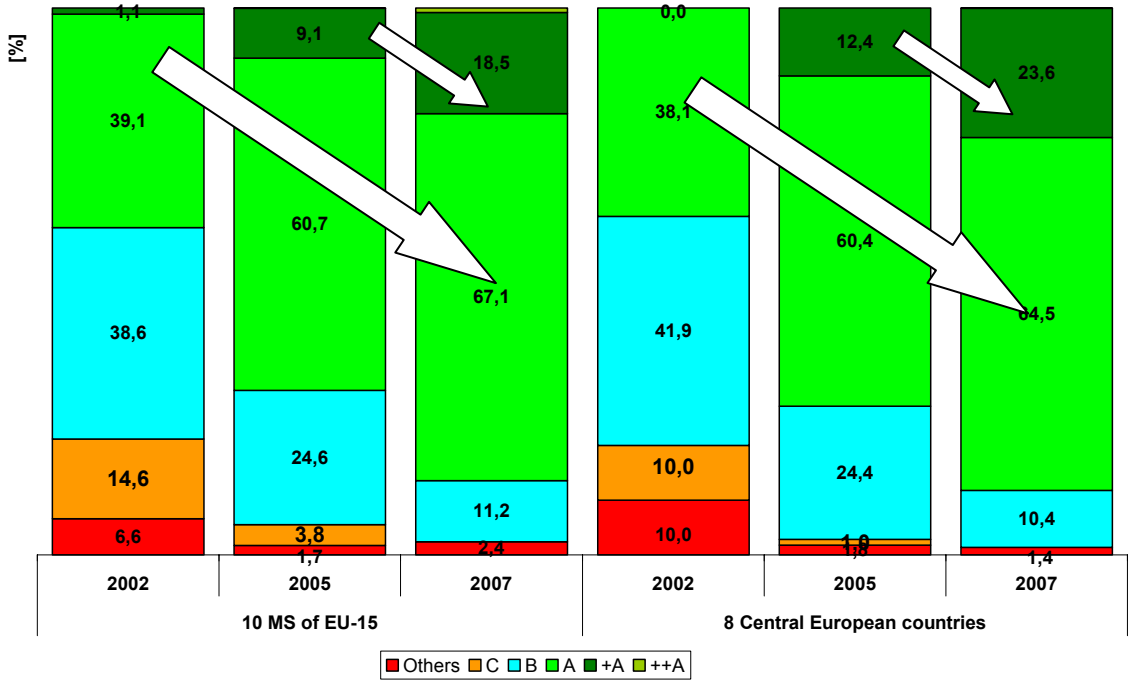

Figure 9: Comparison of cold appliance sales for the 10 EU-15 and 8 NMS-12 countries in 2002, 2005 and 2007, by energy class (Source GfK)

[3] GfK panel includes Central European countries: Czech Republic, Hungary, Poland, Romania, Slovenia, Slovak Republic, Bulgaria, Croatia, Baltic countries: Estonia, Latvia, Lithuania and Western European countries: Germany, France, UK, Spain, Italy, Austria, Belgium, The Netherlands, Portugal, Sweden

The energy efficiency index (EEI)[4] of cold appliance sales improved continuously between 1993 and 2007, reaching a remarkable 44% efficiency improvement over 14 years (figure 10). It is also interesting that in 2007 the EEI of the market sales of cold appliances in NMS-12 overtook that in EU-15. The explanation resides in the high replacement rate of cold appliances registered in NMS, around 30% in the last 4 years, according to GfK studies. In Italy and the UK the same high replacement rates were registered, mainly due to the support policies from these countries, such as income tax deductions (in Italy) and the Energy Efficiency Commitment[5] programme (in the UK).

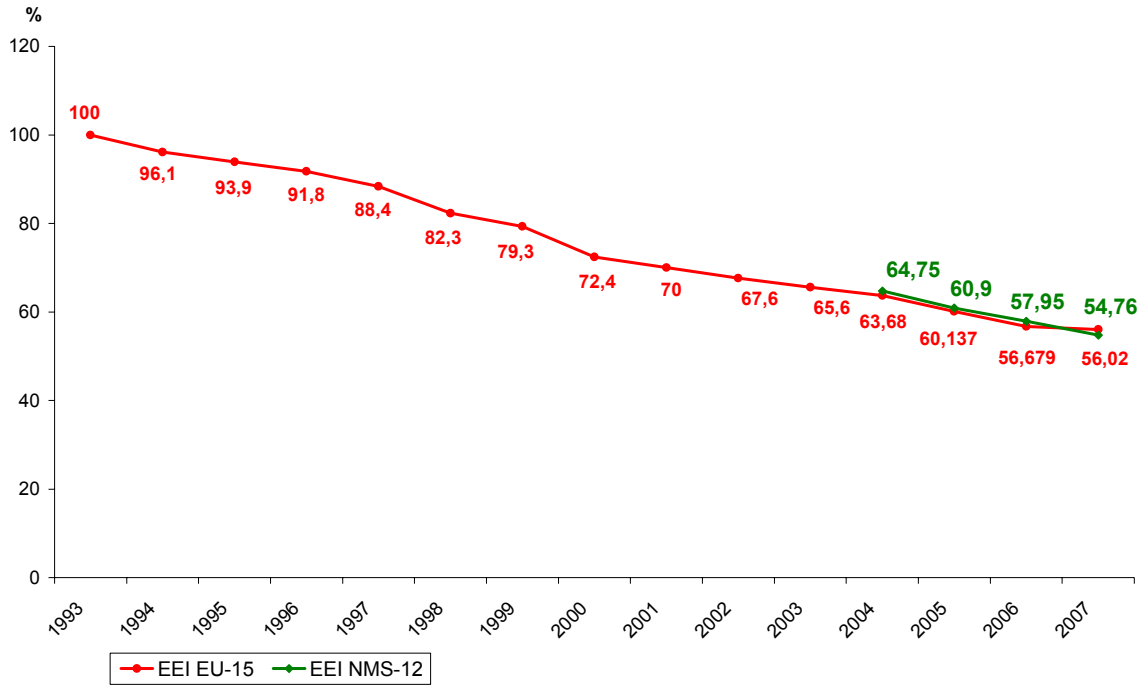

Figure 10: Evolution of the EEI for cold appliances sales (source: JRC, [Wai 2004a])

In January 2008 the Italian Government introduced a tax subsidy programme, in order to promote the sales of highly efficient cold appliances, and consumers buying an A+/A++ refrigerator or freezer could deduct 20% of the appliance cost (up to 200 euro) from their income tax [ECK2008]. The market response seen was a growth in the sales of A+ class appliances by a factor of 2,5 in 2007 compared to the previous year. The share of A+ appliances in sales reached 45,5% in 2008 (figure 11).

4 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.

5 Under the Energy Efficiency Commitment (EEC), electricity and gas suppliers were required to achieve targets for the promotion of improvements in domestic energy efficiency. The EEC contributed to the Climate Change Programme by cutting carbon dioxide emissions. At least 50 per cent of energy savings were focused on priority groups of low-income consumers in receipt of certain benefits, including tax credits and pension credit. The second phase of the EEC ran until mid-2008. The third phase has been re-named the Carbon Emissions Reduction Target (CERT).

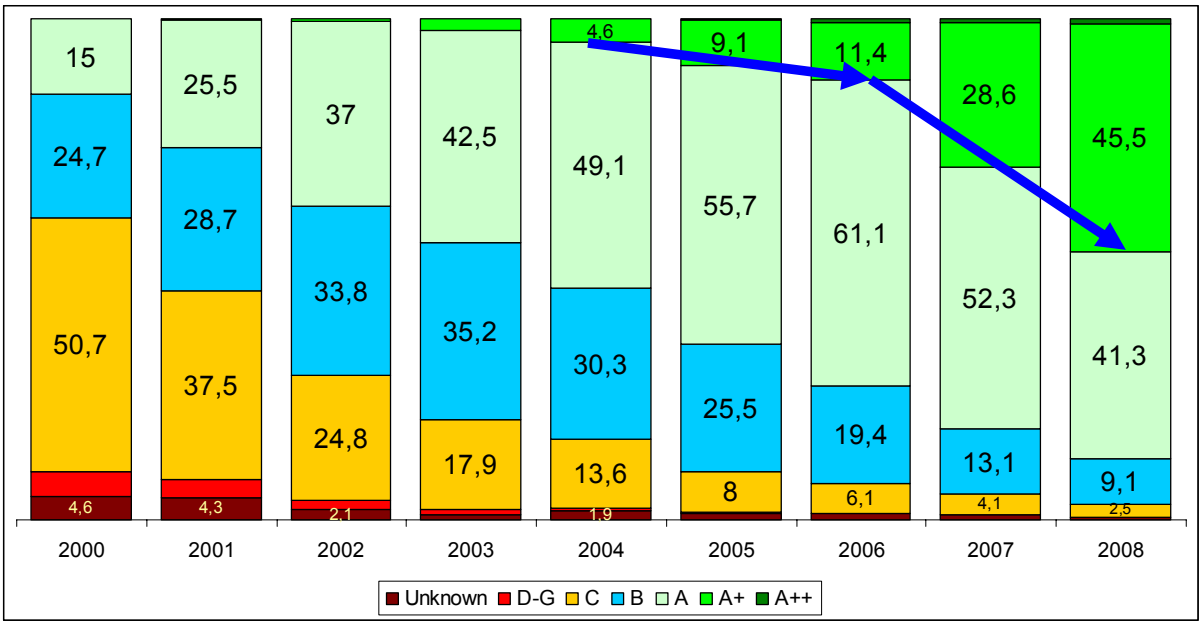

Figure 11: Evolution of cold appliance sales in Italy before and after the introduction of the tax subsidy programme [PAU2009]

With energy labelling[6] and minimum efficiency requirements[7] in force since 1994 and 1996 respectively, domestic refrigerators and freezers are one of the success stories of Community energy efficiency policy. Over the last 15 years, an energy efficiency improvement of almost 45% has been achieved, and the EU Energy Label has become one of the most important market drivers. Despite a population growth of 15% over the same period, the absolute energy consumption of domestic cold appliances in 2007 is currently 15% lower than in 1990. In the same period, the industry has practically phased out CFCs and HCFCs and substituted them by hydrocarbons, thus diminishing the Ozone Depletion Potential and the Greenhouse Gas impact of the refrigerant and foaming agents.

In the meantime, the minimum energy efficiency requirements have long been exceeded and the industry (CECED) has implemented a self-commitment banning the least efficient appliances from the market. However, partly as a consequence of the enlargement of the EU, the increased imports and mainly because of the new market development which has become too scattered for a proper and fair implementation, the industry has decided not to table a new voluntary agreement. In addition to minimum requirements, an energy-labelling scheme is in force.

The labelling energy efficiency classes, revised in 2003 by adding classes A+ and A++, has become a victim of its own success proving not to be sufficient anymore in driving innovation.

6 Commission Directive 2003/66/EC amending Commission Directive 94/2/EC implementing Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations

7 Directive 1996/57/EC of the European Parliament and of the Council on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof

Stakeholders, including the industry and consumer organisations, are unanimously asking for a combined revision of the labelling directives on refrigerating appliances[8].

In March 2009, the Regulatory Committee for the implementation of the Eco-design Directive agreed on new minimum energy performance requirements and an updated version of the Energy Labelling Directive for refrigerators and freezers. The European Parliament rejected the proposal of the new energy label in May 2009, asking the Commission to prepare new proposals for updating the A to G efficiency rating system.

On 22 July 2009, the European Commission adopted the Regulation implementing the Eco-design Directive with regard to eco-design requirements for household refrigerating appliances[9].

According to the Regulation, the proposed minimum energy requirements will be based on an "energy efficiency index" (EEI), which will represent the ratio between annual consumption of the appliance and a standard consumption of a typical similar model.

The mandatory requirements that will take effect in 2013 will include automatic switch-off of the "fast-freeze" function after 72 hours, electronic thermostats for optimising the switch to "winter setting" and automatic switch-off of small appliances with a volume of less than 10 litres.

For compressor-type cold appliances (representing today 95% of the market), minimum energy requirements are foreseen according to the follow roadmap:

- From July 2010: The current Class A becomes the new minimum energy performance requirement (EEI<55).
- From July 2012: The current Class A+ becomes the new minimum energy performance requirement (EEI<44).
- From July 2014: Stronger requirements than the current Class A+ becomes the new minimum energy performance requirement (EEI<42). The best appliances today reach EEI<30.

For absorption-type and other type refrigerating appliances, minimum energy requirements are foreseen according to the follow roadmap:

- From July 2010: The new minimum energy performance requirement will be EEI<150.
- From July 2012: The new minimum energy performance requirement will be EEI<125.
- From July 2015: The new minimum energy performance requirement will be EEI<110.

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[8] Member States have initiated in the past fiscal incentives programmes to foster the market take-up of energy efficient appliances but the insecurity as regards the future of the energy efficiency classes do not allow them to initiate new support programmes. Furthermore, the Eco-design Directive implies that efficiency standards on domestic appliances cannot be taken at Member State level.

[9] Commission Regulation (EC) No 643/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for household refrigerating appliances, Official Journal of the European Union L 191/53, 23.7.2009

Estimated savings of 6 TWh/year within the EU-27 are expected by 2020, when the energy labelling and performance requirements for fridges and freezers reach their full impact [PRE2008].

3.1.2. Washing machines

Washing machine stock has reached saturation, reaching penetration rate levels around 100% in all the EU-27 countries.

In the NMS-12, the existing stock was lower than in EU-15, but grew fast reaching the same saturation level as in the rest of EU in almost all the countries from the region.

The EU-27 washing machine stock in residential sector was estimated to be around 172,85 million units (JRC estimation based on [PRE2007]).

According to the Eco-design preparatory study for wet appliances, the estimated energy consumption of washing machine stock in 2005 was around 51 TWh/yr, with 295 kWh average yearly energy consumption per appliance and 90% penetration rate in the EU-27 households (JRC estimation based on [PRE2007]).

Taking into consideration that the market has already reached a saturation level, as well as a growing penetration rate of efficient washing machines in NMS-12 due to high substitution level, the energy consumption remained almost constant in 2007, at around 51 TWh/yr.

The sales for washing machines in EU-27 are at around 13,7 million units per year, increasing significantly over the last years by some 8% on the Western Europe and by around 25% on the Eastern Europe markets. [PRE2007]

The washing machine sales show a preference of buyers for the spin speed of the equipment. The very fast spin speed (>800 rpm) washing machines market share was higher in the NMS-12 than in EU-15: 77,3% of the sales in 8 NMS from Central Europe were washing machines with spin speed more than 800 rpm, in 10 EU-15 countries being only 33,6% (figure 12). [SOR2008]

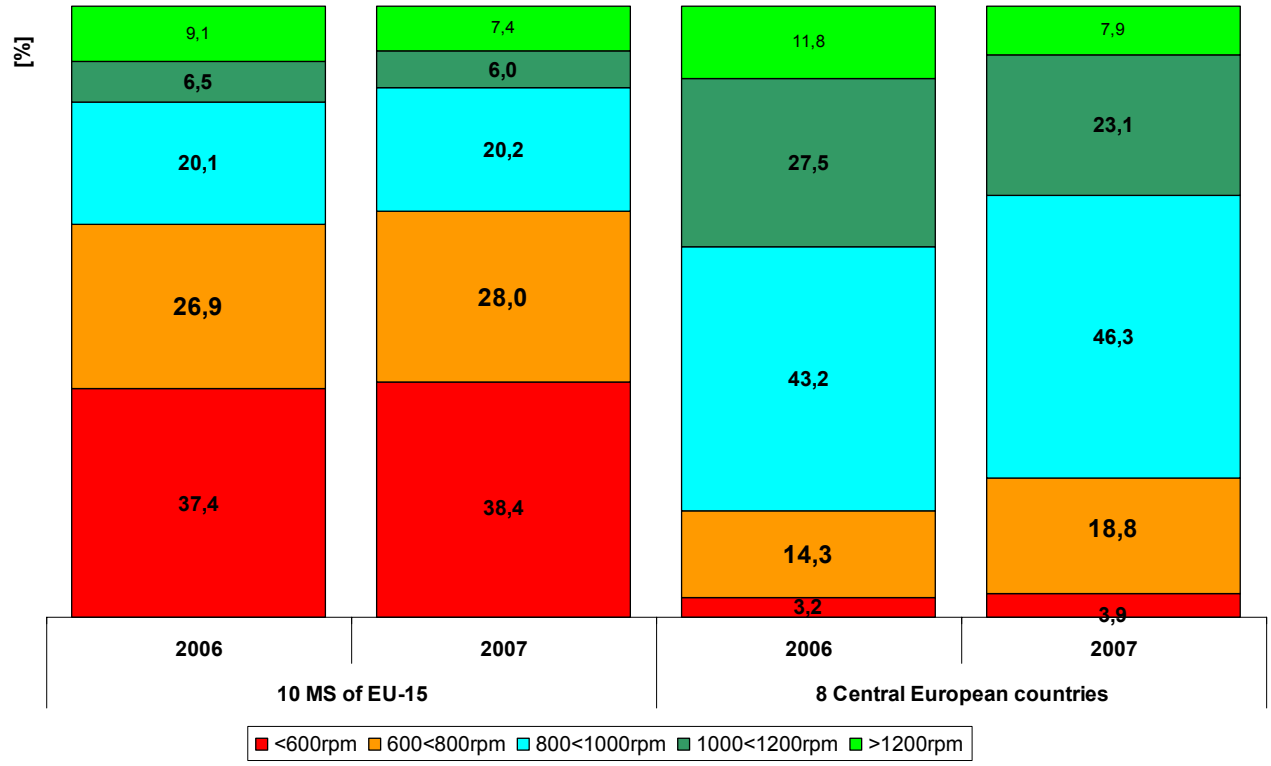


Figure 12: Sales of cold appliances: the market importance of spin-speed in 2006 and 2007 (Source GfK)

As in the case of refrigerators, the washing machine market is characterised by a high level of substitution of old appliances, rather than increasing the household stock. The efficiency improvement continues mainly due to the increase in awareness about energy consumption, the energy label contributing to a real market transformation across EU-27.

In the period 2002 to 2007, washing machine sales were dominated by A class, with A and A+ classes together taking in 2007 a share of 96,7% and 95,3% in EU-15 and NMS-12 respectively (figure 13). In the countries observed by the GfK panel, the A+[10] class share has been rapidly growing, reaching 39% in EU-15 and 40% in NMS-12 in 2007. Appliances below B class have almost disappeared from the market, registering less than 2% market share on both EU-15 and NMS-12 markets.

[10] A+ is not an official energy class, being used only by several manufacturers

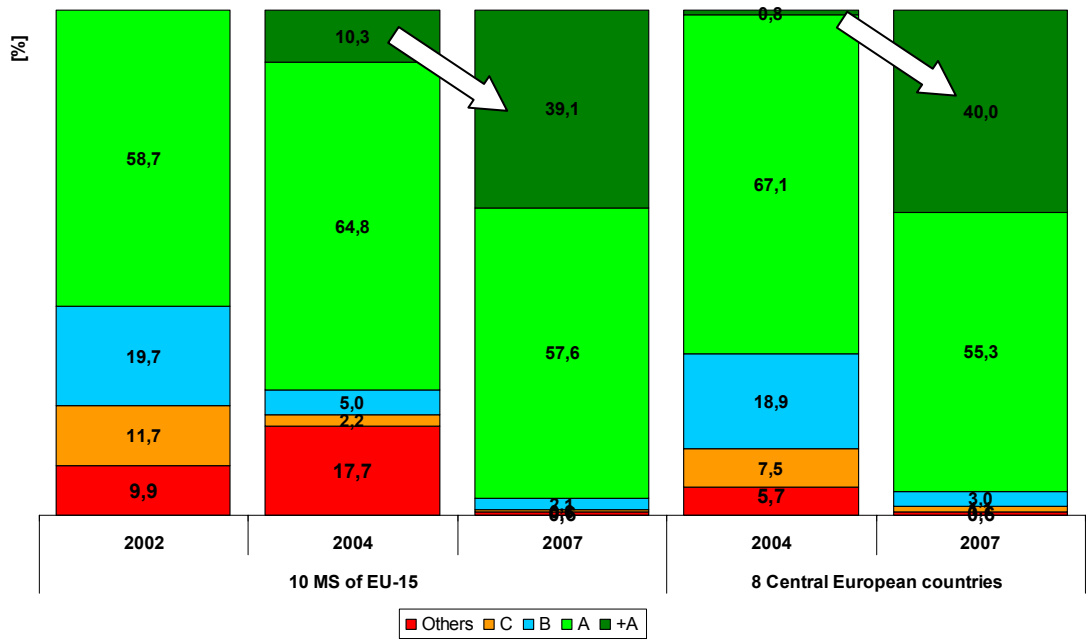


Figure 13: Comparison of washing machine sales for the 10 EU-15 and 8 NMS-12 countries in 2002, 2004 and 2007 by energy class (Source GfK)

The energy efficiency index (EEI)[11] of the washing machine sales continuously improved from 1996 to 2007, reaching a notable 30% efficiency improvement over 12 years. In 2007, the EEI of the market sales cold appliances became the same in the NMS-12 as in the EU-15, due to a faster replacement rate in NMS-12, where the stock was older and less efficient. According to the GfK panel, for washing machines the attention of the consumer to efficient energy consumption appliances is much higher than for refrigerators and the price seems to be an important element in supporting the growth of segments A+.

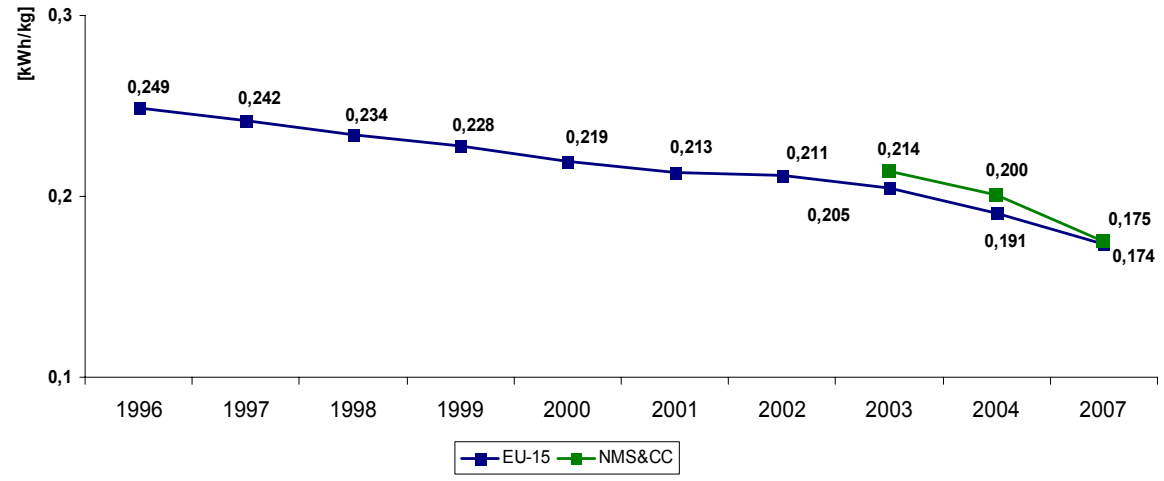


Figure 14: Evolution of the EEI for washing machine sales (source: JRC)

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

The current Directive 97/17/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines provides consumers with a set of information related to energy consumption (kWh/cycle), cleaning performance, drying performance, water consumption and noise emission.

The washing machine manufacturing industry represented by CECED, the European Committee of Domestic Equipment Manufacturers, agreed upon two Voluntary Commitments (the first in 1997, the second in 2002) which proved to be very successful in driving energy efficiency of washing machines. The participants of the 1st commitment agreed to remove from the market the least efficient washing machines in two steps[12], agreeing to introduce an energy class, A+ (< 0,17kWh/kg and minimum A class washing performance)[13]. The second voluntary commitment finished in December 2008 without renewal, the EU industry calling for legally binding energy efficiency requirements[14].

In March 2009, the Regulatory Committee for the implementation of the Eco-design Directive agreed on minimum energy efficiency requirements for washing machines and an updated version of the Energy Labelling Directive for washing machines.

The proposed minimum energy performance requirements are based on the Energy Efficiency Index (EEI), which will be the ratio between annual consumption of the machine and a reference consumption of a model with similar capacity.

For washing machines, minimum energy requirements according to the follow roadmap will be foreseen:

- From 2010: Minimum requirement of current energy class A (EEI shall be lower than 68) and limit on water consumption for the 60°C full-load programme.
- From July 2015: Minimum requirement of the current energy class A+ (EEI shall be lower than 59) for washing machines above 4 kg load.

Energy labelling and minimum energy requirements for washing machines are expected to deliver savings of 2 TWh/year within the EU-27 by 2020, when these policy tools reach their full potential [PRE2007]. On the other hand, behavioural measures, most importantly lowering the washing temperature, could still contribute with important savings.

[12] CECED Voluntary Commitment on Reducing Energy Consumption of Household Washing machines –September 1997, downloadable from www.ceced.org

[13] This is not an officially recognised class under the EU labelling scheme.

[14] See CECED press release on 21 March 2007, "Top executives Discontinue Voluntary Energy Efficiency Agreements for Large Appliances", downloadable from http://www.ceced.org.

3.1.3. Dishwashers

In the EU-27 dishwashers have a lower saturation level than major appliances (refrigerators and washing machines). Penetration differs from country to country and is around 50-60% at maximum. [PRE2007]

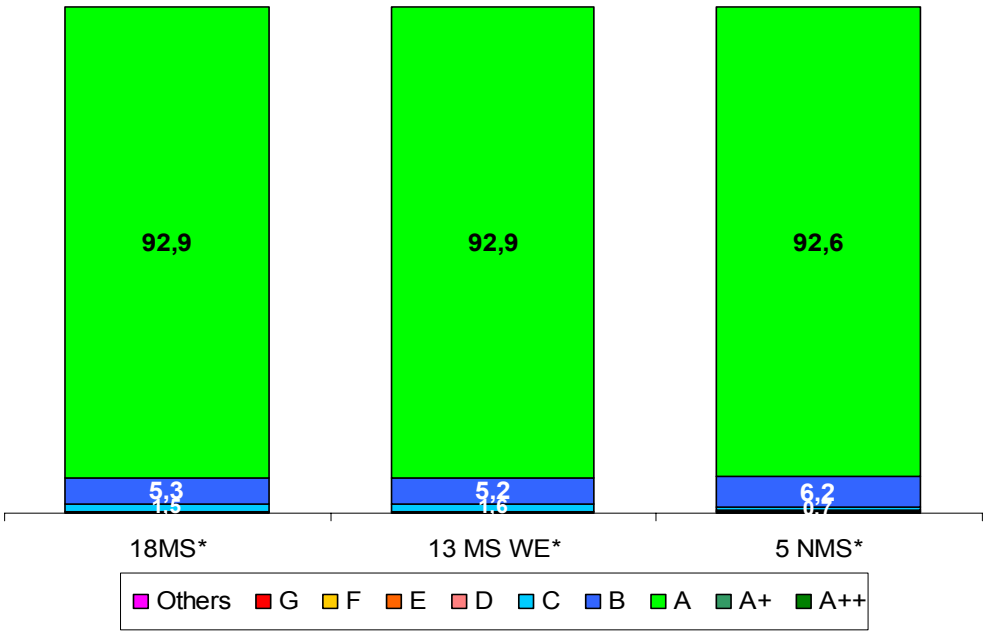
The EU-27 dishwasher stock in the residential sector was estimated at around 69,307 million units (JRC estimation based on [PRE2007]).

According to the Eco-design preparatory study for wet appliances (Lot 14), the estimated energy consumption for the dishwashers stock in 2005 was around 18,75 TWh/yr, considering a 270 kWh average yearly energy consumption per appliance (JRC estimation based on [PRE2007]).

JRC estimates show that taking into consideration that the market continues to grow, especially in the NMS-12, but also in some EU-15 countries, the energy consumption of dishwashers grew slightly in 2007, reaching around 21,5 TWh/yr.

The sales for dishwashers in EU-27 are at more than 6 million per year, increasing significantly over the last years by more than 10% on Western Europe and by around 50% on the Eastern Europe markets. The majority of dishwasher models placed on the market in 2005 had a capacity of 12 and 9 place settings and this trend continued also into the next two years [PRE2007].

The A energy class dishwashers dominated the EU market in 2007, with more than 92% of the sales being in this category. Appliances below B class have almost disappeared from the market, registering less than 2% market share. (more than 92%, figure 15)



**Note: 13 MS WE=AT,BE,DE,DK,ES,FI,FR,GB,GR,IT,NL,PT,SE ; 5NMS=CZ,HU,PL,SI,SK*

Figure 15: Dishwashers sales in 2007, according to the energy classes [ECK2009]

For dishwashers there was only relatively small efficiency progress between 2001 and 2005. In 2003 the average consumption per test cycle wash of a 12-place setting dishwasher was 1,197 kWh: down by 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 no large energy saving potential due to technological progress. This also indicates that there is no possibility to introduce an A+ class.

Table 7: EU-15 Dishwasher energy consumption progress (source CECED, [PRE2007])

period	energy average consumption [kWh/yr]	efficiency improvement vs. previous period [%]
1968-1979	2,57	-
1980-1984	2,35	8,56
1985-1989	2,13	9,36
1990-1994	1,91	10,33
1995-1997	1,69	11,52
1998-1999	1,434	15,15
2000-2004	1,268	11,58
2005	1,035	18,38

The current Directive 97/17/EC implementing Council Directive 92/75/EEC with regard to energy labelling of household dishwashers provides consumers a set of information related to energy consumption (kWh/cycle), cleaning performance, drying performance, water consumption and noise emission.

The introduction of the label helped consumers in identifying the most efficient models on the market and weighing energy efficiency against the other performance aspects. At the same time, the label benefited manufacturers who could state the energy efficiency of their appliances through a neutral (and mandatory) informative label, which spurred a competitive race in achieving the highest energy efficiency scores.

The dishwasher manufacturing industry represented by CECED, the European Committee of Domestic Equipment Manufacturers, agreed upon a Voluntary Commitment in 1999, which also proved to be very successful in driving energy efficiency of dishwashers[15]. The agreement committed to removing the least efficient dishwashers from the market in two steps (with deadlines in December 2000 and 2004) and was successfully completed in 2004. It has not been renewed subsequently.

The Eco-design Directive preparatory study for Lot 14 covers both dishwashers and washing machines, but by the Regulatory Committee from March 2009 approved only proposals for washing machines. The evaluation of the dishwashers proposals has been postponed.

The main energy efficiency measures proposed for dishwashers include imposing the current energy class B (EEI shall be lower than 71) as minimum requirement from 2010, and the current energy class A (EEI shall be lower than 63) as minimum requirement from 2015.
By 2020, when the energy labelling and the minimum energy requirements for washing machines reach their full impact, savings of 2 TWh/year are estimated within the EU-27 [PRE2007].

3.2. Cooking Appliances

The total electricity consumption for electric cooking is estimated to be of around 60 TWh (electric hobs and electric ovens together). There is a mandatory energy label (Directive 2002/40/EC) only for electric ovens, which covers also the electric ovens in free-standing cookers. The impact of the energy labelling started to be visible on the market and the A class appliances represent more than 50% of the EU market (figure 16). Comparing to the 2005 status, the NMS markets had a positive change from less than 40% share of the A class appliances to almost 60% share in 2007.
For cooking appliances, there is still an important potential for energy savings that could be exploited in the next future by related national and EU policies.

**Note: 13MS WE=AT,BE,DE,DK,ES,FI,FR,GB,GR,IT,NL,PT,SE ; 10NMS=BG,CZ,EE,HU,LT,LV,PL,RO,SI,SK*

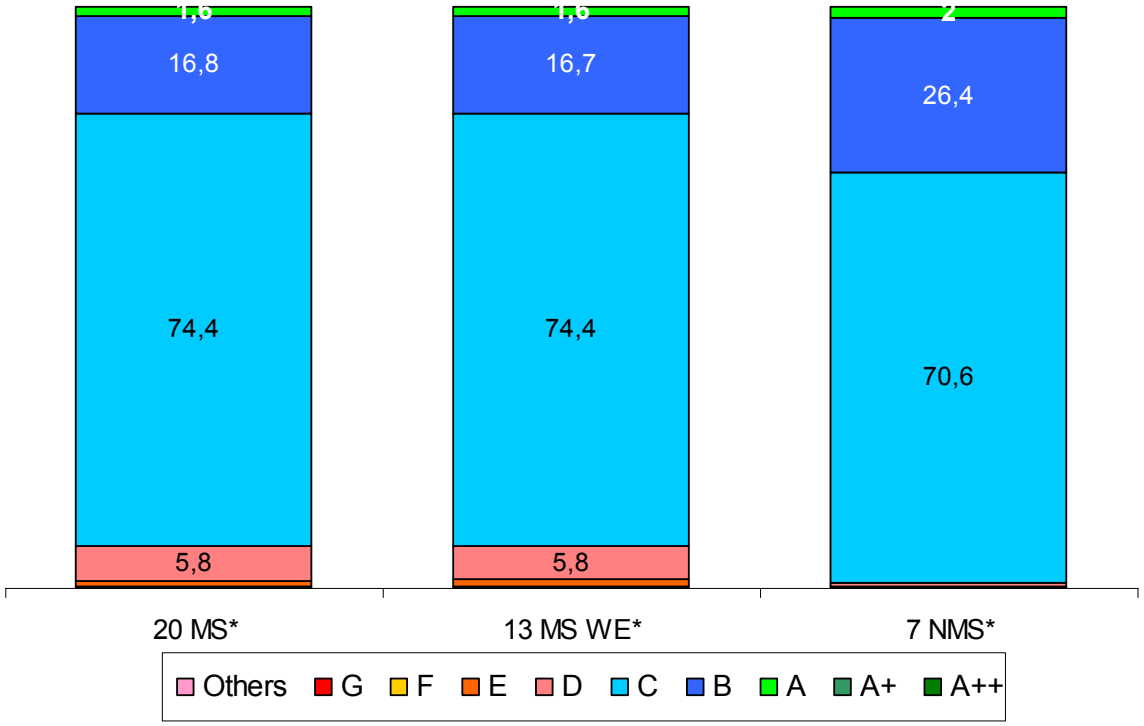
Figure 16: Electric cooking appliances sales in 2007, according to the energy classes [ECK2009]

[15] CECED Voluntary Commitment on Reducing Energy Consumption of Household Dishwashers –November 1999, downloadable from www.ceced.org

3.3. Dryers

Dryers are the appliance where little progresses in energy efficiency have been achieved with the mandatory energy label (Directive 95/13/EC) and transforming the dryer market to A-label equipments will save a lot of energy.

According to GfK, the market sales of domestic tumble dyers are dominated by C class appliances (above 70%), the B class share being more important on the NMS markets (figure 17).



**Note: 13 MS WE=AT,BE,DE,DK,ES,FI,FR,GB,GR,IT,NL,PT,SE ; 7NMS=BG,CZ,HU,,PL,RO,SI,SK*

Figure 17 : Tumble dyers sales in 2007, according to the energy classes [ECK2009]

3.4. Heating and cooling appliances

Space and water heating appliances together account for 29,8 % of the total electricity consumption in the residential sector.

Space heating and cooling represent the largest single electricity end-use consumers in the residential sector, with 21,7% share, comprising the electricity consumption of air-conditioning, electric boilers, heat pumps, radiators and other electric heating appliances.

The energy consumption for space heating and cooling is strongly dependent on the regional weather characteristics, such as seasonal and annual temperature variation. The actual heating degree-days in EU-27 (figure 9) demonstrate that in almost all the countries, the last years' tendency was negative, i.e. that temperatures were higher. This means that the

heating needs decreased in 2007 in comparison to 2006 and this also explains the lower heating energy and electricity consumption in 2007 (figure 18).

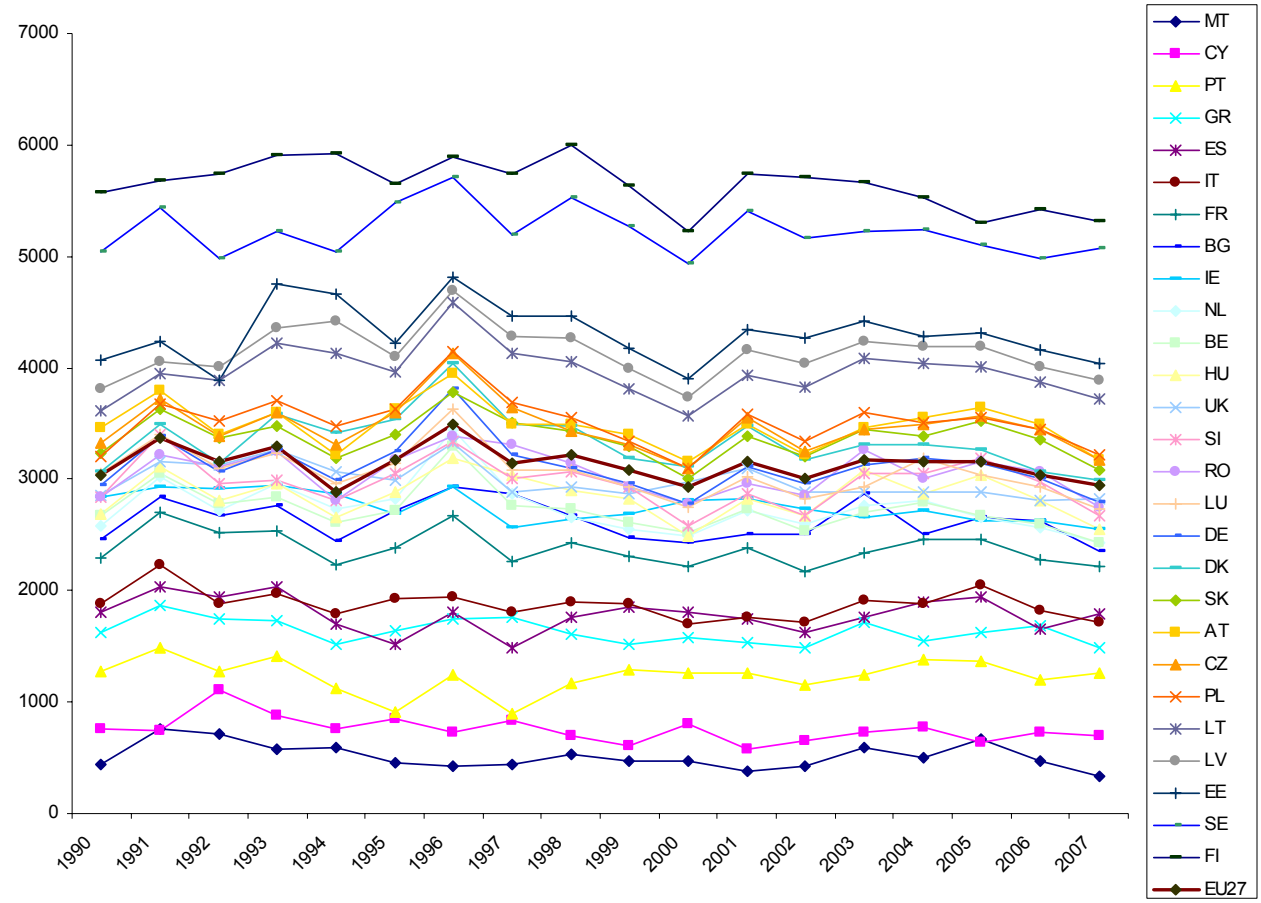


Figure 18: Actual heating degree / days (source: Eurostat)

In 2007 the heat energy consumption in the EU-27 residential sector[16] was 3,3% above that in 1990, but the variation over this period was higher, reaching the absolute peak in 1996 (both in EU-15 and NMS-12), with a 33% higher consumption in comparison to 1990.

The heat energy consumption in EU-15 increased constantly from 1990, reaching 9,56 Mtoe (27,7% growth). Heat energy consumption patterns were more dynamic in NMS-12, but decreasing to 18,9 Mtoe in 2007 (decreasing by -13,3% from 1990).

However, the heat energy consumption was higher in NMS-12 than in EU-15, and this is explained by the fact that the data represents only centralised production of heat energy (district heating), excluding distributed production of heat energy. District heating is still more developed in urban areas across the NMS-12 than in EU-15, while in EU-15 distributed heat energy production (mainly from gas but also electrical) is more common.

However, in NMS-12 the heat energy consumption was decreasing from the mid '90s due to several factors:

[16] The heat energy consumption accounted by Eurostat represents only the centralised heat energy/district heating and not also the distributed heat energy.

-higher efficiency of district heating systems because of refurbishments (i.e. better insulation for transport pipelines, retrofit of heat generation plants),
-warmer winters,
-decreased utilisation (higher prices influenced the consumption, disconnection, customers reoriented for independent heating systems)

Figure 19 demonstrates the link between heating degree-days and heat energy consumption. Gas consumption[17] is related to the heating degree-days too, but is also influenced by market demand and prices. Gas consumption shows a significant growth in the period 1990 to 2007 (44,6% growth from 1990). However, the gas consumption started to decrease from 2004-2005, following the decrease in heating degree-days.

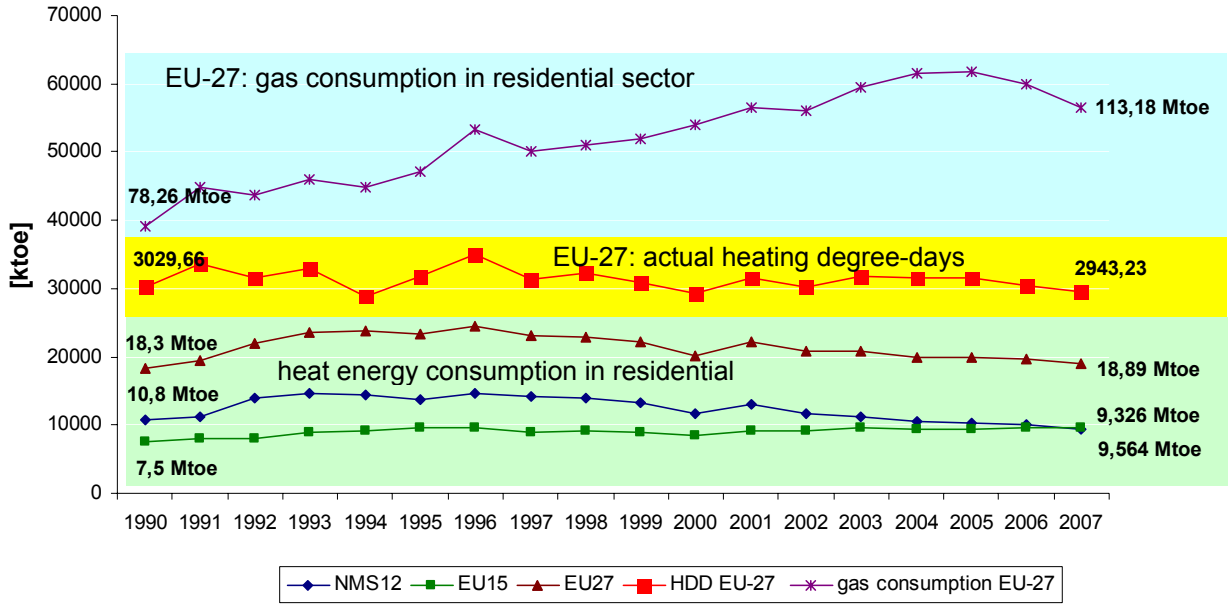


Figure 19: Heating energy and gas consumption in EU-27 households vs. heating degree-days

3.4.1. Space heating and boilers

The space heating equipment is still the largest electricity consumer, with an estimated consumption of around 150 TWh/year, including electrical equipment (electric boilers and radiators), monitoring and control equipment of other heating equipment fuelled by gas or oil. The EU central heating stock rose in the last years reaching an estimated 80% of the installed heating systems (some 163 millions dwellings) in 2007. [KEM2007a]

[17] The gas figures includes also a share of water heating corresponding consumption.

The fastest growth was registered by individual hydronic heating systems – 52-53% from 1990 until the present day – reaching almost 100 million units. Gas-fired systems account for the biggest share of the individual central heating sector (almost 80%). 75% of gas-fired systems are wall-hung ones. The electric central heating boilers represent around 1,2 % (1,11 million units) of the existing stock and 0,5 - 0,6% (39.000 units) of the market sales.

Apart from individual hydronic central systems, around 10% of the residential stock is connected to the district heating, from which 3% is in the NMS-12. Other 15% represent collective heating and 7% dry electric or gas heaters (room heating). The market trends indicate that the electric boilers will preserve their marginal position also in the future. [KEM2007a]

The overall residential boiler sales registered some 7 million units sold in 2007, from which 60% represent replacements of old existing boilers, 22% for new houses and only some 14% representing first-time installation in a dwelling.

The wall-hung gas boilers dominate the stock (51,5%) and the sales (80%), but the biggest part is still taken by the non-condensing boilers.

In The Netherlands, Germany, UK and Denmark condensing boilers, which represent a more efficient alternative, have significant shares in both the existing stock and market sales. Several countries like France, Ireland, The Netherlands, Austria, Italy and Denmark, have developed specific national programmes offering subsidies and tax credits for high efficiency condensing boilers.

The preparatory study for boilers and combi-boilers[18] (Lot 1) for implementing the Eco-design framework Directive was finalised and includes proposed requirements for central heating boilers for gas, oil and electricity with a power of 3,6 to 350 kW.

The following main requirements are proposed for central heating boilers from 2013:

- Minimum performance of seasonal energy efficiency for XS and S class boilers with an output power of less than 10 kW shall be 56 % from 2011 and 64% from 2013.
- Minimum performance of seasonal energy efficiency for boilers with an output power of less than 70 kW shall be 56 % from 2011 and 76% from 2013.
- Minimum performance of seasonal energy efficiency for boilers with an output power of more than 70 kW (and < 400kW) shall be 56% from 2011 and 96% from 2013.
- From 2013 a set of maximum NOx emissions, according to the boiler type, are proposed (50 mg/kWh for gas boilers, 105 mg/kWh for oil boilers).

In accordance with the comments received, the proposal has now been revised.

[18] A central heating (CH) combi boiler has the functionality of both a CH boiler and a water heater

3.4.2. Residential Room Air Conditioners (up to 12 kW)

The air conditioners included in our survey are those with cooling capacity below 12 kW: single duct, double duct, window and through-the-wall packages, single-split package, multi-split package, central air conditioners and mini-chillers.

Based on the findings of the preparatory study Lot 10 and on Prodcom database figures, JRC estimates that around 2,6 million units were sold in 2007 on the EU-27 market, contributing with more than 10% to an existing stock of around 24 million air-conditioning systems[19], equivalent to a 100GW cooling capacity.

In 2007 the overall electricity consumption of the EU-27 air-conditioning stock was around 17TWh. [RIV2008]

The European market for air-conditioning is relatively young and still growing substantially, and the installed stock is far from the saturation levels [RIV2008].

According to the Eurovent-Certification public database (available at: www.eurovent-certification.com), the single-split packages take the biggest share of the market, cumulating around 78% of it (figure 20).

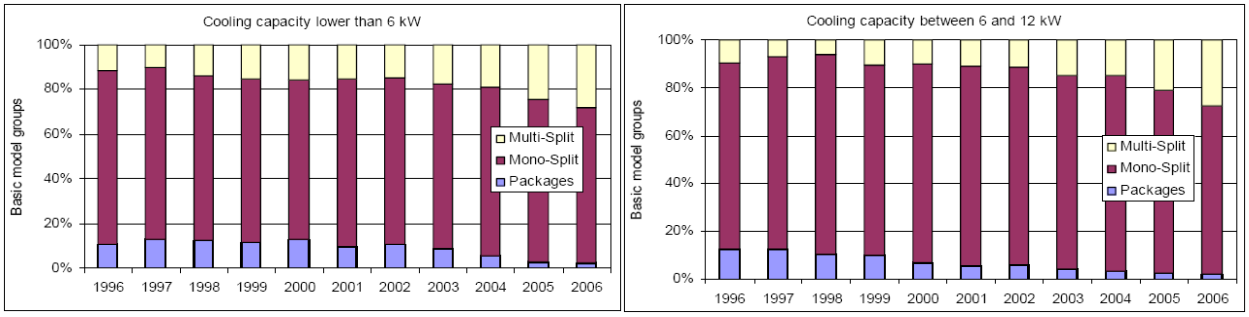


Figure 20: Non-moveable air conditioners by type, in number of models, Eurovent-Certification (<12kW) (source: Eurovent, [RIV2008])

The air-conditioning market is directly influenced by climatic variations: the warm years of the last decade contributed to a significant increase of the sales and stock.

According to GfK analysis, the EU market is dominated by air-conditioning systems between 2,34kWh (8000 BTU) and 3,5 kWh (12000 BTU), the average capacity being around 2,64kWh (9000BTU).

The biggest EU markets are Italy, Spain, Greece and southern-France. Spain represents 37% of the EU-27 market, followed by Italy with 20%, Greece with 15% and France with 11%, cumulating more than three quarters of the EU sales for residential use in 2005 (cooling capacity) [RIV2008].

The fast penetration of small residential air-conditioners on these markets, and their extensive use during the summer months, are among the main drivers to increases in electricity consumption and the power peak.

With the introduction of energy labels for air-conditioning, the EU market has seen a positive transformation into a more efficient one with A class systems sales growing by 361% from 2005 to 2008 on the main EU markets (fig. 21). [STO2009] At the same time, the sales for air-conditioning systems, below or equal to C class, diminished more than twice, from 78,4% to 33% and the unknown/not labelled systems sales decreased by some 40%.

Figure 21: Evolution of the air-conditioning sales in Italy and Spain by energy classes ([STO2009])

The A class limit in cooling mode for the split, non-ducted, air-cooled air conditioners up to 12kW is set at EER[20] of 3,2 (3<EER for packaged units). In 2008, several models introduced on the market had the EER above 4, with the best market models having an EER of 5,71 (fig. 22). In the period 2002-2008 the evolution in terms of energy efficiency was impressive: in 2002 the great majority of the market models was below A class, while in 2008 the large majority of the market models under the Eurovent certification scheme were A class.

19 The figure comprises the cumulative number of air-conditioning and reversible heat pumps.

20 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.

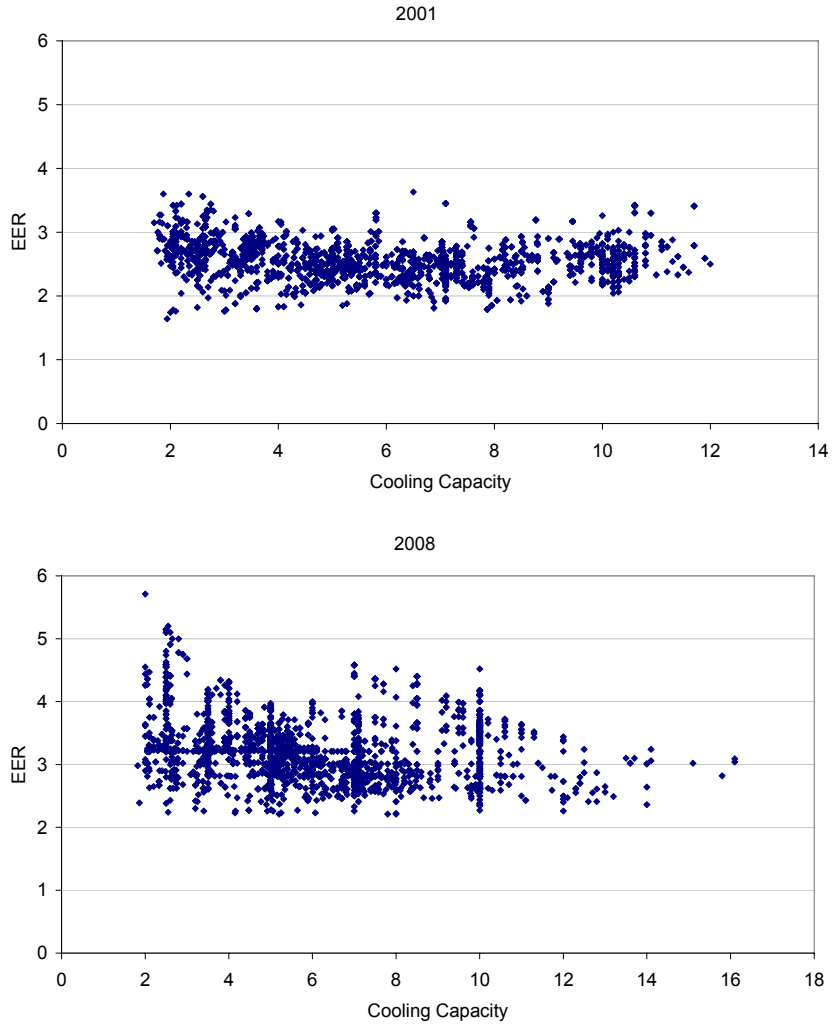


Figure 22: Evolution of the EER for air-conditioners according to the Eurovent certification scheme [SAN2009]

The A class limit in heating mode for the split, non ducted, air-cooled air conditioners up to 12kW is set at COP[21] of 3,6 (3,4 < COP for packaged units).

In 2008, the average EER of the EU-27 air-conditioning sales was around 3,23 and the average COP was approx. 3,4.

The energy efficiency ratio of air-conditioning systems sales improved faster from 2005 on, after the adoption of the voluntary scheme to remove G class air conditioners from the Eurovent certified products. Over the period 2005-2008, the average EER of the products under the Eurovent certification scheme increased by 12,77%, the improvement of energy efficiency from 2001 being of around 26,9% (figure 23).

[21] COP = Coefficient of Performance. For reversible air-conditioners (working as heat pump) the efficiency indicator is the COP (coefficient of performance), defined as the EER during the heating mode. COP is the ratio between the input power and output heat power.

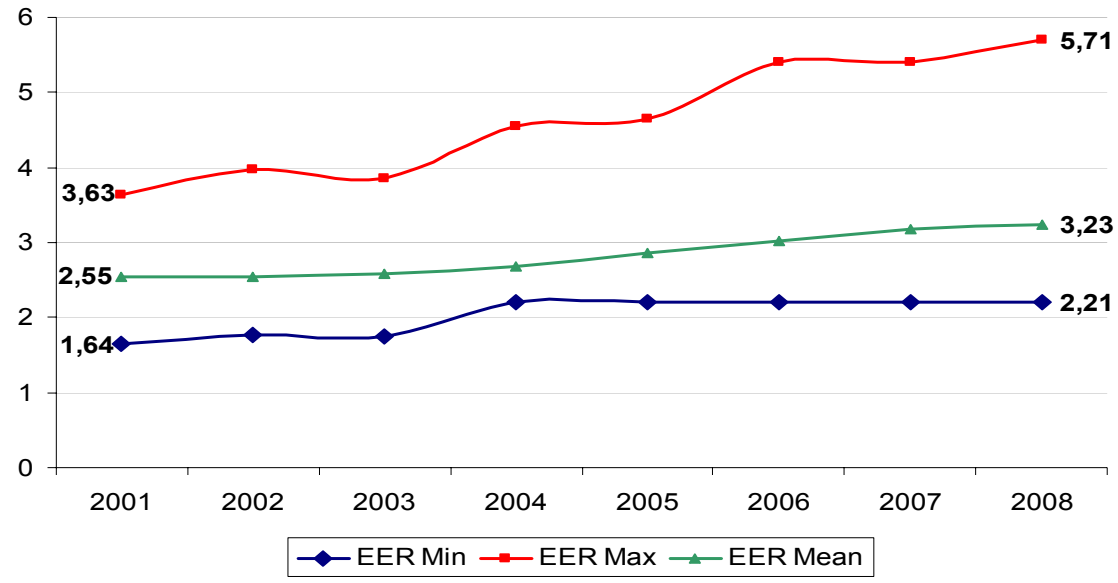


Figure 23: Evolution of the EER (model-weighted average) for split, non-ducted, air-cooled air conditioners up to 12kW [SAN2009]

The air-conditioning systems with AC inverters are more efficient than the systems without them, due to several capabilities that the standard compressors do not have:

- discrete continuous regulation of the temperature (vs. off-on cycles for a standard compressor);

-the energy consumed is directly related to the required amount of cooling;

-the regulated temperature is achieved faster and more efficiently, maintained more constant (and with less energy) than with standard compressors.

The market price of the air-conditioning systems with inverter is approx. 50% higher than the price of air-conditioning systems without an inverter. Considering that systems with inverters have electricity consumption almost twice lower than those without inverters, the price difference is paid-back in some 3 years at actual electricity prices.

However, in 2008 the sales of air-conditioning systems with AC inverters were much lower than for the other types (fig. 24), almost all of them being for systems from A and B energy classes for capacities between 2,34kWh (8000 BTU) and 3,5 kWh (12000 BTU). [STO2009]

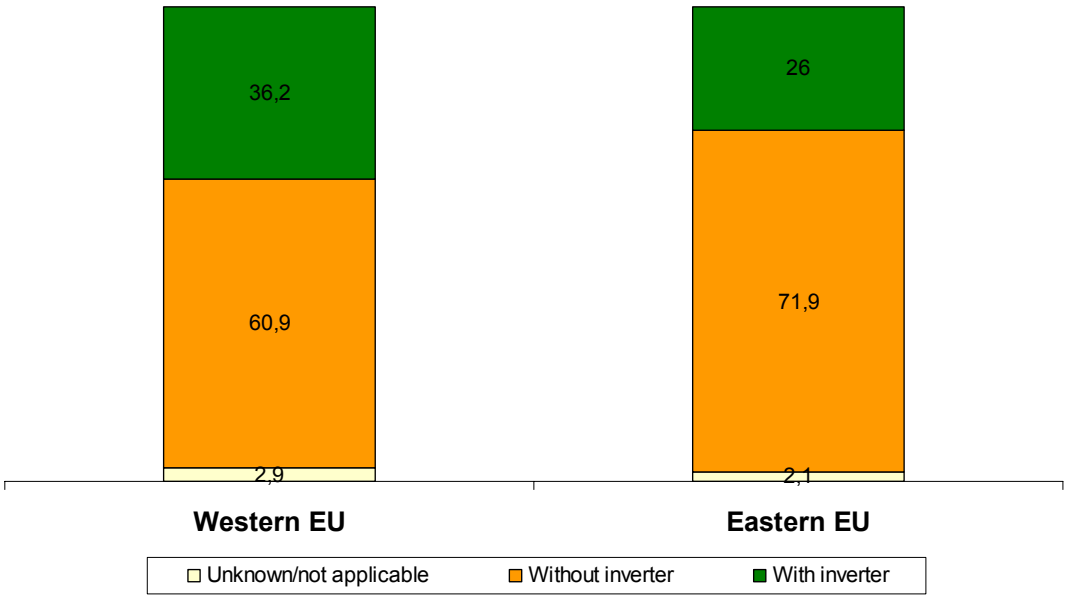


Figure 24: Market share of the air-conditioning sales by type ([STO2009])

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. [EU2002a]

Following the preparatory study for Lot 10 [RIV2008] finalised under the framework for the Eco-design Directive, a new EC Regulation imposing minimum energy efficiency performance requirements and additional requirements on noise, energy use in standby, off-mode and other relevant modes is expected in the near future.

3.4.3. Electric Water Heaters

Electric water heaters account for 8,1% of the total residential electricity consumption, or around 68,7 TWh/year in 2007.

JRC estimates show that in 2007 the installed stock of electric water heaters in EU-27 was around 119 million units (out of a total of 267 million units' domestic water heaters) of which 29 million units electric instantaneous and 90 million units electric water heaters with storage. For the same year, estimates show around 2 million solar water heater units installed.

In 2007, around 31,7% of the EU-27 households owned a secondary water heater, usually a small one for kitchen or bath.

Electric storage water heaters, with a capacity over 30 litres, represent about 27 % of the installed park for primary water heaters, with an additional share of 6,6 % for instantaneous electric water heaters (>12kW) as a primary installation and around 7% of instantaneous water heaters (<12kW) as a secondary one.

In terms of sales, about 5,9 million of storage models were sold in 2007 (or about 34 % of total water heaters sales), with 2,4 million instantaneous models. (JRC estimation based on [KEM2007], fig. 25)

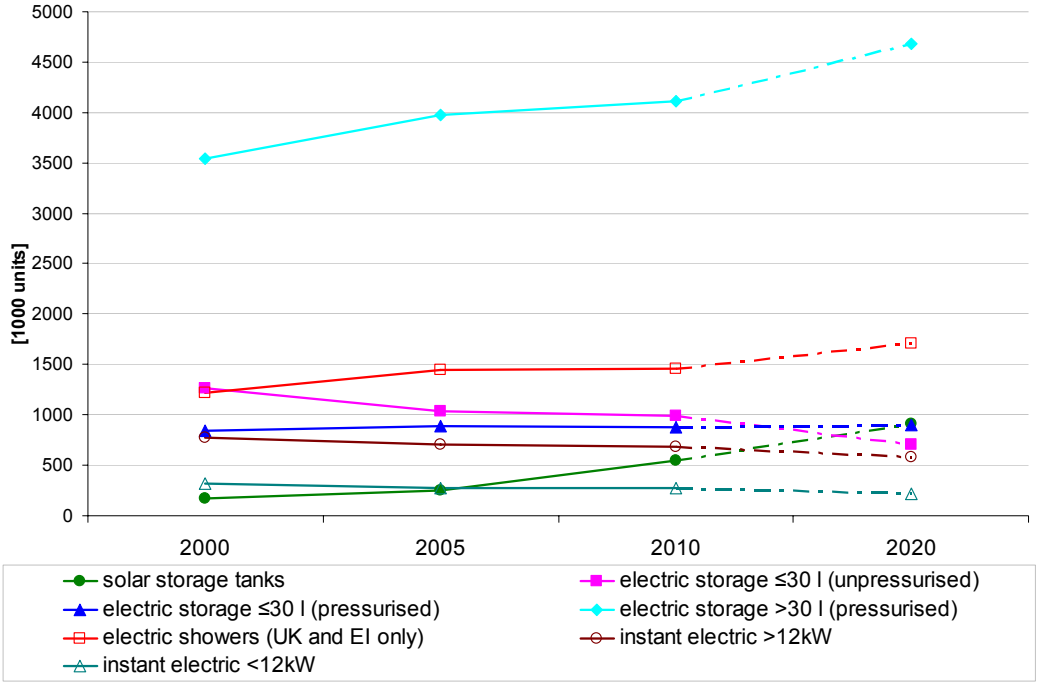


Figure 25: Evolution of the sales for electric water heaters in EU [KEM2007]

The preparatory study on Ecodesign of water heaters estimated a 34% efficiency of the water heaters stock in 2005. According to different proposed scenarios, the stock efficiency in 2020 may remain the same, or can also be improved reaching 36%-82% [KEM2007].

In 2008, the solar thermal heating and cooling systems had an impressive development on the EU-27 our market. While much of the market is in one and two family houses, demand by housing companies, office building operators and other commercial users is increasing significantly.

The solar thermal market in the EU-27 showed a strong performance in 2008, growing by 60% to 3,27 GW_{th} of new capacity (4,68 millions m^2 of collector area[22]). The biggest yearly growth came from the German market, which from 2007 increased by 123% (2,1 million m^2 of collector area or 44,8% of the EU-27 sales), but demand for solar thermal technology grew strongly also in smaller markets. [EST2008]

The overall installed capacity[23] in EU-27 was around 18,97 GW_{th} or 26,67 millions m^2.

[22] The relation between collector area and capacity is $1m^2 = 0,7kW_{th}$ (kilowatt-thermal)

[23] Capacity "in operation" refers to the solar thermal capacity built in the past and deemed to be still in use. ESTIF assumes a time of use of 20 years for all systems installed since 1990. Most products today would last considerably longer, but they often cease to be used earlier, e.g. because the building is torn down, or the use of the building has changed.

In 2008, Cyprus has the EU-27 leadership at the number of installed capacity per 1000 inhabitants with 61kW_{th} 1000 inhabitants, followed by Austria with 29kW_{th} 1000 inhabitants.
Developments in 2009 are expected to vary strongly throughout Europe. On the one hand, there are countries which have already been hit hard by the financial crisis – Spain and Ireland suffer from an abrupt end of their housing boom, while on the other hand early market figures from Germany and Austria indicate a robust market. [EST2008]

Currently, there are no EU policies regarding energy efficiency of water heaters.
The minimum performance and labelling requirements for boilers and water heaters were discussed in one proposal in the Consultation Forum in February 2008 and a revised proposal for water heaters was submitted in September 2008.
Some of the proposed requirements for water heaters are:

- From 2013: minimum performance of Class B level (for M, L and XL loads).
- From 2015: minimum performance of Class A level for all loads (with some exceptions for replacements).

Voting in the Regulatory Committee should take place by the end of 2009.

3.5. Residential Lighting

Lighting represents 10,5 % of the residential electricity consumption, being the third main consumer after electricity for heating and cold appliances. Household lamp technologies include incandescent lamps (GLS), halogen lamps, self-ballasted compact fluorescent lamps, and to some extent, also single and double capped fluorescent lamps without integrated ballast and high intensity discharge lamps. These technologies include also control gear and luminaires designed for these lamps.
Compact Fluorescent Lamps (CFLs) represent one of the most efficient solutions available today for improving energy efficiency in residential lighting (table 8). The recent drop in price, 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 (up to an 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).

Table 8: Energy savings and energy classes of lamps vs. incandescent lamps

Lamp technology	Energy savings	Energy class
I. Incandescent lamps	-	E, F, G
II.1 Conventional halogens (mains voltage 220 V)	0 – 15 %	D, E, F
II.1 Conventional halogens (low voltage 12 V)	25%	C
II.2 Halogens with xenon gas filling (mains voltage 220 V)	25%	C
II.3 Halogens with infrared coating	45%	B (lower end)
III. CFLs with bulb-shaped cover and low light output	65%	B (higher end)
III. CFLs with bare tubes or high light output	80%	A

In 2007, in the EU-27 the incandescent lamps (GLS) still held the dominant position with 767 million units sold and some 54% (2,6 billion units or 13,1 lamps/household) of the existing stock. One third (33%) of the sold non-directional GLS lamps are 60W and 31,6% are 40W.
The halogen low-voltage lamps account for 18% of the existing stock (4,45 lamps/household) and the halogen-mains voltage around 5%.
The CFLs stock in the residential sector grew by some 690 million units (3,47 CFLs/household) over the period 2003-2007, with a 340% increase in the apparent consumption of CFL from 145 million in 2003, 177 million in 2004, 241 million in 2005, a dramatic increase to 316 million in 2006, arriving to 628 million in 2007. The biggest part of these lamps are CFLi, used in the domestic sector, the estimated sales being around 488 millions units/yr in 2007. [TIC2008]
The CFL penetration was strongly stimulated in many MSs because of some specific national policies and measures, like the white certificate schemes in the UK and Italy.
In 2007 residential lighting accounted for electricity consumption of around 84TWh/yr, slightly below the 2004 figures (86TWh/yr.). The equivalent electricity consumption of the incandescent lamps represents more than half, 56%, halogen lamps being responsible for around 31%. [BER2007], [TIC2008]

In March 2009 the European Commission adopted an Eco-Design Regulation to improve the energy efficiency of household lamps, which stipulates the progressive phasing out of incandescent bulbs starting in 2009 and finishing at the end of 2012 [COM2008b]. The Regulation applies to non-directional lamps. Directional (reflector) lamps, such as spots, will be covered by a dedicated measure at the end of 2009 or in 2010.
All non-clear (non-transparent) incandescent lamps are to be phased out, as from September 2009. Non-clear lamps will be required to be A-class (or slightly less efficient for certain lamps, such as those with external envelope). In practice, considering currently available technologies, this means that non-clear lamps will have to be compact fluorescent lamps,

which save about 80% energy compared with incandescent lamps. Consumers who for various reasons (aesthetics, size, shape etc.) would prefer another lamp technology can buy clear (transparent) lamps.

The less efficient clear lamps will also be phased out progressively, starting with the brightest lamps (100W incandescent bulbs and above, and equivalent lamps) in 2009. From September 2009, lamps equivalent in light output to 100W incandescent bulbs and above will have to be C class (phasing out all 100W/150W incandescent bulbs). At the same time, all lower wattage incandescent lamps of the F and G class will be phased out, so that only E-class incandescent lamps will remain. By the end of 2012, the level will be made progressively stricter (to class C) for the other wattages too, completely phasing-out clear incandescent bulbs.

Halogen clear lamps (xenon-filled) from energy class C will remain on the market until 2016. Unless new technologies emerge, from 2016 the dominant clear lamps will be the class B low voltage halogen lamps, with integrated or non-integrated transformer.

LEDs are a more promising emerging technology, covered as A-class lamps by the energy efficiency requirements in the afore-mentioned the Eco-Design Regulation.

In addition to the minimum efficiency requirements, the Eco-Design Regulation also contains requirements concerning lamp functionality and product information.

Table 9: Timetable of the EC Regulation for Non-directional Lamps and the Directional (reflector) Lamps

Date	Non-clear lamps				Clear lamps						
	Requirement energy class	Incandescent	All halogen	CFLs	Requirement energy class	Conventional halogen				Halogen C	Halogen B
						≥100 W	≥75 W	≥60 W	<60 W		
Today	None				None						
Sep-09	A	phased-out			C for ≥100W, E for the rest[1]	phased-out					
Sep-10	A				C for ≥75W						
Sep-11	A				C for ≥60W						
Sep-12	A				C for all						
Sep-13	Second level of functionality requirements										
Review 2014					Review						
Sep-16	A	phased-out			B / C[2]	phased-out				3	

[1] The requirement is raised for all clear lamps to class E, phasing out F and G class incandescent and halogen lamps in all wattages already in September 2009. After the first stage, only E-class incandescent lamps remain available in some wattages until they are also gradually phased out by September 2012.

[2] Special cap halogen lamps will be required to be at least class C, all other clear lamps will have to be at least class B.

[3] Only special cap halogen lamps are allowed to be C-class.

3.6. Information and Communication Technologies

ICTs[24] are among the fastest growing electricity end-use in the residential and tertiary sector. In 2008, the digital technology world market has reached €2 000 billion, and is currently growing at around 4% per year. Europe's digital technology market represents 30% of the world total [IDA2008]. The size of the digital technology sector in Europe represents 4.5% of EU aggregate GDP and even more if the value added of digital technologies in other sectors is also accounted for. [DIG2009]

In 2006 the annual average growth rate of the EU ICT services was 4,4% and continued to grow in 2007, with around 4% growth rate. The analyses of the ICT manufacturing industries show that the German, Italian and French ICT manufacturing industries registered the highest growth rate in the last six years. [INT2009]

The International Telecommunication Union (ITU), in a recently published report, shows the new ICT development index (IDI), comparing developments in information and communication technologies (ICT) in 154 countries over a five-year period from 2002 to 2007. The IDI is a combination of 11 indicators related to ICT access, use and skills, such as

households with a computer, the number of Internet users and literacy levels (table 10). [INT2009]

Table 10: ICT penetration in EU households [INT2009]

	Fix phone lines per inhabitants [%]		Mobile cellular subscriptions per inhabitants [%]		International Internet Bandwidth per internet user [bit/s]		Computers in households [%]		Internet in households [%]	
	2002	2007	2002	2007	2002	2007	2002	2007	2002	2007
AT	47,8	40,8	18,6	82,9	11996	30116	49,2	71	33	60
BE	47,6	44,6	78,2	102,7	17662	37831	40,9	67	43	60
BG	36,4	30,1	32,9	129,6	110	15878	5,1	23,3	3,4	19
CY	53	44,9	51,8	115,6	739	4218	36	53	24	39
CZ	35,9	23,6	84	124,9	9108	14649	27,8	43	13,5	35
DE	65,1	65,1	71,7	117,6	6448	35487	61	79	46	71
DK	68,8	51,9	83,2	114,5	31721	42752	72,2	83	56	78
EE	35,2	37,1	65,3	148,4	985	18772	21,8	57	13,9	53
ES	42,4	45,9	80,6	109,4	5594	21456	36,1	60,4	17,4	45
FI	52,4	33	86,8	115,2	5140	21847	54,5	74	44	69
FR	57,1	56,5	64,6	89,8	11076	46086	36,6	62	23	49
GR	57	53,9	84,3	110,3	1476	13805	25,3	40	12	25
HU	36,1	32,4	67,7	110	1477	9203	26	54	8	38
IE	50,2	49,1	76,3	115,9	13254	27122	41,1	65	32,8	57
IT	46,9	49	93,6	153,1	4173	27339	39,9	53	34	43
LT	27	23,6	47,5	145,2	526	9461	12	46	4,1	40,3
LU	55,6	53,2	105,8	129,5	8212	9617645	52,6	80	40	75
LV	29,9	28,3	39,2	97,4	825	6428	15	49	8,5	51
MT	52,3	56,6	69,9	91,4	1359	12817	42,9	63	31,3	54
NL	50	44,7	75,3	117,5	17064	92832	69	86	58	83
PL	30,7	27,1	36	108,7	779	6251	23,1	54	11	41
PT	42,1	39,5	83,9	126,6	2048	11960	27	48,3	15,1	39,6
RO	19,2	19,9	23,3	106,7	1350	12335	6	34	3,9	22
SE	62,5	60,4	89	113,7	14962	62484	75	83	66	79
SI	41,1	42,8	84,8	96,4	1943	12784	55	66	37	58
SK	26	21,4	54,1	112,6	3775	9932	24,6	55	12,6	46
UK	58,8	55,4	83,3	118,5	9662	55281	57,9	75	50	67

According to ITU, the most advanced countries in ICT are the Northern European countries and the Republic of Korea.

Sweden tops the new ITU ICT Development Index, followed by the Republic of Korea, Denmark, The Netherlands, Iceland, Norway, Luxembourg, Switzerland, Finland and UK. Poor countries, in particular the least developed countries, remain at the lower end of the index with limited access to ICT infrastructure, including fixed and mobile telephony, Internet and broadband.

Based on ITU estimates, 23 out of 100 inhabitants globally used the Internet at the end of 2008, but penetration levels in the developing countries remain low. Given the rapid spread

[24] ICT=Information and Communication Technologies

of IMT-2000/3G mobile cellular networks in many countries, including in the developing world, there is a clear potential for mobile broadband to connect more and more people — and at higher speed.

Globally, the greatest progress was on ICT access, including fixed and mobile telephony, Internet bandwidth, and households with computers and Internet. In terms of ICT use, including the number of Internet users, fixed and mobile broadband, progress has been much slower. In particular, broadband, a more recent technology, still has to take off in many countries. [INT2009]

3.6.1. Television

2007 electricity consumption of TVs in EU-27 is estimated at 60 TWh, of which 54 TWh in on-mode power consumption and 6 TWh in stand-by/off-mode power consumption. Following the findings of the preparatory study for the Eco-design Directive, JRC estimates indicate that the installed stock of TVs in the EU-27 residential sector is around 310 millions units. Penetration rate of around 150% reflects the market tendency towards 2 TVs per household. [FRA2007a]

Small screen sizes (14"-26") are still dominating the stock (more than 50%), but the medium screen size (27"-39") segment is steadily growing towards an estimate of 33% in 2010. The large screen sizes (larger than 40") are the smallest segment, with approximately 12% share.

Regarding the penetration rate of different display technologies, there are more than 60% CRT-TVs in the households, followed by 30% LCD TVs and up to 10% PDP TVs, but CRT-TVs are sharply reducing the penetration rate in favour of flat TVs[25].

The estimates show that in 2007, the CRT TVs (35% market share) lost EU market leadership in favour of LCDs (53% market share).

On mid-term, some promising “disruptive” display technologies might enter the market, some sources indicating the OLED technology as the most market-challenging one after 2010. [WHI2006]

On the TV market, dramatic changes in technology happened and will take place, driven by the technology change. Four main factors influence the market development:

- Flat panel displays (flat TVs);
- Larger screen sizes;
- Digital television broadcasting;
- High-resolution television (HDTV).

Due to these, the estimates show that in 2007, for the first time, the CRT TVs (35% market share) lost the EU market supremacy in favour of the LCDs (53% market share, figure 26). [FRA2007a]

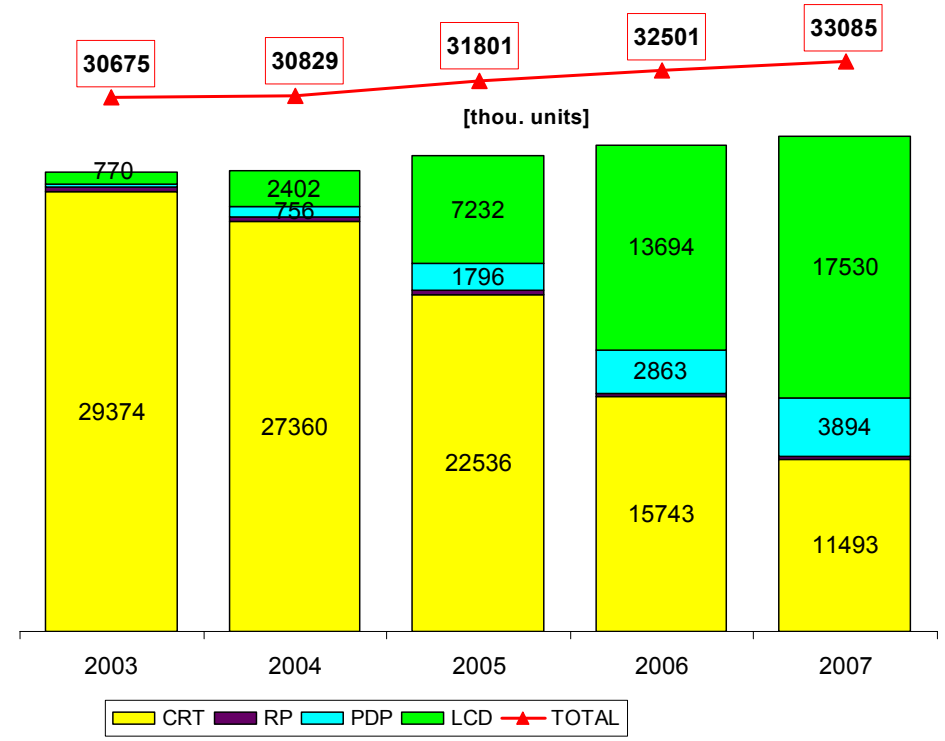


Figure 26: Market sales by type of TVs ([BOY2008])

Forecasts based on market trends indicate a shift in TV sales towards larger screen sizes and in 2007, the TVs with screens larger than 26" registered an estimate market share of 56% (figure 27).

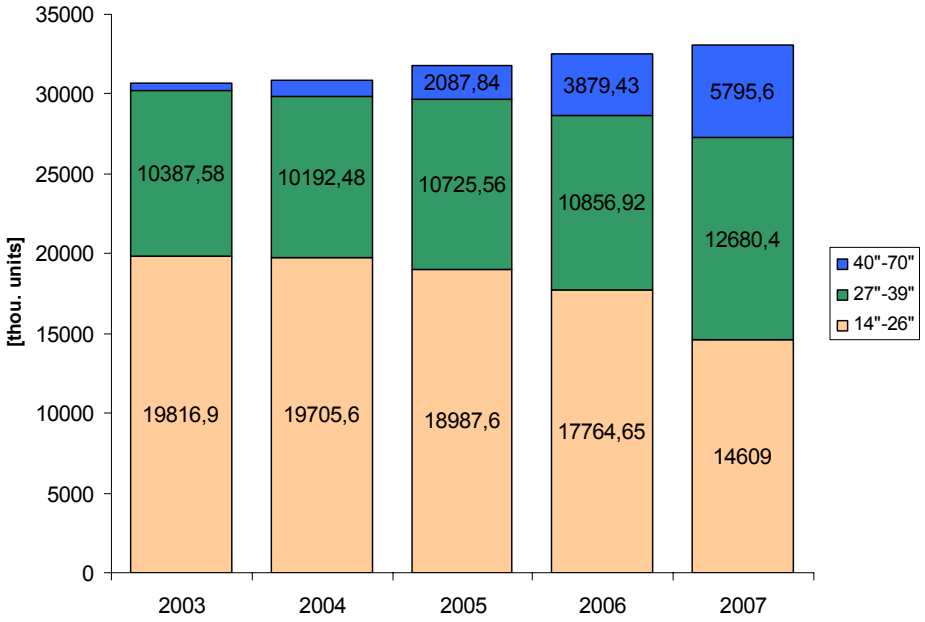


Figure 27: Market sales by screen size of TVs ([BOY2008])

[25] LCD= liquid crystal display, PDP= plasma display panel, CRT= cathode-ray tube, RP= rear-projection

According to GfK, the average number of viewing minutes (watching times) decreased slowly in the last 2 years at the global level (figure 28). In some of the biggest EU countries, in 2007 the viewing minutes on TV remain constant or grow compared to 2006. In the UK TV consumption decreased.

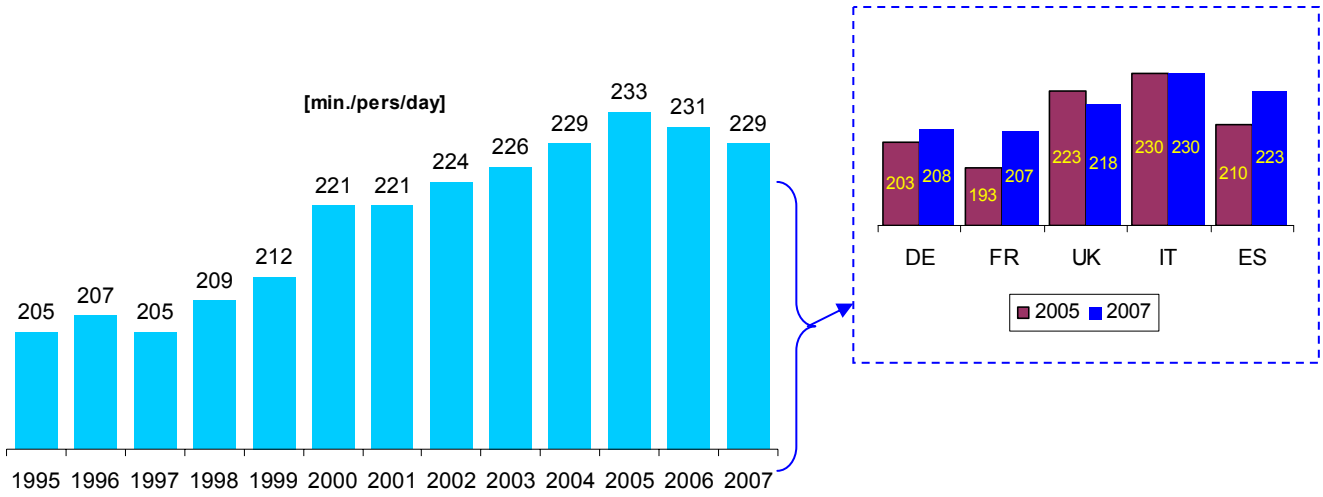


Fig. 28: Daily viewing time of TV programmes (worldwide 30 regions, [BOY2008])

According to the European Social Survey (ESS) most recently published figures on TV watching time, 31,2% of the European[26] population watch TV more than 2,5 hours/day, a significant 40% spending less than 1,5 hours watching TV. [ESS2009]

Table 11: TV watching in Europe, total time on average weekday

	[% of population]
No time at all	3,4
Less than 0,5 hour	5,9
0,5 hour to 1 hour	14,9
More than 1 hour, up to 1,5 hours	14,3
More than 1,5 hours, up to 2 hours	17,1
More than 2 hours, up to 2,5 hours	13,2
More than 2,5 hours, up to 3 hours	12
More than 3 hours	19,2

According to EICTA, for the on-mode power consumption of models on the market in late 2007, the liquid crystal display (LCD) and plasma display panel (PDP) technologies, which

[26] The survey covered 19 EU countries, Switzerland, Norway, Russian Federation and Ukraine

together currently account for the largest part of TV sales, are predicted to dominate the market in the near future[27], both for "HD ready" and "full HD" resolution.

In 2003, EICTA (the European Industry Association for Information Systems, Communication Technologies and Consumer Electronics) submitted a new Self Commitment (unilateral commitment) to the European Commission. The Self Commitment pledges to reduce the energy consumption of TVs by continuously seeking to improve the energy performance per appliance.This has been signed by a large number of the EICTA member companies, but was not successful in reducing the on-mode consumption.

The preparatory study Lot 5 for Consumer Electronics: "Television" under the Eco-design Framework Directive [EC2005] was concluded in 2007.
The proposed new labels (based on the present labelling scheme) are with levels from A to G and have additional classes for products that are more efficient than an A-market product. A-10% indicates that a product is 10 % more efficient than a current class A model. The scale is built on an "energy efficiency index" (EEI), which is the ratio between annual consumption of the appliance and a standard consumption of a typical similar model. The proposal of the new energy label was rejected by the European Parliament in May 2009, requesting the Commission to prepare new proposals for updating the A to G efficiency rating system.
On 22 July 2009, the European Commission adopted the Commission Regulation implementing the Eco-design Directive with regard to eco-design requirements for televisions[28].
The proposed requirements for televisions are supposed to be introduced in two steps:

- From August 2010: the minimum energy performance requirements are set so that all TVs must be more efficient than today's current sector average.
- From April 2012: Standard television sets must be 20% more efficient and full-HD sets to be 30% more efficient than the current sector average.

In the Regulation, through the main provisions are foreseen requirements for automatic power-down availability of off-mode and/or stand-by and stand-by (<1Watt in any condition provided only a reactivation function and <2Watts in any condition providing only information or status display) and off-mode (<1Watt) consumptions.

[27] E.g. TV sales in Germany in 2008: 76% LCD TVs, 9% PDP TVs, the remaining part being Cathode Ray Tube TVs (13%) and others (2%, including Rear Projection TVs). The share of CRT TVs decreased sharply from 24% in 2007, and is predicted to decrease further rapidly.

[28] Commission Regulation (EC) No 642/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for televisions. Official Journal of the European Union, L 191/42, 23.7.2009

With energy labelling and performance requirements for televisions reaching full impact, estimated savings of around 43 TWh/year are expected by 2020 [FRA2007a].

3.6.2. Digital Services

Digital TV, in the form of digital cable, satellite, digital terrestrial (DTT), and IPTV (Internet Protocol Television), is fast replacing the analogue technologies. The adoption of digital television in Europe should show strong growth over the next years, providing enhanced image quality and advanced futures (greater breadth of content and bundled communications).

In 2007, the European ICT market accounted for about 30% of the world market, being the second largest market after the North-American one. [ID2008]

Apart from quality enhancement, the switch-off of analogue transmission is a further key driver of the transition to digital TV in these regions. The EU is leading in switching from analogue to digital television.

The EU Member States are gradually closing analogue transmissions and moving to digital broadcasting, including a growing range of interactive TV services (such as HD TV or video on demand), available on multiple transmission platforms including terrestrial, cable, satellite, TV on internet and mobile TV networks.

Overall, the switch-off of analogue terrestrial TV transmission in Europe is well on track. Five Member States (Germany, Finland, Luxembourg, Sweden and the Netherlands) have already completed the switch-off at the beginning of 2009 and by 2010 the process should be well advanced in the whole EU. It will take place by end of 2010 or earlier in all of Austria, Estonia, Denmark, Spain, Malta and Slovenia. Analogue terrestrial TV will be switched off between the end of 2010 and the end of 2012 in Belgium (Wallonia and Brussels capital region), Bulgaria, Cyprus, Czech Republic, Greece, France, Hungary, Italy, Lithuania, Latvia, Portugal, Romania, Slovakia and the United Kingdom. In Poland the final switch-off date is 2015 at the latest (table 12). [EC2009]

Table 12: Switch-off of analogue transmission in EU-27 [EC2009]

Group	Member States
A (switch off completed)	BE (Flanders), DE, FI, LU, NL, SE
B (switch-off date end 2010 or earlier)	AT, DK, EE, ES, MT, SI
C (switch-off date: end 2012 or earlier)	BE (Brussels capital area), BG, CY, CZ, EL, FR, HU, IT, LT, LV, PT, RO, SK, UK

According to the e-Media Institute, as of mid 2007, UK and Finland were the EU leaders with 36% penetration of DTT-only (some 9,14 million and 0,866 million households), followed by

Spain with 21% (3,347 million households), Sweden with 19% (0,81 million households), Italy with 16% (3,82 million households), France with 15% (3,63 million households) and Germany with 8% (2,87 million households). [EME2008]

Digital Satellite still leads in terms of overall subscriptions (table 13), but is facing increased competition by other technologies, such as Video on Demand in Cable and IPTV and the future growth is estimated to be modest. In the mean time, coupling the benefit of a competitive channel selection in DTT with the growing popularity of on-line premium video, DTT could emerge as the dominant digital television service in Western Europe in the upcoming years. [LEE2009]

Table 13: Digital Television by primary access platform in Western Europe [LEE2009], [EME2008]

	June 2007 [millions households]	2008 [millions households]
Digital Satellite	37,2	40,0
Digital Cable	12,6	17,1
Digital Terrestrial	25,3	36,1
Telco IPTV	4	10,0
Total Digital TV Subscriptions	79,1	103,2

Digital TV household penetration will surpass 90% in 2012, driven largely by the widespread distribution of DTT. In many countries, free DTT service is competitive compared to the traditional basic cable package in terms of channel selection and quality. [LEE2009]

Forecasts from the analyst firm Canalys indicate the IPTV market will see rapid growth over the next three years, driven by telecom operators' desire to boost ARPU (average revenue per user) and counter the growing threat from competing triple-play providers. Worldwide IPTV subscriber levels will increase more than ten times, growing from fewer than 4 million in 2006 to almost 40 million in 2010.

Canalys defines IPTV as a digital TV service delivering broadcast-quality digital TV and interactive services over xDSL, FTTH or cable networks using IP via a set-top box to the main TV in the home; this includes hybrid IPTV solutions (such as those offered by BT in the UK) but excludes web TV services delivered to a PC. [BRO2007]

IPTV has already become a significant fourth platform for digital TV in many markets, and its importance across the broadcast sector will increase over the next three years. In Western Europe, for example, Canalys expects IPTV to account for 11 percent of digital TV households by the end of the decade, up from just 3 percent at the end of 2006.

In order to exploit the potential of IPTV, service providers will quickly have to develop and introduce advanced services that set their offerings apart from those already available. This means that significant investment in intelligent network infrastructure is required.
France is the European IPTV leader with some 1.3 million subscribers at the end of 2006, driven by several factors like low broadband prices, broadband/telephony packages, limited competition from cable operators.
However, the favourable market conditions that have helped IPTV thrive in France are not evident in all markets. In most, high levels of competition from existing services will make it difficult for IPTV providers to compete, unless they can differentiate their services, either by providing better quality of service or by maintaining lower subscription fees.

3.6.3. Set-top boxes (STBs)

Expectations are that equipment for the reception, decoding and interactive processing of digital broadcasting and related services will contribute substantially to the electricity consumption of EU households in the near future. Taking into consideration penetration level, equipment specifications and service provider requirements, a total European consumption of up to 10 TWh/yr is attributed to STBs.
The potential new electrical load represented by this equipment poses a problem for EU energy and environmental policies. It is important that the electrical efficiency of equipment required to support digital TV and related services is maximised.
The simple digital TV converter is a stand-alone device, using an integral or dedicated external power supply, for the reception of (free) Standard Definition (SD) or High Definition (HD) digital broadcasting services and their conversion to analogue RF and/or line signals, without conditional access[29]. Simple digital PVR are included in this category, but devices that record to a standard library format removable media (e.g. tape, disc), such as devices with integrated VCR and/or DVD player/recorder are excluded.
The simple set-top boxes (SSTBs) have the primary function of converting digital input into analogue output signals. During the ongoing transition from analogue to digital broadcasting TV sets not adapted to receive digital signals will need to be accompanied by SSTBs. Taking into account the fast penetration of the digital TV sets on the EU markets, it is expected that in the next years the SSTBs will lose importance in favour of the complex SSTBs.
Starting from the estimation from the Preparatory Study for Eco-design Requirements of the Energy Using Products on Simple Digital TV Converters (Simple Set Top Boxes), in 2007

[29] Conditional Access means an active system that enables the STB to process and apply targeted data from a Service Provider. In the context of the definition of the simple converter STB and PVR this means that the operational state chosen by the user (Off, Standby Passive, and On) can not be restricted or changed by a Service Provider.

there were around 47,5 millions SSTB and some 3 million SSTB/PVR in the EU-27, with an overall consumption of 3 TWh/yr[30]. [HAR2007]

Under the Framework Eco-design Directive, a Commission Regulation regarding to eco-design requirements for simple set-top boxes was published in February 2009 [COM2009b]. The Regulation imposes limits to the stand-by and active modes STB power consumption to be implemented in two steps:

- One year after the regulation has come into force, the maximum allowed power consumption is 5 W for on mode, and 1 W for stand-by and off-mode.
- Three years after the regulation has come into force, the limit will still be 5 W for on-mode but 0,5 W for stand-by and off-mode.

In addition, the Regulation stipulates that in one year after the publication, all the STB must have a stand-by mode option (and not only active e-mode) and automatic power-down function set as default. The manufacturers shall also provide to the consumers clear indications of the power consumption, either in stand-by and active mode, and follow clear measurement procedures for proving these consumption indications.

To limit the potential growth in energy consumption, a voluntary programme was introduced, the European Code of Conduct for Digital TV Services[31], developed by a working group that includes all relevant 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 (fig. 29 and 30) shows the 2008 power consumption of the new Set Top Boxes (STBs) sold in 2008 within 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 stand-by and on-mode power have decreased in the period 2001 to 2005 despite a strong improvement in performance and features.

[30] The annual power consumption per SSTB was estimated at around 54,75kWh/device (4h/day on-mode) and around 108,97 kWh/yr per SSTB/PVR (8h/day on-mode) [HAR2007]

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

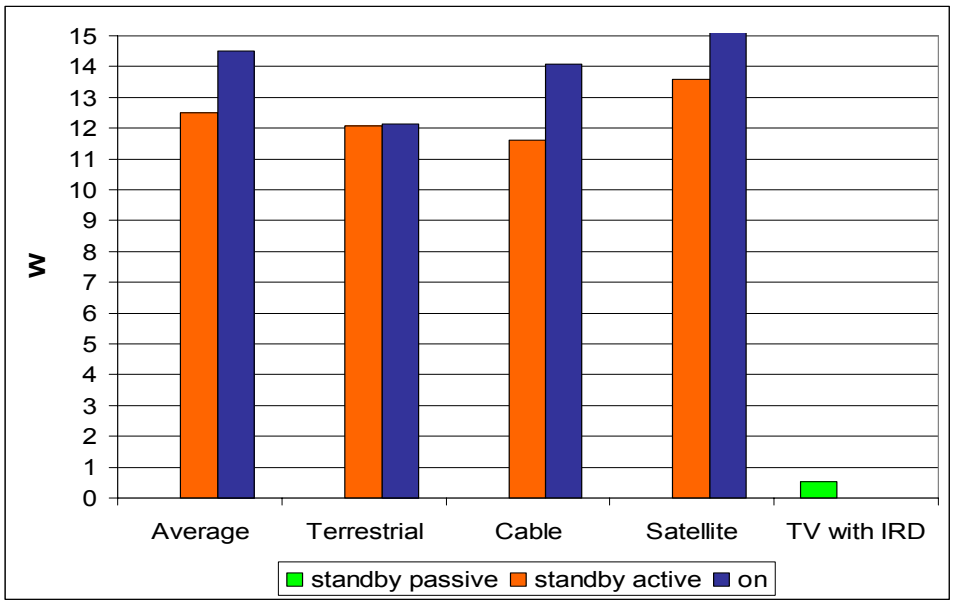


Figure 29: Power consumption for individual set-top boxes in year 2008 (source [SID2009])

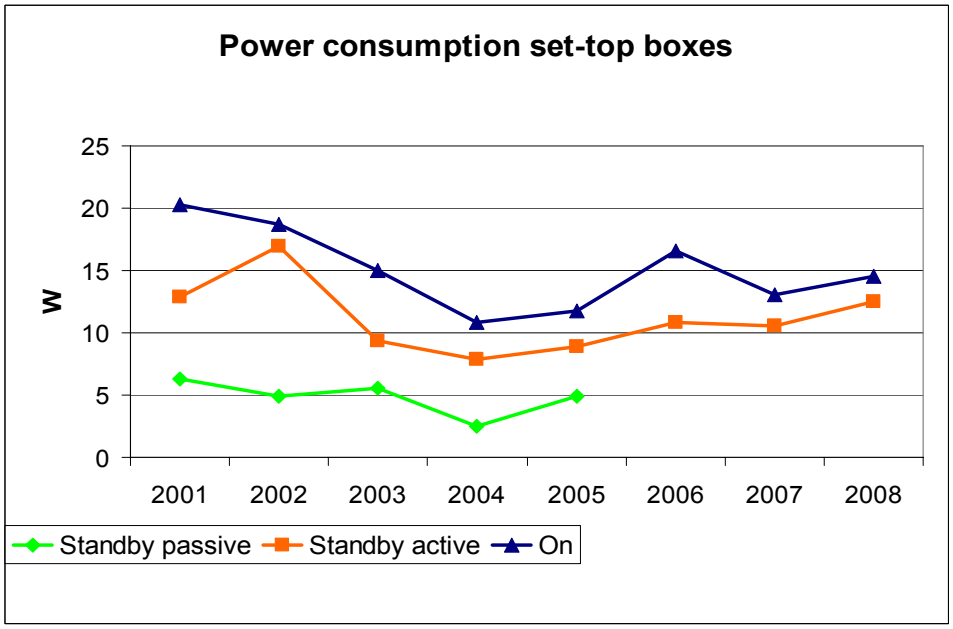


Figure 30: Power consumption for set-top boxes between 2001-2008 (source [SID2009])

From January 2008 version 7 of the Digital TV Service Systems Code of Conduct is in force. According to the EU Code of Conduct for digital television, any STB with conditional access is a complex STB (CSTB). Following the key features there are different types of complex STBs with different energy consumption values: STBs with standard or high definition, with or without internal mass storage media, with or without second tuner or return path.

The preparatory study for eco-design requirements for the energy using products (EuPs), Lot 18 estimates an CSTB stock of 71,6 million units in 2007 with an estimated electricity consumption of around 6,31 TWh/yr. For the same year, the CSTB market sales were estimated at 24,2 million units [BIO2008].

3.6.4. Information technologies

In the last decade, computers have become ubiquitous and their role will continue to be more and more important due to their impacts on productivity, education, society, and personal lives.

Consequently, the number of computers and information technologies is continuously growing, Europe is becoming more computerised, and Internet access is spreading among households across the European Union.

According to Euro-barometer, nearly half of the household population in the EU now has access to the Internet (49%).

Accessing the Internet through a broadband connection is increasing in the EU27, while narrowband technology is losing ground: 36% of the total population now have broadband access and 10% has a narrowband connection (fig. 31).

The majority of households with an Internet connection access the web via an ADSL line (59%). The percentages using cable television network or standard telephones for that purpose are considerably lower. The share of households with a Wifi router has increased significantly in the European Union. Around a fifth of the total household population (22%) now have such a device.

The main reason given for not upgrading a narrowband connection to a broadband connection is satisfaction with the speed of the current connection (30%).

The main reason by far, for not having an Internet connection (49% of all households), is a lack of interest among household members (50%). 22% of European households have difficulty contacting their Internet service provider about connection problems. A similar number said the cost of the support they get is not affordable.

The level of overall Internet access (i.e. narrowband, broadband) shows that there has been a significant increase in Internet penetration rates across Europe since 2007 (+7 percentage points). However, the Internet access remains considerably higher in the EU15 (52%) than in the NMS12 (33%).

The growth trend is the most pronounced in Slovenia, the Czech Republic and Cyprus (+14 percentage points) and the penetration rates remain the highest in The Netherlands (86%), Denmark (80%) and Sweden (78%). Meanwhile, less than a quarter of households in

Bulgaria (22%, 57% annual growth), Greece (22%, 15,7% annual growth) and Romania (24%, 100% annual growth) have Internet access. [EC2008a]

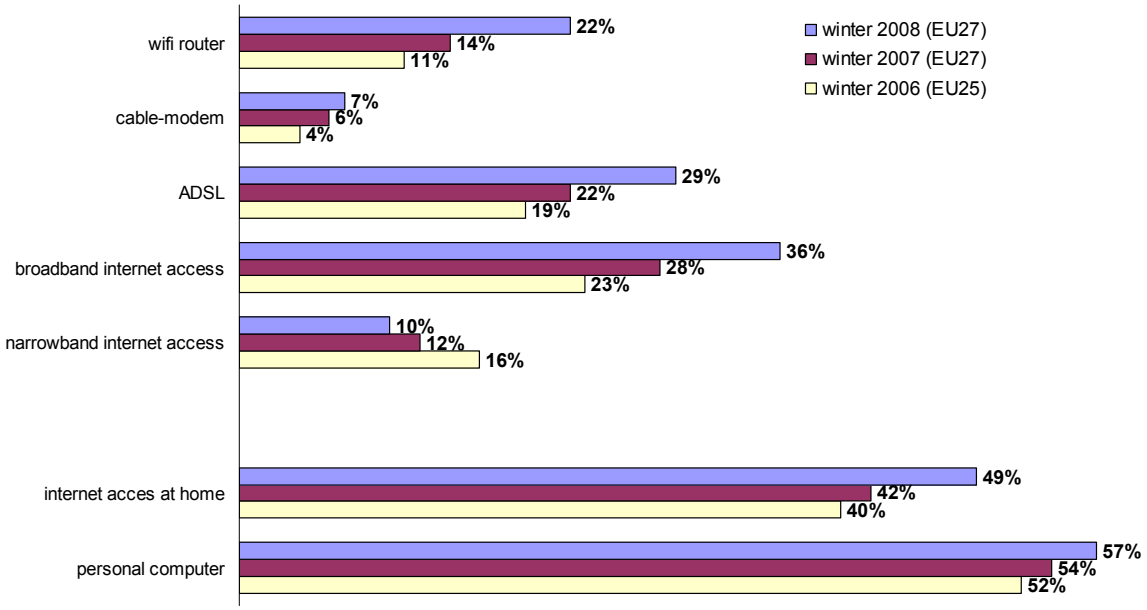


Figure 31: Penetration rates of information technology in the European Union

More than half of Europeans (57%) have at least one computer in their household and the penetration rate rose constantly in the last two years (figure 26). Computers are much more widespread in the EU-15 (60%) than in the NMS-12 (45%). A country-by-country analysis shows that computers have highest penetration rates in The Netherlands (90%), Denmark (85%) and Sweden (82%). The strongest growth, since 2007, was recorded in Cyprus, Luxembourg and Slovenia (+10 percentage points in all 3 countries). Computer penetration rates in Latvia and Ireland also increased strongly by 9 and 8 points respectively. [EC2008a]

Starting from the above data and based on the findings of the preparatory studies for implementing the Energy using Products (EuP) Directive, Lot 3-Personal Computers (desktops and laptops) and Computer Monitors, JRC estimates that in 2007 there were around 111 millions computers (49,6 desktops and 61,2 laptops) and almost 56 million monitors (42,2 millions CRT and 13,7 millions LCD monitors) in EU-27 households. The estimated electricity consumption of the computers and monitors in the residential sector was around 22TWh/year in 2007, representing 2,7% of the overall domestic electricity consumption. [IVF2007]

Table 14: EU-27 computer stock and electricity consumption in 2007

	Desktop	Laptop	LCD	CRT
EU-27 stock [million units]	49,6	61,2	42,2	13,7
Annual electricity consumption/unit [kWh/yr]	194	98	86	189
Annual consumption [TWh/yr]	9,62	6,00	3,63	2,59
Total consumption [TWh/yr]	21,85			

The US Environmental Protection Agency (EPA) introduced the Energy Star as a voluntary Labelling Programme designed (in 1994) to identify and promote energy-efficient products to reduce greenhouse gas emissions. Personal computers and monitors are products within the scope of Energy Star. In 2000, the European Union made an agreement with the US Government to coordinate the energy-efficiency labelling programmes for office equipment some years ago (from July 2007).

The revised Energy Star technical specifications Version 5.0 for computers became effective on 1 July 2009. Version 5.0 Energy Star Specification for Displays has been finalised, pending adoption by the European Union. The new version 5.0 specification will go into effect on:

- 30 October 2009: for displays under 30 inch viewable diagonal screen size, and on
- 30 January, 2010: for displays between 30 and 60 inches, inclusive. [ENE2009]

The revised Energy Star specification for Imaging Equipment Version 1.1 was published in October 2008 and will became effective also from 1 July 2009. The new specifications for imaging equipment comprise efficiency requirements for typical energy consumption, for the external power supply and for the additional cordless handset of certain imaging equipment.

In the framework of the Eco-design Directive, the preparatory studies for computers and for imaging equipment are completed and energy efficiency measures are expected to be agreed by the Eco-design Regulation Committee.

3.6.4.1. Broadband communication

Broadband penetration in Europe continues to grow, from 18,2% in July 2007 to up to 21,7% in July 2008.

As of mid 2008, EU-27 registered 107,602 million fixed broadband lines, with a 7,8% increase in the last six months. Out of these lines, 85,873 million were DSL (79,8% of total) and 21,729 (20,2%) were provided using other transmission means, predominately cable modem.

In July 2008 at EU-27 level the fixed penetration rate[32] was 21,7%, up by 3,5% from a year ago (figure 32).

Regarding speeds, 25,1% of fixed broadband lines are in the range of 144 Kbps - 2 Mbps, 62,0% of reported lines are in the range of 2 - 10 Mbps and 12,8% of the lines are in the range of speeds beyond 10 Mbps.

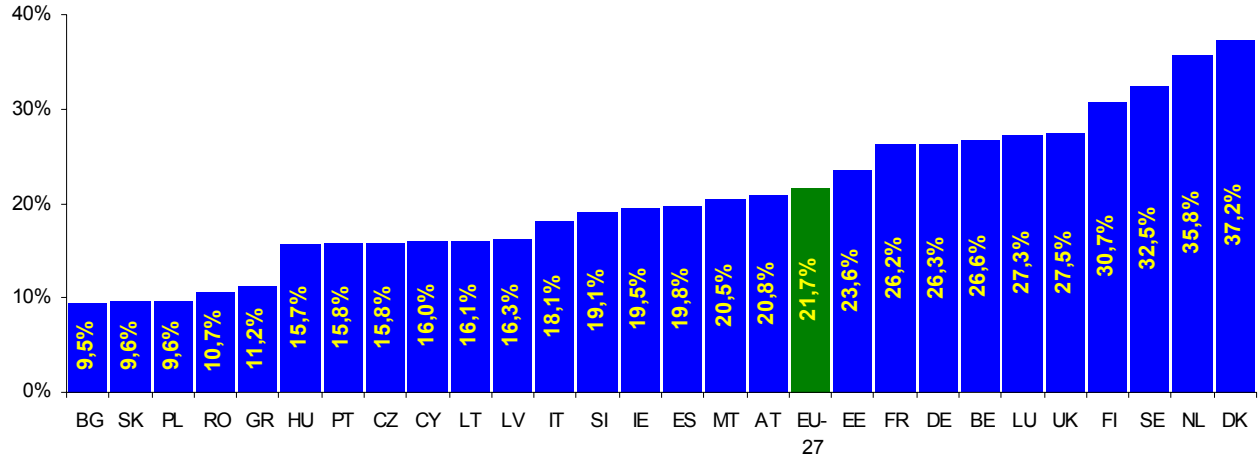


Figure 32: EU fixed broadband penetration rate (July 2008), source [EC2008]

In the period July 2007-July 2008 a total of 17,401 million new broadband lines were added, representing a 19,3% annual growth, less than the previous year (31,4% grow in 2006/2007). From these, 76,9% were by means of xDSL technologies, while 23.1% were connections using other types of technologies.

The number of DSL lines in EU-27 reached 85,873 million in mid-2008, with an 18,5% (13,376 new lines) increase in the last year. In 2008, the number of the non-DSL lines reached 21,729 million, which represents a 22,7% (4,025 million new lines) growth in the last year. However, DSL growth continues to decrease, slowed down by 10.9% compared to July 2007, to the benefit of other fixed broadband technologies like cable, fibre to the home (FTTH) and wireless local loops.

The penetration rate of broadband fixed lines in EU-27 households reached 53,78% at mid-2008 (table 15). [EC2008]

Table 15: EU-27 Broadband communication in 2008, source [EC2008]

	Retail broadband lines	from which: DSL retail lines	Non-DSL broadband lines	Fixed penetration rate [per 100 people]	Household penetration rate [%]
AT	1723271	1084541	638730	20,8	49,15
BE	2811591	1657831	1153760	26,6	63,38
BG	730373	204858	525515	9,5	25,45
CZ	1626330	644330	982000	15,8	39,29

[32] Fixed penetration rate means the number of broadband lines per 100 population

CY	124263	122129	2134	16	49,31
DK	2035468	1246643	788825	26,3	86,07
DE	21618300	20226000	1392300	37,2	55,16
EE	316969	130935	186034	23,6	59,03
ES	8793517	6922777	1870740	19,8	55,65
FI	1618098	1271496	346602	30,7	67,06
FR	16617461	15867461	750000	26,2	64,72
GR	1245974	1240148	5826	11,2	29,90
IE	841590	611594	229996	19,5	58,44
IT	10727651	10338972	388679	18,1	45,52
LV	370772	170272	200500	16,3	43,37
LT	546082	244228	301854	16,1	45,36
LU	130113	113316	16797	27,3	70,33
HU	1576937	789613	787324	15,7	41,37
MT	83767	41861	41906	20,5	67,55
NL	5851300	3541300	2310000	35,8	81,78
PL	3659289	2445698	1213591	9,6	28,66
PT	1672312	1014235	658077	15,8	43,56
RO	2310243	509791	1800452	10,7	31,33
SI	383521	263868	119653	19,1	50,86
SK	516935	302270	214665	9,6	30,30
SE	2959500	1755000	1204500	32,5	73,99
UK	16710169	13111769	3598400	27,5	64,44
EU-27	**107601796**	**85872936**	**21728860**	**21,7**	**53,78**

In 2008, EU-27 registered 34,040 million mobile broadband[33] active users (subscribers)[34], with an average EU fixed penetration level at 6,9% (fig. 33). The number of mobile broadband connections, using only dedicated data cards/modems/keys is significantly lower (around 2 to 3%).

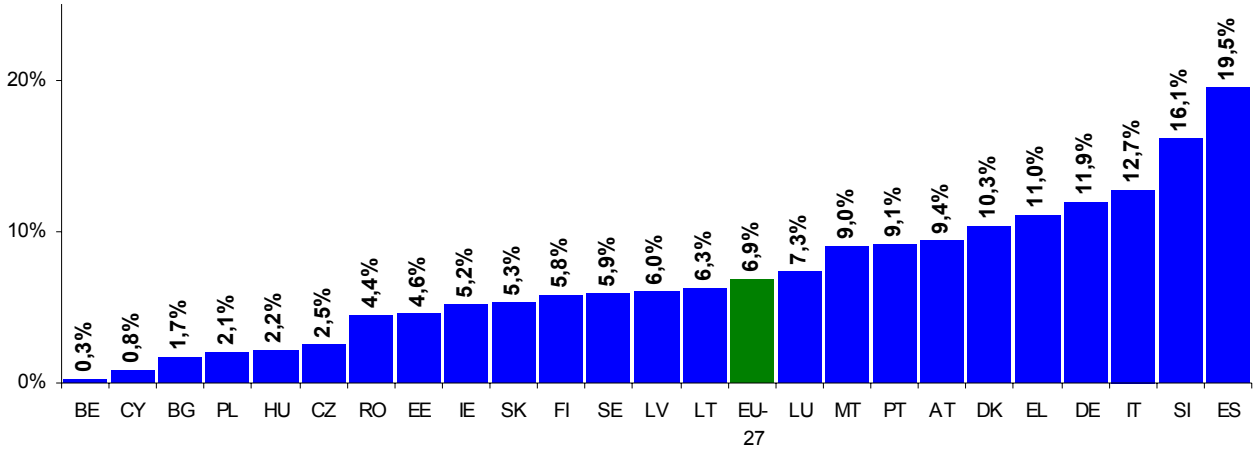


Figure 33: Mobile broadband penetration rate July 2008, source [EC2008]

[33] Mobile broadband active users are users using broadband dedicated data services via data modems/cards/keys and other active 3G equivalent users using mobile terminals in last 90 days.

[34] The figure must be significantly bigger, as time as France, the Netherlands and the UK did not report on.

ADSL[35] and cable modem are expected to remain the main broadband technologies in Europe, ADSL coverage being expected to reach 95% of the population in 2015 (figure 34).

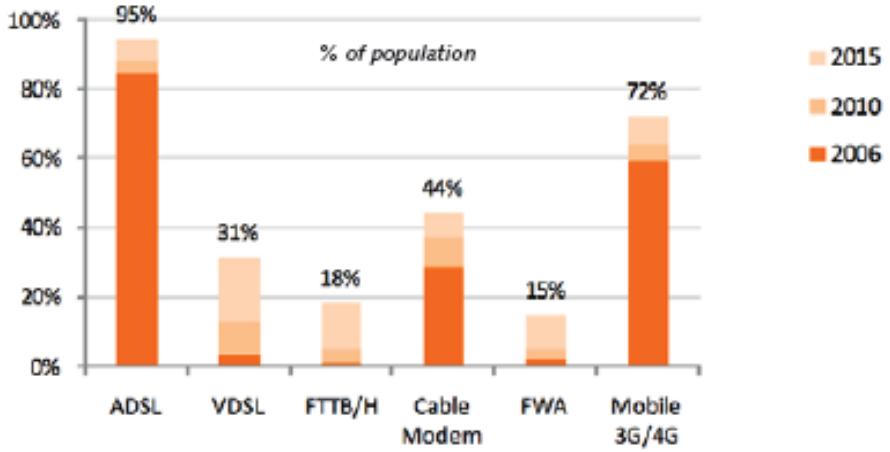


Figure 34: Broadband coverage in the EU-27 until 2015 [FOR2008]

According to their development plans, the European internet service providers do not intend to develop the VDSL[36] and FTTH/B[37] infrastructure on a wide scale in the short term; a much more dynamic investment pattern regarding infrastructure deployment will start after 2010.
Differences in broadband coverage are likely to occur between Member States. In particular, fixed wireless access (FWA) is expected to play an important role in countries where the telephone infrastructure is under-developed, while it will remain marginal in other countries. VDSL and FTTH/B development will occur earlier in most advanced knowledge societies.
The total broadband penetration is expected to grow to 81% of all households in Europe by 2015 (figure 35). [FOR2008]

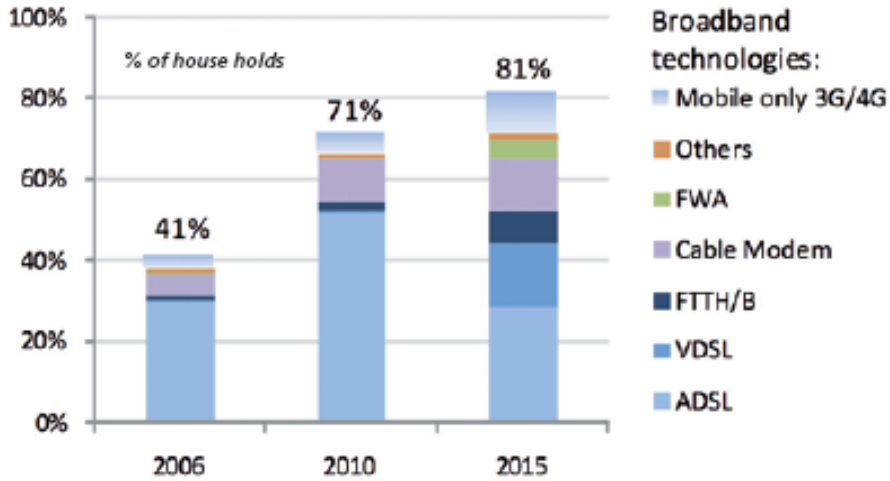


Figure 35: Total broadband penetration in EU-27 [FOR2008]

[35] Asymmetric Digital Subscriber Line
[36] Very High Speed Digital Subscriber Line
[37] Fiber-to-the-Home/Building

Expectations are that broadband equipment[38] will contribute considerably to the electricity consumption of European households in the near future. Depending on the penetration level, the specifications of the equipment and the requirements of the service provider, in 2015 broadband equipment could have consumption of up to 50 TWh per year in the EU-27. 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[39].

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 the energy efficiency. The Code of Conduct covers both 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.

3.6.5. External Power Supplies

External power supplies (EPS) and battery chargers are important energy consumers, accompanying portable appliances and being used for the operation of many electrical and electronics devices.

Apart from battery chargers sold individually for charging rechargeable batteries, EPS and battery chargers (BC) are often delivered as a part of an end-appliance, e.g. mobile phone, notebook computer, inkjet printer, flat screen display. The end-user is rarely conscious of the energy and environmental performance of the EPS/BC and often does not have a choice, as they are bundled with the end-application. The manufacturers, on the other hand, tend to focus on the main application and their approach for the design of EPS/BC is in terms of the energy requirement for the main application.

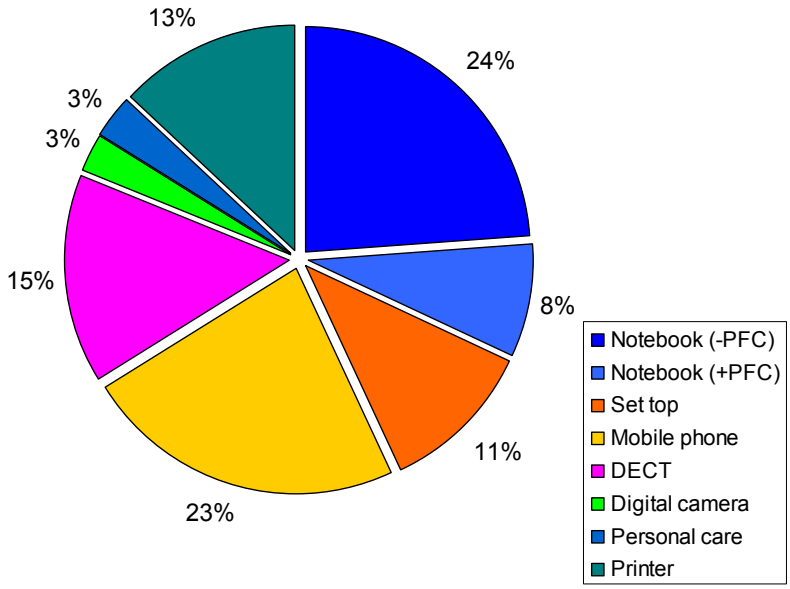
The preparatory study Lot 7 (Battery chargers and external power supplies) has shown that the significant environmental aspects related to external power supplies, are due to energy consumption in all life cycle stages.

[38] The broadband equipment consist mainly in home gateways, modems, routers, home network infrastructure devices, VoIP telephone, DSL network equipment

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

The 2009 stock of 2 billion units EPS implies an estimated 17,3 TWh electricity consumption in the EU-27 in the use phase[40]. Sales are estimated at around 611 million units per year. The share of the total energy consumption, related to the several primary load product categories powered by EPS, is illustrated in figure 36. [BIO2007]

The estimates done under the EPS Code of Conducts indicates an electricity consumption of around 14 TWh in 2006 (BaU)[41]. Based on these, the JRC estimates EPS electricity consumption of around 15,5 TWh/yr in 2007.



Note: "+PFC"/"-PFC" means with/without power factor correction and "set top" means set top box and modems

Figure 36: Shares of total energy consumption in primary-load product categories powered by EPS in 2009

Following the preparatory study for Lot 7, the Eco-design Regulation for battery chargers and external power supplies entered into force in April 2009 [COM2009a]. The requirements for external power supplies include most stand-alone AC/AC and AC/DC devices with a rated power up to 250 Watts and will be introduced in two stages: from 2010 and 2011. The requirements from 2011 are harmonised with the EU Code of Conduct for power supplies and the current US Energy Star requirements.

In the first stage (which takes effect on April 2010), the no-load power consumption shall not exceed 0,50 W.

The estimated savings from implementing this Eco-design Regulation are at around 9TWh/year by 2020.

[40] Here "electricity consumption" means the sum of energy losses due to the conversion of electricity from the mains power source (expressed as "active efficiency"), and of no load energy consumption. The energy consumption of the primary load product is not considered.

Before the adoption of the Eco-design Regulation, the only energy efficiency measure in place for external power supplies was the European Code of Conduct on Energy Efficiency of External Power Supplies (EU CoC EPS)[42]. This was introduced in 2000, for reducing the no-load losses and for improving the on-mode efficiency.

Before the introduction of the Code of Conduct, many external power supplies had no-load power consumption above 1 W, and low efficiency in operational modes, but by 2005 many of the external power supplies in the European market had no-load losses below 1 W.

With actions resulting from this Code of Conduct, the stand-by consumption of external power supplies and chargers can be reduced by 5 TWh/yr, which can be achieved starting from 2010. The operation losses can also be reduced by increasing the power conversion efficiency, resulting in energy savings of the same order of magnitude (1 to 5 TWh).

Version 4 of the Code of Conduct has been in force since 1 January 2009. It sets the new requirements for no-load consumption and the efficiency criteria for active mode (table 16).

Table 16: EU CoC EPS requirements for no-load consumption and the efficiency criteria for active mode

	Rated output power (Pno)	Entry in force date	No-load power consumption
All EPS, excluding external power supplies up to 8 W for mobile handheld battery driven applications	0.3 ≤ Pno < 50 W	from 1.01.2009	0,30 W
	50 ≤ Pno < 250 W	from 1.01.2009	0,50 W
For external power supplies up to 8 W for mobile handheld battery driven applications	0.3 ≤ Pno ≤ 8 W	from 1.01.2009	0,25 W
	0.3 ≤ Pno ≤ 8 W	from 1.01.2011	0,15 W
	Rated output power (Pno)	Entry in force date	Minimum Four Point Average Efficiency in Active Mode (expressed as a decimal)
All EPS, excluding external power supplies up to 8 W for mobile handheld battery driven applications	0 < Pno ≤ 1 W	from 1.01.2009	≥ 0,48 * Pno + 0,145
	1 < Pno ≤ 36 W	from 1.01.2009	**≥** [0,08 * ln(Pno)] + 0,585
	36 < Pno ≤ 250 W	from 1.01.2009	≥ 0,870
For external power supplies up to 8 W for mobile handheld battery driven applications	0 < Pno ≤ 1 W	from 1.01.2009	≥ 0,50*Pno+0,029
	1 < Pno ≤ 8 W	from 1.01.2009	**≥** [0,095*ln(Pno)]+0,529

[41] EPS Code of Conduct http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoC%20PowerSupply%20Version3-28112007.pdf

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

3.6.6. Stand-by consumption

Standby functions and off-mode losses are a common feature of electrical and electronic household and office equipment (consumer electronics, information and communication technology equipment, personal care products etc.). The users are often not aware of the electricity consumption and costs for stand-by/off-mode (small for a single product) and low power consumption in stand-by/off-mode is not an important purchasing criterion. Taking into consideration that a typical household is in general equipped with dozens of products having stand-by/off-mode, the resulting electricity consumption and the related costs are significant.

The technical solutions reducing energy consumption in stand-byby/off-mode are frequently not applied e.g. due to possible additional costs for the manufacturer, and also because it is not a market access requirement. [FRA2007]

Although cost-effective solutions for improving the stand-by/off-mode exist, these have not been widely implemented. This market failure is explained by the fact that the stand-by/off-mode consumption has not until now been a required market feature and any improvements have only been associated with additional production costs.

The stand-by/off-mode power is small compared to the operational power of a single product but, taking into account that stand-by/off-mode last longer than the operation mode and cumulating this consumption for all equipment, results in significant losses of energy and money.

Home appliances stand-by represents 5,4% of the residential electricity consumption, more than (among others) the air-conditioning (4,4%) or computers' (2,8%) consumption.

According to the Eco-design preparatory study for stand-by consumption (that considered 15 main products with stand-by/off-mode consumption), some 3.7 billion installed products have stand-by/off-mode resulting in electricity consumption of some 43 TWh in the EU-27 residential sector in 2007. By 2020 it is expected that some 4.6 billion installed products will have stand-by/off-mode and that, without specific counter-measures, electricity consumption in stand-by/off-mode will rise to 49 TWh per year.

It is estimated that the adopted Eco-design requirements would lead to a reduction of approximately 35 TWh of electricity per year by 2020 in the EU. Energy savings are expected in other parts of the world too because some equipment categories are produced for the world market to identical specifications.

Until recently there was no regulation across EU on stand-by/off-mode consumption, apart from some focused Codes of conduct implemented on voluntary based[43] and the EICTA voluntary agreement on TVs.

[43] EU Code of Conducts for Digital TV service, on energy consumption of broadband communication, on efficiency of external power supplies and on AC uninterruptible power systems
http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative.htm

In December 2008, the EU Commission adopted the Commission Regulation (EC) N^{o} 1275/2008 for implementing the Eco-design Directive with regard to requirements for stand-by and off-mode electric power consumption of electrical and electronic household and office equipment. [COM2008]

The Regulation focuses on an extensive list of equipment with stand-by/off-mode consumption, comprising four big categories of products:

1. household appliances,
2. information technology equipment intended primarily for use in the domestic environment,
3. consumer equipment,
4. toys, leisure and sports equipment.

The Regulation stipulates that in one-year's time the following conditions must be fulfilled by the above-mentioned products on the EU-27 market:

1. Power consumption of equipment in any off-mode condition shall not exceed 1 W.
2. The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 1 W.
3. The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display, shall not exceed 2 W.
4. Equipment shall, except where this is inappropriate for the intended use, provide off-mode and/or stand-by mode, and/or another condition, which does not exceed the applicable power consumption requirements for off-mode and/or stand-by mode when the equipment is connected to the mains power source.

In four years' time the conditions will become more restrictive in the following way:

1. Power consumption of equipment in any off-mode condition shall not exceed 0,5 W.
2. The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 0,5 W.
3. The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display shall not exceed 1 W.
4. Equipment shall, except where this is inappropriate for the intended use, provide off-mode and/or stand-by mode, and/or another condition which does not exceed the applicable power consumption requirements for off-mode and/or stand-by mode when the equipment is connected to the mains power source.

5. When equipment is not providing the main function, or when other energy-using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into:
    a. Stand-by mode, or
    b. off-mode, or
    c. another condition which does not exceed the applicable power consumption requirements for off-mode and/or stand-by mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.

4. Electricity end-use in the tertiary sector

In this report, the tertiary sector refers to the public sector, education, healthcare, services and commerce[44].

The final energy consumption in the tertiary sector of the EU-27 grew by 6,47% between 1999 and 2007 by 21,14% between 1990 and 2007 (figure 37). In NMS-12, the energy consumption growth in the tertiary sector was 16,58% between 1999 and 2007, twice the EU-15 in the same period (8%). However, the energy consumption between 1990 and 1999 had an 18% growth in EU-15 and decreased by -7,3% in NMS-12. The explanation is the different economic path in these two groups of countries in this period, the NMS-12 facing a transition period in the '90s and EU-15 being under a constant economical growth.

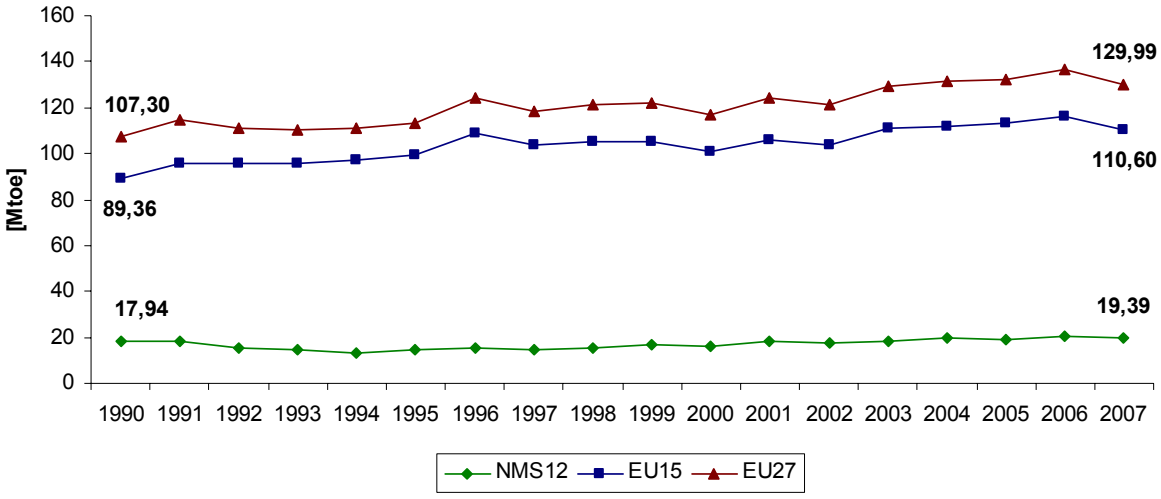


Figure 37: Trends of EU-27 energy consumption in the tertiary sector (source Eurostat)

In the period 1990 to 2007 gas consumption in the tertiary sector grew by 48,6% in EU-27, by 43% in EU-15 and by 83,7% in NMS-12 (figure 38).

The gas consumption continued to grow during the period 1999 to 2007 in the EU-27 from 37,911 Mtoe to 39,15 Mtoe (3,28% growth), but the trend changed, as in the case of residential consumption, from 0,24% increase over the period 2004-2005 to -6,83% decrease over the period 2006-2007. The explanation was mainly the warmer winters, but also more efficient boilers and building insulation.

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

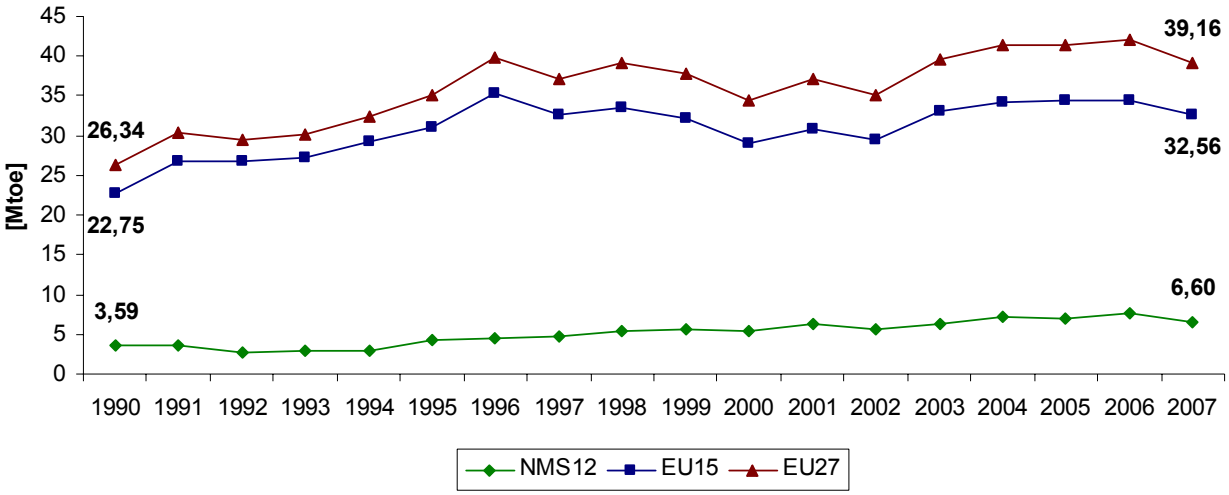


Figure 38: Trends of EU-27 gas consumption in tertiary sector (source Eurostat)

The electricity consumption in the EU-27 tertiary sector was 589 TWh in 1999 and 760 TWh in 2007, representing a growth of 29%. Compared to 1990 consumption, the final electricity consumption in the tertiary sector rose by 75,5% (in EU-15 by 70,1% and in NMS-12 by 126,8%). Between 2004-2007 the electricity consumption in the tertiary sector rose by 10,4%, with 9,5% growth in EU-15 and 16,4% in NMS12 respectively (figure 39).

In 2007, for the first time, the electricity consumption in the tertiary sector was almost constant from one year to another (a mere 0,42% growth in 2007 as compared to 2006).

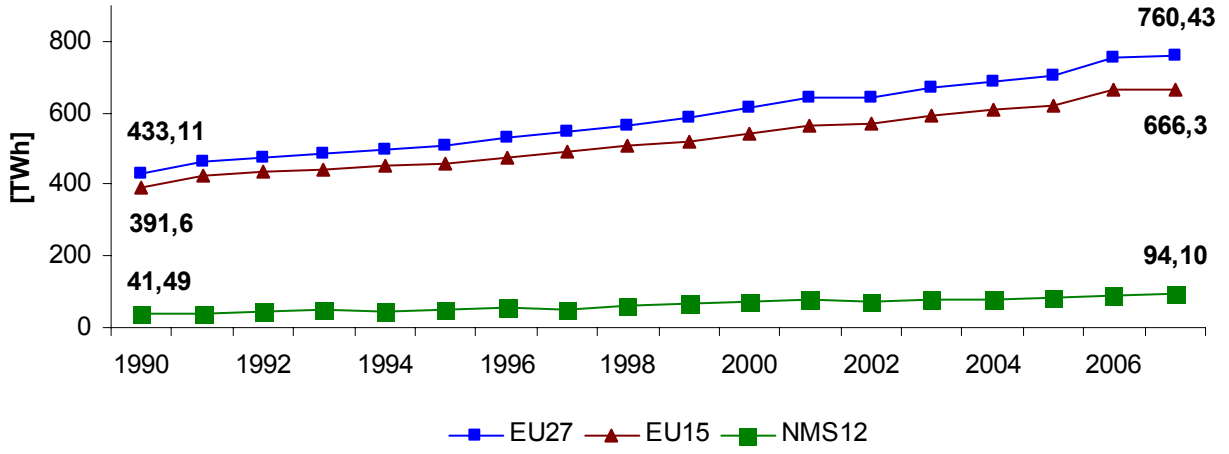


Figure 39: Trends of EU-27 final electricity consumption in the tertiary sector (source JRC)

The bigger variation in the NMS-12 tertiary electricity consumption is explained by a faster growth of the economies in these MS and consequently a much higher growth in GDP in these countries than in the EU-15[45].

There is much less data available for individual electricity end-uses in the tertiary sector than for the residential sector, and only a few sources attempted to divide the total electricity consumption among different end-uses.

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

	1999 [TWh]	2000 [TWh]	2001 [TWh]	2002 [TWh]	2003 [TWh]	2004 [TWh]	2005 [TWh]	2006 [TWh]	2007 [TWh]	1999-2007 [%]
EU-27	589,424	614,718	642,353	644,09	672,796	688,814	706,206	757,244	760,431	29,01
EU-15	521,982	543,584	565,177	569,099	593,917	608,349	622,318	666,387	666,329	27,65
NMS-12	67,442	71,134	77,176	74,991	78,879	80,465	83,888	90,857	94,102	39,53
At	13,505	12,619	13,346	12,939	14,142	13,412	12,378	11,78	11,336	-16,06
Be	11,738	12,236	12,791	11,858	11,906	11,928	12,703	17,148	18,146	54,59
Bg	4,42	5,062	5,144	5,641	5,989	5,821	6,192	6,938	7,047	59,43
Cy	1,247	1,251	1,456	1,584	1,664	1,712	1,786	1,858	1,942	55,73
Cz	10,25	11,559	11,849	11,379	12,592	12,213	12,53	12,98	13,253	29,30
De	106,521	108,352	111,68	110,256	113,896	114,932	119,1	130,302	119,8	12,47
Dk	10,284	10,215	10,159	10,19	10,262	10,332	10,449	10,573	10,349	0,63
Ee	1,242	1,362	1,451	1,51	1,643	1,818	1,919	2,166	2,347	88,97
Es	44,963	50,023	51,266	53,227	57,232	60,671	62,584	76,202	77,125	71,53
Fi	12,885	13,279	14,124	14,634	14,657	15,158	15,576	16,115	16,19	25,65
Fr	97,396	104,012	106,639	106,398	113,915	117,951	120,826	127,953	130,474	33,96
Gr	11,482	12,26	13,233	13,954	14,978	15,872	16,479	17,757	18,773	63,50
Hu	8,603	8,88	8,986	8,723	8,647	9,124	9,929	10,298	10,853	26,15
Ie	5,014	5,59	5,905	6,748	8,163	8,167	8,465	8,116	8,71	73,71
It	53,898	56,595	59,236	62,83	67,426	69,955	73,875	78,057	79,865	48,18
Lt	1,949	1,872	1,995	2,096	2,398	2,567	2,707	2,86	3,037	55,82
Lu	0,974	0,999	1,04	1,06	1,105	1,19	1,189	1,232	1,224	25,67
Lv	1,553	1,546	1,466	1,727	1,865	1,988	2,142	2,331	2,704	74,11
Mt	0,47	0,504	0,546	0,577	0,634	0,627	0,563	0,664	0,663	41,06
Nl	28,087	30,248	31,424	30,668	30,925	32,596	31,303	31,171	31,413	11,84
Pl	26,184	27,756	29,129	28,64	29,892	31,019	33,546	37,15	37,179	41,99
Pt	10,444	11,288	12,013	12,363	13,185	13,705	14,407	15,24	15,606	49,43
Ro	3,415	3,908	5,552	2,741	4,749	3,586	4	4,9	5,721	67,53
Se	26,092	25,383	29,201	28,354	27,263	27,557	26,812	27,139	30,235	15,88
Si*	2,151	2,166	2,348	3,023	2,335	2,637	2,423	2,472	2,512	16,78
Sk	5,958	5,268	7,254	7,35	6,471	7,353	6,151	6,24	6,844	14,87
UK	88,699	90,485	93,12	93,62	94,862	94,923	96,172	97,602	97,083	9,45

* tertiary sector data for Slovenia are provided by the Jožef Stefan Institute

The largest electricity consumers in the EU-27 tertiary sector are lighting in offices (21,6% and 26,3% together with street lighting), electric space and water heating systems (19,7%), ventilation (12,7%) and commercial refrigeration (8,7%). (figure 40, table 18).

[45] Between 1999-2007 the GDP grow in NMS-12 was 45,75% comparing with 20,57% in EU-15. Between 2004-2007 the GDP

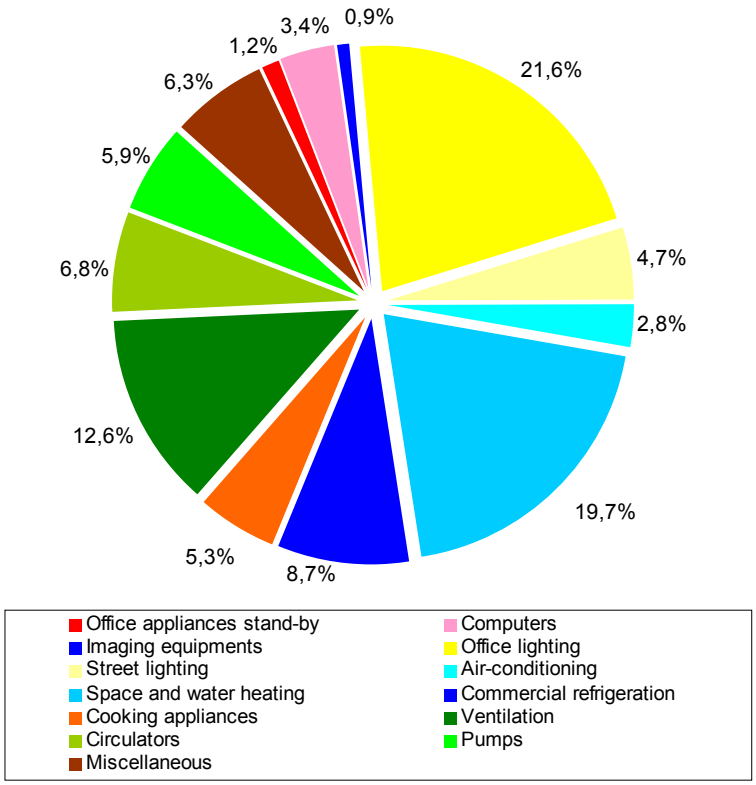


Figure 40: Breakdown of the tertiary sector consumption (source JRC)

Table 18: Estimate breakdown of electricity end-use in the EU-27 tertiary sector in 2007 (source JRC)

EU-27 tertiary electricity in 2007	**[TWh]**
Office appliances stand-by	9,43
Computers	26
Imaging equipments	7
Office lighting	164
Street lighting	36
Air-conditioning	21,6
Space and water heating	150
Commercial refrigeration	65,83
Cooking appliances	40
Ventilation	96
Circulators (and other similar)	52
Pumps	45
Miscellaneous	47,57
Total final consumption	760,43

grew with 19,69% in NMS-12 and with 8,23% in EU-15. (GDP, 2000 exchange rates)

4.1. Office and street lighting

Lighting equipment is without doubt an important energy-using service that has been present in office buildings of the tertiary and industrial sector for many decades. It is a common practice to install task oriented lighting according to specified technical requirements in indoor work areas of the tertiary and industrial sector in accordance with technical standards or guidelines. The fixed lighting equipment installed during the last years to fulfil these requirements is almost without exception based on fluorescent lamp technology. It is expected that this technology will be the base case for another decade. Fluorescent lamp technology and the related ballast and luminaire technologies have made significant performance progress in the lasts two decades. A broad range of performance levels of these products is installed in buildings and is put on the market nowadays; therefore policy measures are needed in order to move towards efficient equipment.

According to the Eco-design preparatory study for office lighting, in 2004 (most recent available data) LFLs represented a market share of 16% of the total lamp sales and CFLs 6%. The annual increase in 2004 was 4,2% for LFLs and 8,3% for CFLs. [TIC2007]

There is no data on recent years' sales of linear fluorescent market, previous years' trends indicate that T8 lamps dominate the linear fluorescent market and the new T5 lamps (14-80W) are the new 'challengers' on the market.

The old halo-phosphate fluorescent lamp technology cannot satisfy the colour rendering requirements of EN 12464-1 (2002) and has a poor lamp efficiency. Nevertheless, halo-phosphate lamp sales are still considerable, either as replacement lamps or in applications where no technical lighting requirements are imposed.

Using this European Standard as a basis, CELMA (the European Federation of the National Association of the manufacturers of luminaires, control gear and lampholders) has fixed both energy classes for the ballast-lamp combination of the common fluorescent lamps. The CELMA “Energy Efficiency Index” system contains 7 classes: A1, A2, A3, B1, B2, C and D. The guidelines are valid for mains-operated ballasts for fluorescent lamps. The EEI system comprises the following lamp types:

- Tubular fluorescent lamps T8
- Compact fluorescent lamps TC-L, TC-D, TC-T and TC-DD.

In the recent years, there has been a new trend to promote more white light sources for outdoor lighting and the Solid State Lamps (SSL or LEDs) become a very promising efficient solution on the market. Until now, solid-state lamps have rarely been used in street lighting because of the high price, but technology is changing and prices go down. Traffic lights are already using this technology thanks to the high efficacy for coloured light. Apart of the higher

energy efficiency, another big advantage of the SSL is the long life-time of more than 50.000 hours. [TIC2007a]

White-light emitting diode WLED lamps are recently becoming available on the market with increasing efficacy and increasing life-time as a result of decades of semiconductor research and development. In street lighting, amber LEDs could be used too that offer a higher efficacy (e.g. 40 lumen/W), but a lower colour rendering. Applications where efficient coloured light is required benefit nowadays from LEDs too, e.g. traffic and other signs (applications with a low power density). LEDs also have perfect dimming capabilities far better than HID lamps which could be beneficial for lighting where dimming is required, like in the case also of indoor (office and residential) lighting.

Several manufacturers are developing WLED (white LEDs) lamp luminaries. LEDs cannot tolerate high operational temperatures and are only available in relatively low power compared to the HID lamps (power range starts at 20 Watt). The future application of WLEDs would therefore also influence luminaire design.

The electronic ballasts for street lighting offer more power control and dimming and are more efficient than the classic magnetic ballasts. In the recent years the 'multi-watt' and 'multi-lamp' electronic ballast have become increasingly popular, making distribution and stock management easier. For electronic ballasts, life-times of 40.000 to 60.000 hours (10 to 15 years) are considered realistic by manufacturers.

Some examples of advanced lighting for office buildings from the GreenLight[46] programmes have reported lighting power densities in the range of 7 to 10 W/m^2 for office buildings, and annual power consumption density of 10-20 kWh/m2.

According to the Eco-design preparatory studies for office and public lighting, the EU-27 office lighting consumption is the biggest in the tertiary sector with 21,57%, representing 164TWh/yr. The street outdoor lighting take a share of 4,73% of the overall tertiary sector electricity consumption, representing 36 TWh/yr. [TIC2007], [TIC2007a]

In order to assess the criteria for Eco-design implementing measures, the Commission has carried out technical, environmental and economic studies for office lighting and public street lighting products. For public lighting, two studies covering “public street lighting products” and “office lighting products” were carried out. After completion of the studies, it was decided to integrate the work on public street lighting and high-intensity discharge lighting products and on fluorescent and office lighting products as they are the main technologies used in those applications into one single discussion on “tertiary” sector lighting products. The improvement potential is based on already-available technical solutions such as:

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

- reducing the electricity consumption in tertiary sector lighting products, compared to the market average, while providing the same functionality;
- reducing the life-cycle cost for the end-users.

The mercury content of lamps varies on a wide range, and the variation is not always dependent on additional features of a particular lamp type compared to others, therefore we can consider that there is potential to reduce the mercury content without affecting product functionality.

The electricity consumption and the improvement potential are considered significant, at around 44-54 TWh/yr in 2020. The potential of reducing the mercury content of the installed base of lamps by 75% is significant.

Following the preparatory studies and the impact assessment for tertiary lighting, in March 2009, the EU Commission published a Regulation concerning the eco-design requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council. [COM2009]

The Regulation imposes minimum requirements on lamps, ballasts and luminaires, resulting in minimum efficiency and quality requirements on remaining products and in phasing-out as follows:

- linear T12 and T10 halo-phosphate lamps will be banned from 2012 with the exception of lamps for special purposes;
- minimum requirements for performance for T8 and T5 linear lamps will be imposed and the T8 halo-phosphate lamps will be banned from 2010;
- from 2012 new luminaires must be sold with electronic ballasts and from 2017 magnetic ballasts will not be permitted even for replacement in existing luminaires;
- from 2017 (8 years after the Regulation takes effect) all fluorescent lamps must be designed to work with an electronic ballast;
- minimum performance requirements are introduced for high intensity discharge (HID) lamps, consisting in phasing out of high-pressure mercury (HPM) lamps following an agreed schedule, the largest wattages being phased out first;
- requirements on minimum lumen maintenance levels are introduced;
- 90% of the high-pressure sodium (HPS) lamps should have a life-time of more than 16000 hours;
- Metal halogen lamps should have a minimum life time of 12000 h for 80 % (frosted) and 90 % (clear);

- requirements of directional light sources for street lighting luminaires (not only HID) are introduced in order to reduce light pollution;
- new minimum performance requirements are introduced for all HID lamps to minimise mercury content.

The Regulation foresees extensive technical specifications to be provided on free-access websites and that CELMA's voluntary ballast energy efficiency index will be updated and made compulsory for indication on all ballasts. The Regulation will be applied in three main and two intermediary stages and a revision after five years.

4.2. HVAC and Refrigeration

Air-conditioners in non residential buildings are estimated to consume about 21,6 TWh, (2,8% of the total tertiary electricity consumption). In 2007, some 0,52 million air-conditioning units and around 1,9 million heat pump units were sold to be used in offices and retail sectors. In the same years, estimates show that the stock was of about 8,7 million of air-conditioners and 17,5 million reversible heat pumps. [RIV2009]
Eurovent established classification for full-load EER[47] 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.

Another important share of electricity is consumed by fans for **ventilation systems (including fans)** which account for about 96 TWh electricity consumption in 2007 (12,6% of tertiary electricity consumption).
One important factor driving the energy consumption for ventilation systems is the way in which the space is ventilated. There are four main types of ventilation systems: natural ventilation, fan assisted exhaust ventilation, fan assisted supply ventilation, fan assisted balanced ventilation.
Non-residential buildings refer to a broad range of building types, which have many similarities in the technologies used for ventilation, but could differ significantly in the way the building is used. The variety of applications ranges from concert halls in which fans are used only in the evening for a limited number of hours, to school buildings which might be used only in the morning, over to office buildings where the ventilation is mainly required during office hours. In addition, there are also workshops in which there is a three-shift production, making it necessary to operate the ventilation system around the clock.

As the ventilation is used to exchange the air and to remove heat, humidity and other contaminants, the required airflow varies typically over the year with higher ventilation rates during summer time.
According to the Eco-design preparatory study Lot11 for fans (finalised in 2008), the energy consumption in use represents the main environmental impact (more than 90%) and efficiency improvements of the fan product are possible with the same or reduced life cycle costs. The cumulative savings that could be achieved by introducing minimum energy performance standards are estimated to be up to 30 TWh by 2020. [RAD2008]

A similarly important sector in terms of consumption is **commercial refrigeration**, with an estimated electricity consumption of 65,83 TWh in 2006, around 8,7% of the tertiary electricity consumption (table 19). [MON2007]
The specific refrigeration products covered by commercial refrigeration equipment are: 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.

Table 19: The estimated electricity consumption of main commercial refrigeration units [MON2007]

	consumption
Refrigeration unit	[TWh]
Open Chilled Vertical Multi-deck (RCV2)	37,04
Open Frozen Island (RHF4)	5,11
Beverage cooler	16,55
Ice-cream freezer	4,45
Spiral cold vending machine	2,98
Total	65,83

The stock of refrigeration units in 2007 was estimated in the Eco-design preparatory study, Lot 12 and is shown in table 20.

[47] Energy efficiency ratio

Table 20: Stock and sales data for refrigeration units in 2006/2007 [MON2007]

Refrigeration unit	Stock [mil. units]	Sales [mil. units]
Remote refrigerated display cabinets	2,2	0,24
Plug-in refrigerated display cabinets	1,9	0,15
Beverage coolers	6,48	0,8
Ice-cream freezers	2,7	0,34
Cold vending machines	1,497	0,126

There are no specific regulations for HVAC and refrigeration commercial appliances, but once the Eco-design preparatory studies on air-conditioning, ventilation systems and commercial refrigeration are finalised, possible corresponding EC Regulations will follow, imposing energy efficiency requirements for the above-mentioned equipment and strengthening the labelling schemes.

4.3. Office Equipment

Personal computers, monitors and imaging equipment[48] are relatively young technologies, coming out on the market since the mid '80s and reaching a spectacular development today. Due to this dynamic evolution, it is difficult to evaluate with accuracy the penetration, market status and electricity consumption of the office equipment.

The EI-tertiary IEE project [GRU2008] estimated that the office equipment consumption represents around 5,3% of the tertiary sector consumption in France, up to 6% in Italy, some 14% in Germany and around 7,5% in The Netherlands.

Based on the recent Eco-design studies for personal computers and computer monitors [IVF2007], JRC estimates that in 2007 some 48,5 million desktop computers and 59,3 laptop computers were installed in non-residential applications. The trend in office applications seems to be a smooth switch from desktop to laptop computers, due to the higher mobility features of the latter. In 2007 the number of the desktop computers grew by more than 7% and the number of laptops rose by almost 60% as compared to 2005 (figure 41).

According to the same study, the EU-27 computer monitor stock in 2007 was around 13,3 million CRT and more than 41 million flat panel monitors. As in the case of television sets, flat panel monitors are growing very fast on the market (doubling the stock in only two years, from 2005), replacing the out-dated CRT monitors.

[48] Imaging equipment consists of printer, copier, scanner, facsimile machines, and multifunctional devices (MFD).

Growth in both laptop and flat-panel monitors has contributed to the decrease of the electricity consumption of computing office equipment, which reached some 3,4% of the tertiary sector electricity consumption of around 26 TWh/year in 2007.

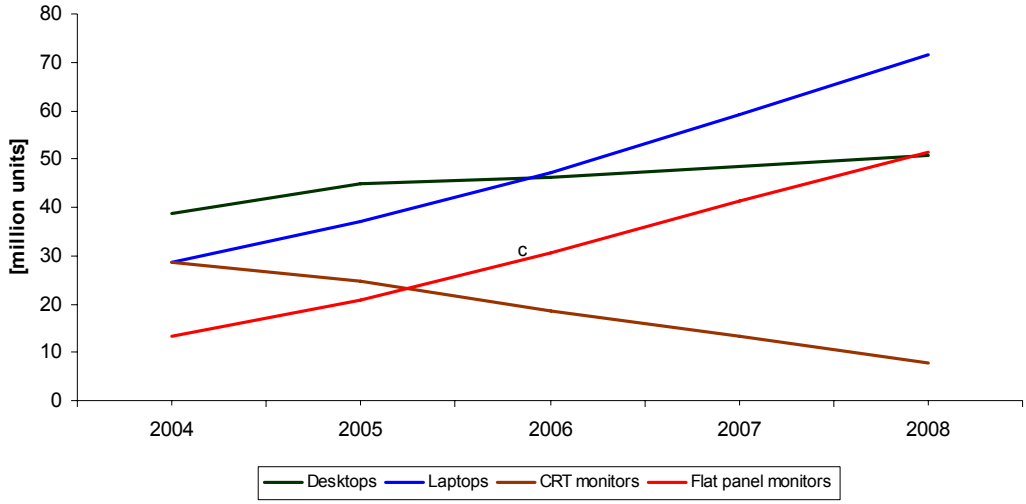


Figure 41: Estimated installed computers and monitors in EU-27 (JRC based on [IVF2007])

For imaging equipment, based on the eco-design preparatory study Lot 4, JRC estimated an electricity consumption of about 9 TWh/year.

At European level, the Energy Star label and the new specification added in 2008 are the present policies in place to reduce the energy consumption of office equipment (see www.eu-energystar.org).
Under the Eco-design Framework Directive, following the preparatory studies for computers, monitors and imaging equipment (Lots 3 and 4), Regulations imposing new energy efficiency requirements will be proposed.

Electricity consumed in data centres, including enterprise servers, ICT equipment, cooling equipment and power equipment, is expected to contribute substantially to the electricity consumed in the EU-27 commercial sector in the near future. Western European electricity consumption of data centres has been estimated at 56 TWh/year in 2007[49] and is projected to increase to 104 TWh/year by 2020.
The projected energy consumption rise poses a problem for EU energy and environmental policies. It is important that the energy efficiency of data centres is maximised to ensure that

[49] This is based upon the Draft UK Market Transformation Programme European Enterprise Server installed base model, and assumes an upper bound ratio of 1:2 between electricity consumed by the server equipment within the data centre or server room, against that consumed by cooling equipment and through power losses. The lower bound ratio of 1:1 gives total electricity consumption close to 37 TWh. The upper and lower bound ratio is based on several different sources of measurements of electricity consumption in the data centre.

the carbon emissions and other impacts, such as strain on infrastructure associated with increases in energy consumption, are mitigated.

In March 2007 the EU Code of Conduct for Data Centres was initiated. This is a voluntary scheme within the EU that provides a platform to bring together European data centre owners and operators, data centre equipment and component manufacturers, service providers, and other large procurers of such equipment to discuss and agree voluntary actions which will improve energy efficiency. This Code of Conduct (CoC), coordinated by EC Joint Research Centre, proposes general principles and practical actions to be followed by all parties involved in data centres, operating in the EU, to result in more efficient and economic use of energy, without jeopardising the reliability and operational continuity of the services provided by data centres.

The EU CoC for Data Centres is addressed to all buildings, facilities and rooms which contain enterprise servers, server communication equipment, cooling and power equipment and provide a form of data service. The CoC covers two main areas of energy consuming equipment in the data centres, IT loads and facilities loads, but considering the data centre as a complete system and being oriented on the optimisation of the IT system and the infrastructure in order to deliver the desired services in the most efficient manner.

The first Code of Conduct on Data Centres Energy Efficiency (Version 1.0) from October 2008 entered into force at the beginning of 2009.

5. Industrial Sector Electricity Consumption

In the EU-27, energy consumption of the industrial sector has continued to grow in the period 1999 to 2007, increasing by 1,87% from 316,9 Mtoe to 322,8 Mtoe. Compared to 1990, the 2007 consumption was down by -11,7% (figure 42). The decrease of the energy consumption in the industrial sector was remarkable in NMS-12 (-46,8% drop between 1990 and 2007), mainly due to the structural changes in these countries, while in EU-15 there was a slight growth by 1,3% between 1990 and 2007.

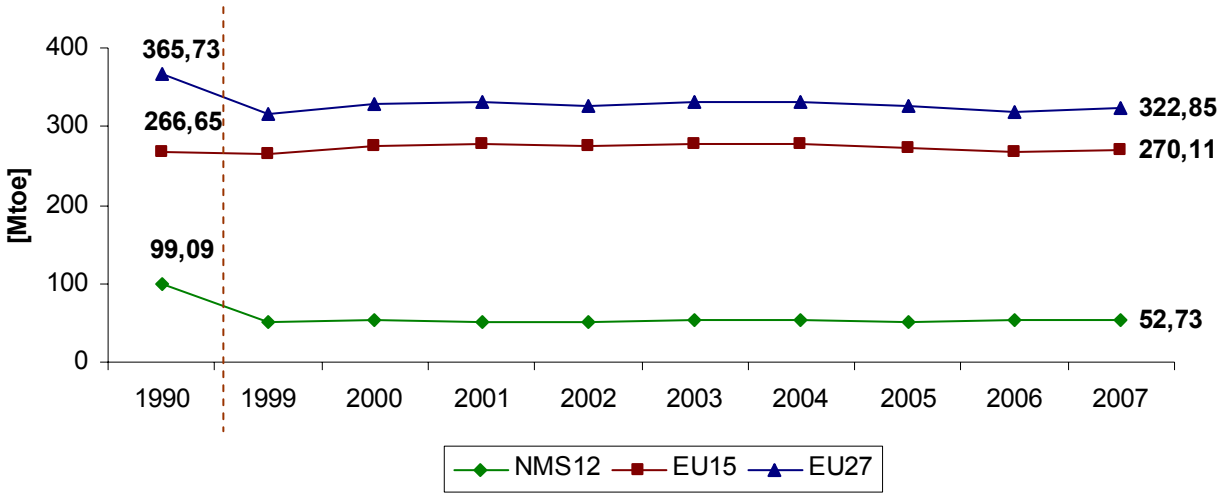


Figure 42: Energy consumption trends in the industrial sector (source Eurostat)

The EU-27 gas consumption in industry decreased by -9,2% in the period 1990 to 2007, mainly due to a strong decrease by -53,3 % in NMS-12 which compensated the 10% growth in the EU-15 (figure 43).

The gas consumption continued to decrease in the period 1999 to 2007 in EU-27: down from 106 Mtoe to 101,86 Mtoe (-3,93%). There was a decrease of -5,1% in EU-15, partially compensated by 3,15% growth in NMS-12.

Once more this evolution can be explained by the fact that in the '90s the NMS-12 economies were affected by structural changes of the economy.

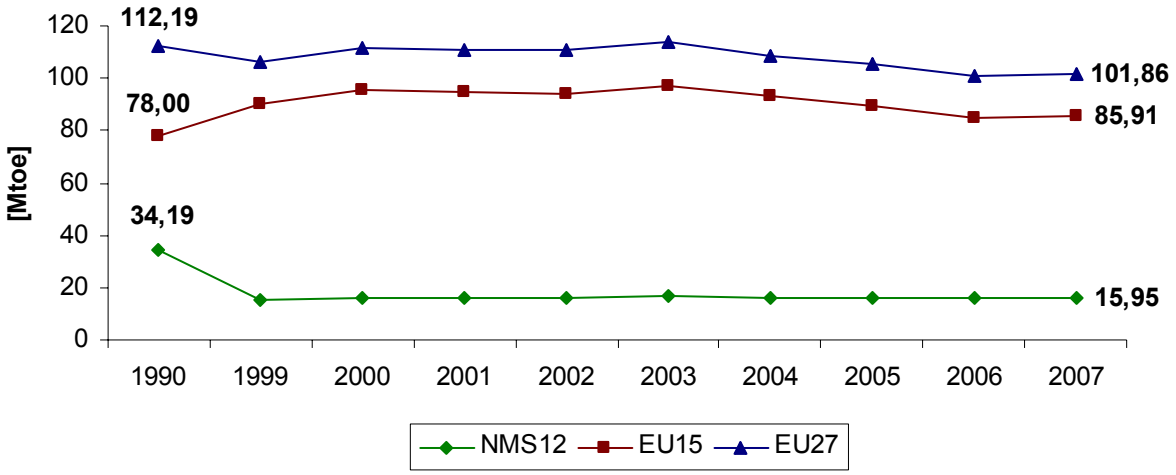


Figure 43: EU-27 gas consumption trends in the industrial sector (source: Eurostat)

The total electricity consumption of the industrial sector in the EU-27 was 978,5 TWh in 1990, growing to 1019,97 TWh in the year 1999 [EC 2004b] and reaching 1150 TWh in 2007 (figure 44).

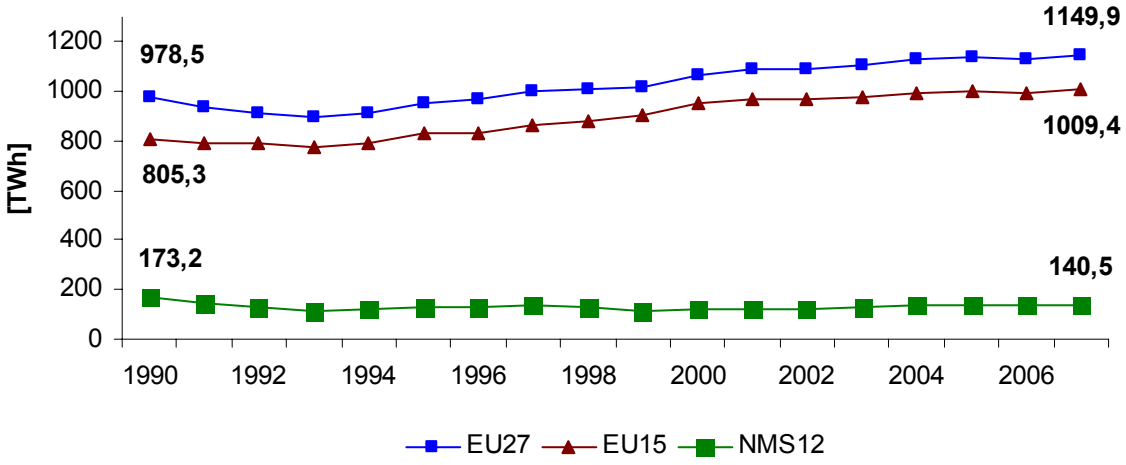


Figure 44: Electricity consumption trends in the industrial sector (source Eurostat)

The electricity in the industrial sectors has grown by 12,74 % in the period 1999-2007 and by 2,06% in the period 2004-2007 (table 21).

Table 21: Electricity consumption in the EU-27 industrial sector

	1990	1999	2000	2001	2002	2003	2004	2005	2006	2007	1999-2007	1990-2007
	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[TWh]	[%]	[%]
EU27	978,5	1020,0	1068,6	1088,6	1092,1	1102,4	1126,7	1135,6	1132,7	1149,9	12,74	17,52
EU15	805,3	903,2	950,1	968,4	970,1	976,3	992,5	1002,4	995,1	1009,4	11,76	25,34
NMS12	173,2	116,7	118,5	120,2	122,0	126,0	134,2	133,2	137,6	140,5	20,37	-18,86
AT	18,0	19,4	20,7	21,5	21,6	21,6	23,3	25,0	26,7	27,7	42,72	54,10
BE	30,5	37,6	39,9	39,2	38,9	40,0	40,4	39,4	40,2	40,1	6,65	31,49
BG	18,6	8,5	8,6	9,0	8,5	9,2	9,7	9,8	10,0	10,2	20,25	-45,13
CH	17,2	17,0	18,1	18,5	18,1	18,3	18,6	18,9	19,0	19,0	11,68	10,19
CY	0,3	0,4	0,4	0,5	0,5	0,5	0,5	0,5	0,6	0,6	40,98	81,33
CZ	26,9	18,8	18,9	19,9	20,6	20,6	22,4	23,1	23,6	24,2	28,59	-10,21
DE	207,8	206,1	221,9	236,6	233,6	231,8	233,8	232,1	229,4	242,8	17,79	16,81
DK	8,4	9,9	10,0	10,1	9,9	9,7	10,0	10,3	10,4	10,2	3,16	20,87
EE	3,0	1,8	1,8	1,8	1,9	2,0	2,1	2,2	2,3	2,4	30,42	-19,35
ES	63,3	76,5	85,6	90,3	92,9	98,3	101,5	105,0	97,7	98,8	29,29	56,21
FI	32,5	41,5	42,7	42,4	43,7	44,3	46,1	43,3	46,9	46,8	12,66	43,85
FR	114,7	132,6	134,7	134,7	133,4	133,8	136,6	139,5	134,3	132,6	-0,01	15,64
GR	12,1	12,9	13,5	13,8	14,1	14,2	14,0	14,4	14,2	15,3	18,82	26,58
HU	13,8	8,5	8,8	9,4	10,3	9,6	9,5	9,3	9,4	9,5	11,38	-31,13
IE	4,5	7,3	7,7	7,8	7,8	7,3	6,9	7,7	9,0	8,5	16,57	88,99
IT	110,8	133,8	141,8	143,2	143,1	144,4	144,2	144,8	147,4	146,2	9,21	31,88
LT	5,5	2,4	2,3	2,3	2,5	2,6	2,7	2,8	2,9	3,1	27,95	-43,57
LU	2,6	3,7	3,9	3,7	3,7	4,0	4,2	4,0	4,3	4,4	19,85	69,12
LV	3,2	1,4	1,4	1,5	1,5	1,6	1,6	1,7	1,8	1,8	27,44	-43,07
MT	0,0	0,5	0,5	0,5	0,5	0,6	0,6	0,5	0,5	0,5	13,01	430,00
NL	33,2	40,0	40,6	40,6	41,1	40,7	41,4	41,6	41,6	42,3	5,73	27,23
PL	42,7	39,4	40,5	39,0	38,2	40,2	42,4	41,3	42,8	45,8	16,16	7,12
PT	12,2	15,1	16,0	16,2	16,5	16,8	17,1	17,2	17,6	18,0	19,19	47,24
RO	38,3	20,3	19,9	20,8	22,7	22,3	25,2	23,7	24,3	22,8	12,23	-40,34
SE	54,0	56,0	56,9	57,1	57,3	56,1	57,2	57,6	57,3	58,0	3,59	7,47
SI	6,0	5,1	5,5	5,7	5,8	6,6	6,8	7,2	7,4	7,5	45,83	25,11
SK	15,0	9,5	9,7	9,7	9,0	10,3	10,7	11,0	11,9	12,2	27,94	-18,80
UK	100,6	110,9	114,1	111,3	112,6	113,4	115,8	120,5	118,3	117,7	6,2	16,98

Of this consumption, around 680[50] TWh was by motor-driven systems, which includes compressors, refrigerators systems, pumps, ventilations, conveyors and other equipment. From this, the greatest share is taken by small and medium size motors (1,1 KW-11kW). Typically electric motors are a component in a motor system, being responsible for the conversion of electrical power into mechanical power. Therefore, the motor system's consumption corresponds to the electricity consumption of their motors. Electric motor systems are by far the most important type of electric load in industry in the EU, using about 60% of the consumed electricity.

[50] the JRC estimation based on [EC2003a], [ECi2004], [ALM2008]

There is a great potential to improve the energy efficiency of industrial motor systems by more than 25%, and this can be achieved by using energy efficient motors, by using variable-speed drives and by optimising the overall system that incorporates electric motors, including mechanical components (pumps, compressors, fans) and distribution system.

A voluntary agreement, supported by the European Motor Manufacturers' Association (CEMEP) and the European Commission, was negotiated and signed in 1999 by 36 motor manufacturers representing 80% of the European production of standard motors. The unilateral motor agreement is based on a new system of efficiency classification: motors are divided into 3 categories, according to their efficiency with EFF 1 being the high efficiency motors, the EFF2 the medium efficiency motors and EFF 3 the low efficiency motors. The agreement goal has been to reduce the market share of motors in the lower efficiency class by 50% of 1998 levels. By 2007 EFF3 motors (new sales) represented only 2% of the market and EFF1 motors represented 12% of the sales, double the share in 2004 (figure 45). 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 motors responsible for the largest share of energy consumption, which are sold in large numbers.
Through the unilateral commitment described above, CEMEP manufacturers almost phased out the low efficiency motors (class EFF 3)[51].

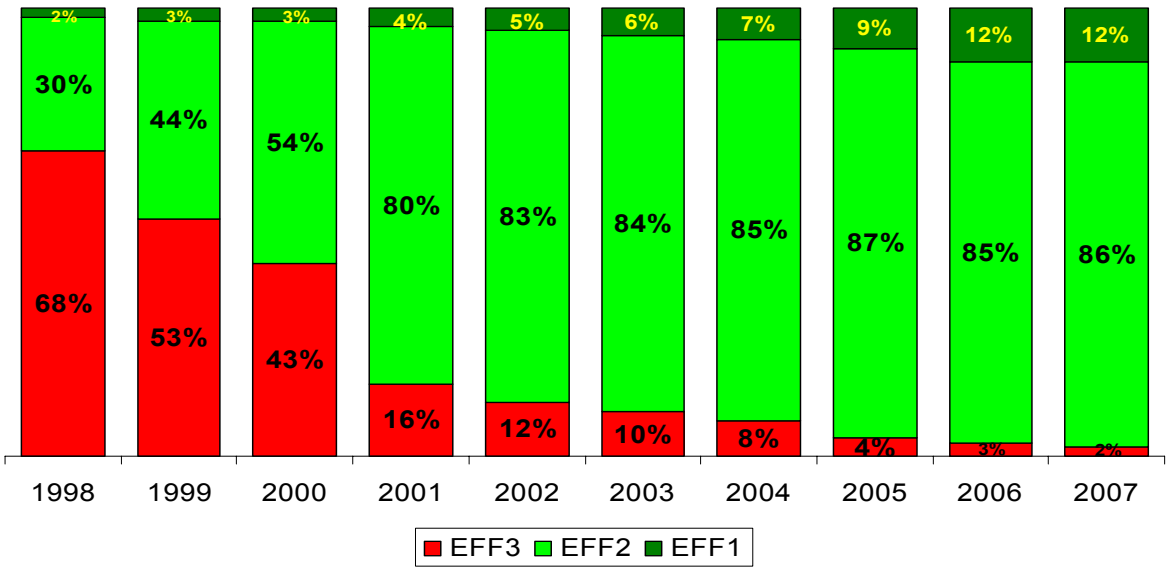


Figure 45: Change of market share among the three motor efficiency classes (Source CEMEP)

[51] The European Motor Classification Scheme at: http://re.jrc.ec.europa.eu/energyefficiency/motorchallenge/tools.htm

There is a new designation of the energy efficiency class, which consists of the letters “IE” (short for “International Energy Efficiency Class”), directly followed by a numeral representing the classification. Four efficiency classes are defined:

• IE4 – Super Premium

• IE3 – Premium efficiency

• IE2 – High efficiency (equiv EFF1)

• IE1 – Standard efficiency (equiv. EFF2)

Until recently there was a lack of a simple and clear way for the user to specify and inspect the motor efficiency. In accordance with IEC 60034-30 (published in October 2008), the rated efficiency and the efficiency class shall be durably marked on or near the rating plate, for example 86% (IE2). For a motor with dual frequency rating, both 50 HZ and 60 Hz efficiencies shall be marked.

In 2008, the Eco-design preparatory study Lot 11 for implementing the Eco-design Directive in the field of electric motors and other equipment using electric motors (pumps, compressors, fans) was finalised. Following this study, the European Commission adopted on 22 July 2009 the EC Regulation implementing the eco-design criteria for electric motors[52].

The Regulation imposes nominal minimum efficiency requirements for motors for IE2 and IE3 levels, stipulating the follows:

- from January 2015 all motors with a rated output of 7,5-375 kW shall not be less efficient than the IE3 efficiency level or to meet the IE2 efficiency level and be equipped with a variable speed drive.
- from January 2017 all motors with a rated output of 0,75-375 kW shall not be less efficient than the IE3 efficiency level or to meet the IE2 efficiency level and be equipped with a variable speed drive.

The findings of the study show that the implementation of minimum efficiency levels for motors sold in the EU from 2011 on would result in savings from 12 -18 TWh in the year 2020, representing cumulative savings of 72-92 TWh by 2020. However, it is emphasized that these figures do not show the total savings' potential, as the full impact of the implementation of minimum energy performance standard with IE2 level (standard IEC 60034-2-1) and the stock rotation will be completed in 2025-2030. [ALM2008]

Water pumps are another major electricity consumer in industry, agriculture and tertiary sectors.

The eco-design preparatory study for water pumps, finalised in April 2008 [AEA2008] covers the following water pump types for commercial buildings, drinking water, agriculture and the food industry: single stage close-coupled (end suction close coupled - ESCC), in–Line ESCC

[52] Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors. Official Journal of the European Union, L 191/26, 23.7.2009

pumps (ESCCi), single stage Water (end suction own bearing - ESOB), submersible multistage well pumps (4” & 6”) and vertical multistage water pumps. The estimates show that there are some 17 million installed pumps of these types in the EU and the total energy used by these pumps is estimated at 117TWh/year.

The same study reveals that removing the worst 40% of pumps from the market would yield energy savings of 3,4TWh/year by 2020 at little additional cost to the consumer. Once the full impact of such an action is seen (in 20 years time), then the energy savings from this measure will be 4.8TWh/year at the estimated 2020 usage.

For pumps and fans, it is expected that soon the EU will introduce minimum energy performance standards by Regulations under the Eco-design Framework Directive.

6. Conclusions

Over the period 2004-2007 EU-27 energy and electricity consumption trends in the residential sector remained rather stable. From the first time since 1990, the final electricity consumption in 2007 was lower than in the previous year in the residential sector and almost constant in the tertiary sector. This may be seen as an indication that energy efficiency policies and measures start to be effective. However, it is too early to conclude this unambiguously, given that winters were rather warm in this period and the climate has a great impact over the electricity and energy consumption (for heating but not only).

The largest electricity consumers in EU-27 households are the electric heating systems (18,8%), cold appliances (15,3%), lighting (10,8%) and water heating systems (8,6%). The home appliances stand-by consumption accounts for 5,9%, being the eighth main consumer with almost the same share as home computers and dishwashers together.

For certain main electric appliances, such as refrigerators and washing machines, stock saturation has been reached in almost all MSs and the average market sales efficiency class is A. Nevertheless, an important efficiency potential remains unutilised, especially for refrigerators.
The white appliances show a success story for improving energy efficiency. This is mainly due to the combined effects of EU legislation (energy labels, minimum energy performance standards), national programmes (tax incentives in Italy, price rebate schemes in Spain, awareness raising campaigns in UK and Hungary, supplier obligations and white certificate schemes in France, Italy and the UK) and voluntary agreements (CECED) of the industry).
With the full deployment of the impact of energy labelling and performance requirements for white appliances (refrigerators, freezers, washing machines and dishwashers), by 2020 estimated savings equal to some 10 TWh/y can be realised in the EU-27.

Italy, Spain, Greece and Southern-France are the biggest EU markets for air-conditioning systems, cumulating more than three quarters of the EU sales for residential use in 2005 (cooling capacity). In these countries, the air-conditioning systems represent one of the main drivers to increases in electricity consumption and the electricity peak demand during the summer months. With the introduction of energy labels for air-conditioning, the EU market has seen a positive transformation into a more efficient one with A class systems' sales growing by 361% from 2005 to 2008 on the main EU markets. At the same time, the sales for air-conditioning systems below or equal with C class diminished more than twice. There is no energy efficiency EU policy for air-conditioning systems. Subsequent to the finalisation of

the Eco-design preparatory study in 2009, an EC Regulation is expected to impose minimum energy efficiency performance requirements and additional requirements on noise, energy use in standby, off mode and other relevant modes.

With respect to space heating, efficient condensing boilers have significant shares in both the existing stock and market sales in The Netherlands, Germany, the UK and Denmark. Several countries like France, Ireland, The Netherlands, Austria and Italy, have developed specific national programmes offering subsidies and tax credits for high efficiency condensing boilers. Even though space heating and water heating remain major consumers with a great energy savings potential, no policy action has been implemented in these end-uses. The Eco-design preparatory study on water heaters estimated a 34% efficiency of the water heater stock in 2005. According to different proposed scenarios, stock efficiency in 2020 can be improved in order to reach 36%-82%.
The Eco-design Regulations are under preparation and are expected to positively influence the energy efficiency of these appliances.

Compact Fluorescent Lamps (CFLs) represent one of the most efficient solutions available today for improving energy efficiency in residential lighting. The CFL stock in the residential sector has been growing and there has been a 340% increase in the apparent consumption of CFLs in 2007 as compared to 2003. In March 2009 the European Commission adopted an Eco-Design Regulation to improve the energy efficiency of household lamps, which stipulates the progressive phasing out of incandescent bulbs starting in 2009 and finishing at the end of 2012 [COM2008b]. The estimated savings by implementing this Regulation should be around 39TWh/year by 2020.

ICTs[53] are among the fastest growing electricity end-use in the residential sector and will be soon among the main drivers of the electricity consumption growth in the residential sector.
Over the last years, the greatest growth was in ICT access including mobile telephony, broadband communication and households with computers and internet.
TV markets have seen dramatic changes in technology. Four main factors influence the market development: flat panel displays (flat TVs), larger screen sizes, digital television broadcasting, high-resolution television (HDTV). Estimates show that these important changes caused CRT TVs to lose the EU market leadership to LCDs (53% market share) for the first time in 2007.
If the proposed Eco-design Regulation for minimum performance and labelling requirements for TV sets and monitors is adopted, estimated savings of around 43 TWh/year can be

[53] ICT=Information and Communication Technologies

achieved by 2020, when the proposed energy labelling and performance requirements for televisions will reach their full impact.

Digital TV, in the form of digital cable, satellite, digital terrestrial (DTT), and IPTV (Internet Protocol Television), is fast replacing the analogue technologies. Digital television adoption in Europe is expected to show strong growth over the next years, providing enhanced image quality and an advanced future (greater breadth of content and bundled communications).

To ensure that the EU can have the benefits of digital television, the Member States are gradually closing analogue transmissions and moving to digital broadcasting. Overall, the switch-off of analogue terrestrial TV transmission in Europe is well on track. IPTV has already become a significant fourth platform for digital TV in many markets, and its importance across the broadcast sector will increase over the next three years.

Expectations are that equipment for the reception, decoding and interactive processing of digital broadcasting and related services will contribute substantially to the electricity consumption of EU households in the near future. Taking into consideration penetration level, equipment specifications and service provider requirements, a total European consumption of up to 10 TWh/yr can be attributed to STBs. The potential new electrical load represented by this equipment poses a problem for EU energy and environmental policies. It is important that the electrical efficiency of equipment required to support digital TV and related services is maximised. By implementing the Eco-design Regulation for simple STBs, energy savings are estimated at up to 6TWh/year.

The largest electricity consumers in the EU-27 tertiary sector are indoor lighting in commercial buildings (21,6% and 26,3%, together with street lighting), electric space and water heating systems (19,7%), ventilation (12,7%) and commercial refrigeration (8,7%).

The fixed lighting equipment installed during the last years is almost without exception based on fluorescent lamps and this technology is expected to be the base case for another decade. In the absence of recent market data, previous years' trends indicate that T8 lamps dominate the linear fluorescent market and the new T5 lamps (14-80W) are gaining importance on the market.

White-light emitting diode WLED lamps are becoming available on the market with increasing efficacy and increasing life-time as a result of decades of semiconductor research and development. LEDs also have perfect dimming capabilities superior to HID lamps. This could be beneficial for lighting, where dimming is required, like in the case of indoor (office and residential) lighting.

In March 2009 the EU Commission adopted a Regulation concerning the Eco-design requirements for fluorescent lamps without integrated ballast, for high intensity discharge

lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council. The estimated savings by implementing this Regulation are at about 38 TWh/year by 2020.

In 2007, the electricity consumption of air-conditioners in non-residential buildings was estimated at about 21,6 TWh, the fans for ventilation systems (including fans) at about 96 TWh and the commercial refrigeration at around 66 TWh. All of them have an important potential for energy savings and energy efficiency Regulations should follow the correspondent Eco-design preparatory studies.

Electric motor systems are by far the most important type of electric load in industry, in the EU, using about 60% of the consumed electricity accounting for some 680 TWh/year. Following the 1999 voluntary agreement supported by the European Motor Manufacturers' Association (CEMEP) and the European Commission, the manufacturers have almost phased out the low efficiency motors (class EFF 3).
The findings of the Eco-design Preparatory Study for Electric Motors shows that the implementation of minimum efficiency levels for motors sold in the EU from 2011 on would result in savings of 140 TWh/year by 2020 and additional measures for fans and pumps will contribute significantly to increasing the savings.

To summarise, energy efficiency policies and programmes such as minimum energy performance standards and energy labels at EU level, unilateral agreement with manufacturer trade associations, utility DSM programmes, incentives, tax rebates, supplier obligations and white certificates, implemented at EU and national level over the last decade, have resulted in market transformation. The EU energy efficiency policies have been significantly reinforced since 2005, new important legislation has come into force, is under assessment or under revision, in order to contribute to the achievement of the 20-20-20 target by 2020[54]. The measures already adopted by the EU should achieve energy saving of about 13% by 2020 if properly implemented by Member States. In the light of the need to counterweigh the risk of falling short in achieving the 2020 target, the EU Commission has proposed a new energy efficiency package under the Second Energy Review from November 2008[55]. The Eco-design of the energy-using products Framework Directive 32/2005/EC (Eco-design Directive), the End-use Energy Efficiency and Energy Services

[54] In January 2008 the EU Commission adopted an integrated energy and climate change policy, including ambitious targets for 2020 (available at: http://ec.europa.eu/energy/strategies/2008/2008_01_climate_change_en.htm):

- cutting greenhouse gases by 20% (30% if international agreement is reached)
- reducing energy consumption by 20% through increased energy efficiency
- meeting 20% of our energy needs from renewable sources.

[55] Second Strategic Energy Review - Securing our Energy Future, available at: http://ec.europa.eu/energy/strategies/2008/2008_11_ser2_en.htm

Directive 32/2006/EC (ESD), the re-cast of the Energy Performance of Buildings Directive (EPBD) and the re-cast of Labelling Directive will contribute significantly to realising the energy saving potential in European Union.

The Labelling Directive has been an important policy for promoting the energy efficiency measures, contributing substantially to the market transformation for domestic appliances.
It has been shown that this measure has lived up to the expectations, and revision of the energy classes is now needed, as for many appliances types the large majority of the market models are in the A energy class. A recast of the Labelling Directive is expected to happen soon.
The voluntary initiatives of the industry, including the EU Codes of Conduct, have also made a very important contribution to improving the efficiency by the reduction of stand-by energy consumption of certain products, such as external power supplies, set-top boxes, and broadband equipment.
Under the EU Directive for Eco-design of the Energy-Using Products, mandatory standards for 25 product lots are already under assessment. For four products, final legislation has been adopted (residential lighting, tertiary sector and street lighting, external power supplies, and simple set top boxes). A horizontal regulation has been adopted to reduce stand-by and off-mode losses in all electric and electronic products. The estimated savings impact of the first 11 Regulations - 5 of which are already in force and the rest expected to be adopted later on in 2009 - is around 340 TWh/yr by 2020, representing more than 21% of the final electricity consumption in the EU-27 residential sector (table 22) [19].

Table 22: Total estimated annual savings by 2020, as an effect of the Eco-design Regulations and Energy Labelling

Measure	Estimated savings (annual by 2020) [TWh]	Measure adoption
Domestic lighting (ecodesign)	39	March-09*
Street & office lighting (ecodesign)	38	Feb-09*
Freezers & refrigerators (ecodesign & labelling)	6	Jul-09*
Washing machines (ecodesign & labelling)	2	-
Dishwashers (ecodesign & labelling)	2	-
Televisions (ecodesign & labelling)	43	Jul-09*
Stand-by (ecodesign)	35	Dec-08*
Simple set-top boxes (ecodesign)	6	Jan-09*
External power supplies (ecodesign)	9	Mar-09*
Electric motors (ecodesign)	135	Jul-09*
Circulators (ecodesign)	25	Jul-09*
Total savings (annual by 2020) [TWh]	**340**	

** EC Regulation already in-force*

The estimates for remaining energy saving potential for the white appliances are very low compared to lighting, television and electronics, and this is because policies were successfully developed for white appliances rather than for the other consumers. The reduction of the stand-by consumption of electric and electronic equipment will be another important driver for achieving important savings by 2020.

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Abstract

This report summarises the outcome of the results of an in-depth survey of electricity consumption in buildings in the EU-27 conducted by the JRC, the main findings of the first preparatory studies for implementing the Eco-design Directive, as well as other recent analyses and studies on different aspects of the electricity final consumption in EU27. One of the aims of this report is to show the present status of electricity consumption of the main appliances and equipment, the energy efficiency progress and estimates of the saving potential in the EU-27 electricity sector. The report summarises the policy actions introduced at EU level and some of the national policies for the building sector and for the electric motor systems.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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