

Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe

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Abstract

This paper presents the preliminary results of the residential monitoring campaign, which is being carried out in the scope of the EIE project REMODECE, whose overall objective is to contribute to an increased understanding of the electricity consumption in the EU-25+2 households for the different types of equipment, including the consumers' behaviour and comfort levels, and to identify demand trends. The paper presents results on electronic loads, whose relevance is increasing significantly. Particular attention is given to standby consumption, which is generated by a large variety of appliances. From the measurements carried out it can be concluded that there is wide range of performance levels.

Keywords

Residential monitoring, stand-by consumption, energy efficiency policies, market transformation, climate change

1 - Introduction

Although significant improvements in energy efficiency have been achieved in home appliances and lighting, the electricity consumption in the average EU-25 household has been increasing by about 2% per year during the past 10 years. Some of the reasons for such increase in the residential sector electricity consumption are associated with a higher degree of basic comfort and level of amenities (particularly in the new EU member countries) and also with the widespread utilization of relatively new types of loads whose penetration and use has experienced a very significant growth in recent years.

The overall objective of the REMODECE project is to contribute to an increased understanding of the electricity consumption in the EU-25+2 households for the different types of equipment, including the consumers' behaviour and comfort levels, and to identify demand trends. This project will evaluate the potential electricity savings that exist in the residential sector in Europe, and that can already be implemented by existing means, like the use of very efficient appliances or the elimination/mitigation of standby consumption. The availability of high quality data is an essential condition for the definition of policy recommendations to influence through a combination of measures the energy efficiency of the equipment to be sold in the EU-25+2 in the next decade, as well as to influence the user behaviour in the selection and operation of that equipment.

In this scope, the main objectives of this survey are:

- Contribute to an increased understanding of the energy consumption in the EU-25+2 households for the different types of equipment, including the consumers' behaviour and comfort levels;
- To identify demand trends;
- Evaluation of the potential electricity savings that can already be implemented by existing means, like the use of very efficient appliances or the elimination/mitigation of standby consumption;
- Analysis of market transformation for different types of equipment;
- Policy recommendations for each type of equipment.

The residential electricity consumption in 2004 for the EU-25 was close to 744 TWh and by 2015 is expected to significantly grow according to the following estimates by the IEA:

Table 1: Consumption in 2015

Consumption with the Current Policies (TWh)	854
Savings with LLCC (TWh)	293
Savings (%)	34.34%

Efficiency policy can be used to target the most cost-effective level of efficiency (established through a life-cycle cost analysis [LLCC] and aiming at the technology improvement set at the least lifecycle cost) for appliances to be sold in the next decade.

The impact of vigorous market transformation activities in the residential sector in EU-25 by 2015 lead to 34% % reduction of the electricity consumption in relation to business as usual), that is almost 300 TWh by 2015. This electricity savings translate into about 150 million tons of avoided CO2 emissions. In terms of primary energy savings, considering that most of the electricity generation expansion is the EU will be done with natural gas CCGT, and assuming 10% transmission and distribution losses, about 60 Billion m³ of natural gas (most of which imported) could be saved. These figures represent one of the most relevant cost-effective electricity savings potential in the EU.

Different approaches for market transformation, in consultation with the most relevant market stakeholders, will be analysed for different types of equipment, leading to a set of specific policy recommendations for each type of equipment.

In particular, in Western Europe the focus of investigation is on new electronic loads, whereas in Central and Eastern Europe the monitoring effort deals with both conventional loads and electronic loads. The idea is to take advantage of existing monitoring and surveys, by structuring the available data into a data base of the residential electricity measurements and consumption (per country and appliances), which are being updated with the project results. The monitoring approach is the following:

- In most Western European countries the consumption of the main domestic appliances, namely the load curve, and the peak power, is roughly known. Conventional “main domestic appliances” include cold appliances, washing machines, dryers, fans and lighting. As an example of available data, Figure 1 and 2 show the Daily load curves for traditional home appliances (SINTEF), in a normal work day and in the weekend, respectively.
- In Central and Eastern European countries there are no significant measurements on residential electricity consumption. Therefore it is essential for the policy makers to have relevant data on electrical consumption for domestic appliances in this new (or soon to be) EU countries.
- In all countries, four types of consumption seem to be rising particularly fast:
 - The domestic computer and peripherals;
 - New domestic entertainment;
 - Standby power;
 - Some lighting technologies such as halogen lamps. The increasing number of CFLs also deserves to be investigated

Residential air conditioner loads are also increasing significantly in Southern Europe and their use will also be assessed during the project.

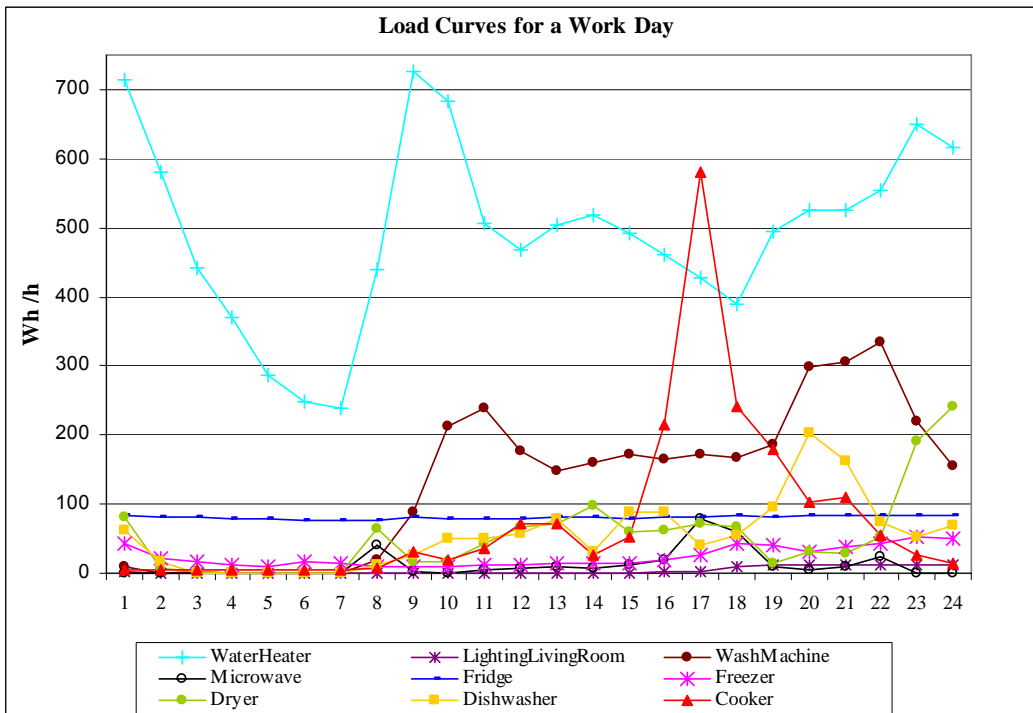


Figure 1: Daily load profiles for traditional home appliances in a normal work day

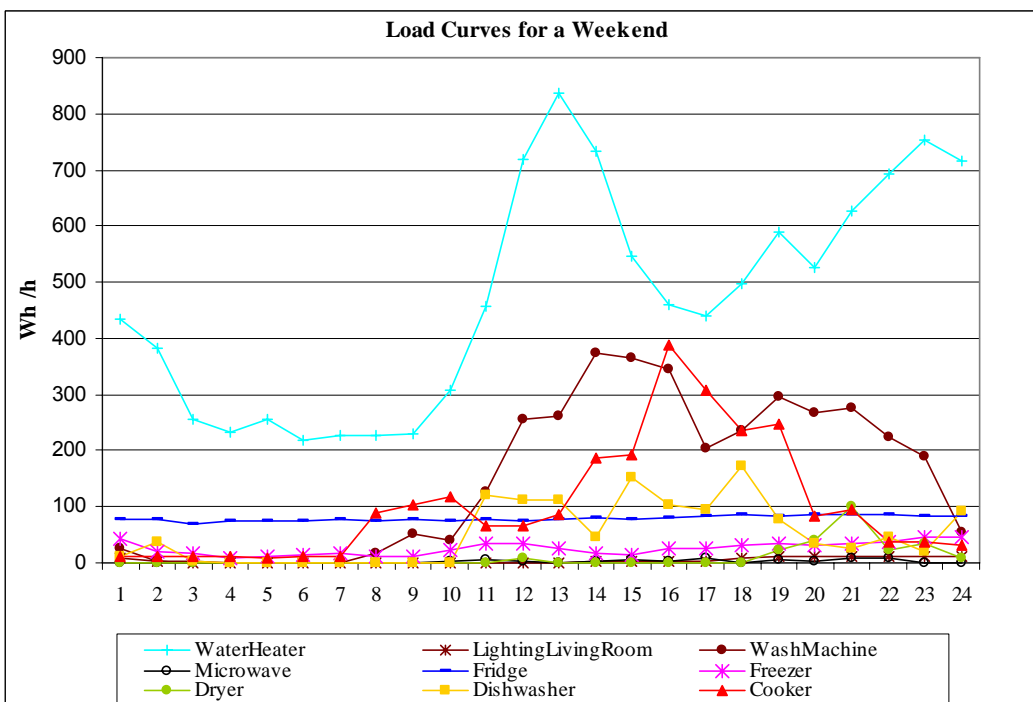


Figure 2: Daily load profiles for traditional home appliances in a weekend day

2 - End-Use devices in households – The overall picture

Figure 3 shows the average electricity consumption per household in 2005, in each country of the study, in comparison with the average per household in Europe-OECD countries (4670 kWh/year).

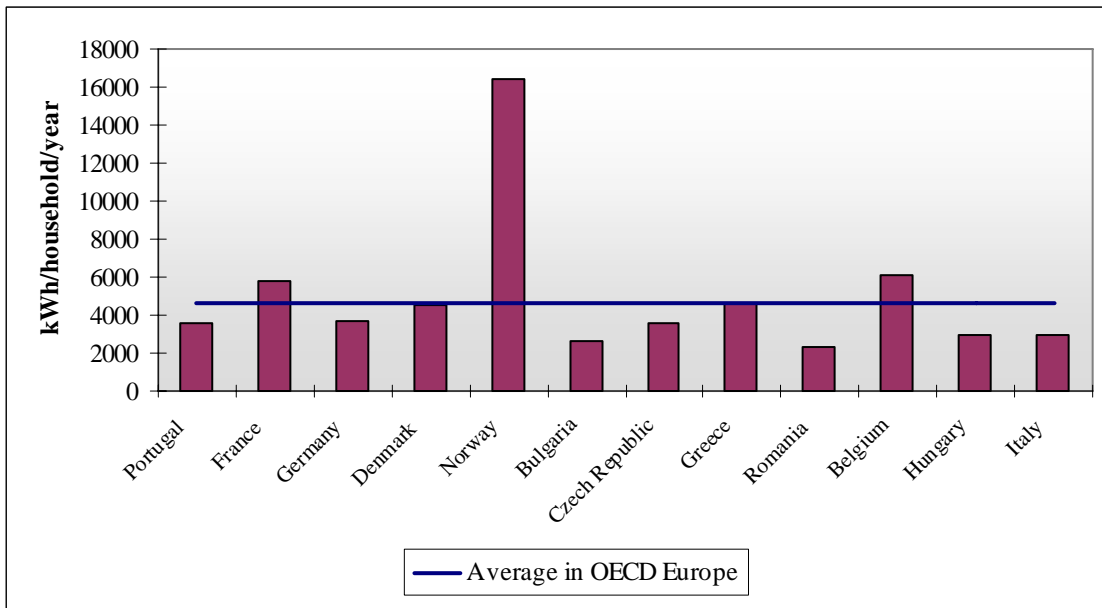


Figure 3: Estimated residential electricity consumption in each country of the study, 2005

The demand for electricity to power residential appliances and equipment does not appear to be slowing down. The increasing income of the population in general, and the increasing diversity of available appliances in the market, are causing people to use more and more appliances in the home. IEA estimated that, even with a continuation of all existing appliance policy measures, the appliance electricity consumption will grow by 13% from 2000 to 2010, and by 25% by 2020 [IEA, 2003].

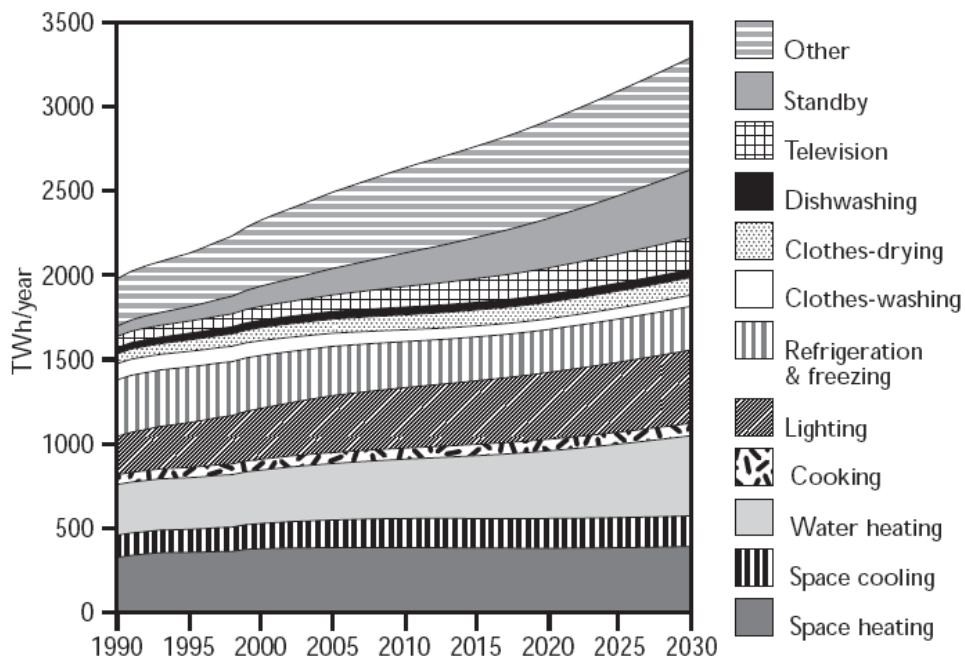


Figure 4: Projected IEA residential electricity consumption by end-use with current policies [IEA, 2003]

As it can be seen in the Figure 4, the fastest growing electric end-use is projected to be standby power consumption, or the consumption of electricity by appliances that are turned “off” or, that are in a low power consumption mode, (Standby, hibernate, sleep modes, etc.). According to IEA, by 2020, 10% of total appliance electricity consumption in the OECD could be for standby functionality, which is currently unregulated in OECD countries. In contrast, electricity consumption for clothes washing declined by 9% over the 1990s.

Although the electricity consumption of some end-uses is better known than others, Figure 5 present the share of residential electricity consumption by major end-use in EU countries in 2004 [Bertoldi].

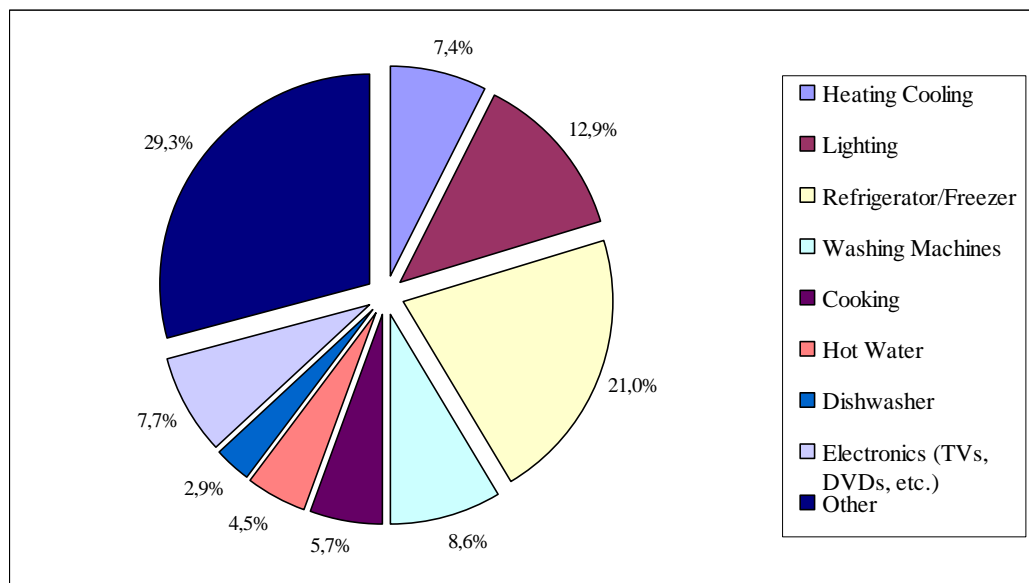


Figure 5: Disaggregation of the residential electricity consumption in EU countries by major end-use, in the year 2004

The main focus of this paper is new electronic loads, such as entertainment, domestic computers, peripherals and communications. The present total EU consumption for home consumer electronics in stand-by is estimated to be about 36 TWh and is forecast to grow to 62 TWh by year 2010.

It is generally accepted that the demand for information and communication services and technologies will sharply increase. The future power demand is more influenced by the technical improvements introduced in the equipments by manufacturers, mainly caused by voluntary agreements and programmes (such as EACEM TV agreement and the VCR agreement, Code of conduct for Digital TV Services, Code of Conduct on Energy Consumption of Broadband Communication Equipment, Code of Conduct on Efficiency of External Power Supplies and IEA Stand by Power Initiative). The power consumption is also caused by market demand, and by the behavioural changes resulting from the increasing awareness of consumers and the increasing number of electronic "gadgets" available in the market. Electrical and electronic equipment with stand-by losses is a fast growing load (e.g. entertainment, information and communication technologies -ICT, setop boxes-STB). All domestic equipment (including white goods) is likely in the near future to be controlled by electronic equipment, and will have the capability to communicate with other equipment. This situation will lead to an increase in the stand-by electricity consumption.

It is important to investigate about the "other loads", which represent a large share of the total electricity consumption in the residential sector. Therefore a further degree of disaggregation of that type of loads needs to be characterised, in order to understand those load profiles and to identify effective market transformation strategies.

Based on a recent market survey carried out by CETELEM, the household electronic loads market increased significantly in the EU countries, in 2005. France is still the country with the highest budget per household for buying electronic appliances. [Observador]. Based on this survey and on a recent survey carried out in Germany [Schlomann, 05], the following tendencies emerge with regard to the development of the stock of ICT and electronic appliances in households up to 2015:

- Audio devices represent an almost saturated market so that only a slight increase in the stock of such appliances is expected.
- More than 75% of the households own more than one TV. About 25% of families have 3 conventional TVs in Home. The number of televisions will keep rising to 2015; this increase

is due to the growth in second or third TV sets. CRT TVs are gradually replaced by LCDs, plasma TVs as well as front and rear-projection televisions.

- There will be a strong growth in the future in the number of set-top-boxes (STB) which are increasingly necessary for digital television reception. In particular, the switch of television technology from analogue to digital services leads to a stock increase in set-top-boxes since a STB is required for each television set, i.e. for second and third TVs as well. Taking into account the set-top-boxes already needed today for pay TV reception, the total number of STBs (including SAT boxes) will increase several fold until 2015.
- Appliances for recording audio-visual data (video VCR recorders, DVD recorders) have become prevalent in households in the past few years. It can be expected that the stock of DVD players will increase tenfold in the next ten years and that a rapid displacement of conventional video VCR recorders will take place.
- The stock of video cameras or camcorders will increase by about two times, by 2015, and massive stock growth can be expected for digital photo cameras. However, a modest increase is anticipated for game consoles because market saturation is already becoming apparent in many EU countries.
- Households are already almost fully equipped with fixed network telephones. However, within the stock, a clear structural shift has begun away from simple telephones to so-called "smart phones", which are relevant for electricity consumption and feature many additional functions, as well as to cordless phones, consisting of a base station with message recording, and one or more handsets. This trend will continue in the future, especially for the households with higher incomes.
- The number of mobile phones in most EU countries has grown enormously over the last five years, reaching almost saturation levels. A slight increase in mobile phone users is expected for the near future. In spite of the currently uncertain development of the UMTS system, this technology will gradually spread in the years up to 2010 and that the simple GSM devices will be replaced by UMTS.
- The number of computers in households has been increasing significantly. A 40% increase is expected up to 2015 with the strongest growth in the number of laptops. The often observed trend towards mobile IT and telecommunications support can also be seen in the growing number of PDAs (Personal Digital Assistants). The total number of computer monitors is growing in parallel to the number of desktop PCs. Up to 2015, the cathode ray tube screens still common today will be completely replaced by the TFT (LCD) screens. The number of ICT peripherals that can be connected to the computers has been increasing and becoming more complex. The majority of peripherals are the standard equipment like printers and loud speakers, but the digital era has been changing the household habits, and besides PDAs it is common to find digital cameras, pen drives, mp3, etc., in many households, as the second largest group of peripherals to be connected to the computer.
- Households with PCs now also feature printers as standard equipment so that the situation here is likely to evolve in the same way as for PCs. The sales of combined printer/scanner/copier devices (possibly with additional fax function) have also risen strongly recently. It is expected that the share of multifunctional devices will become largely dominant in 2015.

Based on the annual sales, on the number of households per country and on the lifetime of equipment, it was possible to estimate the stock of appliances and the ownerships of the main domestic appliances and electronic loads, in 2005. It is important to note that these are conservative figures, and in some cases the penetration rates are most likely much higher.

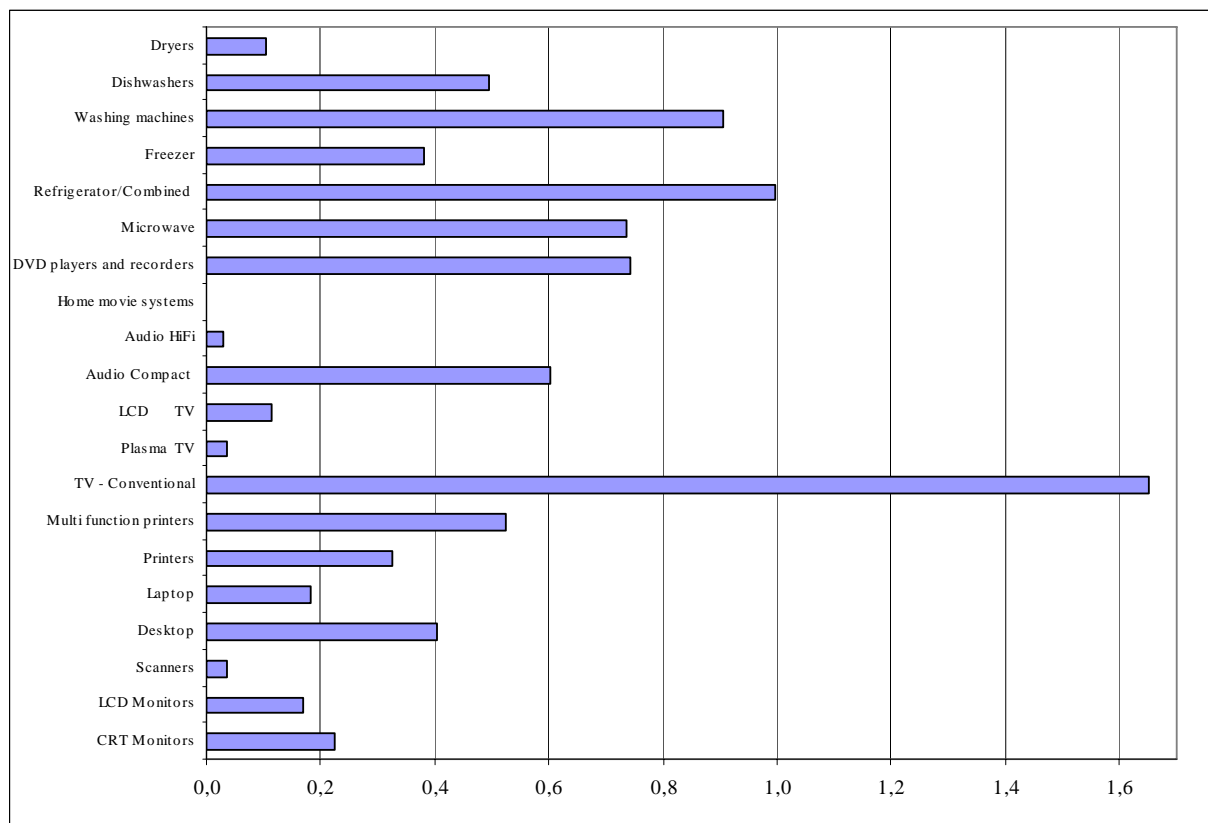


Figure 6: Estimated average ownership rate by the main end-use by 2005

3 - Definition of stand by consumption within this project

There is not a uniform definition for the operating modes for electronic appliances, and several approaches have been developed worldwide (ACPI, Energy Star, GEEA, Ecolabel, etc.). However, taking this situation into consideration the Standby consumption in this survey will be based on the standard IEC62301.

The final draft international standard IEC 62301 “House electrical appliances – Measurement of standby power”, published in June 2005, and its European on going transcription EN 62301, specifies methods of measurement of electrical power consumption in standby mode. It is applicable to mains powered electrical household appliances and to mains powered parts of appliances that use other fuels such as gas or oil. The objective of this standard is to provide a testing method to determine the power consumption of a range of appliances and equipment in standby mode, generally when the product is not performing its main function.

According to this international standard, the definitions for **standby mode** and **standby power** are as follows:

- The **standby mode** is the lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions.
- The **standby power** is the average power in standby mode.

The standby mode is usually a non operational mode when compared to the intended use of the appliance's primary function. The measurement of energy consumption and performance of appliances during other operating modes or intended use are generally specified in the relevant product standards and are not intended to be covered by this standard.

Based on the experience from some partners in the project, it was found to be useful to measure two major standby modes for some appliances, like for example, TVs, DVDs, Power Supplies/Chargers, some domestic equipment, etc. These modes are: the Off-Mode and the Standby Active Mode. The first, the Off-Mode is when the device is totally switched off (i.e. the power button is off, but the mains plug is connected). The later, the Standby Active Mode, is the mode when the device is able to respond to outside commands, such as when it is possible to use the remote control to switch on the equipment (i.e. typically is when the LED or display is still on).

In addition to power monitoring, the project will also investigate the number of hours per day the appliances in each of the modes. This information is required, because it will give an insight about the people behaviour with equipment. In particular, regarding standby consumption, the two above mentioned modes can be assessed as behavioural standby vs. technological standby.

4 - Data Collection

The decision about what data to collect is very important for a cost-effective and reliable characterisation. Based on the already existing databases, enough data should be collected to update the existing information and gather new data. To estimate the disaggregation of electricity consumption by each major end use, the following methodology was selected:

- Analysis of already existing studies, surveys, metering campaigns, databases, statistics, manufacturer's information, market information, etc., on energy consumption in the residential sector, focusing end-use equipment, operating modes;
- Conducting households questionnaires (500 per country of the study). The questionnaires will be accompanied by expert interviews in most cases, and user behaviour will be addresses within this survey.
- Conducting detailed audits in 100 households per country, focusing demand load profiles in real situations.
- Conducting own measurements for a series of appliances/ end-uses, especially to determine consumption in the stand-by and off modes of operation, because the available data is still relatively poor in this area.

The starting point of this study was to elaborate a detailed list of all the main end-uses to be analysed, in Eastern European Countries and in the old EU Countries, as well as the definition of the main modes of operation to consider for the monitoring of the different appliances.

The list is divided into 4 main groups according to their main function: domestic computers and peripherals, new domestic entertainment, other standby loads and other loads, including lighting and air conditioning.

4.1 - Characterization of the Electricity Demand of Electronic Appliances

Several measurements have been carried out on the products available in the market in many installations and stores. A database was set-up, with the measurements carried out, and in a wide range of different types of end-uses. The following paragraphs present summary tables with the average power consumption for all the audited equipment in each considered mode of operation, for the domestic computers and peripherals loads, for the new domestic entertainment loads, and for other standby loads, in each operating mode: On mode, Active Standby mode and Off mode.

There is an increasing diversity of electronic equipment on the market, which makes more complex the characterization of its consumption. Figure 7 shows the average standby power for several entertainment appliances available on the market in 2006. These values were measured in a large number of appliances with dedicated low power wattmeters and are instantaneous measurements. The number of appliances involved in the measurements is indicated on each bar.

Results from a major end-use metering project in four European countries [Eureco, 2002] assessed the standby power consumptions of the most important domestic appliances. Figure 8 presents the results of the measurements. Set top boxes and computers are among the appliances with the highest standby powers. Standby powers below 4 W mostly concern appliances with a clock (like microwave ovens), or the ones with a separate electric transformer (phones, answering machines, table vacuum cleaners, etc.) and the numerous alarm-clocks.

Table 2: List of the equipment type within this survey

Domestic computers and Peripherals	CRT Monitors LCD Monitors Scanners Desktop Laptop Printers Multi function printers
New Domestic Entertainment	TV - Conventional Plasma TV LCD TV Setop box Audio Compact Audio HiFi Home movie systems Game/playstation consoles DVD players and recorders
Other stand by loads	Electronic alarm clocks Chargers for cordless phones and mobile phones Cordless tools
Other Loads	Microwave Refrigerator/Combined Freezer Washing machines Dishwashers Dryers Tubular (longer than 40 cm) fluorescent Lighting Compact fluorescent Lighting Incandescent Lighting Halogen Lighting Residential air conditioning (Southern countries)

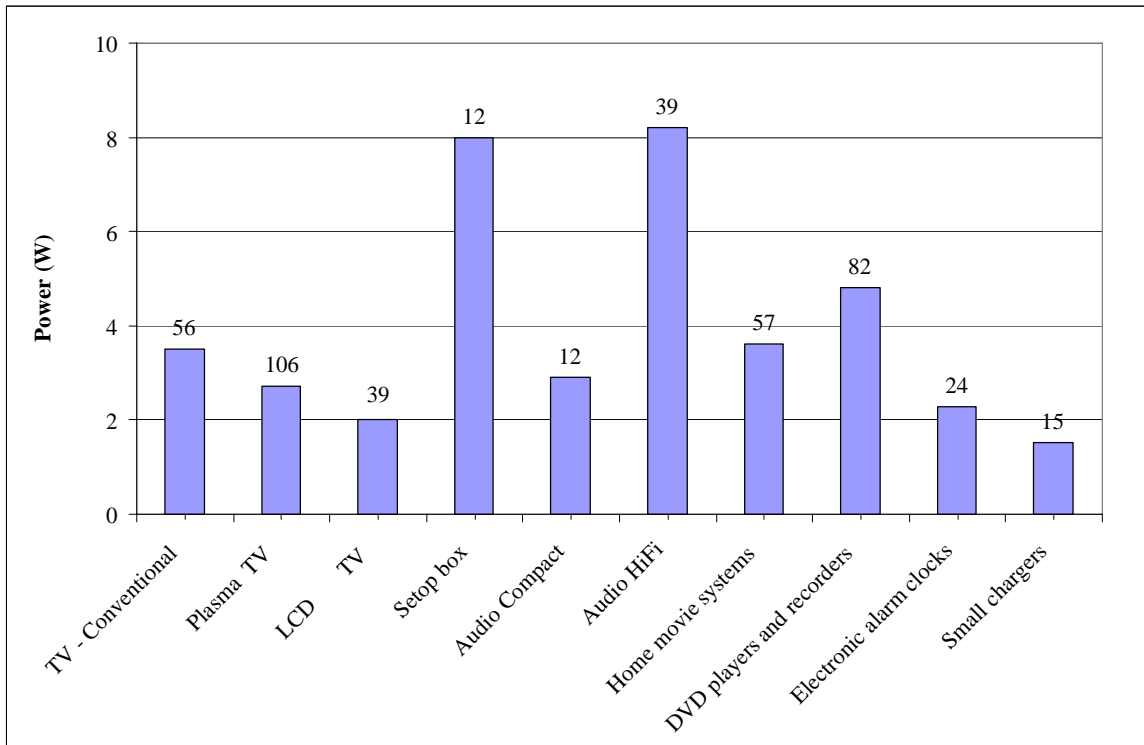


Figure 7: Distribution of the active standby power for some electronic appliances, [ISR-University of Coimbra, 2006]

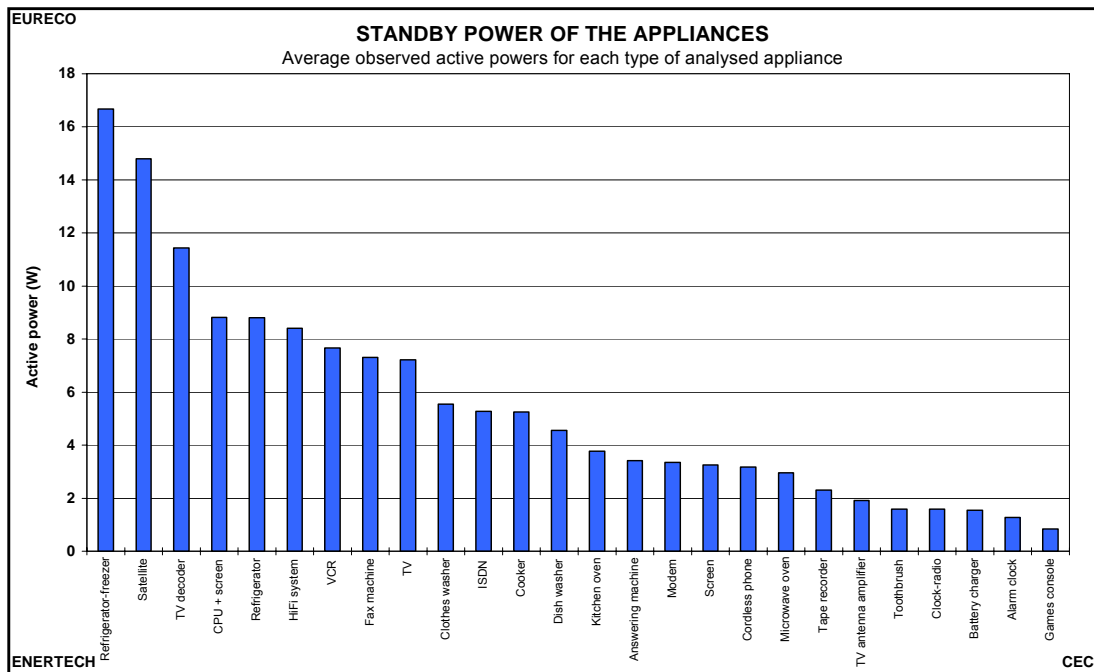


Figure 8: Distribution of the standby power of the main appliances [EURECO, 2002]

4.2 - Domestic computers and peripherals

A recent market survey carried out in Portugal found that 57 % of households had a personal or laptop computer in the home in the year 2005. In most European countries this value is predicted to be similar or even higher. The ownership of several computers and laptops is strongly related to the presence of young people in the homes.

Table 3: Power Consumption for each mode of operation of Domestic computers and peripherals

	On			Active Standby			Hibernate			Off Mode			External Power Supply only		
	min	Av.	max	min	Av.	max	min	Av.	max	min	Av.	max	min	Av.	max
CRT Monitors		73			15						2				
LCD Monitors	18,9	44,4	181,7	0,5	1,5	5,1				0,2	0,9	3,2			
Scanners		16,0	18,0		4,0	6,0					2,0	3,0			
Desktops	48,0	102,2	170,0	36,9	68,3	123,0	4,0	13,4	23,5	2,6	7,1	22,0			
Laptops	38,0	69,0	97,0	22,1	36,1	55,0	2,5	18,5	41,0	1,0	3,5	8,1	0,3	0,5	0,8
Printers (laser jet)	87,9	179,0	270,0	13,2	16,5	19,7				0,0	0,0	0,0			
Multi function printers															

¹ On mode: normal operation, the device is carrying out main function.

² Active Standby Mode: Energy consumption is reduced; the device is able to awake very quickly.

³ Hibernate/Sleep Mode: Deep sleep mode, the device is suspend to disk; Energy consumption greatly reduced.

⁴ Off-mode: Device is not carrying out any function, seems to be off but is consuming energy.

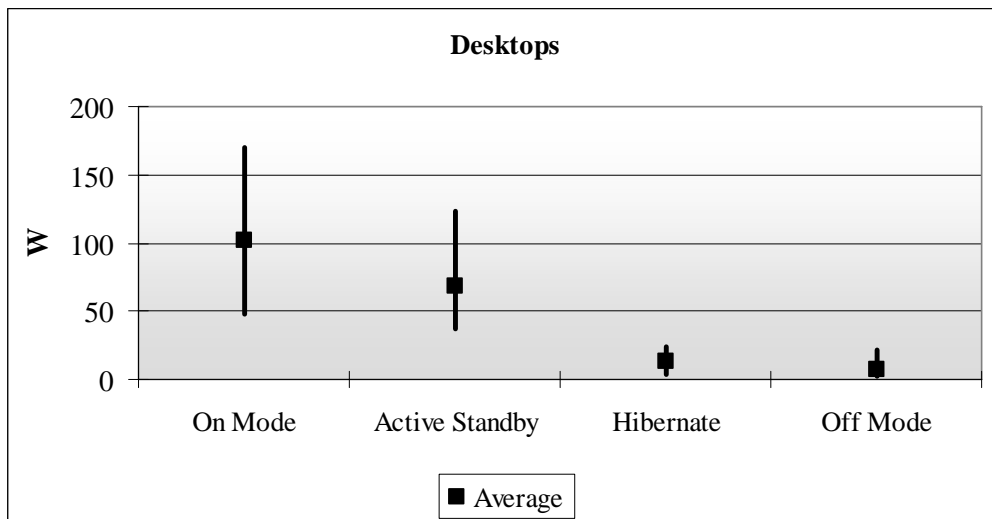


Figure 10: Power consumption of desktop PCs, for each operating mode

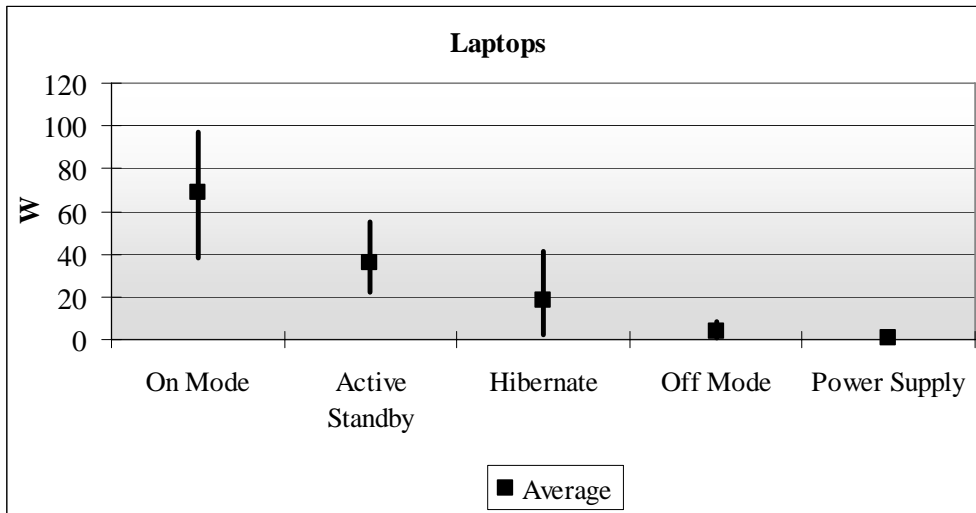


Figure 11: Power consumption of Laptops, for each operating mode, and for the power supply alone

Laptop average consumption is 69W in active mode. The average Standby power consumption is 36,1W, 18,5W and 3,5W in the Active Standby mode, Hibernate/sleep mode and off-mode, respectively. The power supply alone is responsible for 0,5W. The increasing number of personal computers and peripherals (e.g. printers, internet) in the homes will have implications in the residential electricity consumption, predominantly standby loads, because they are left on the standby mode during large periods of time.

One important reason for the increasing number of personal computers and laptops in households is the widespread use of Internet. Internet access is a major driver for the accelerating growth of number of computers in the homes as well as their increasing number of operating hours. More than 50% of the European households had Internet connection in 2005. This percentage will likely stabilize in the year 2006 according to the global purchase intentions projected. France, UK and Germany are responsible for 60% of the total office equipment European market. [Observador, 2006].

Market transformation strategies towards energy efficiency, namely the Energy Star labelling initiative, have been very effective with office equipment. Laptop sales will rise and operating power will fall for a given household. The laptop market, in which autonomy is a key advantage, has largely driven reduced energy consumption of computers. There is a clear market differentiation in models that offer longer battery life and as a result companies have invested heavily in demand side reduction methods that encompass all aspects of computer technology.

4.3 - New domestic entertainment

The penetration rate of conventional TVs is estimated to be 2 per house in 2005. LCDs TVs and Plasma TVs market is deploying as the prices have been decreasing significantly in the last few years. The electricity consumption of these appliances is related to the technology, the size of the screen and with the brightness.

Regarding the developments in the proliferation of home entertainment in the last year, a recent market survey shows that Plasma TVs, LCD TVs and home movie systems, are increasing their market share, especially because the price has been falling. The REMODECE study will analyse the role of new technology currently entering in the market place, in terms of impacts in the residential electricity consumption, but savings should be concentrated in the standby mode in which they spend a large percentage their operating time.

Sales of DVD Players and Recorders appliances in 2005 is estimated to be 22 Million units for the EU-25 countries. There was a significant reduction in sales of videos (VCRs) suggesting that this is a replacement market for the near future. Table 4 shows the power consumption for each mode of operation of new electronic loads.

Table 4: Power Consumption for each mode of operation of new electronic loads

	On			Active Standby *			Off Mode **		
	Min	Av	Max	Min	Av	Max	Min	Av	Max
TV - Conventional	32,2	83,9	185,0	0,5	3,5	12,0	0,0	1,5	6,6
Plasma TV	102,7	252,8	450,0	0,0	2,7	6,0	0,6	2,0	4,3
LCD TV	31,6	130,0	421,0	0,0	2,0	18,1	0,0	1,3	8,4
Setop box		17,0	20,0		8,0	9,0			
Audio Compact		16,6		0,2	2,9	13,3			
Audio HiFi	4,0	14,3	40,6	0,2	8,2	37,6	0,5	2,5	5,3
Home movie systems	8,9	28,4	150,5	0,0	3,6	12,6			
Game/playstation consoles		40,0						5,2	
DVD players and recorders	4,2	17,0	73,4	0,0	4,8	32,4	0,0	1,5	8,5

* When the LED is still on, i.e. it is possible to use the remote to switch on.

** Technological stand-by, when the device is totally switched off (i.e. the power button is off).

Figure 12 shows the average power of domestic entertainment loads in the distinct operating modes and Figure 13 shows in more detail the average standby consumption.

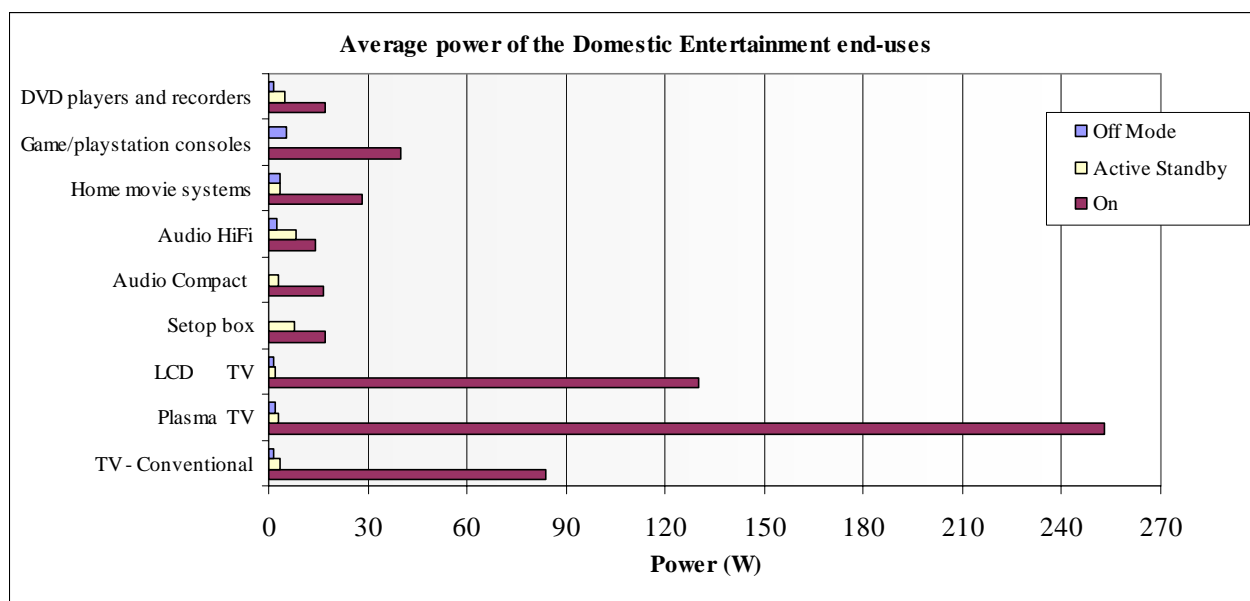


Figure 12: Average power of domestic entertainment loads in the distinct operating modes.

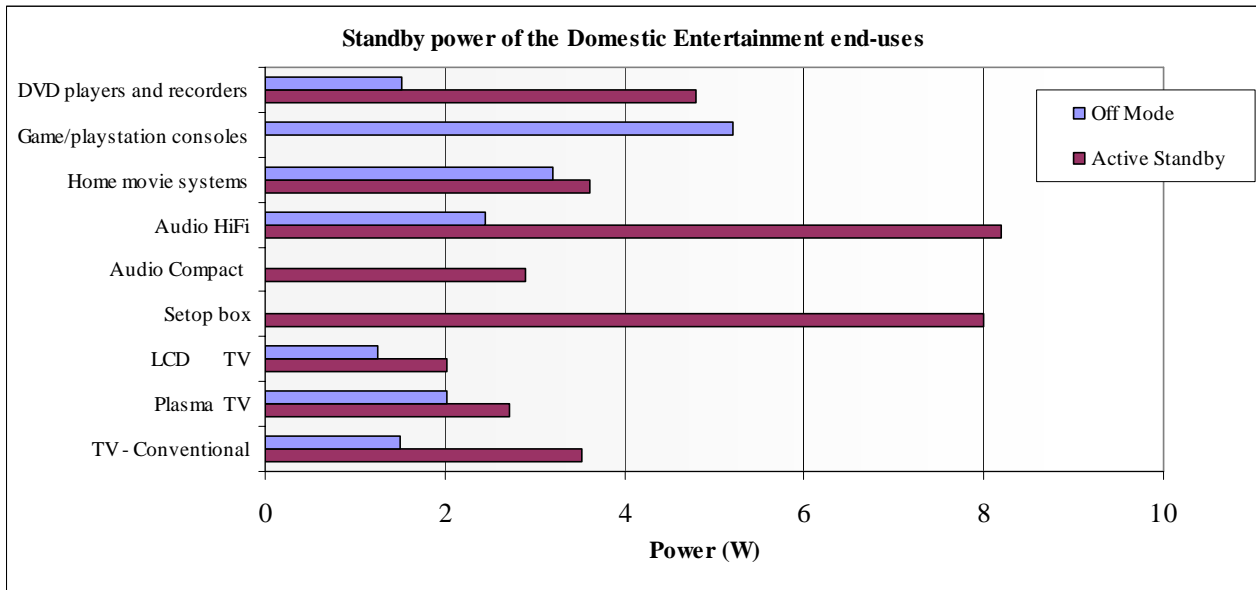


Figure 13: Average Stand by power of domestic entertainment loads.

The main conclusions that can be drawn from the aggregated data presented in the Figures 12 and 13, are:

- The on mode consumption of CRTs is on average 84 W. The database gave an average standby load of 3,5 W for CRT TVs (56 models monitored). The variation in standby power consumption of CRT TVs range between 0,5W and 12W. Plasma TVs seem to be particularly energy intensive in normal operation, the average on mode consumption being 253W. The variation of the normal operation consumption can range from 100W to 450W. The standby consumption in on average 2,6 W. LCDs have a power consumption in normal operation of about 130 W (about half of plasmas) and the standby consumption in on average 2 W
- The database gave an average standby load of 3,6W for home cinema systems with DVD players and recorder (57 models). The On consumption mode range from 9W to 150 W, depending on the brand and on the model. The Stand-by consumption mode can range from 0W to 24 W and the Off mode can range from 0W to 13 W.
- The stand by consumption of HiFi and systems and of Setop boxes is high (around 8W), being the highest values in the list of end-uses. This is particularly important in terms of final electricity use because these devices are in the standby mode most of the time. DVD players and recorders, particularly the ones with hardisk, also have high standby consumption and stay in the stand by mode many hours per day.
- Setop boxes are predicted to replace conventional forms of satellite receiver. Typically a Setop box consumes 20W in the on-mode and 9W on the Standby mode in which they spend 80% of the time.

4.4 - Other standby power

There is a large number of small electronic appliances in the home with external power supplies (mobile phones, laptops, cordless phones, etc), most of which are always left on the socket. It is estimated that these devices stay in the standby mode during 8600 hours. The average power input of these loads in the stand by mode can vary from 0,8W to 4,8W.

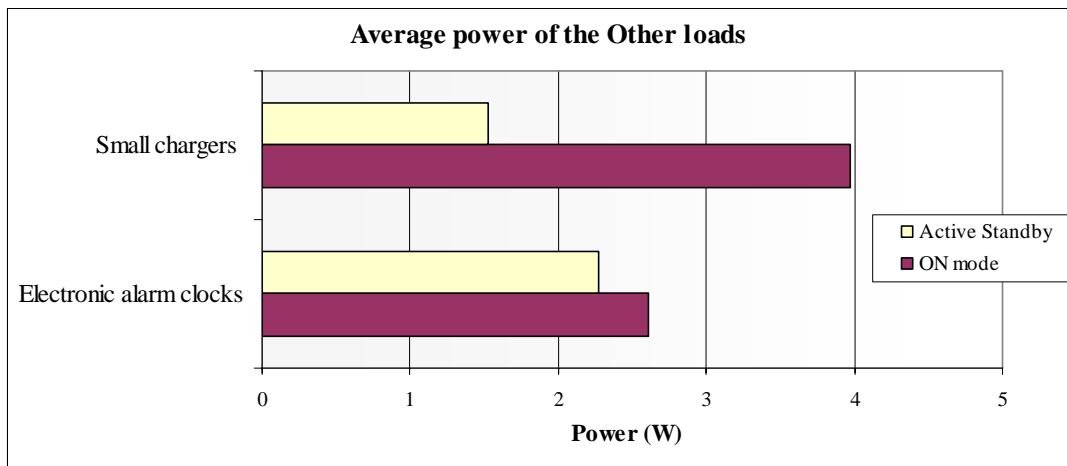


Figure 14: Average power on Normal operation mode (On Mode) and on the Active Standby mode, of chargers and electronic alarm clocks.

4.5 - Load Profiles

In the REMODECE project load profiles are also being investigated, in order to better understand the consumer behaviour. Figure 15 and 16 show the daily load curves for some of the electronic loads that we can find in a house, in a normal work day and in the weekend, respectively. It is particularly worrying the availability of appliances, such as the DVD Recorder/Hard disk which can have a very high consumption during all of the time.

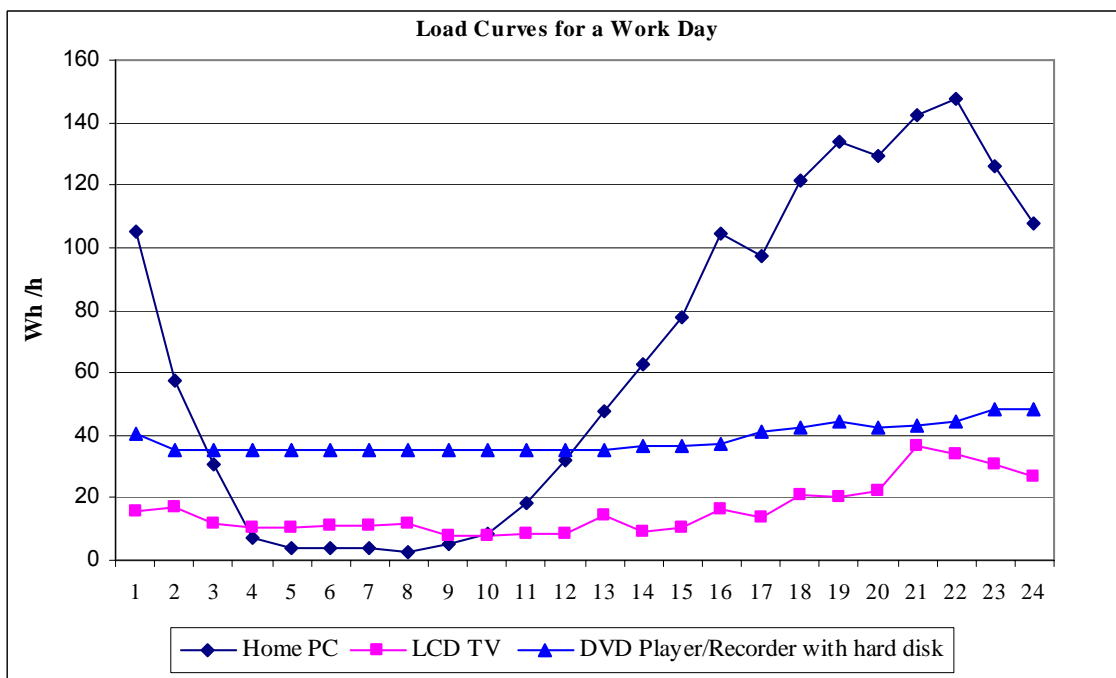


Figure 15: Daily Load profile of Desktops PCs, LCD TVs and DVD Recorder/Hard disk, in a normal working day (SINTEF, 2006)

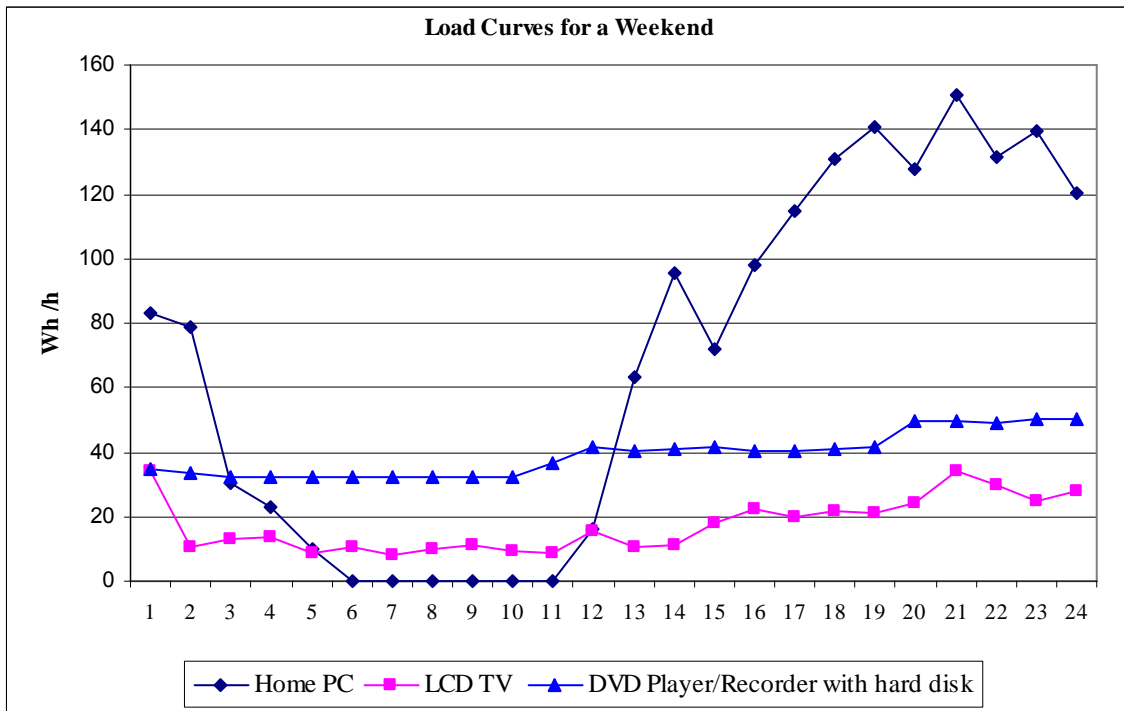


Figure 16: Daily Load profile of Desktops PCs, LCD TVs and DVD Recorder/Hard disk in a Weekend day (SINTEF, 2006)

5 - Conclusions and Future Work

The availability of high quality data is an essential condition for the definition of policy recommendations to influence through a combination of measures the energy efficiency of the equipment to be sold in the EU-25+2 in the next decade, as well as to influence the user behaviour in the selection and operation of that equipment. In the project a large monitoring campaign will be carried in 12 countries, accompanied by a consumer survey. So far the measurements carried out have been concentrated in electronic loads, whose diversity and relevance is increasing fast. From the measurements carried out it can be concluded that electronic loads are a key contributor to the power demand and that there is wide range of performance levels in the models available in the market. Available technology, associated with responsible consumer behaviour, can dramatically reduce wasteful consumption of electronic loads.

It is expected that based on the project results, to be conclude in June 2008, a better understanding of the residential electricity consumption will be achieved and strategies to achieve a desirable market transformations will be identified.

6 - References and Bibliography

- [1] [IEC 62301]; “Household electrical appliances - Measurement of standby power”, published in June 2005, Ed.1.
- [2] [Bertoldi]; “The Kyoto Protocol: the role and potential of End-use energy and the recommended actions”, Bertoldi P., European Commission, Directorate General JRC, Implementation of the Kyoto Protocol, Energy Efficiency and Climate Change Mitigation, Geneva, 29 June 2005.
- [3] [DGGE, IP-3E]; “Eficiência energética em equipamentos e sistemas eléctricos no sector residencial”, DGGE, 972-8268-35-1, Lisboa, Janeiro 2005.
- [4] [IEA, 2003]; “Cool Appliances, Policy strategies for Energy Efficient Homes”, OECD/IEA 2003.
- [5] [Schlomann, 05]; “Technical and legal application possibilities of the compulsory labelling of the standby consumption of electrical household and office appliances”, Report N°53/03, Schlomann B., et all, Fraunhofer ISI, June 2005.
- [6] [Observador]; “O Observador - Grandes Mercados”, CETELEM, 2006.
- [7] [Observador2]; “A relação dos Portugueses com as novas tecnologias”, CETELEM, 2006.
- [8] [EURECO]; “End-use metering campaign in 400 Households of the European Community”, Project EURECO, European Commission, January 2002.
- [9] [40% house Project]; “The 40% House Project – Task two: Technical potential”, Peacock A. and Newborough M., HWU, Edinburgh, December 2004.
- [10] [EDP Survey], 1997.
- [11] <http://energyefficiency.jrc.cec.eu.int/>
- [12] IEA Energy Statistics, 2003.
- [13] http://energyefficiency.jrc.cec.eu.int/html/standby_initiative.htm.