EURECO Project

1 - The partners

The ***Euréco*** project was financed by the Save program of the **Commission of the European Communities** (N° 4.1031/Z/98-267), as well as the French Agency of Environment and Demand Side Management (**ADEME**), and by the **Greek ministry of Development**, by the **Ministry dell'Ambiente** and the **Comitato Nazionale per le Celebrazioni Voltiane** in Italy, by Electricity of Portugal (**EDP**) and by **ERSE** (Entitade Reguladora do Sector Electrico) in Portugal, and by the Danish society **Odensee Elforsyning Net A/S**.

Five countries were involved in this project: Denmark, Greece, Italy Portugal, and France. The measurement campaigns took place in the first 4 countries. Because of its experience in this field, France was in charge of the data analysis. The main proposer was **ENERTECH** society (France).

2 - Objectives of the project, methods and means

The main objective of the ***Euréco*** project, was to 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 class A appliances or the elimination of standby powers.

This project follows on from the ***Ecodrôme*** campaign (Save n° 1031/S/94-093) that took place in France between 1995 and 1997, which showed by a life-sized experiment that it was possible to save about 40% of specific electricity consumption, that is 1.200 kWh/year per household.

The ***Ecodrôme*** project, firstly consisted in a one-year-monitoring campaign of the appliances in place in 20 households. Then, these appliances were replaced by efficient ones, and the households were monitored for one additional year. This procedure was heavy and too expensive for the ***Euréco*** project.

The adopted method for the chosen 400 European households (evenly shared out in Denmark, Greece, Italy and Portugal) consisted in the monitoring of the house utility meter, of the kitchen temperature, and of most of the domestic appliances of these households. The measurement campaigns lasted for one month in every household. A detailed questionnaire was also used to survey the participants.

The measurement system used is known as DIACE. It is an original system that uses power line carrier technology, that does not need any wire link. Measured data is transmitted via the power line every ten minutes to a collector.

One of the special feature of ***Euréco*** is that every single source of light in the households were also individually monitored using another device called "Lamp-Meter" developed by Enertech society. The data collected by the Lamp-Meters are fully compatible with the one gathered with DIACE system.

The measurement campaigns took place between January 2000 and July 2001. About 50 millions of measures were collected, inserted into databases, and analysed.

3 – Main lessons about the existing appliances use

For each type of appliance, we determined the average yearly electricity consumption, as well as the average hourly specific load curve, the distribution of the observed consumptions, the levels of installed power, etc.

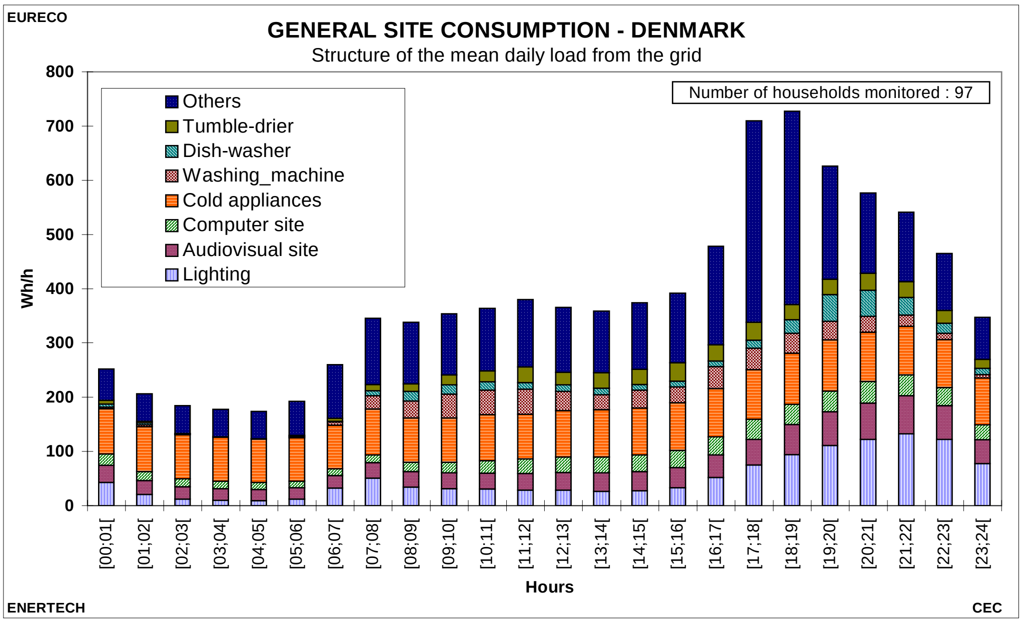

Figure 1 : structure of the hourly load curve in Denmark

The annualized consumptions of different appliance types and of the lighting equipment, were determined for the four countries, and compared with the results of the ***Ecodrôme*** project (see figure 2).

Uses	**Denmark**	**Greece**	**Italy**	**Portugal**	***Ecodrôme France (1995)***
Refrigerator	288	687	354	228	362
Fridge-freezer	589	844	629	563	721
Freezer	409	636	517	598	619
Clothes-washer	243	163	211	154	262
Dishwasher	289	157	369	256	290
Clothes-dryer	368	-	-	546	379
Lighting	426	381	375	179 (?)	465
Audiovisual	330	258	355	306	201 (TV alone)
Computer	226	110	132	219	0
Standby power	482	424	472	377	180-200 ?

in kWh/year

Figure 2 : annualized consumptions of monitored uses in Euréco and Ecodrôme

The special characteristics revealed for each type of use are:

■ **Cold appliances**

- on average, the inside temperature of the refrigerator compartment was 5,6°C in Denmark and 7,9°C in Italy, what is more than the advised values (5°C). On the other hand, the average temperature inside freezers was –20,8°C in Denmark and -20,2°C in Italy, what is always below the advised values.

- the electricity consumption of cold appliances increases with age (see figure 3)

- the apparition of the energy label first, and the recent regulation for the appliance consumptions, are very appreciable. As an example, figure 4 shows the refrigerator consumptions measured during some campaigns that took place between 1995 and 2000 in France, Portugal, and Sweden/Denmark. The regular fall of the consumptions is very sharp for refrigerators or freezers, but less marked for fridge-freezers. It explains why the consumption measured in the Ecodrôme project in 1995 is by far higher than the one noticed in the Euréco project in 2000.

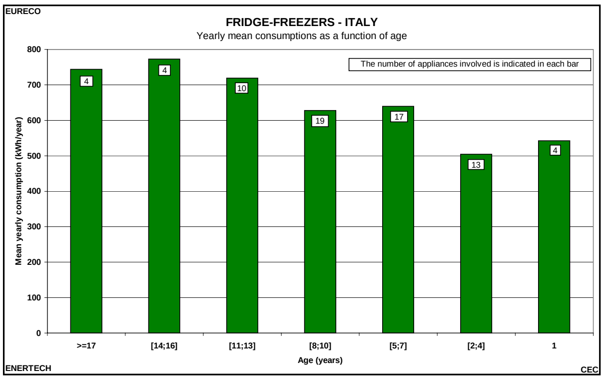

Figure 3 : consumptions of the fridge-freezers in Italy as a function of age

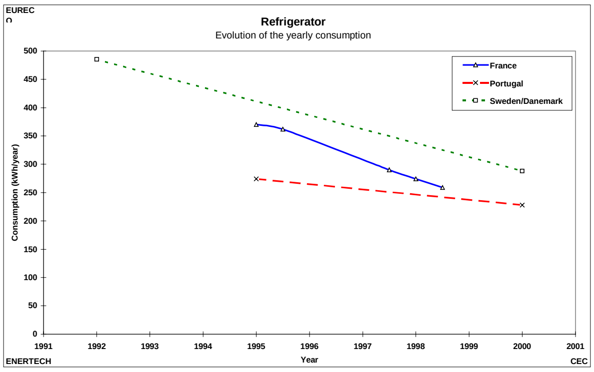

Figure 4 : consumptions of the refrigerators according to measurement campaigns, between 1995 and 2000

■ Clothes-washers

- no reduction of the consumption of the 60°C wash cycles can be observed for recent appliances, proof that the stock of clothes-washers has made no appreciable improvement during the last ten years and more (figure 5).

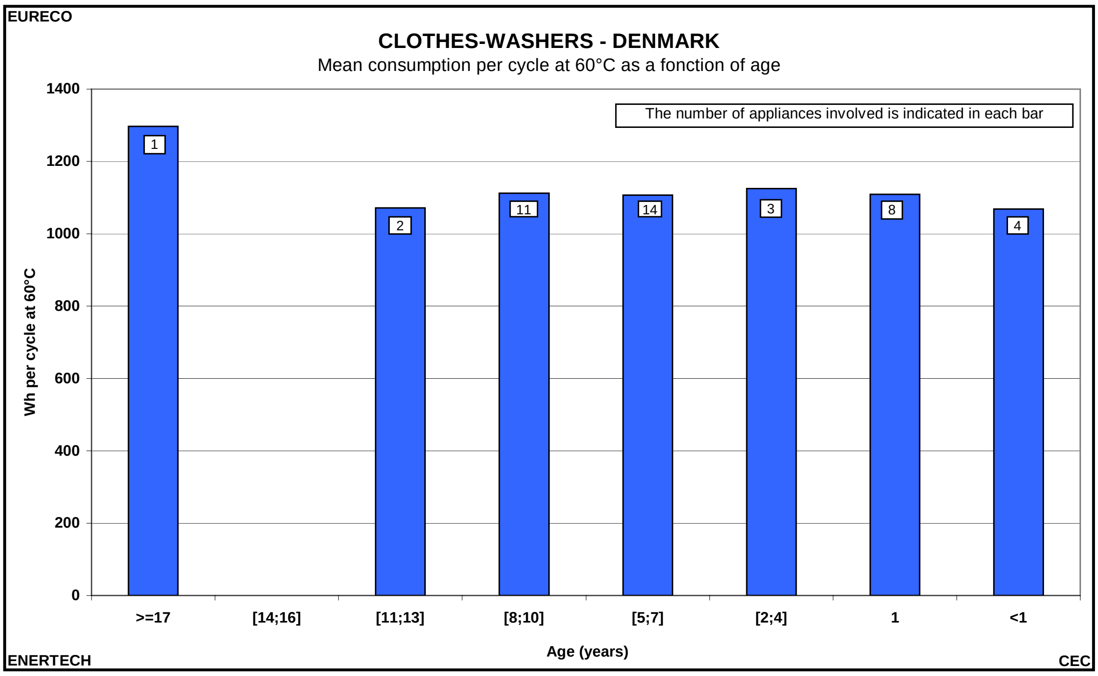

Figure 5 : evolution of 60°C wash cycle energy consumption in Denmark as a function of appliance age

- the analysis of the wash cycles allowed us to determine their main characteristics per country. Table of figure 6 shows the mean values for the four countries of the ***Euréco*** project and for France.

	Cold	30/40°C	60°C	90°C
Average consumption/cycle (Wh/cycle)	147	548	1149	1861
Average duration/cycle (minutes/cycle)	45,0	71,2	95,2	115,7
Distribution of hot cycles		66,5 %	25,0 %	8,5 %
Average number of hot cycles per week		4,6		
Average consumption of a hot cycle (kWh)		0,816		

Figure 6 : average characteristics of the clothes-washers cycles for 5 countries of the European community

■ Lighting

- there is on average 23.7 sources of light per household in Denmark, 10.4 in Greece, 14.0 in Italy and 6.9 in Portugal. Among these sources, the number of compact fluorescent lights (CFL) is 3.5 (DK), 0.6 (GR), 1.8 (IT) and 1.3 (PT). The total installed power, including all the different kinds of lights, is 740 W (DK), 675 W (GR), 883 W (IT) and 274 W (PT). This power was equal to 1308 W in the ***Ecodrôme*** project
- we also studied the nature of the lamps, the installed power per type of room, as well as the distribution of the unit power of the bulbs per type of source (see figure 7)
- the dining/living room is the room where the lighting consumption is the highest one (160 kWh/year except for Portugal: 60 kWh/year), before the kitchen (between 40 and 100 kWh/year depending on the country) or the bedrooms in some countries. Lighting in bathrooms consumes more electricity than all the household bedrooms in Denmark and Portugal.

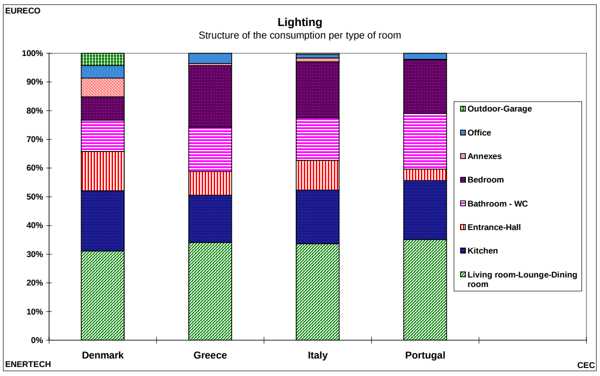

Figure 7 : structure of the lighting consumption per type of room

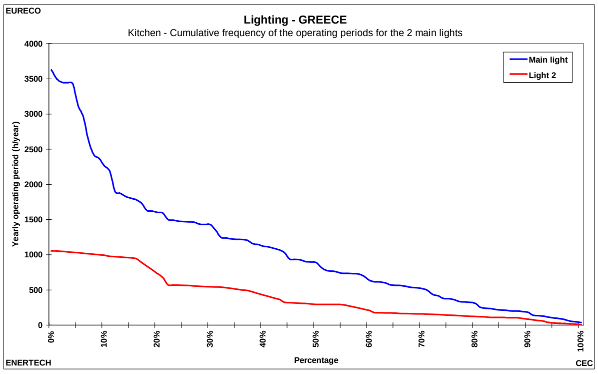

Figure 8 cumulative frequencies of the kitchen lamps operating periods in Greece

- The operating period of all the sources of light were measured per type of room and per type of light. For instance, figure 8 shows that in Greece, 20% of the main lights are switched on more than 1.700 hours/year, and 30% of the secondary lights work more than 600 hours/year. But we also found out that, on average, the main kitchen light works for 1.044 hours a year in Greece, 1.144 hours in Denmark, 1.150 hours in Italy, and 1.022 hours in Portugal. This information is available per type of room and per country.

- We also determined that, on average for the 400 households, only 25% of the lighting consumption happened during the daylight hours (corresponding to a consumption of 42 to 120 kWh/year depending on the country). This reduces the interest in natural lighting, knowing that a glass surface leads to more thermal losses during winter.

■ Audiovisual

Above all, the analysis of audiovisual consumptions revealed the role of standby powers : their consumptions represent 42% of the total site consumptions in Denmark, 35% in Greece, 40% in Italy and 37% in Portugal. On average for the 4 countries, this ratio is equal to 38,5%. The generalised standby power use (especially with televisions), sometimes leads to situations in which standby power consumption represents 99.4% of the total consumption of the audiovisual site in Denmark, 93.6 % (Italy), 92.0 % (Greece) or 88.4% (Portugal), without any service to be rendered.

■ Computer

Standby power for computer site is fast growing. If we consider all the computer sites (with or without standby power), the average standby power consumption is 73 kWh/year in Denmark, 25 kWh/year in Greece (non significant sample), 38 kWh/year in Italy, and 63 kWh/year in Portugal. Taking into account all the countries but Greece, the average standby power consumption is 58 kWh/year, that is 30% of the total consumption of the computer sites.

■ Standby power consumption

The methodology used in ***Euréco*** in order to determine the total level of standby power, is new and original : it consisted in a direct analysis of the household utility meter measurement, while taking into account the powers drew by the other monitored appliances. By means of analysis algorithm, we were able to calculate precisely the total standby power. Then, the induced standby power consumption was accurately estimated thanks to the monitoring of the two main electricity consumers in standby mode: the computer and audiovisual sites.

On average, the total standby power is 60W in Denmark, 50 W in Greece, 57 W in Italy and 46 watts in Portugal. The maximum observed standby powers are 286 W in Denmark, 216 W in Greece, 152 W in Italy and 141 W in Portugal.

The yearly average standby power consumptions are **482 kWh/year in Denmark, 424 kWh/year in Greece, 472 kWh/year in Italy, and 377 kWh/year in Portugal,** that is to say a mean of 439 kWh/year. This represents 14.2% of the specific electricity consumption of the monitored households. The maximum reached values are 1800 kWh/year in Denmark, 1.900 kWh/year in Greece and 1200 kWh/year in Italy and Portugal. Standby power consumption could not correlate with any particular indicator.

At the same time as this global study, the standby power of 1080 appliances and some power factors were measured with wattmeters, in order to build a first draft of a European database. Figure 9 represents the standby power consumptions of the most important domestic appliances. Set top boxes and computers are among the appliances with the highest standby powers.

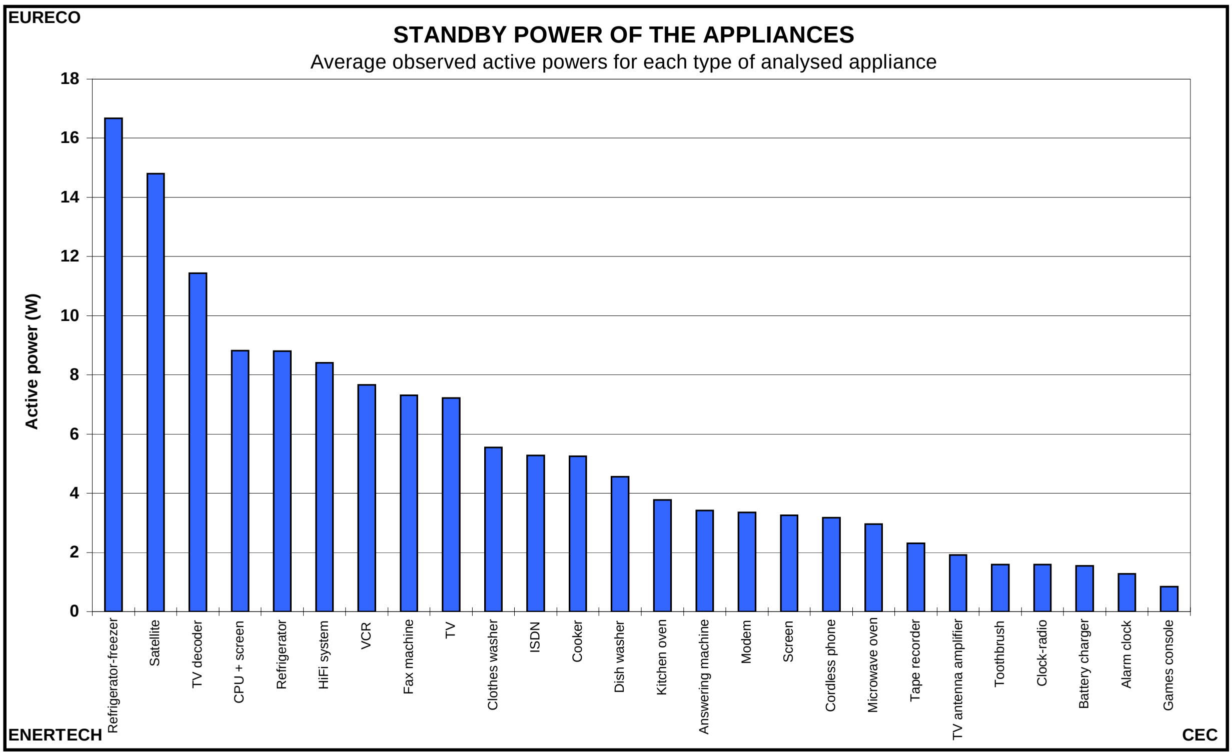

Figure 9 : distribution of the standby powers of the main appliances

Figure 10 shows the power factors of the most common appliances used in standby mode. These power factors are very low.

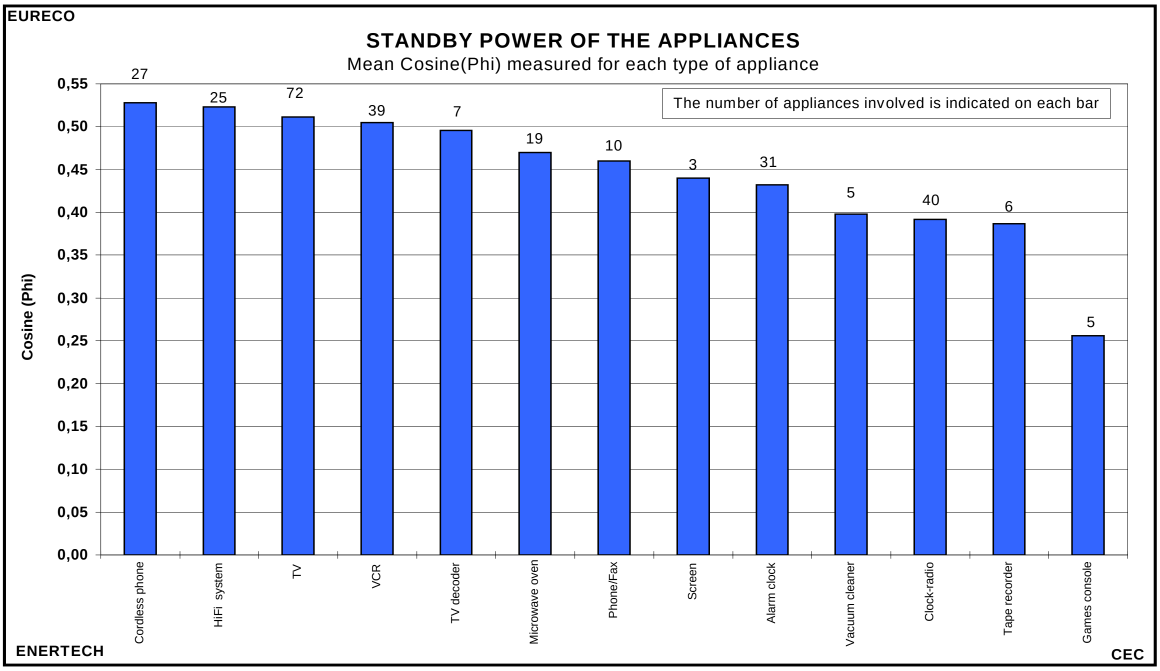

Figure 10 : average power factor for 13 types of appliance in standby mode

4 - Assessment of the potential energy savings per country

Savings were calculated from the measured operating conditions. Results are therefore reliable. We assumed that the following modifications could be done on the original equipment:

- replacement of all the cold appliances by class A appliances (energy label)
- substitution of all the incandescent and halogen lights for compact fluorescent lights (CFL)
- removal of all the standby powers that can be eliminated by simple means,
- substitution of the existing clothes-washers for class A appliances, or for appliances kept supplied with hot water (cold wash cycles only).

The potential saving was determined for each country, from the present operating conditions of the appliances. The yearly saving varies between 1.000 and 1.200 kWh/year and represents about 35% to 40% of the specific electric consumption, depending on the country.

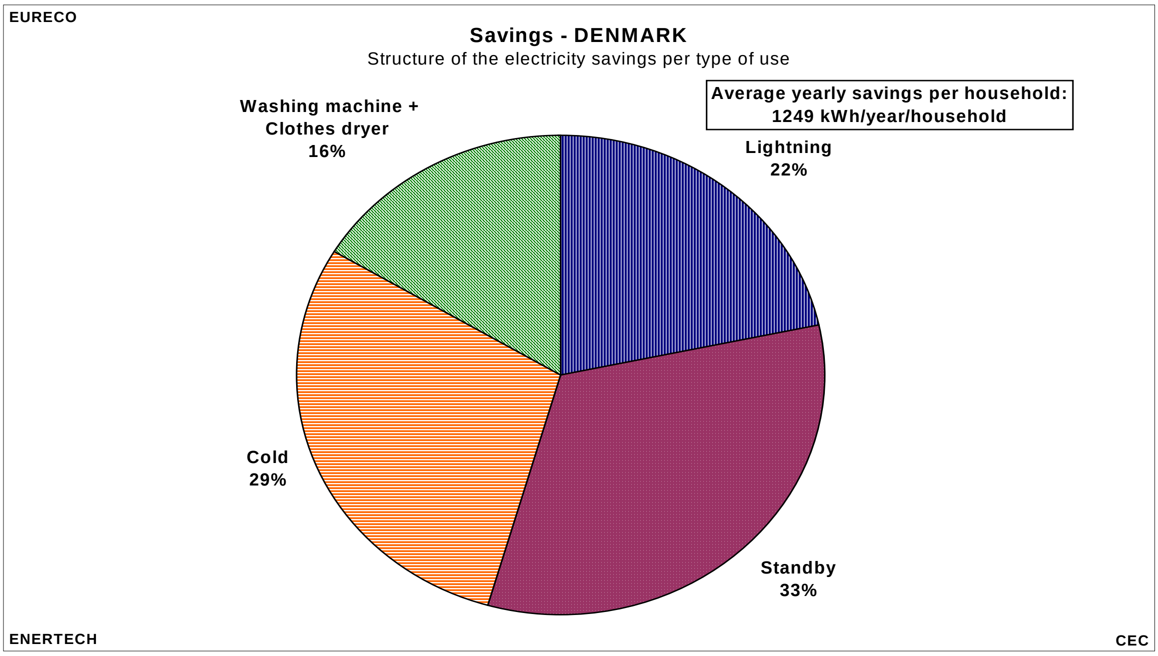

Figure 11 : structure of the potential saving in Denmark

One of the main surprise of this campaign is the influence of standby power, which from now on is the first source of saving, neck to neck with cold appliances. The weight of standby power has not been taken into account at its right level in Europe, whereas this sector is in rapid growth. On the other hand, the cold appliances part has decreased regularly because of the energy label use, and of the recent regulation on appliance consumptions.

Concerning the cold appliance group, its seems that these appliances as a whole, have changed since the ***Ecodrôme*** project in 1995. There are in ***Euréco*** many cold appliances with an average quality, and much less appliances with a very "poor" quality, than in 1995. Figure 12 shows for instance that **in Denmark, the replacement of the 7% worst freezers would allow to save 30% of the potential energy savings of this field.** This transformation of the group of cold appliances leads to a paradoxical situation, for which it is not worth changing a more and more important part of these appliances, but where it would be highly pertinent to find a method to detect the worst appliances and to replace them first and foremost (this replacement could even become compulsory).

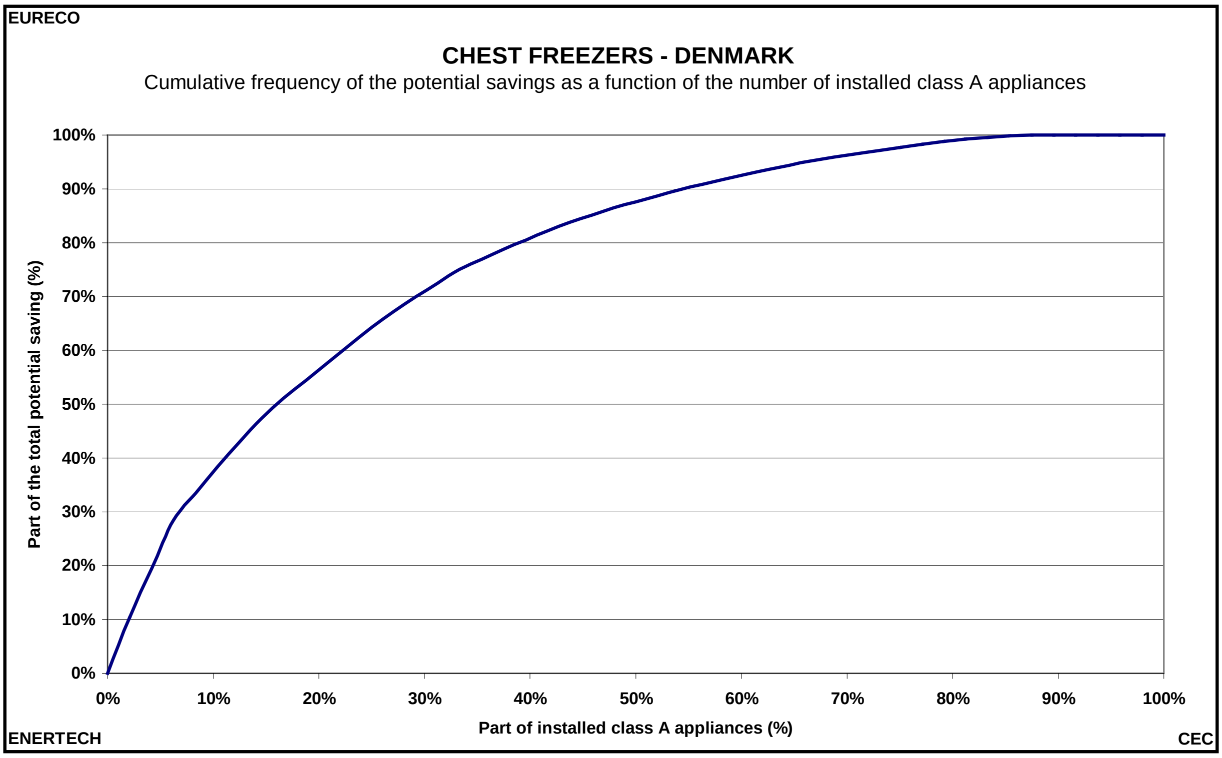

Figure 12 : cumulative frequency of the savings as a function of the number of freezers replaced in Denmark (worst freezers are replaced first)

Observations concerning lighting are very interesting as well. The measurements allowed us to answer to several questions such as "what fraction of the maximum potential saving can we access for a country, if we change the only light bulbs for which the payback time would not exceed a given value (for a given price of the CFL bulbs and of the electricity kWh)?

Figure 13 shows the answer to this question for Italy.

We can notice that for a CFL bulb that is worth 6 Euros (inclusive of tax) and with a maximum payback time of 2 years, we can reach a saving of 190 kWh/year/household, that is 72% of the total potential saving for lighting. But this method does not tell which light should be changed. It only puts forward the hypothesis that the most profitable lights are changed first and foremost.

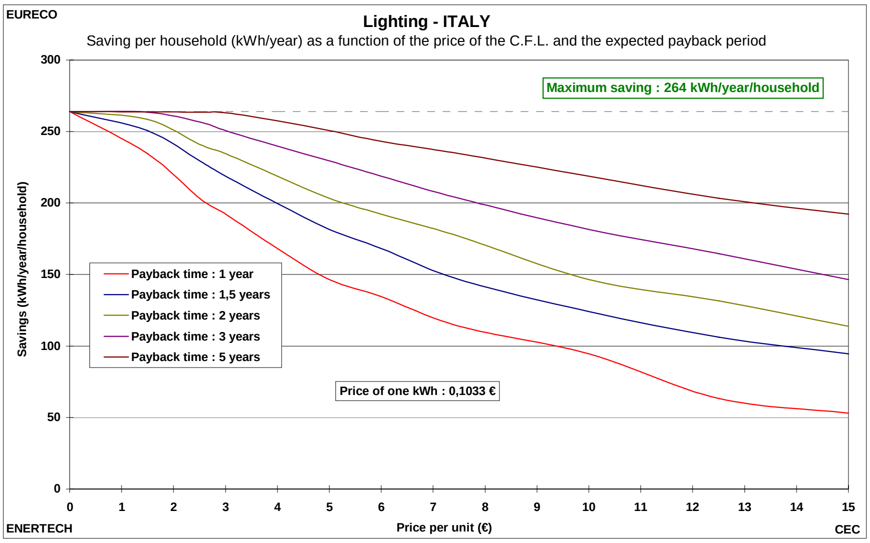

Figure 13 : Italy – Energy saving per household as a function of the price per unit of the CFL bulb, and of the expected payback time

Another approach consists in replacing the same number of bulbs in every households. This method is obviously less profitable than the former one, but it is more simple. Measurements also allowed to quantify this approach. Figure 14 shows, still for Italy, that the replacement of one light (the most energy consuming), allows us to get 33% of the total potential energy savings, and that the global payback time of this operation is 1,1 years if the price of the CFL bulb is 10 Euros inclusive of tax.

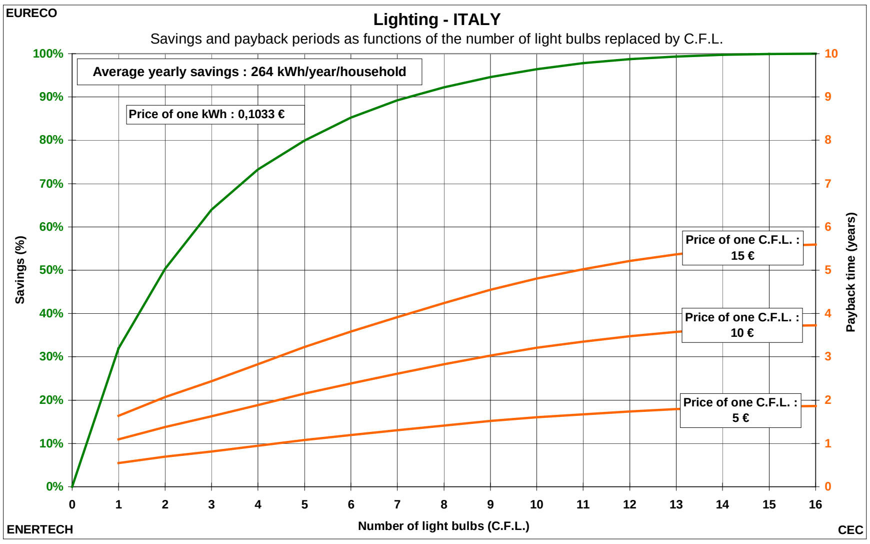

Figure 14 : Italy – Cumulative frequency of the savings, and payback time as functions of the number of CFL bulbs placed in the households

The following table recapitulate the **total** saving per household and per country with 2 different hypothesis concerning the modifications of the clothes-washers.

Country	**Denmark**	**Greece**	**Italy**	**Portugal**	***Ecodrôme.***
TOTAL SAVINGS (kWh/year) **% of the consumption saved** ***(with class A clothes-washers)***	1131 (33,7 %)	1001 (21,5 %) (2)	1163 (36,8 %)	636 (19,5 %) (2)	1192 (38,2 %)
TOTAL SAVINGS (kWh/year) **% of the consumption saved** ***(hot water supply CW)***	1249 (37,2 %)	1074 (23,1 %) (2)	1257 (39,8 %)	676 (20,7 %) (2)	-

Figure 15a : total savings with class A clothes-washers or with clothes-washers kept supplied with hot water

The following table shows the breakdown of the total saving, considering the second hypothesis (clothes-washers kept supplied with hot water).

Country	Denmark	Greece	Italy	Portugal	*Ecodrôme.*
COLD Mean Saving (kWh and %) Fraction of the total saving (%)	385 (-53%) (29%)	483 (-59%) (40%)	431 (-55%) (32%)	261 (-46%) (33%)	723 (-68%) (61%)
LIGHTING Mean Saving (kWh and %) Fraction of the total saving (%)	265 (-62%) (22%)	250 (-68%) (21%)	264 (-70%) (23%)	99 (-55%) (12%)	340 (-73%) (23%)
STANDBY POWERS Mean Saving (kWh and %) Fraction of the total saving (%)	425 (-88%) (33%)	341 (-80%) (27%)	402 (-85%) (33%)	325 (-86%) (42%)	-
CLOTHES-WASHERS Mean Saving (kWh and %) Fraction of the total saving (%)	200 (-74%) (16,0%)	128 (-79%) (12%)	151 (-72%) (12%)	88 (-57%) (13%)	69 (-28%) (6%)(1)
BOILERS Control of the circulation pumps of individual boilers	0	0	0	0	227(-72%) (9%)

*N.B. : for **Ecodrôme** the values are not calculated ones, but were measured for one year*
*(1) : in **Ecodrôme** we only used class A clothes-washers, but no clothes-washers with hot water supply*
(2) : in this country, there are many non-specific electricity appliances (like water-heater, heating)

Figure 15b : breakdown of the total savings considering clothes-washers washing with cold water only

The reduction of the power demand, from the grid point of view, was also estimated thanks to these measurements. For instance in Denmark, the reduction ration varies between 0.43 between 4 and 5 A.M., and 0.77 at the peak hour in the evening. DSM appears like an important factor for the reduction of the peaks.

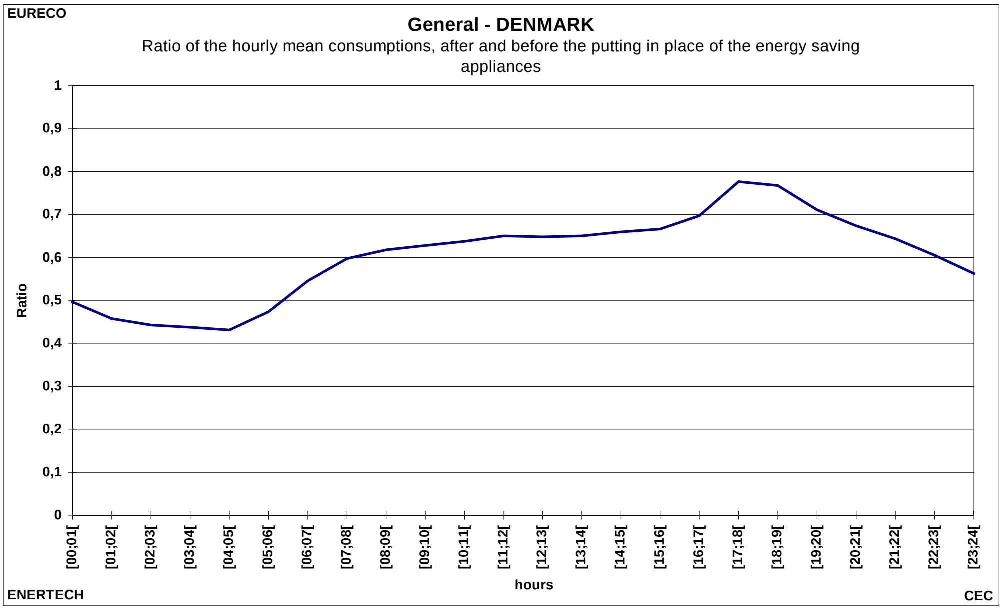

Figure 16 : ratio of the hourly consumptions after and before the putting in place of the electricity savings

CONCLUSION

Euréco confirms the main conclusion of the ***Ecodrôme*** project : **we can really save 1.000 to 1.200 kWh/year/household on the specific electricity uses in the biggest European countries, by means of simple and existing arrangements and measures (change of the appliances,etc.).** But the structure of the potential saving has changed much during the last 5 years, because of the changes in the stocks of appliances, notably the cold ones (important reduction of the installed appliance consumptions) and the audiovisual appliances (because of their increasing number and their very high standby power consumptions), and finally because of the recent penetration of computers (with high standby power consumption as well).

On a European scale and for 150 millions of households, we estimated that 150 to 180 TWh/year could be saved, that means about the electricity consumption of the whole Spain.

But this project also allowed the bringing out of the priority actions:

- First, to fight against standby powers that has become the main field of energy saving, neck to neck with cold production. Their very rapid growths and their weights, suppose to put very quickly in place, a regulation that bans the sale of appliances with standby power above 1 watt, or even 0.5 watts. Reliable power management systems should also become compulsory for computers (Energy Star or other). Also, private individuals should be encouraged to remove the existing standby powers (particularly on the audiovisual site) by means of ordinary switches or standby power managers,

- The second priority action concerns cold appliances. The Commission should intensify and accelerate the fixation of stricter consumption norms, and class A appliances should in a very short term become the standard. That would be profitable for all the actors (industrials and users). But the present problem with the existing appliances, is to detect the most energy consuming ones, in order to remove them first and foremost. A very simple mean of detecting these appliances needs to be invented. We should also keep in mind that, in Denmark for instance, the substitution of 7% (the most energy consuming) of the freezers for class A appliances, would induce 30% of the potential energy saving for this field.

- The third priority action in the short-term would be to place and use 5 compact fluorescent light bulbs in every household of the European Community. We would therefore reach 78% of the total saving for lighting. This measure is simple and the global payback time is 2 years on average.

Euréco project showed that in general, the specific electricity consumption in the European Community could be, without any technical difficulty, reduced to 2.000 kWh/year for an household with 4 persons. We did not envisage further saving in this study. But this would obviously require an increasing use of innovative technologies (which payback times will be longer and longer as the consumption will be reduced), and also probably a reflection on the level of needs. Are these needs really extendable ad infinitum? Do they correspond to a higher satisfaction level, or only to a change of habits and markets?

The Earth is not limited to the western World. If we do not watch out, the pressure of our way of life on the environment and on the planetary resources, could lead us to wars for energy or natural resources. These wars already exist, but they would be more frequent and more violent. Anticipation might be the admitting of being on the wrong track, and the decision to come back to a more balanced and stable position.