REMODECE

Work Package 2

REVIEW OF ALL EXISTING EUROPEAN MONITORING CAMPAIGNS IN HOUSEHOLDS

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1 Introduction

The overall objective of the REMODECE project is to 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, 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 first task of the project (WP2) consists in gathering all the data from previous European monitoring campaigns on home appliances. These data will then be stored in a database which will be accessible free of charge from the website of the REMODECE project. The data collected during the project will also be included in this database.

Detailed end-use metering campaigns help to improve knowledge of the various different areas of electricity use, and to provide more accurate data for forecasting with predictive models. For the time being the utilities, appliance industry, energy agencies and public authorities continue to use estimates of uncertain origins.

Measurement campaigns are interesting for different reasons :

1. It allows to know and to understand. Particularly, it gives the consumption level of each type of appliance, their exact power demand, the appliances that are the highest priority for efficiency measures, the mode of utilisation, etc. From this knowledge, some clear and well-founded strategies for action will be planned.
2. It is of interest to the electricity producers and distributors, who will finally be able to use precise figures, to forecast demand-load curves. Furthermore, it allows to evaluate all Demand Side Management (DSM) strategies with precision, what will allow more rigorous planning of the generating capacity and of the power transmission and distribution systems (especially in rural districts).
3. It is valuable for the appliance industry that has already partly expressed its interest. Industry wishes to know how the appliances function *in situ*, as well as their consumption levels, their frequency of use, the cycles that are used most often, their ages and whether consumptions depend on these ages, if the possible dysfunctions depend on the way appliances are used… This information is necessary not only for the existing appliance stock, but also for new high-performance appliances, for which industry needs even more information. The future industry strategies depend on this information.
4. It is also valuable for public authorities that try to change the residential sector for the community interest. Monitoring campaigns will allow them to assess the stakes, to establish priorities and to define strategies. These strategies may be multi-faceted and could include the provision of public information as well as limits on maximum permissible appliance energy consumption levels. Similar regulations already exist in numerous sectors of industrial activity.

5. It is of interest to organisations concerned with forecasting future energy consumption levels. The value of these scenarios is strongly dependent on the quality of the primary information they use.
6. It is of interest to standardization organisations: this information can help defining standard test and experimental conditions, so that the consumption measured under the norm procedure could better reflects the value measured in reality.
7. Finally, it is the basis for the information about energy consumptions that should be given to users. As was previously mentioned, it is necessary for users to understand how they consume electricity. Equally, it will aid the conduct of awareness campaigns that will foster the development of an 'energy culture' among the public. Yet provision of this information, even if its delivery is not a simple matter, remains an essential step because the success of DSM. programmes depends on the management of individual consumption.

This report makes the inventory of all the monitoring campaigns that have been conducted so far in European households.

2 The CIEL CAMPAIGN

DATE 1995-1996

NUMBER OF HOUSEHOLDS INVOLVED 114

SUBJECT All domestic appliances, except lighting and cooking

DURATION OF THE CAMPAIGN 1 month per household

MEASUREMENT SYSTEM DIACE (Landys&Gyr)

TIME STEP 10 minutes

SUPPORTED BY European Commission, EDF, ADEME

MAIN RESULTS

The CIEL campaign is one of the first European attempts to systematically examine electricity consumption by the existing domestic appliance stock. It took place in a fairly typical region of France and covered a mixture of rural and urban households. This mixture has ensured that the lifestyle and habits of the sample were reasonably representative of France in general.

The detailed and painstaking study of each appliance type has helped to understand:

· their mode of use (see figure 2.1)
· the importance of standbys
· the performance of different technologies and the significance of user behaviour with respect to the technology.

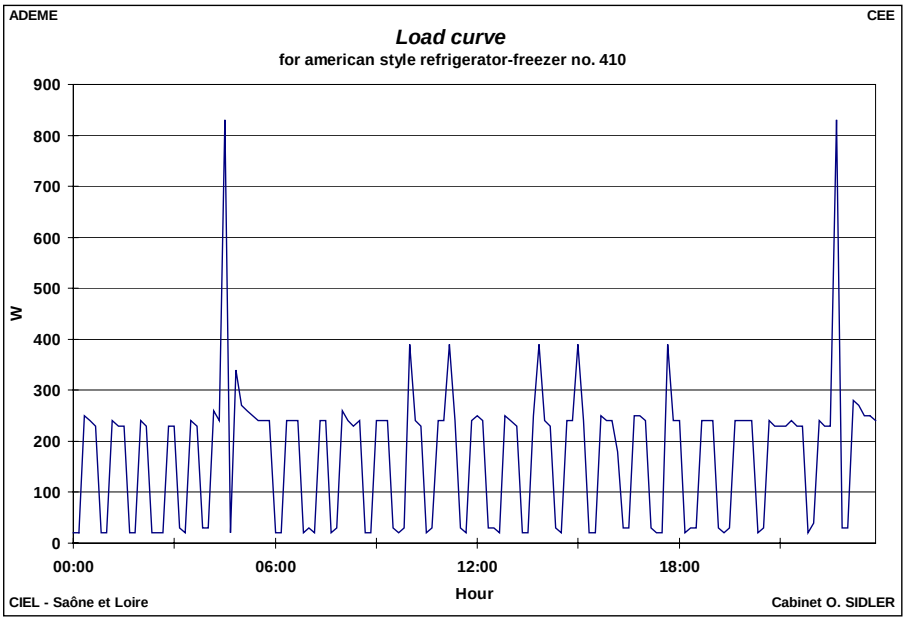

Figure 2.1 : Example of load curve from the ECUEL project

Appliance	Stand-by power (W)	Daily time spent in stand-by mode (h)	Annual consumption (kWh/year)
TV	8-13	18	53-86
VCR	5-19	23	42-160
Antenna amplifier	1-2	18	7-14
Decoder	10-14	22	80-112
Satellite dish electronic control	14-15	18	92-98
HiFi	0-21	23	0-184
		Total	**274-654**

Figure 2.2 : Evaluation of stand-by consumptions

Above all it has enabled a hierarchy of priorities to be established. One of the most important goals of the CIEL campaign was to establish the actual and relative energy consumption of each end use. This is manifest in having:

· established that cold appliances are far and away the major source of electricity-specific domestic energy consumption
· explained why in general clothes-washers do not consume as much as was hitherto thought
· shown that boilers and mechanical ventilation systems can consume a lot more energy than a dishwasher or clothes-washer.

The CIEL campaign has helped to establish the real order of importance of appliance electricity consumption and hence has helped to establish the order of priority for future energy-saving measures. Secondarily, the CIEL campaign, through the analysis of operative cycles, for example, has allowed an understanding of how people's habits have evolved and what the role of television is in their leisure time.

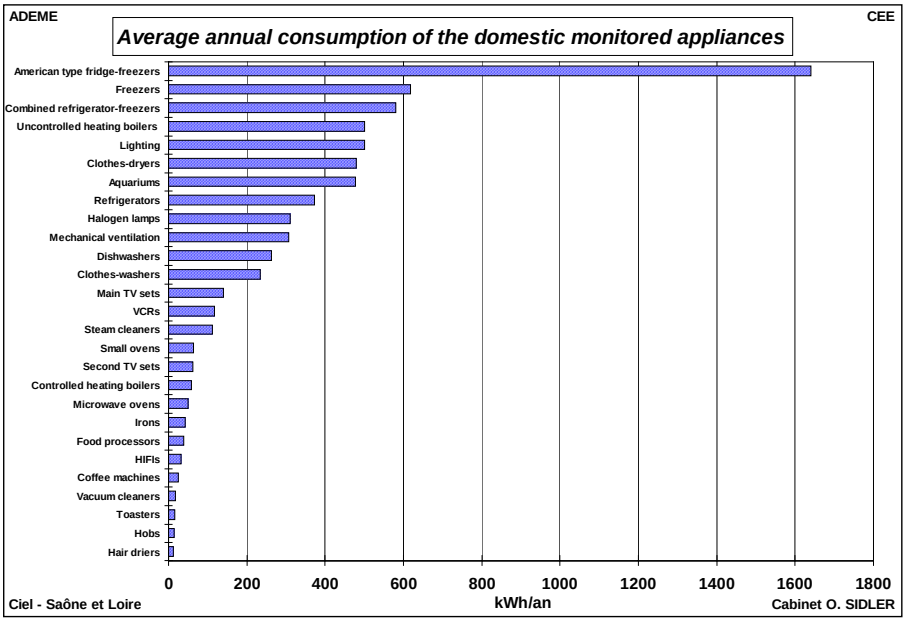

Figure 2.3 : Average yearly consumptions of the monitored domestic appliances

3 The ECODROME campaign

DATE 1995-1997

NUMBER OF HOUSEHOLDS INVOLVED 20

SUBJECT evaluation of the energy savings by using Class A domestic appliances

DURATION OF THE CAMPAIGN 2 years per household

MEASUREMENT SYSTEM DIACE (Landys&Gyr)

TIME STEP 10 minutes

SUPPORTED BY European Commission, ADEME

MAIN RESULTS

Ecodrome allowed to know better the operation of the household appliances. It was notably possible to obtain very precise data about the seasonality of the uses, thanks to the one-year-long monitoring (see figure 3.1). The global load curve and its structure were also studied, what allowed to show the particular role of some appliances during certain periods of the day.

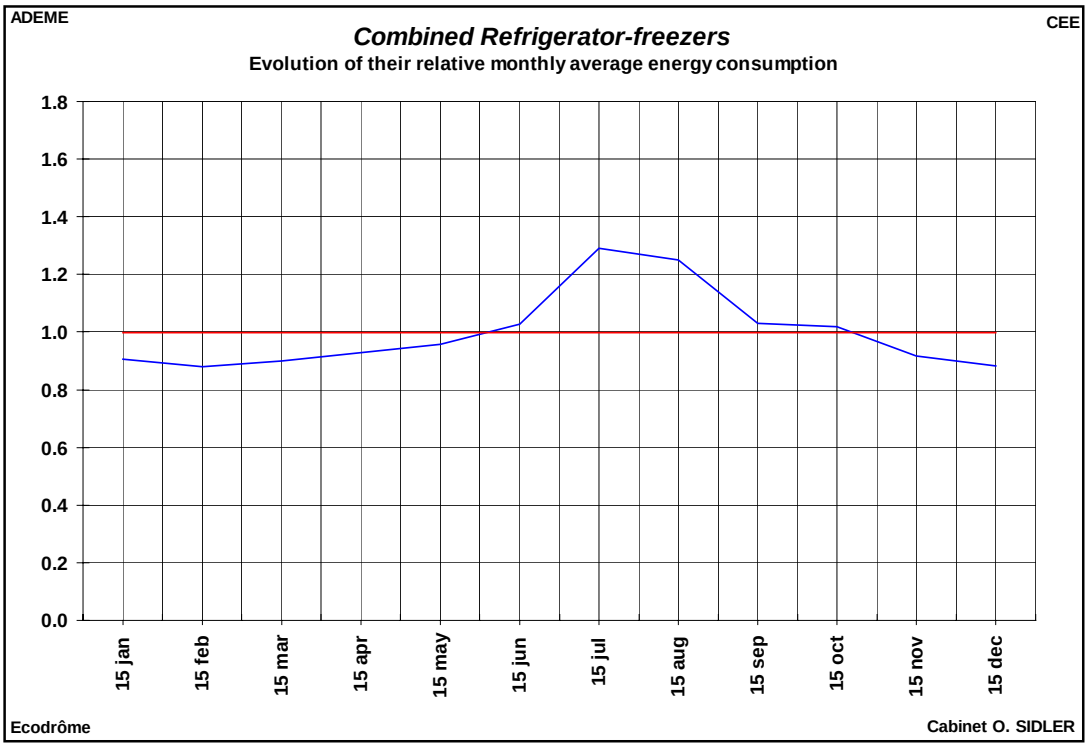

Figure 3.1 : Example of evolution of the relative monthly average energy consumption of combined fridge-freezer

But the most important aspect of ***Ecodrome*** is that it allowed an *in situ* estimation of the potential energy saving obtained by replacing of the original appliances with efficient ones. This assessment was necessary as it allowed to take into account all the real and unknown phenomena that were not controlled in laboratory. The advantage of the *in situ* operation is also to identify some problems that were not really suspected before, or some practical difficulties that should now be taken into account, as well as some unknown human reactions considering Demand Side Management (DSM). The merit of this assessment is to include all the non-controllable parameters and to provide some precious elements in order to build new DSM strategies.

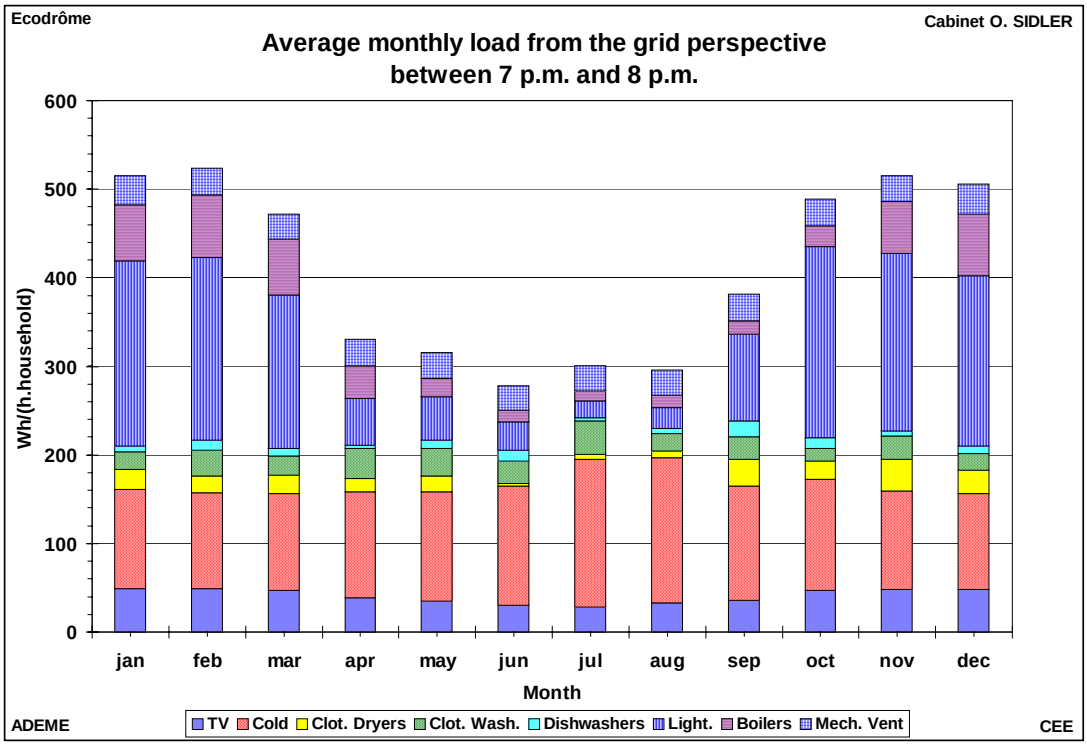

Figure 3.2 : Average monthly load from the grid perspective

This study notably shows that most of the potential electricity saving can be reached by only four end-uses:

■ cold production represents the main potential saving, by very far,

■ lighting represents probably the second potential saving, but this potential saving will vary as a function of the latitudes of the sites,

■ the correct control of the circulation pump of the boilers is the first “surprise” saving of this study. It is also not the least and it can be reached almost for free, as the wiring modification is very simple: it just consist in exchanging the place of two wires on the connection box of the boiler, what can be done quickly, for instance during the yearly maintenance visits,

■ the elimination of standby powers, notably on the audiovisual equipment, is the second “surprise” potential saving revealed by ***Ecodrome***. This saving depends on the

equipment in each household, and can reach 600 kWh/year. The access to this saving is here again almost free.

The standby power consumption was not really investigated in ***Ecodrome*** because of material and delay questions. One could then conclude that with the four axes of action suggested above, the potential saving per household is probably at least equal to the 1,200 kWh/year measured in this operation.

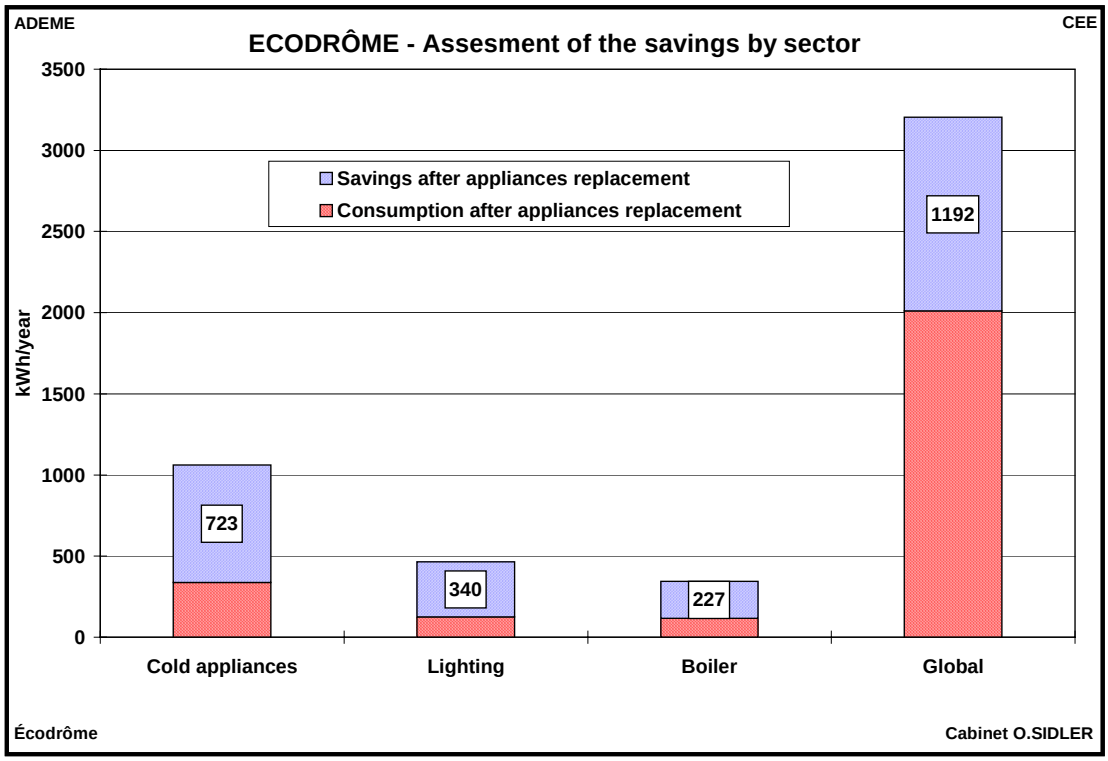

Figure 3.3 : Assessment of the savings by sector

4 The “FRENCH GUYANA” campaign

DATE 1996-1997

NUMBER OF HOUSEHOLDS INVOLVED 100

SUBJECT all domestic appliances, except lighting

DURATION OF THE CAMPAIGN 1 month per household

MEASUREMENT SYSTEM DIACE (Landys&Gyr)

TIME STEP 10 minutes

SUPPORTED BY EDF, ADEME

MAIN RESULTS :

The aim of this monitoring campaign was to monitor all the electrical appliances from the households, except lighting. The figure 4.1 gives a comparison between metropolis and Guyana for the average consumptions of the monitored domestic appliances.

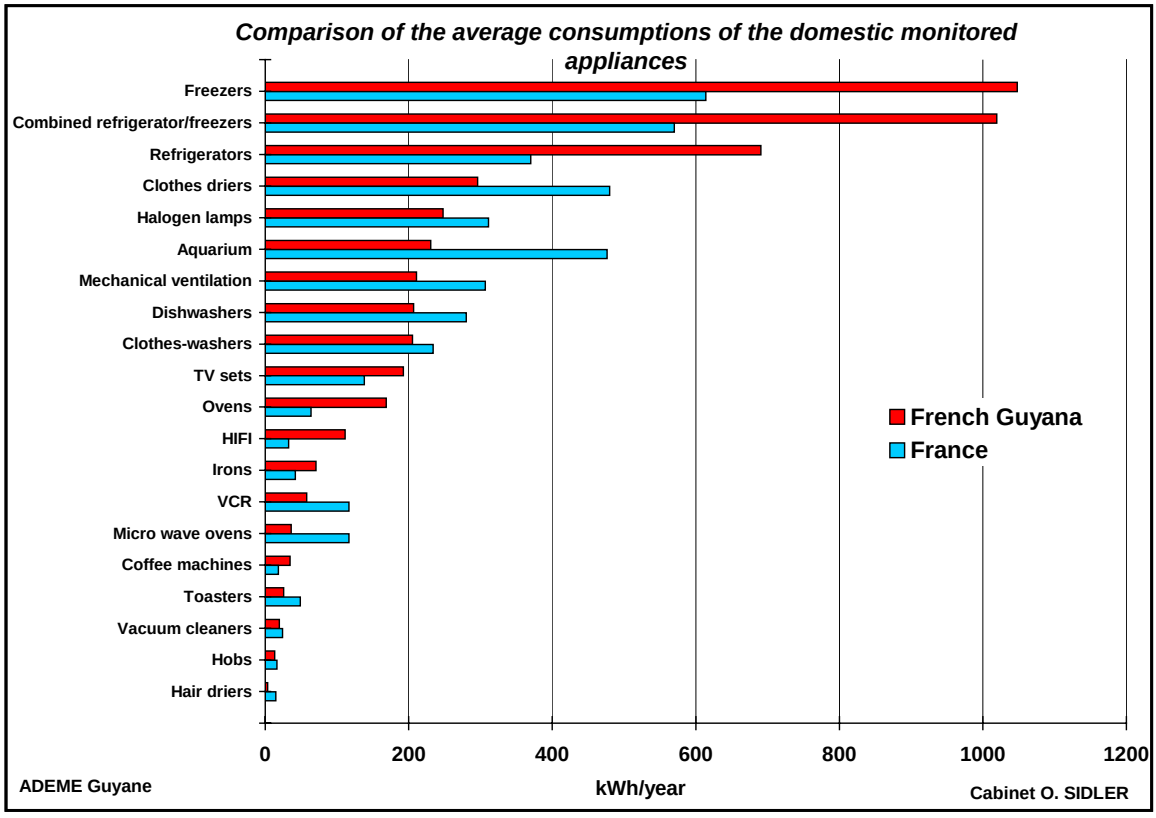

Figure 4.1 : Comparison of the average consumptions of the monitored domestic appliances

In this monitoring campaign, air conditioners and pumps of swimming pools that are very common in Guyana and that were never studied before have been investigated. These two appliances are the biggest energy consumers of the whole monitoring campaign. These uses which are spreading out very fast will weight heavier and heavier in the household's total consumption.

5 The ECUEL campaign

DATE 1998

NUMBER OF HOUSEHOLDS INVOLVED 98

SUBJECT cooking and cold appliances

DURATION OF THE CAMPAIGN 1 month per household

MEASUREMENT SYSTEM DIACE (Landys&Gyr)

TIME STEP 10 minutes

SUPPORTED BY European Commission, EDF, ADEME

MAIN RESULTS

The aims of the study were, firstly, to provide an evaluation of the energy consumption levels involved in electric cooking, secondly, to gain a fuller understanding of the effect of external conditions on the operation and energy consumption of domestic cold appliances, and lastly, to ascertain whether using a tumble-dryer can reduce the energy consumption involved in ironing laundry.

The study centred around the establishment and analysis of a database **containing 517 examples of 32 types of domestic electrical appliance** covering the main forms of electric cooking, as well as auxiliary usages, such as coffee-makers, kettles, etc.

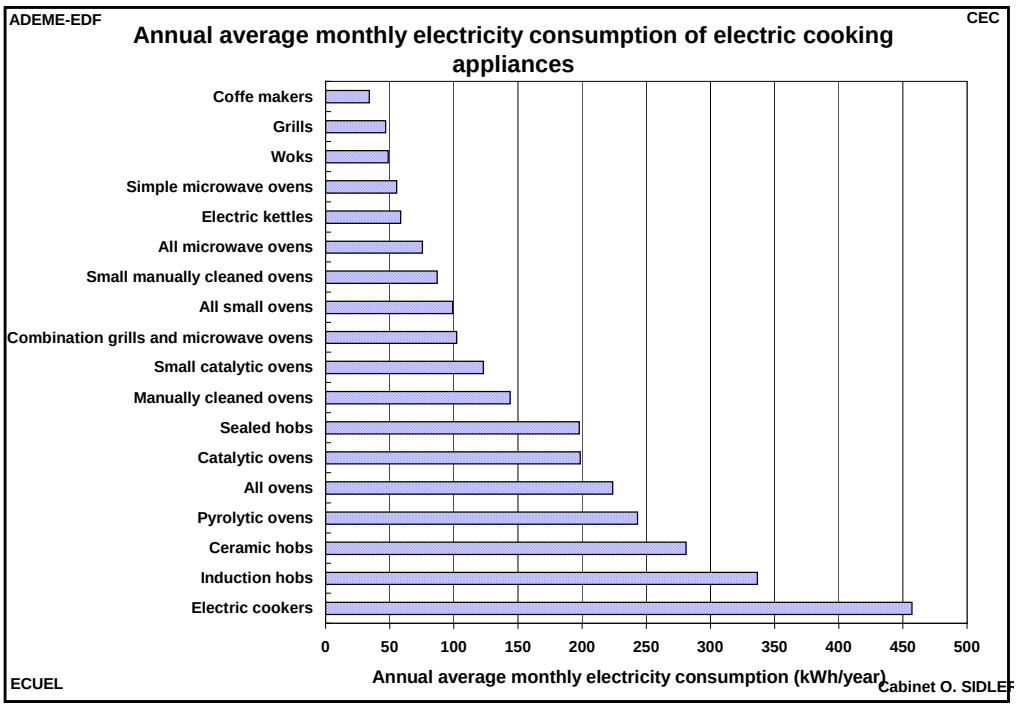

Figure 5.1 : Annual average electricity consumption of electric cooking appliances

ECUEL is probably the most thorough end-use metering campaign investigating electric cooking to have been carried out in the world.

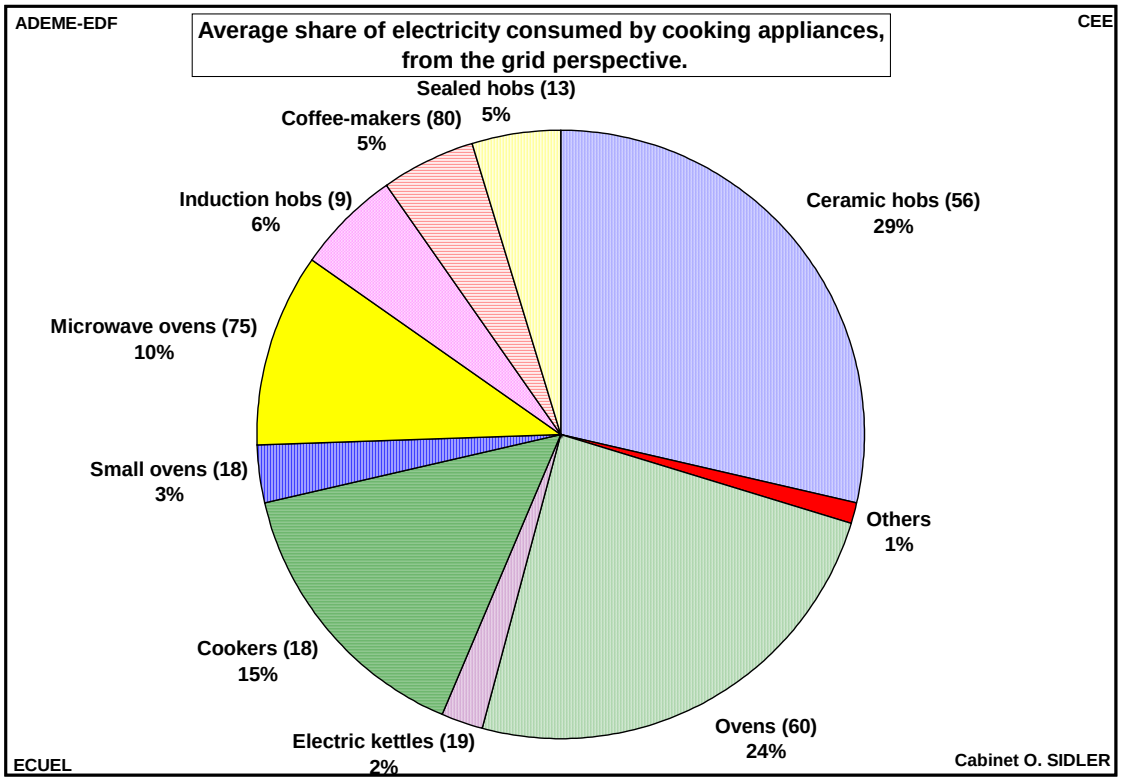

Figure 5.2 : Average share of electricity consumed by cooking appliances from the grid perspective

By studying the location of cold appliances within the household it was possible to show that simply by keeping a cold appliance in a non-heated store room rather than a kitchen, average energy savings of 36 % were achieved.
The measurement of the compartment temperatures of appliances showed that most freezers were not operating at the recommended temperature (-18 °C). On average, the compartment temperatures of freezers were 3.1 °C lower than this temperature. This produced energy consumption levels within the appliances that were 17.6 % higher than they would have been had the appliances been operating at the recommended temperature.
Taken individually, the estimated annual energy consumption values recorded in the ECUEL study did not show a strong correlation with those measured according to the European standard EN153. However, the average of these estimates was close to that of the test-condition energy consumption values. In conclusion, therefore, the use of standard EN153 is a reliable means of establishing the average annual energy consumption of cold appliances being used in south central France.

One can not sensibly justify the use of electric clothes-dryers on the basis of reducing the energy consumption of irons (they use 11 times more electricity than irons). Moreover, the energy consumption levels of irons were found to be some 39 % higher in households that owned an electric clothes-dryer than in those that do not. This is not to suggest, of course, that the presence of a clothes-dryer actually increases the energy consumption of irons, but the same phenomenon was recorded in French Guyana, where the energy consumption of irons was 22 % lower in households in which there was no clothes-dryer.

6 The STAND-BY POWER campaign

DATE 1997-1999

NUMBER OF HOUSEHOLDS INVOLVED 1280

SUBJECT stand by power and consumption

DURATION OF THE CAMPAIGN instant power measurement

MEASUREMENT SYSTEM EMU (portable wattmeter)

TIME STEP -

SUPPORTED BY ADEME for IEA

MAIN RESULTS

The purpose of this study was to gain a better understanding on the domestic appliances that can be in stand-by mode. The method of investigation was based on an instant power monitoring campaign in which the mains features of the equipment of the surveyed households were noted. In each visited household, the assignment was to survey the characteristics of all the appliances that was all the time or temporarily in stand-by mode. In every case, an instant measurement was carried out.

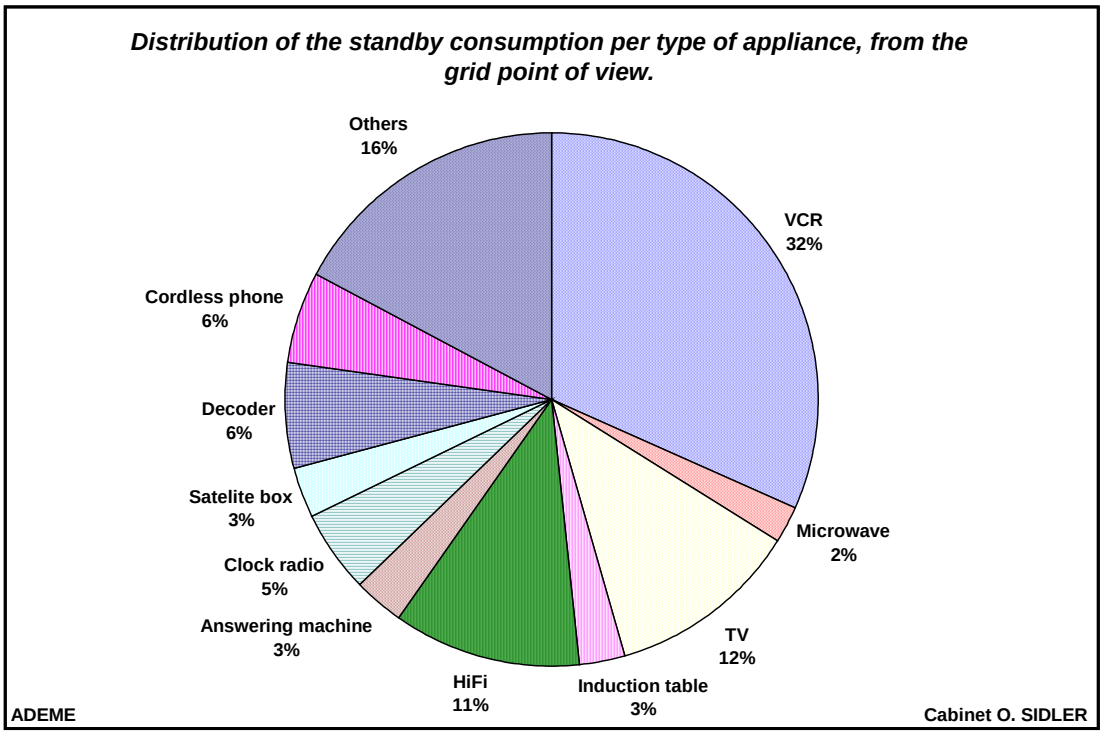

Figure 6.1 : Distribution of stand-by consumption per type of appliance from grid point of view

7 The LIGHTING campaign

DATE 2003

NUMBER OF HOUSEHOLDS INVOLVED 100

SUBJECT lighting (bulbs were 100 % monitored)

DURATION OF THE CAMPAIGN 1 year per household

MEASUREMENT SYSTEM Lampmeters designed by ENERTECH (datalogers)

TIME STEP time for each switch on and switch off were recorded

SUPPORTED BY EDF, ADEME

MAIN RESULTS

In this campaign the lighting consumption of 100 households has been monitored during one year. In each household, every light sources and the mains have been monitored which allows to have a very precise representation of electricity that is consumed for lighting.

The households were equally located in Strasbourg (North east), Angers (North west), Nice (South east) and Toulouse (South west). The purpose of the choice of these regions was to investigate different latitudes and longitudes.

The average number of light bulbs was 28,3 per household. The repartition between the different light sources is given on the figure 7.1.

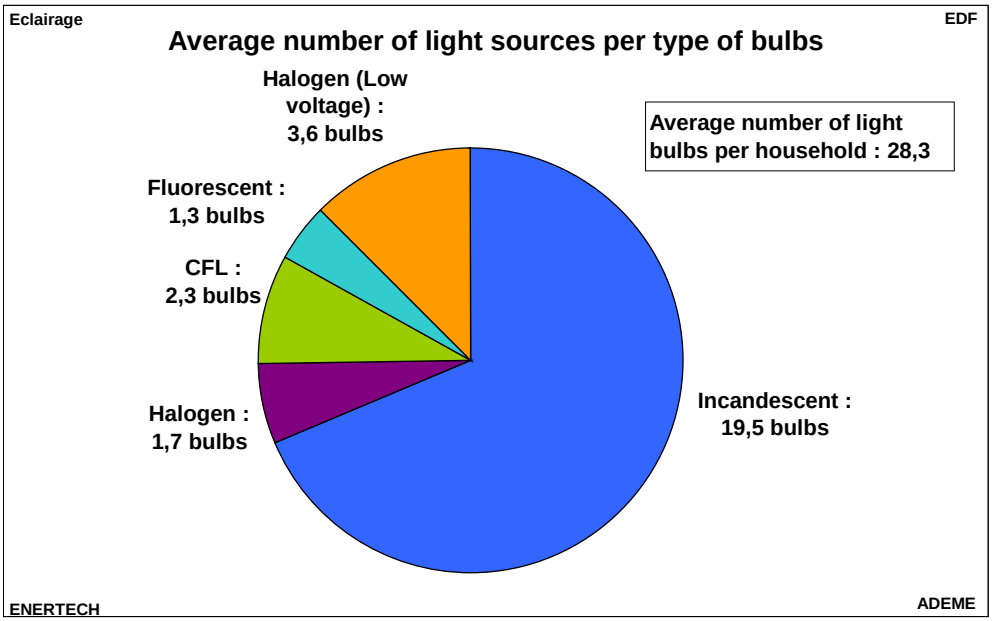

Figure 7.1 : Average number of light sources per type of bulbs

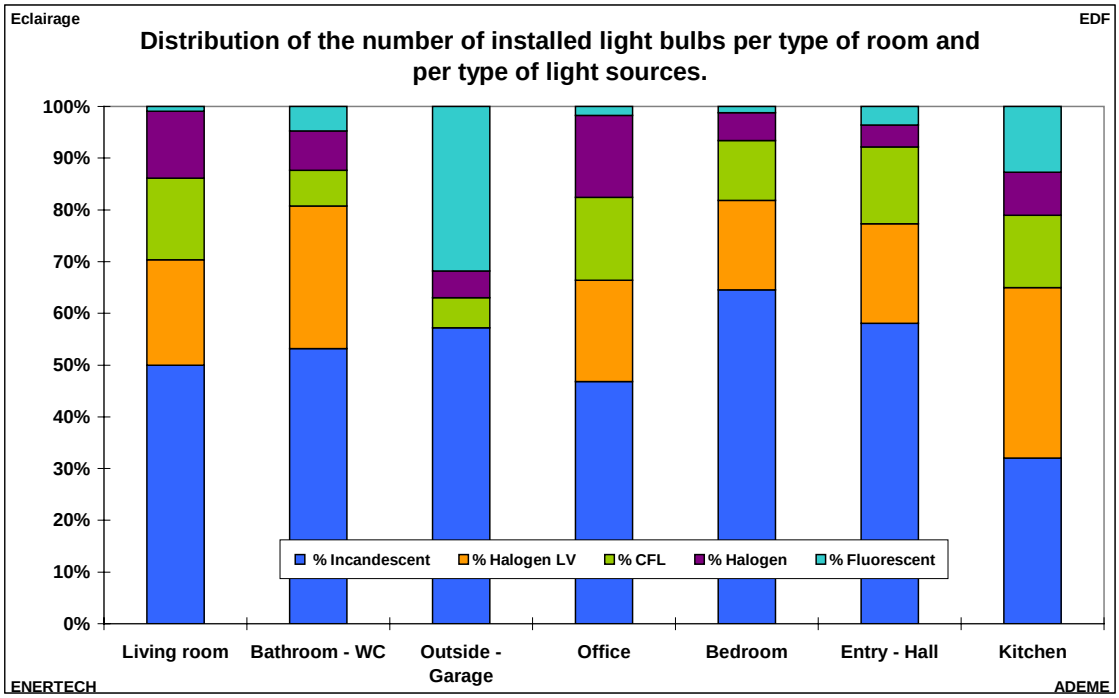

Figure 7.2 : Distribution of the number of installed light bulbs per type of room and per type of light sources

The average installed power per household was 1578W which were shared as indicated on figure 7.3.

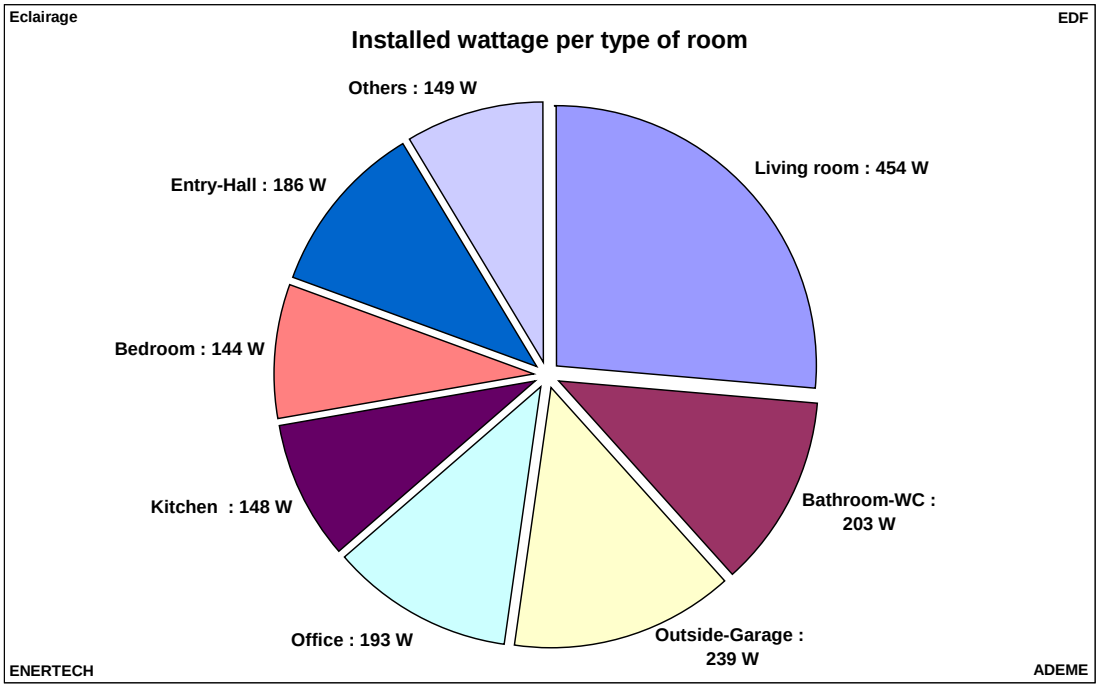

Figure 7.3 : Installed wattage per type of room

The average yearly consumption was 354 kWh per household and the average load curve is the one given on the figure 7.4. The average yearly switching on time was equal to 2426 hours (it is the time during which at least one luminaire is switched on).

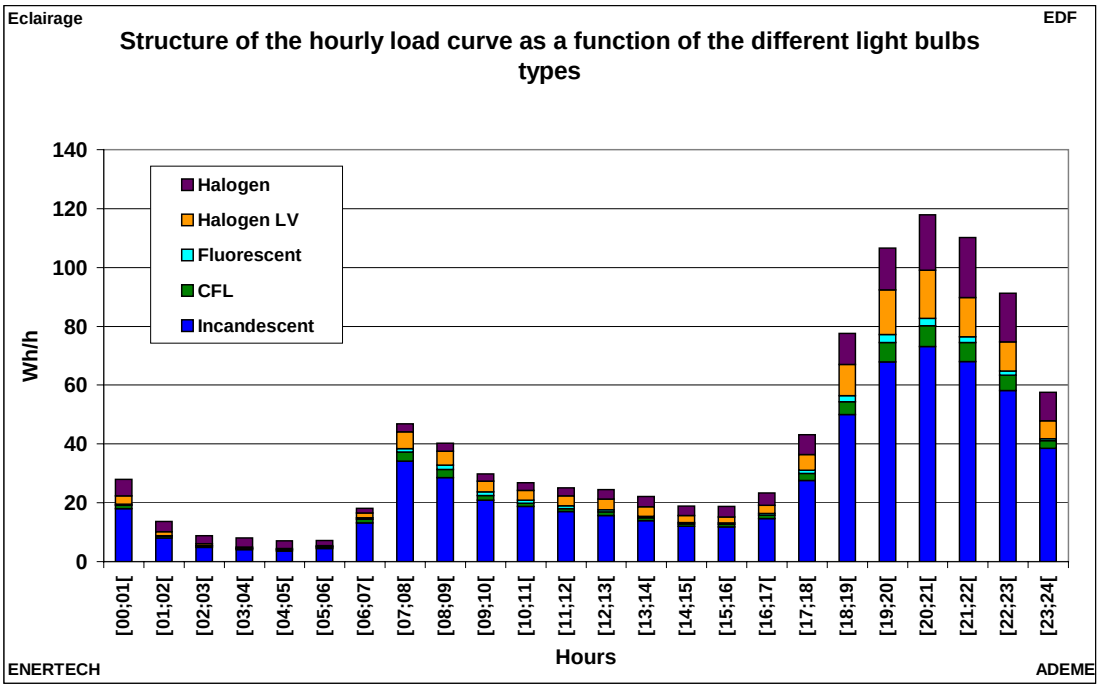

Figure 7.4 : Structure of the hourly load curve as a function of the different light bulbs types

The graph 7.5 gives an estimation of the potential savings that can be achieved by replacing all the incandescent and halogen lamps by CFL. The annual savings are 210 kWh per year and per household.

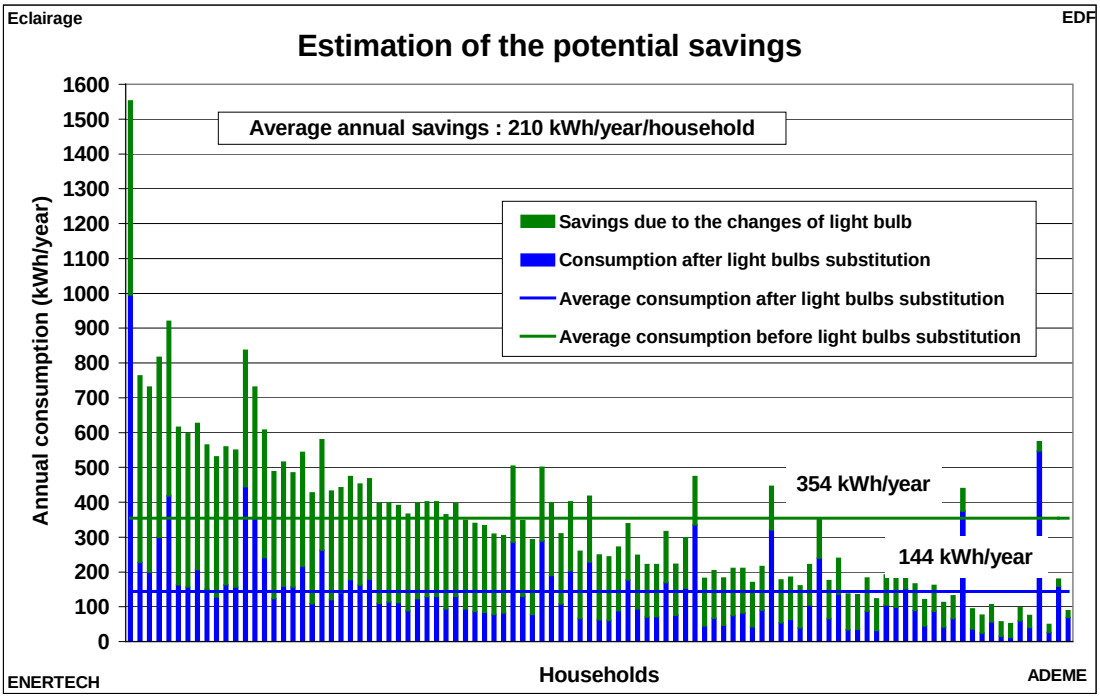

Figure 7.5 : Estimation of the potential savings achievable by replacing incandescent and halogen lamps by CFL

This monitoring campaign has helped to deeply analyse the use of lighting by french households. This was necessary in order to evaluate the potential savings on this use.

8 The EURECO campaign

DATE 2000-2001

NUMBER OF HOUSEHOLDS INVOLVED 400 (100 in four countries)

SUBJECT all domestic appliances, including lighting

DURATION OF THE CAMPAIGN 1 month per household

MEASUREMENT SYSTEM DIACE (Landis & Gyr) and Lampmeters ENERTECH

TIME STEP 10 minutes

SUPPORTED BY European Commission and numerous partners in each country

MAIN RESULTS

Five countries were involved in this project: Denmark, Greece, Italy Portugal, and France. The measurement campaigns took place in the first 4 countries.

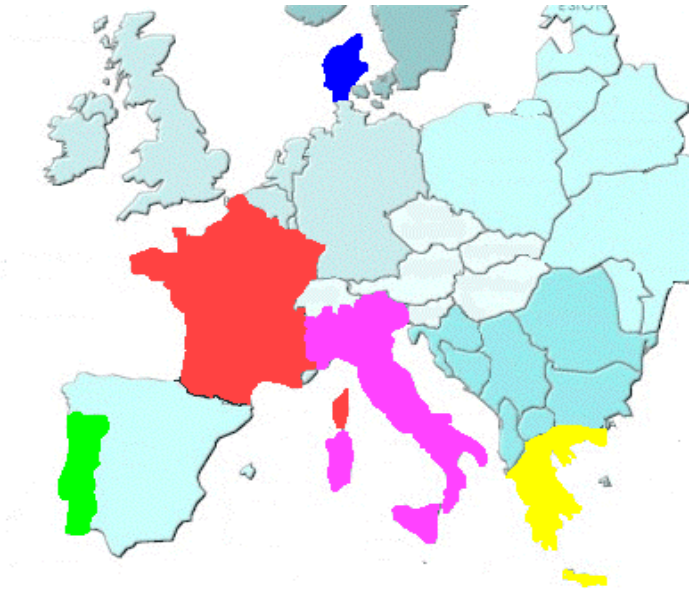

Figure 8.1 : Localisation of the five countries involved in the Eureco project

The main objective of the ***Eureco*** 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.

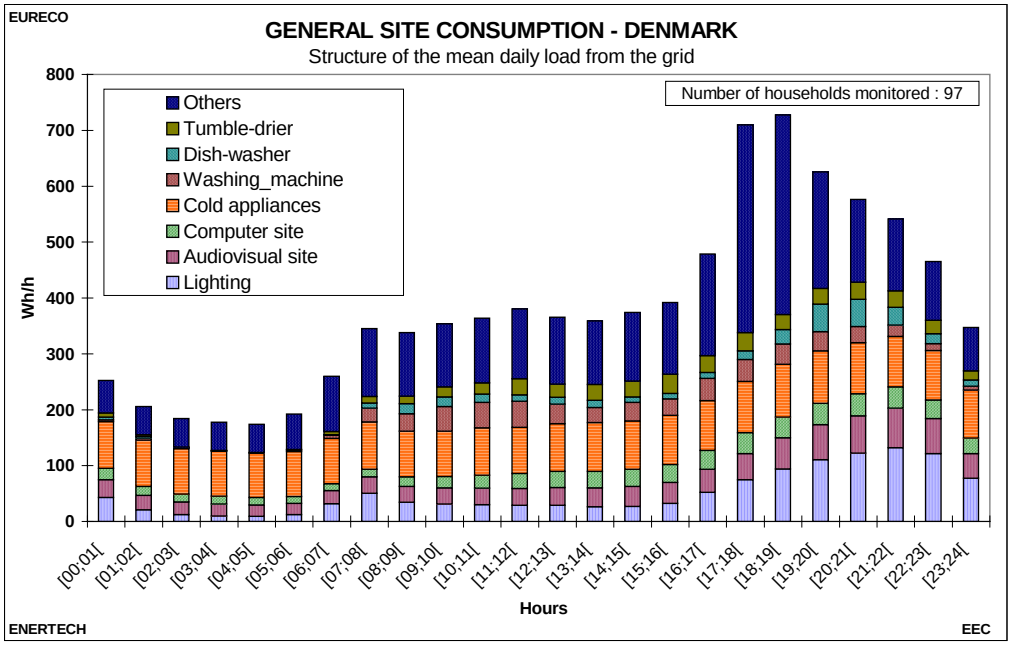

Figure 8.2 : Example of load curve of the mains from the Eureco project

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. One of the special feature of ***Euréco*** is that every single source of light in the households were also individually monitored.

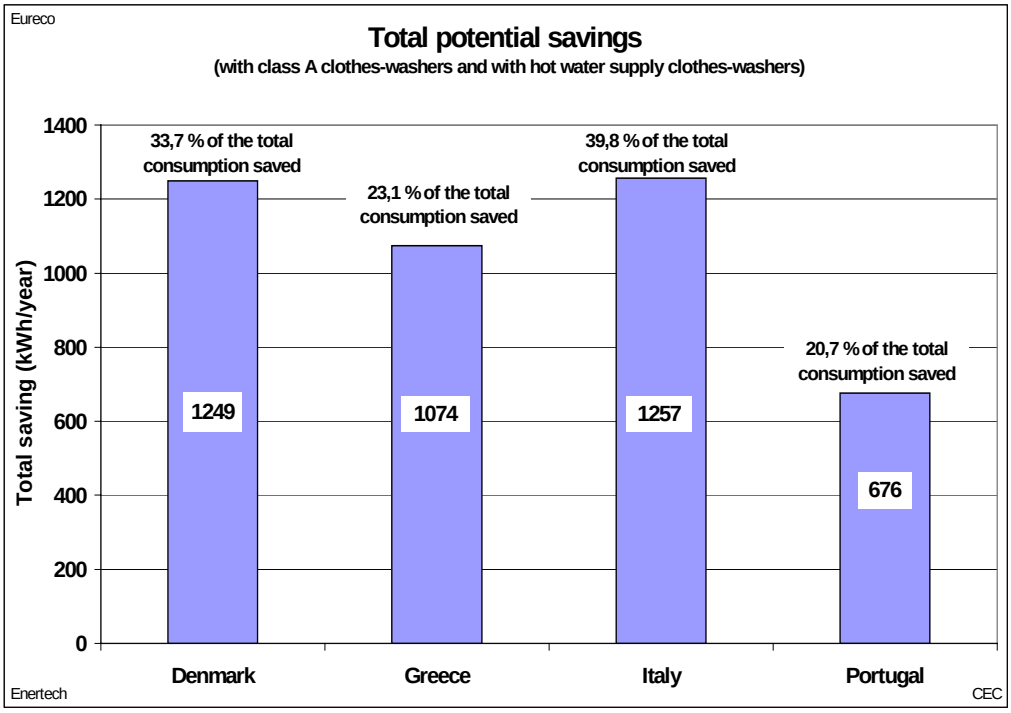

Figure 8.3 : Assessment of the total potential savings

9 The IRISE campaign

9.1 Description

DATE 1997-1999

NUMBER OF HOUSEHOLDS INVOLVED 100

SUBJECT all domestic appliances, including global lighting and cooking

DURATION OF THE CAMPAIGN 1 year per household

MEASUREMENT SYSTEM DIACE (Landis & Gyr)

TIME STEP 10 minutes

SUPPORTED BY EDF

MAIN RESULTS

This data was the property of EDF so it has never been studied by Enertech. EDF agreed to integrate it in the common database that is going to be built in the REMODECE project.

10 The NUTEK campaign

DATE 1992

NUMBER OF HOUSEHOLDS INVOLVED 66

SUBJECT main domestic appliances, except lighting

DURATION OF THE CAMPAIGN several months per household

MEASUREMENT SYSTEM global wattmeter (end value-beginning value)

TIME STEP -

SUPPORTED BY NUTEK

MAIN RESULTS

The results of this monitoring campaign are quite old. They will not be integrated in the common database built in the Remodece project.

11 The ELECTRICITY ASSOCIATION campaign

DATE 1995

NUMBER OF HOUSEHOLDS INVOLVED 100

SUBJECT all domestic appliances

DURATION OF THE CAMPAIGN 1 month per household

MEASUREMENT SYSTEM POEM

TIME STEP 15 minutes

SUPPORTED BY English Electricity Companies

MAIN RESULTS

The results of this monitoring campaign are now the property of David Cooper who does not want them to be public. That is the reason why they will not be integrated in the common database that will be built in the Remodece project.

12 Conclusion

This report gives a general description of all the monitoring campaigns of electrical appliances in households conducted so far in Europe. Most of them have been conducted in France.

The next step of the project will consist in gathering all the available data in a single database. It appears that at the moment there are no data for new members states like Bulgaria, Czech Republic, Hungary, Romania… that is why the monitoring campaigns that are going to be done in these countries are very important. Indeed all the data that will be collected in the REMODECE project will be inserted in it. The database will be updated along the project development. The database will be a powerful tool that could be used by different categories of users like scientists, politics…

It will contain raw data as well as aggregated values. It will also contains more general information on monitored appliances and the corresponding households.