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Report D8

MEASUREMENT CAMPAIGNS

End Use Recording in the Residential Sector

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Summary

The availability of high quality end-use data is an essential condition for the definition of policy recommendations to influence through a combination of increased energy efficiency of household appliances to be sold in the EU-27 in the next decade, as well as to influence the user behaviour in the selection and operation of that equipment.

In the REMODECE project, 12 countries have by measurement campaigns collected a large amount of end-use data time series with integration period 10 minute for a period of 2 weeks in 100 households per country.

The concepts for data collection are described for countries new to household campaigns as well as countries that have some experience. The focus is very much on computer equipment, entertainment appliances and lighting where both technical matters and behaviour has an influence on the electricity consumption.

A new detailed ID system has been developed to handle data exchange and database storage.

Guidelines for installation, data handling (including quality control, repair etc.) and spot metering of standby consumption are given.

The way the 12 countries have selected households for participation in the campaigns are described along with information about building types and equipment used.

Most countries has experiences that execution of measurement campaigns requires a lot of resources for finding the right equipment, buying or renting equipment, installation, data retrieval, data handling (control, repair and storage), data analysis and reporting. Due to lack of economical resources for buying or renting recording equipment, most countries had to do with less equipment than planned which caused delays of several months in executing the campaigns. Campaigns in all countries were finished by September 2008.

Lessons learned from the campaigns are:

- The households want to be informed about their end-use consumptions and saving options.
- In execution of measurement campaigns, it is normal to face technical challenges.
- Cluster monitoring of the summated load of several appliances has been used instead of individual end-use monitoring due to lack of equipment. It is difficult to use cluster data and cluster monitoring is not recommended.
- It is very time consuming to execute monitoring campaigns wit careful data handling.
- End-use recording campaigns deliver many interesting results (see the D10 report). The huge amount of end-use recordings is valuable for further national/international analysis.
- The REMODECE project has started the extremely important process of filling out the huge gap for household end-use data. It is recommended to continue the process with frequent campaigns on a larger scale in the future.

1. Introduction

The overall objective of the REMODECE (Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe) project is to contribute to:

- Increased understanding of the energy consumption in the **EU-27** households for the different types of equipment, the consumers' behaviour and comfort levels.
- Identification of demand trends.
- Evaluation of the potential electricity savings in the residential sector that can be implemented by existing means as very efficient appliances and reduced standby consumption.

The availability of high quality end-use data is an essential condition for the definition of policy recommendations to influence through a combination of increased energy efficiency of household appliances to be sold in the **EU-27** in the next decade, as well as to influence the user behaviour in the selection and operation of that equipment. REMODECE collect data by new monitoring and surveying campaigns.

EU countries without earlier end-use load recording campaigns have as far as possible included all important end-uses as cooker, refrigerator, freezer, washing machine, tumble dryer, dishwasher, entertainment as TV, DVD and CD player, computer and peripherals, oil or gas burner including circulation pump, residential air condition and the 10 most used lamps as separate end-uses.

EU countries that already have executed end-use load recording campaigns (with data to be included in the EU database) have focused at appliances with a lot of changes: computer and peripherals, entertainment systems as home movie systems, game/play station consoles, DVD players/recorders and Large plasma TV, new Standby consumption by set-top box, DVD players/recorders and plasma TV, residential air conditioner and lighting (as many lamps as possible with first priority to CFLs and halogen lighting).

The campaign included 100 homes/country and end-use recording in 2 weeks or one month per home. Summer months with little use of lighting and customer absence due to holidays has as far as possible been avoided except for recording on air conditioners where the consumption in the summer months has to be recorded. In case of recording on appliances sensitive to temperature as air conditioner, the outdoor and indoor temperature has also been recorded.

The purpose of this D8 report is to give:

- The campaign concept of end-uses in focus with difference between “old” (countries that have already performed domestic end-use recordings) and “new” EU-countries.
- Developed ID system in order to handle all measurements with unique identify.
- The developed guidelines for preparation of measurements, installation, data retrieval, quality control and repair of data. This includes standby measurement.
- Detailed description of the campaigns performed in each of the 12 countries with campaigns participating in the Remodece project.
- Description of equipment used in the end-use recording campaigns

2. End-uses included in the measurements campaigns

Due limited national budget for buying end-use recording equipment, priority lists on which end-uses to include was developed during the first months of the project.

Bulgaria, Czech Republic, Hungary and Romania (New countries)

1. Total consumption (if it is not too difficult to establish)
2. Washing machine
3. Tumble dryer
4. Entertainment as a group of appliances in living room: TV, DVD, CD, ...
5. Computer and peripherals as a group for home office
6. Refrigerator (period consumption + spot metering of load at installation by SEM 10)
7. Freezer (period consumption + spot metering of load at installation by SEM 10)
8. 10 most used lamps individually or the sum of lighting by groups in the installation
9. All kind of stand by consumptions recorded at the time of installation by SEM 10 including satellite amplifier, Internet connection, chargers, etc.

If possible add:

- sum of computer and TV set per teenager room
- cooker including oven
- dishwasher
- oil or gas burner including circulation pump
- Water heating

Belgium, Denmark, France, Germany, Greece, Italy, Norway and Portugal (Old countries)

1. Total consumption (if it is not too difficult to establish)
2. TV + VHS + DVD + Home Cinema
3. Large TV screen or other specialities might be recorded separately
4. CD + Stereo
5. Computer and peripherals as a group in office room
6. Sum of computer and TV set for every teenager room
7. 10 most used lamps individually or sum of lighting by groups in the installation
8. Air conditioning (only southern countries)
9. All kind of standby consumptions recorded at the time of installation by SEM 10, including satellite amplifier, settop boxes internet connection, chargers, etc.

If possible add:

1. Separate recording on individual appliances within the nine groups above
2. cooker including oven
3. washing machine, tumble dryer, dishwasher

Refrigerator and freezer consumption might be recorded over a short period along with spot metering of the load at time of installation by SEM10 equipment.

3. ID for end-use recordings and other measurements

It is necessary that all measurements and end-use load recordings from the participating countries have unique ID in order to perform data analysis in WP 5 (SINTEF responsible) and for storage in the EU database created in WP2 (Enertech responsible).

A ID system is developed and is composed by 15 digits including: **cccc pp hhh aaaaaa**

cccc is a country code

pp is the campaign number

hhh is the number of the household included in the program

tt aa nn is a number identifying each recording point/file that can be an appliance, the mains (total consumption per home) or a temperature

3.1. Country code cccc

The code consists of the 1 followed by the national telephone code of the country, e.g. 45 for Denmark and 351 for Portugal.

1032 for Belgium

1045 for Denmark

1033 for France

1049 for Germany

1030 for Greece

1039 for Italy

1047 for Norway

1351 for Portugal

1359 for Bulgaria

1420 for Czech Republic

1036 for Hungary

1040 for Romania

3.2. Campaign number pp

The campaign number is a consecutive numbering of measurement campaigns.

In REMODECE we will use campaign numbers 01.

3.3. Household number hhh

The household number is the numbers of households participating in the campaign e.g. 1-100 for a campaign including 100 households.

3.4. Appliance number tt aa nn

- **tt** identify the type of appliance
- **aa** identify the specific appliance
- **nn** is the relative number of the appliance in case there is more than one.

Due to lack of recording equipment, the sum of consumption for several appliances may be recorded summated by use of a multiple switch box (can be used for audiovisual, computer, lighting and small cooking appliances). In this case, **aa** must be a cluster code. Cluster recording should only be used when it makes sense to analyze the recorded data.

On/off recording of cluster lighting must in the data handling be split into data files for each lighting source in the cluster.

01 Cold appliances

01 01 01 Refrigerator 1
01 01 02 Refrigerator 2
01 01 03 Refrigerator 3
01 02 01 Fridge freezer 1
01 03 01 Chest freezer 1
01 04 01 Vertical freezer 1
01 05 01 American freezer 1
01 06 01 Vine fridge 1

02 Washing machines, dish washers...

02 01 01 Washing machine 1
02 02 01 Dish washer 1
02 03 01 Clothes dryer (without condenser) 1
02 04 01 Clothes dryer (with condenser) 1
02 05 01 Discharge clothes dryer 1
02 06 01 Washing machine with cloth dryer 1
02 07 01 Iron 1
02 08 01 Vacuum cleaner 1
02 09 01 Central hover 1
02 10 01 Steam cleaner 1
02 11 01 Sewing machine 1

03 TV

- 03 01 01 CRT TV ≤55cm 1
- 03 02 01 CRT TV >55 and ≤72cm 1
- 03 03 01 CRT TV >72cm 1
- 03 04 01 LCD TV ≤52cm 1
- 03 05 01 LCD TV >52 and ≤81cm 1
- 03 06 01 LCD TV >81cm 1
- 03 07 01 Plasma TV ≤107 1
- 03 08 01 Plasma TV >107 and ≤120 cm 1
- 03 09 01 Plasma TV >120 cm 1
- 03 10 01 Video projector 1
- 03 11 01 LCD/Plasma TV controller 1
- 03 91 01 Cluster of TV + VCR 1
- 03 92 01 Cluster of TV + VCR/DVD 1
- 03 93 01 Cluster of TV + DVD 1
- 03 94 01 Cluster of TV + VCR + HI-FI 1
- 03 95 01 Cluster of TV + VCR/DVD + HI-FI 1
- 03 96 01 Cluster of TV + DVD + HI-FI 1
- 03 99 01 Cluster of other combination of TV and/or audiovisual appliances 1

04 Audiovisual appliances

- 04 01 01 Combined VCR/DVD 1
- 04 02 01 Combined VCR/TV 1
- 04 03 01 Combined HD/DVD 1
- 04 04 01 VCR 1
- 04 05 01 DVD player 1
- 04 06 01 DVD player and recorder 1
- 04 07 01 Home cinema 1
- 04 08 01 Games console 1
- 04 09 01 Hard Disc 1
- 04 10 01 Set top box with hard drive 1
- 04 11 01 Satellite/cable set top box 1
- 04 12 01 Digital terrestrial television box 1
- 04 13 01 Decoder 1
- 04 14 01 Satellite amplifier 1

04 15 01 Antenna booster 1
04 16 01 Audio/tuner amplifier 1
04 17 01 Subwoofer amplifier 1
04 18 01 Hi-Fi 1
04 19 01 Portable Hi Fi 1
04 20 01 CD player 1
04 21 01 Cassette player 1
04 22 01 Gramophone 1
04 23 01 Speakers 1
04 24 01 Security camera 1
04 25 01 Camera charger
04 26 01 Retro projector 100-150
04 27 01 Retro projector ≥ 150
04 28 01 Active loud speakers 1
04 29 01 Radio 1
04 91 01 Cluster of appliances that accompany TV (amplifier, decoder, DVD) 1
04 92 01 Cluster of HI FI appliances (radio, CD, Gramophone etc.) 1
04 93 01 Cluster of home cinema and DVD 1
04 94 01 Cluster of home cinema, DVD and audio amplifier 1
04 95 01 Cluster of TV and HI FI appliances
04 99 01 Cluster of various TV and audiovisual appliances

05 Computer

05 00 01 Computer site 1
05 01 01 Desktop 1
05 02 01 CRT monitor $<17''$ 1
05 03 01 CRT monitor $17''$ 1
05 04 01 CRT monitor $>17''$ 1
05 05 01 LCD monitor $<17''$ 1
05 06 01 LCD monitor $17''$ 1
05 07 01 LCD monitor $>17''$ 1
05 08 01 Desktop + CRT monitor $<17''$ 1
05 09 01 Desktop + CRT monitor $17''$ 1
05 10 01 Desktop + CRT monitor $>17''$ 1
05 11 01 Desktop + LCD monitor $<17''$ 1

05 12 01 Desktop + LCD monitor 17" 1
05 13 01 Desktop + LCD monitor >17" 1
05 14 01 Desktop + monitor + UPS 1
05 15 01 Laptop 1
05 16 01 Laptop + CRT monitor <17" 1
05 17 01 Laptop + CRT monitor 17" 1
05 18 01 Laptop + CRT monitor >17" 1
05 19 01 Laptop + LCD monitor <17" 1
05 20 01 Laptop + LCD monitor 17" 1
05 21 01 Laptop + LCD monitor >17" 1
05 22 01 TFT LCD monitor
05 91 01 Cluster of desktop + CRT monitor + printer 1
05 92 01 Cluster of desktop + CRT monitor + printer-scanner-copier 1
05 93 01 Cluster of desktop + LCD monitor + printer 1
05 94 01 Cluster of desktop + LCD monitor + printer-scanner-copier 1
05 95 01 Cluster of desktop + CRT monitor + printer + TV + HI-FI 1
05 96 01 Cluster of desktop + LCD monitor + printer + TV + HI-FI 1
05 97 01 Cluster of laptop + printer 1
05 98 01 Cluster of laptop + printer + TV + HI-FI 1
05 99 01 Cluster of PC and/or peripheral computer appliances 1

06 Peripheral Computer appliances

06 01 01 Inkjet printer 1
06 02 01 Laser printer 1
06 03 01 Photo printer 1
06 04 01 Printer-scanner-copier 1
06 05 01 Scanner 1
06 06 01 Copier 1
06 07 01 Modem 1
06 08 01 Internet/TV/Phone box 1
06 09 01 Router 1
06 10 01 WIFI module 1
06 11 01 Wireless mouse 1
06 12 01 Wireless headset 1
06 13 01 Computer amplifier 1

- 06 14 01 External hard disk 1
- 06 15 01 Electrical CD storage 1
- 06 16 01 USB hub 1
- 06 17 01 Fax 1
- 06 18 01 Paper shredder 1
- 06 19 01 Picture receiver 1
- 06 20 01 Picture transmitter 1
- 06 99 01 Cluster of various peripheral computer appliances

07 Air conditioning + heating

- 07 01 01 Mono split 1
- 07 02 01 Multi split 1
- 07 03 01 Heat pump air/air 1
- 07 04 01 Heat pump air/water 1
- 07 05 01 Heat pump water/air 1
- 07 06 01 Heat pump water/water 1
- 07 07 01 Circulation pump 1
- 07 08 01 Humidifier 1
- 07 09 01 Mobile air conditioner 1
- 07 10 01 Fan 1
- 07 11 01 Well pump 1
- 07 12 01 Gas burner for heating 1
- 07 13 01 Oil burner for heating 1
- 07 14 01 Electric water heater 1
- 07 15 01 Electric heater with ceramic line 1
- 07 16 01 Electric heater 1 (eventually a supplementary heater)
- 07 17 01 Air filter 1

08 – 12 + 14 Lighting ID (see below)

tt identify the type of lighting source. In case of cluster recording on more than one lighting source, use code 99.

aa identify the **room** using the following codes:

- 00 Total lighting consumption
- 01 Bar
- 02 Bathroom/Toilet
- 03 Bedroom for parents or guests



- 04 Corridor
- 05 Dining room
- 06 Entrance
- 07 Garage
- 08 Guest room
- 09 Hall
- 10 Kitchen
- 11 Living room
- 12 Office
- 13 Outside
- 14 Sauna
- 15 Stairs
- 16 Store room/pantry
- 17 Studio
- 18 Washing room
- 19 Cellar
- 20 Bedroom for children
- 21 Security lighting
- 22 Loft/Attic

nn identify the relative number of the single lamp. In case of three bedrooms with a total of 4 incandescent lamps, the numbers will be 01-04

In case of up till 10 rooms of the same type and maximum 10 lamps per room: the first digit in **nn** can specify the room number and the last digit to identify the relative number of the single lamp. Example: 08 20 11 (tt aa nn) is the first incandescent lamp in no 1 child bedroom, while 08 20 21 is the first incandescent lamp in no 2 child bedroom.

In case of up till 5 rooms of the same type and maximum 20 lamps per room: **nn** can be 01-20 for the lamps in the room no 1, 21-40 for lamps in room no 2, 41-60 for lamps in room no 3, etc. Example: 08 20 01 (tt aa nn) is the first incandescent lamp in no 1 child bedroom, while 08 20 61 is the first incandescent lamp in no 3 child bedroom.

08 Lighting GLS (also called Incandescent)

Examples 08 02 01 GLS no 1 in bathroom

08 02 02 GLS no 2 in bathroom

08 20 01 GLS no 1 in bedroom for children

99 03 01 Cluster no 1 in parents bedroom (e.g. 2 GLS + 1 halogen)

09 Lighting Low voltage (12 V) halogen

10 Lighting 230 V halogen

11 Lighting Flourescent tubes

12 Lighting CFL

14 LED

13 Cooking

- 13 00 01 Cooker 1
- 13 01 01 Oven 1
- 13 02 01 Microwave oven 1
- 13 03 01 Bread maker 1
- 13 04 01 Espresso coffee machine 1
- 13 05 01 Coffee machine 1
- 13 06 01 Ice cube maker 1
- 13 07 01 Kettle 1
- 13 08 01 Toaster 1
- 13 09 01 Food processor 1
- 13 10 01 Juice blender 1
- 13 11 01 Cooker hood 1
- 13 12 01 Egg cooker 1
- 13 13 01 Electric pot 1 (for frying chicken, potatoes, etc.)
- 13 14 01 Handmixer 1
- 13 99 01 Cluster of cooking appliances (except cooker) 1

15 Reserve

16 Other appliances

- 16 00 01 Electrical seat 1
- 16 01 01 Electrical bed 1
- 16 02 01 Automatic door 1
- 16 03 01 Water softener 1
- 16 04 01 Aquarium 1
- 16 05 01 Whirlpool spa bath 1
- 16 06 01 Sauna 1
- 16 07 01 Hair dryer 1



- 16 08 01 Electric toothbrush 1
- 16 09 01 Alarm system 1
- 16 10 01 Gas sensor 1
- 16 11 01 Guitar amplifier 1
- 16 12 01 Turntable table 1
- 16 13 01 Electric clock/Alarm 1
- 16 14 01 Electric clock with radio 1
- 16 15 01 Electric clock with radio and CD 1
- 16 16 01 Battery charger 1
- 16 17 01 Water bed 1
- 16 18 01 Curling iron 1
- 16 19 01 Iron for steam dry ironing 1
- 16 21 01 Phone call identifier 1
- 16 22 01 Simple answering machine 1
- 16 23 01 Phone-fax 1
- 16 24 01 Mobile phone charger 1
- 16 25 01 Cordless phone 1
- 16 26 01 Blood pressure meter 1
- 16 27 01 Lawn mower 1
- 16 28 01 Room odourize unit 1
- 16 29 01 Electric piano
- 16 99 01 Cluster of several small other appliances 1

17 Total consumption (mains)

- 17 00 01 Total consumption of the site.
- 17 01 01 Total consumption for installation zone/group 1
- 17 01 02 Total consumption for installation zone/group 2
- 17 02 01 Total consumption residual (mains subtracted all end-use recordings)

18 Temperatures

- 18 01 01 Outside temperature
- 18 02 01 Air conditioned room 1, mention the type of room
- 18 02 03 Air conditioned room 3, mention the type of room
- 18 03 01 Electric heated room 1, mention the type of room
- 18 04 01 Room 1 without air con. or elec. heating, mention the type of room

4. Guidelines for preparation, Installation and Data handling

4.1 Preparation

- ☐ Make appointment with the residents for the next month in order to avoid delays
- ☐ Confirm appointments
- ☐ Prepare your recording equipment (programming and configuration)
- ☐ Prepare more equipment than you need to avoid not having enough
- ☐ Site list for households including address, phone numbers and roadmap.

4.2 Installation

- ☐ Equipment for momentary power monitoring e.g. SEM10.
- ☐ All type of recording equipment
- ☐ At least one extension cord with multiple plugs
- ☐ ID appliance code list
- ☐ Installation sheet including appliances and standby consumption measured
- ☐ Questionnaire to be filled on site
- ☐ Check the switch box (size, age, quality and safety) for if it is possible to install.
- ☐ Start by explaining to the residents the way the measurement campaign will be conducted and the type of equipment you will install in their household. If the residents are negative then cancel the participation and find another household which is better than later experience some of the equipment are disconnected.
- ☐ Never give tips on how to reduce the electricity consumption before the end of the monitoring campaign.
- ☐ Never monitor two or more appliances with the same equipment unit before you know from the manufacturer if it is possible (except for the audio and computer equipment).
- ☐ Take photos from the switch box before and after the recording equipment is installed in order to avoid discussions later of the changes carried out.
- ☐ Using the SEM10, take care always to unplug the appliance from the SEM10 before unplugging the SEM10 from the main power.

4.3 Useful things to bring with you at installation

- ☐ multiplug (20)
- ☐ dominos
- ☐ male and female plugs
- ☐ wire ☐ 1,5 mm² ☐ 2,5 mm² ☐ 4 mm² ☐ 6 mm²



- ☐ cable ☐ 2x1,5 mm² ☐ 2x2,5 mm² ☐ 3x1,5 mm² ☐ 3x2,5 mm²
- ☐ adapters 20/16 A
- ☐ Colson ring clamps
- ☐ Nails, fixture accessories.
- ☐ Pocket lamp
- ☐ tools: screw drivers (8), nippers, stripper, phase tester, cutter, hammer, dry rag
- ☐ Tape
- ☐ Voltmeter
- ☐ writing support material
- ☐ scrap paper
- ☐ thumbtack
- ☐ Cork
- ☐ A little mirror for reading appliance information at their back

4.4 Information to collect at the time of installation

At the time of installation of end-use recording we must use the opportunity to collect more information by:

1. Collecting information about every end-use to be recorded - this is especially important when several appliances go in as a sum and one end-use recording.
2. Note of consumption information e.g. from appliance label
3. Size of the family, type of home and area
4. Spot metering on small appliances not included in the end-use recording – standby consumption is very important to measure e.g. by SparoMeter (equipment description later in the report).

The table below includes a list of appliances with standby consumption and serve decisions in every country on which instantaneous standby consumptions to include in the measurements.

The following system was decided for inclusion of standby consumption in the WP2 database:

- Deliver data in a text files or an excel file including four columns: household number, appliance ID **tt aa nn** (see the description in section 3), the measured standby power (in W) and extra appliance description/comment.
- Example for household number 9: 9, 030201, 3500, Sony LCD TV 60 cm
9, 061301, 2200, Motorola ADSL modem
9, 160103, 1850, Mini oven BcB2

...

Type	Appliance	Type	Appliance
Cold	Refrigerator	TV/Video	CRT TV
	Refrigerator - freezer		LCD TV
	Chest freezer		Plasma TV
	American freezer		Videoprojector
Cooking	Coffee machine		DVD player
	Cooker (oven + hotplate)		DVD recorder
	Microwave oven		Hard Disc
	Kitchen oven		VCR
HiFi	HiFi system		Combined VCR/DVD
	Speakers		Combined VCR/TV
	CD player		Combined HD/DVD
	Clock-radio		Home cinema
Office	Desktop		Satellite/cable set top box
	CRT monitor		Digital terrestrial television box
	LCD monitor		Games console
	Laptop		Security camera
	Ink-jet printer	Various	Air conditioning system
	Laser printer		Alarm systems
	Photo printer		Vacuum cleaner
	Printer-scanner-copier		Security lighting
	Scanner		Toothbrush
	Modem		Gas sensor
	Internet/TV/Phone box		Battery charger
	Computer amplifier		Halogen lamp
	External hard disk		Clothes-washer
	Electrical CD storage		Dishwasher
	WiFi module		Electrical bed
	Wireless mouse		Electrical seat
	Router		Alarm clock
Telephony	Phone call identifier		Hairdryer
	Simple answering machine		Condensation clothes-dryer
	Phone-fax		Discharge clothes-dryer
	Mobile phone charger		Water treatment
	Cordless phone		

4.5 Data handling

All partners need to set up careful systematic procedures for handling of all recorded load research data including the following functions:

1. Handling the all customers and load appliances by systematic ID (see part 3).
2. Installation with training and documentation for routines.
3. Remote reading of data every night with daily control of data. Remote reading is preferable due to the high control, but alternatively data can be taken by visit of the customer every week or at least every month.
4. Quality control.
5. Data repair/correction of failures.
6. Storage of accepted data in national database.
7. Load Research analysis facilities for own analysis.

4.5.1 ID of every recording point

See part 3 concerning the ID system to use. Enertech has provided installation sheets which can be used to keep track on all information at installation including standby consumptions measured.

4.5.2 Remote reading, integration period and type of recording

Remote reading is a benefit since data can be taken home every night and data is thus maximum lost for a day in case the equipment fails – this is especially a benefit for long campaigns while campaigns with recording only a month per customer maximum risk a loss of one month data. In case of no remote reading, it is convenient if the equipment have internal storage for the campaign period.

End-use recording in other EU project are nearly all done with 10 minutes integration period while some countries e.g. the Nordic countries has a tradition of using equipment with 15 minutes integration period. It is recommended to use 10 minutes integration period in Remodece as far as possible.

Also the total load from the electronic meter has to be recorded with 10 minutes integration period which makes it possible to calculate the residual of small appliances as the difference between the total load and all the end-uses recorded.

End-use recording is most easily installed by the plug in type which is also giving less visual discomfort for the people living in the houses and much smaller costs for installation. Clamps or cable junction must be used if the appliances can not be plug in.



4.5.3 Quality Control of data

Data must go through a standardized quality control including functions for correction/repair of data in the process or later.

No data must pass into the load research database before the user of the system has approved data.

Types of control to perform:

- Control of start of new file fits with stop of last file
- Control for excessive zero intervals
- Data values should be within a set of high/low boarders specified by the user.
- Load factor should be within a set high/low boarders specified by the user.
- Graphic display of data

4.5.4 Data Repair and Correction:

There shall be facilities for manual editing of data which the option of correcting, adding or deleting data or intervals of data. Manuel editing shall include graphical display of data. Small holes in data may be repaired based on load on same types of days and energy consumption for the period.

Any repair/correction of metered data shall be traceable by

- List of files with problems
- List of missing data for at given period
- List of data which is not accepted due to bad quality

4.5.5 National database

Accepted data is to be stores in a load recording database using the systematic ID of each customer and appliance.

There shall be procedures for data backup as well as the possibility to restore the original data.

5. Measurement campaigns in 12 different countries

5.1 Selection of customers participating

Below is described the method used in the different countries for selection customers participating in the Remodece campaign:

- BE: Households that ordered energy-audits (they pay for this service) performed by e-ster.
- BU: Household giving access and at home during the measurement period.
- CR: Household giving access and using the end-uses of interest.
- DK: 40 customers from Western Denmark and 60 customers from Eastern Denmark using the end-uses of interest.
- FR: Radio/Newspapers/Email advertisement – Participation to a home exhibition – circle of acquaintances
- GE: Selection of households with TV and computer equipment
- GR: Personal contacts
- HU: Snow ball sampling. Due to the low level available financing, and the limited reaction of the public from the small scale advertisements that we were able to do without financing, CEU started to meter households of acquaintances, and asked for further acquaintances of the participants. CEU has limited the geographical scope for the metering to Budapest and agglomeration. In the beginning we had problems in finding participants. When prices increased substantial January 2007, many people were very interested in participation in order to get information about their electricity consumption.
- IT: Own contacts and housing cooperatives
- PT: Together with the utility a random selection of customers was carried among customers with electronic telemeters. A representative sample was obtained by:
 - Cover of all four regions of Portugal (north, south, centre region and Lisbon region) with different climates and different standards of living
 - Selection due to type of household and size of annual consumption within four classes of consumption defined by the utility where the selected number of customers in each class has been found by the weighted consumption in each class.

Power range kWh/year	N° of customers selected
	The success rate is expected to be 50%.
]50,1257]	15
[1258,2425]	37
[2426,3780]	58
[3781,202580]	90

- RO: The participants were selected among the 623 consumers questioned in the survey.

5.2 Building type, equipment used og measurement period

The table below gives an overview of building type for participants, equipment used, length of the recording period per household and a status for how many households are measured and remaining for measurements by the end of January 2008 (two countries has not reported their status).

<i>Country</i>	<i>Building type for participants</i>	<i>Equipment</i>	<i>Measurement period</i>	<i>Mea-sured</i>
Belgium	Primary single family houses and a few flats	Enertech CE meters	2 weeks	100
Bulgaria	86 flats and 14 single or double family houses	SEM 16, Hobo Light	2 weeks	100
Czech Republic	More than 2/3 multi-family houses in locality of Prague	Enertech	2 weeks	115
Denmark	Single family houses	Innovus Sparometer Enertech	2-4 weeks (70 hh) and yearly (30 households)	100
France	90 single family houses and 11 flats	Enertech SEM10 Nanovip Plus	31-97 days with average 44 days	101
Germany	Mainly multi-occupancy buildings and some single family houses	Enertech	2 weeks	100
Greece	Single family houses and multi-occupancy buildings	Enertech	2 weeks	100
Hungary	53 +16 pilot multi-occupancy buildings and 26 +2 pilot single or twin family houses	Enertech Sparometer in pilot	Ave. 20 days (min. 15 days) 1 week in pilot	100
Italy	40 flats, single family or semi detached houses	Enertech	15-80 days	100
Norway	80, primary multi-occupancy buildings and then single family houses	Power Detective	2 weeks	100
Portugal	Single family houses and flats	Enertech	2 weeks	100
Romania	Single family houses and flats	Chauvin Arnoux CA 8334	2 weeks	100

5.3 Lessons learned from the measurement campaigns in the different countries

Bulgaria:

- The measurement campaign including 100 households was implemented on schedule.
- After measurements some households stopped to leave some rarely used appliances at standby.
- Many households are interested in measurement results and guidance on how to save electricity.
- Both the staff and the customers obtained increased knowledge about energy efficiency for the electrical appliances.
- Sometimes the household owner did not agree to measure a specific appliance end-use or did not give access to a specific premise.
- The majority of the households did not have all the appliances that was planned to be included in the measurement campaign.
- In some apartments, the total number of lamps was lower than 10 lamps.
- One HOBO light On/Off data logger was melted by the heat from a 200 W halogen lamp.
- A short-circuit failure happened one time by plugging a SEM 16 into a socket. Fortunately, the fault was introduced in the electric installation and not in the metering device.
- Many electricity supply interruptions appeared during the period of measurements and disturbed the data collection.
- It is very time consuming to transfer the results from the lighting loggers to the requested standard format in the project.
- Two of the Standby Energy-Monitor SEM 16 devices became out of order in the last month of the measurement campaign.

Czech Republic

- In most of the households, the metered end-uses included 55-65 % of the total electricity consumption which is considered sufficient.
- There was several problems with malfunction of the lighting loggers due damage caused by the heat from the lamps. Unfortunately, these data failures were usually found after the loggers were uninstalled.

Denmark

- It was very troublesome to be the first customer using brand new intelligent smart home wireless recording equipment as this resulted in test recordings with many types of failures appearing in more than one year. Due to these problems, end-use recordings were only performed in 10 households with this new equipment while recordings in 120 households were planned. The remaining end-use recording for 90 households were collected by two types of rented equipment by a very intensive man power effort.

France

- There was experienced a very good cooperation with and availability of the monitored households.
- It was hard to find households having all the requested appliances (especially large TV screens).
- Technical problems with monitoring electricity consumption measured by the electricity meter.
- Some data-loggers were pulled out by electricity utility which caused lack of data and recording had to be started again.

Germany

- The end-use recordings delivered very interesting results.
- Some difficulties in finding households willing to participate were experienced.
- In order to be statistically in accordance with the federal statistics mainly households with 1 or 2 persons were included.
- Clusters recordings were often used instead of single appliance recordings due to lack of equipment.

Greece

- End-use recordings on electronic equipment and lightning are performed successfully in all households.
- A limited number of recording equipment did delay execution of the campaign.

Hungary

- The measurement campaign raised interest among household owners after the energy prices increased significantly (often by +50%) in January 2007. It was very interesting to observe the change in people's attitude. Until this happened, participation was considered as a favor to us - afterwards the opposite was the case.
- When results were given as feedback, the households were very satisfied. Feedback is considered as extremely important but also very time consuming.
- CEU had success with volunteer help by very interested students in the campaign.
- The purchase of the meters was supported very well by Energy piano, who produced a valuable catalogue and guide document, and by Enertech that assisted in the detailed selection equipment and purchase from them.
- CEU had expected more guidance (help, training and advice) in the project from the experienced project partners. By starting with pilot measurements CEU overcame the lack of experience. The pilots were valuable to learn how to carry out the measurements but some of the first data had limited value and CEU did what they could to replace these by the end of the campaign.

- CEU had problems in getting the recording equipment to fit to Hungarian sockets - the French standard were usable most places but not at least 1-3 times per household leading often to exclusion of important appliances as fridge, freezer (mainly), washing machines, microwave oven and/or old monitors.
- Some serious problems were faced due to failure of some plugin recorders and lighting loggers. Half of the metering done by plugin recorders failed and were not useable. CEU had very limited resources to employ an electrician to repair the equipment. Gradually CEU identified and excluded the bad meters and got some of them replaced.
- In one household, a plasma TV burned while our meter was there. This created a large problem in the very beginning and the clarification delayed the campaign seriously. Finally, the TV manufacturer accepted the failure as their problem but CEU did find it necessary to sign an extensive insurance not included in project budget. For future campaigns, CEU recommend insurance signing.
- The project was delayed by reorganization of CEU and legal circumstances for the status of the students working in the project.
- The REMODECE metering has started an extremely important process that fill out an extremely huge gap for end-use data. We hope that such metering campaigns will happen more frequently and on larger scale in the future.

Italy

- Good availability of households interested in participation because of large interest for knowledge about on- and standby-consumption in order to improve the energy behavior.
- New technologies (TV, DVD, PC and peripherals) are easier to meter than built-in the kitchen appliances.
- Some problems with the metering equipment and the remote data collection (phone lines) was experienced. Difficulties for clamp installation for the main meter were faced in some cases (external or unsafe) – anyhow the problems were solved. Difficulties for lamp meter installation were faced for a small number of lighting applications.

Norway

- The measurement campaign has deliver interesting results.
- Selection of customers was done by use of a white goods statistical analysis performed by the SSB (Statistics Norway). Metering equipment was send by ordinary mail to the selected households. The participants usually did not have problems in installing the equipment themselves. A problem is the cost of transporting the equipment back and forth between us and the customer. The transport did take time than expected and delayed the campaign.

Portugal

- The monitoring campaign took more time and resources than planned.

- It is important to duly format the devices before installation and pay a lot of attention to the installation in order to avoid losing collected data and avoid data errors.
- Contacts have been established in order to disseminate the project and create collaboration with influent institutions including the utility EDP, the directorate general of energy, the national statistics bureaux, energy agencies and institutions doing similar projects.
- The identification of households that were willing to participate in the monitoring campaign was seen as a major constraint, and thus the collaboration with the Electric Utility EDP, and with other smaller companies was established. However, this solution compromises whether the sample is representative, but was the only way to find interested households within the timeframe.
- EDP did assist in making a representative sample of customers who have intelligent meters installed in their homes because that gives access to recording of the total household consumption.
- The households were very keen on the results of the audits and very collaborative. A short report was prepared for some households, and others did receive a CFL as a gift for their participation. The majority have already heard about energy efficiency and energy efficient appliances but they do not really understand why these appliances can save them money and therefore they had serious scepticism on the announced savings.
- The limited number of sets of monitoring equipment did not enable to record all the electronic equipments within a household. ISR-UC tried to buy additional sets from Enertech, but they were out of stock. Therefore, with respect to monitoring electronic loads and entertainment equipment, ISR-UC did record the load sum for every set of appliances (e.g. a cluster of entertainment appliances and a cluster of computer equipment). Spot measurement was executed for the different modes of operation of every single appliance. The same approach was used by ADENE. Due to the manual recovery data information of the auditing equipment the ADENE recordings was limited to eight different equipments in the household (including the monitoring of total consumption).
- Sometimes, problems with invalid metering data download were faced for certain appliances. The fault was usually due to a mistake made in the installation or technical failure of the metering equipment. It is important the installers pay large attention during the installation of the recording equipment.
- The manual data recovery strategy used by ADENE optimized the quality of data information, without presence of errors. However, during the audit campaign some technical problems occurred that caused the elimination of the data and repetition of the campaign in the same household.

- ADENE experienced also problems with lighting loggers. After correct programming and installation, the downloaded data had several errors, which limited the number of lighting points measured.
- An important constraint was difficulties faced in installing the measurement devices, in particular for monitoring air conditioning loads that don't have a plug but are directly supplied from the mains. This required more sophisticated equipment. Besides this the last summer in Portugal was cold compared to previous years, and therefore the need for using air conditioning was reduced. Only 10 air conditioning devices was monitored during the summer 2007.

Romania:

- The measurement campaign was especially successful in the dwellings which belong to the employees of the ARCE territorial branches.
- It was not possible to record the consumption of all appliances, because of lack of enough project funds to buy the necessary amount of equipment. Some equipment from other projects was also used to overcome this problem as good as possible.

General problems meet in the measurement campaigns has been:

- Difficulties in finding households with the requested appliances (especially large TV screens).
- Technical problems concerning monitoring of the total consumption measured by the electricity meter.
- The lighting loggers from Enertech are very sensitive and some times data are lost.
- Cluster monitoring of the summated load of several appliances instead of separate end-use monitoring has been performed due to lack of equipment.

6. Equipment used for end-use measurement in the REMODECE project

6.1a SEM 10 – Stand by Energy Monitor



Website: <http://www.nzr.de>

Features:

Manual reading of:

- Energy consumption in kWh (pr. Day, week or 30 days);
- Energy costs, currency-independent display (costs);
- Minimal power (W);
- Maximal power (W);
- Current power (W);
- Current current-consumption (A);
- Current voltage (V).

Experience with use of the equipment:

- ISR, University of Coimbra, Portugal

Price/unit: 40 €

18.1b SparoMeter NZR 230



Website: <http://www.sl-electric.dk/>

Features: Same equipment as SEM 10

Experience with use of the equipment:

- Most of the participants e.g. CEU University, Hungary

Price/unit: Depend on the number of units bought.

6.2 Power Detective



Website: <http://www.sl-electric.dk/>

Features:

- Load recording including 70000 loads each with time stamp
- Integration period 1, 5, 10 , 15, 30 or 60 minutes
- Able to record loads in the interval 0,2 – 3600 W (max 2% failure)
- Configuration by power line or internet (through router) connection
- Display of kWh, costs, minimum and maximum load plus actual load, current and voltage
- Data are transferred to a data collector unit by m-bus protocol
- Remote reading by Internet router by TCP/IP 10/100 base T(TX) protocol
- Optional can be added a relay for demand response (load management)

Experience with use of the equipment:

- SINTEF Energy in Norway and Danish utilities

Price/unit:

- 116 € per Power Detective unit (depend on the number you are buying).
- 773 € for Web-server with memory card to collect all the data by power line from all power detective units sued in the house.
- 57 € for powerline modem with USB interface.

6.3 CE Leistungs-energiemessgerate



Website: <http://www.christ-elektronik.de/www/produkte/messgeraete/leistungs-energiemessgeraete/>

Features:

- Version 1 display W and kWh
- Version 2 display W, kWh, V, A and kWh/hour (average?) and costs
- Version 3 also has a pulse output to record load time series and can also measure reactive load.
- Christ also sells a meter recording W and kWh and optional pulse output for load recording.

Experience with use of the equipment:

- E-ster bvba, Belgium (has 77 CE version 1 and 3 CE version 3)

Price/unit: 120-150 € for version 1 of the equipment depending for 10-10 pieces
Around 220 € for version 3 and around 150 € for software

6.4 EMU 1, EMU 10.MEMO Electronic Meter

Web-site: <http://www.emuag.ch/englisch/produkte/steckdosen/steckzaehler.htm>

Features:

The electronic meter **EMU 1** provides instantaneous values.

EMU1.x4K and EMU-CHECK plug-in energy and power analyser with consumption cost accumulation in EURO by setting cost per kWh.

EMU 10. MEMO is used to find the quality and quantity of the electricity consumption as momentary values or load profiles. It is a single-phase electronic electricity meter of class 2 accuracy having a maximum current rating of 16 A. It measures and stores the following values:

- Real Voltage (momentary value) 176 – 264 V
- Real Current (momentary value) 0.010 – 16 A
- Active Energy 0.00 – 999 kWh
- Apparent Energy 0.00 – 999 kVAh
- Reactive Energy 0.00 – 999 kvarh
- Active Power (momentary value) 0.000 – 4.22 kW
- Active Power Demand 0.00 – 4.22 kW every 5, 10, 15, 30 or 60 minute
- Apparent Power (momentary value) 0.000 – 4.22 kVA
- Reactive Power (momentary value) 0.000 – 4.22 kvar
- Power Factor (momentary value) c 0.02 – 1.00
- Network Frequency (momentary value) F 45.0 – 65.0 Hz



The **EMU 10. MEMO** metering system is an open system including:

- Electronic Meter **EMU 10. MEMO** with power plug or clamp-on type current transformer
- Bi-directional infra-red Interface for data transfer and configuration
- Battery-supported real time clock.
- Synchronisation of values in several units by programming the date and hour of the start along with the time interval between the reading of values (between 6 seconds and 99 days)
- NVRAM (non-volatile data storage memory) capacity is 256 kbytes (optional 128 or 512 kB) that can include 7 electrical values with time stamp measured every minute for up to 7 days.
- The display of values might be faded out on the instrument by configuration.
- Configuration and data transfer Software **EMUMEMW**

Experience with use of the equipment:

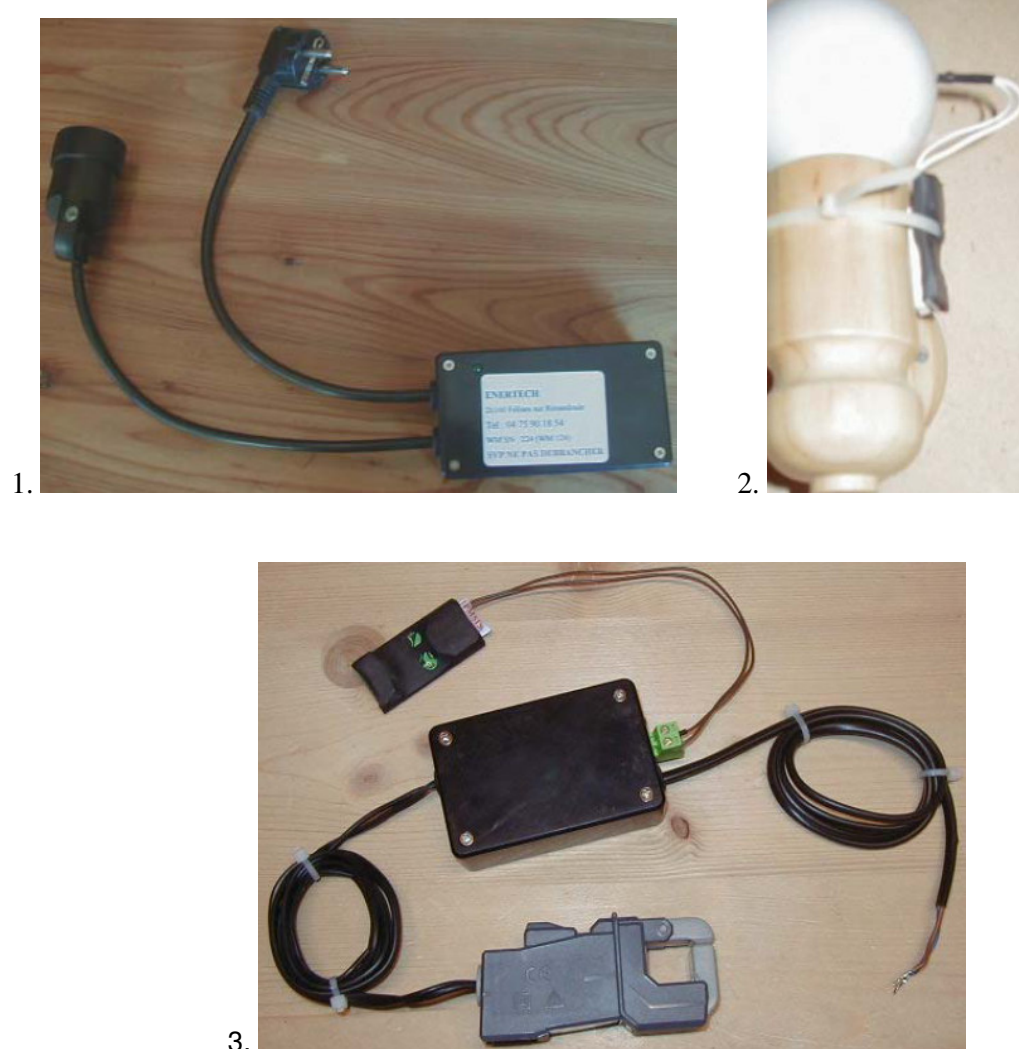
- ISR, University of Coimbra, Portugal
- ADEME, France

Price/unit (€):

EMU 10. MEMO "Starter set" (1 unit, optical interface and EMUMEMW)
Additional EMU 10. Memo (in case software is used at the same pc)
EMU1.x4K
EMU1.x8K or EMU1.x9K

1-9 units	10-24 units
592.1	
526.3	526.3
138.2	134.9
197.4	193.4

6.5 Enertech Data Loggers



Website: <http://siedler.club.fr>

Products and features:

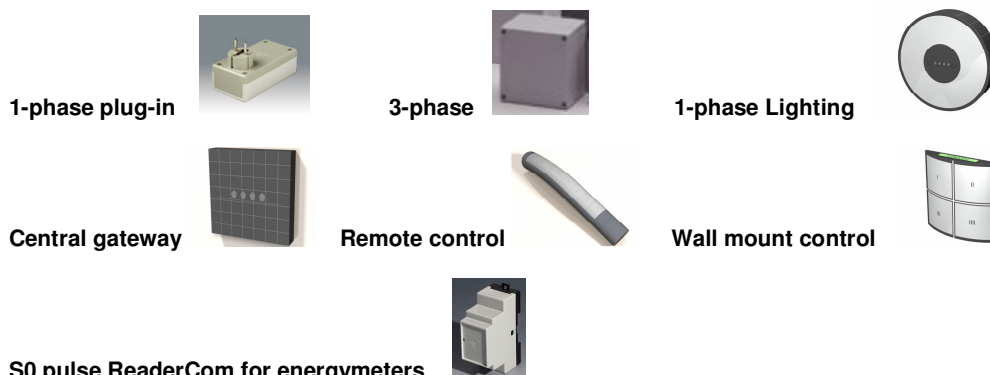
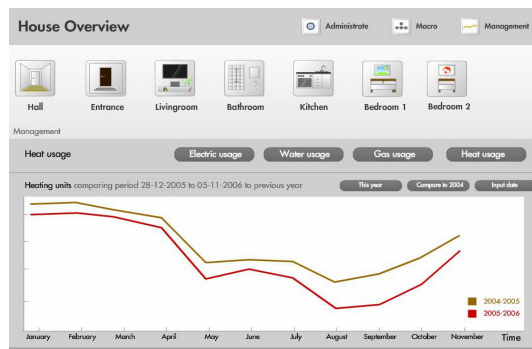
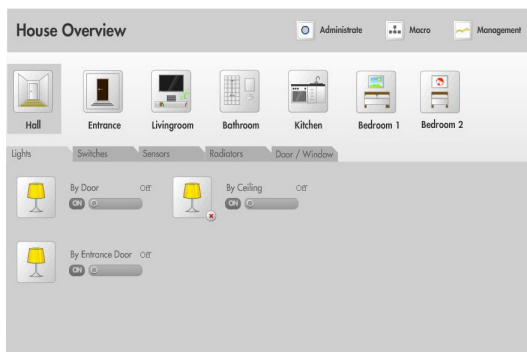
1. Serial watt data logger for maximum 2600 W that works autonomous for 1,2 year with 10 min. integration period. Data are then transferred to pc by Oscar software.
2. Lamp meter logger that require no connection to supply network. Recording up to 32000 events time of the events of turning lighting on and off. Oscar software transfer data to pc.
3. Wattmeter with amp clamp and pulsemeter (the weight of one pulse is 0.5 Wh). It works autonomous for 1.2 year with 10 min. integration period and measurement range 3W – 22kW. Data are then transferred to pc by Oscar software.
4. Thermometer (-50 – 120°C) 1,2 year data with 10 min. integration period. Oscar software.

Experience with use of the equipment:

- Many of the participating countries are using this system or the former system manufactures by Enertech.

Price/unit: Product 1: 120 €, 2: 35 €, 3: 165 €, 4: 45 € and Oscar software: 500 €.

6.6 INNOVUS MyHome@



Website: www.Innovus.dk

Features:

- Home automation system using wireless communication by the Z-wave system
- Management, controlling and data access by interfaces pc, local touch screen, tv screen plus set top box or Mediacenter, cellular phones or PDA.
- 1-phase plug-in unit for load recording but can also serve as relay based switch (on/off).
- 3-phase cable junction for load recording but can also serve a relay based switch (on/off).
- Lighting unit cable junction for load recording but can dim the lighting by touching the unit or by remote control or software based front end.
- Central gateway coordinating all data flow and storing of data for several months.
- MyHome@ application for user management also include consumption feedback.
- Control by Web-interface, own or B&O remote control unit or wall mount switch.
- S0 pulse ReaderCom for recording on energy meters.

Price/unit (approx. dimensions l/w/h [mm]):

- | | |
|--|--|
| • MyHome@ softwareapplication | € 8 product fee + €1 monthly license fee |
| • 1-phase plugin unit (120 x 65 x 40) | 50 € |
| • 3-phase unit | 107 € |
| • 1-phase lighting unit (diameter 90, height 30) | 47 € |
| • Central gateway (120 x 120 x 40) | 162 € |
| • Remote control unit (180 x 30 x 25) | 47 € |
| • Wall mount controller (65 x 65 x 15) | 36 € |
| • S0 pulse ReaderCom for energymeters | 57 € |

This equipment used by: Denmark