European Commission
Intelligent Energy – Europe

Energy Savings from Intelligent Metering and Behavioural Change

Contract N°: EIE/04/107/SO7.38635

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Train-the-Trainer Work Modules

Work Package 7: Dissemination
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Train-the-Trainer Work Modules

For a further dissemination of the Intelligent Metering system it is necessary to provide the gathered information of the Intelligent Metering project in detail to interested people. Therefore the so called train-the-trainer work is carried out. The material for the train-the-trainer workshops contains this Document with an introduction into the train-the-trainer work modules and linked slide packages for each work module for a serious train-the-trainer education.

In general a trainer will know the following details of the Intelligent Metering system after a train-the-trainer workshop:

1. Knowledge about every key step along the road of an IM exercise
2. Examples of how such an exercise was implemented during this IEE-project
3. Knowledge about different training materials and training techniques
4. Examples of how such training was implemented during this IEE-project and how effective those measures were

The following work modules are described in detail in this document:

Module 1: Monitoring objectives, building information and monitoring parameters
Module 2: Definition of the hardware for the monitoring system and the data transmission
Module 3: Selection of the energy accounting approach and the necessary software
Module 4: Training strategy and possible training techniques
Module 5: Training actions and material used during Intelligent Metering
Module 6: Experienced outcome and payback

Intelligent Metering, Monitoring and Training

Introduction

The building sector is responsible for a significant proportion of energy consumption, within the European Union, it accounts for around 40% of total consumption. Intelligent metering can be used to maximise the energy savings available from the implementation of efficient technologies and products as well as from the recognition of problems and system errors. In addition there is scope for further energy saving by using the data to support training and promote responsible energy behaviour by building users. By changing building occupant behaviour energy use can be rationalised.

This document aims to give a short introduction to all the experience gained throughout the project entitled *Energy Savings from Intelligent Metering and Behavioural Change* (the Intelligent Metering Project) EC contract no: EIE/04/107/SO7.38635, a project which has demonstrated economic savings of up to 30% with little or no investment. It is part of the train-the-trainer work and should be used in train-the-trainer workshops along with the related slide packages. For a more detailed description of the Intelligent Metering project and the experiences gained please refer to the Intelligent Metering Roadmap, which is also available for interested persons.

The document is divided into six different work modules. They are interrelated and should be worked through as a whole to get the complete picture of the Intelligent Metering work.

1 Module 1: Monitoring objectives, building information and monitoring parameters

Before the installation of an Intelligent Metering system some basic work has to be carried out. The objectives of the monitoring have to be defined and some important facts about the buildings should be found out. With that information the monitoring parameters can be defined as the basis for the further definition of the hard- and software of the Intelligent Metering system.

1.1 Monitoring objectives

First for our monitoring system the decision must be made as to why the monitoring is required:

- as an overall objective of reducing energy and water consumption,
- as a tool to control plant and devices for malfunction,
- as a tool for rating contracting and redevelopment measures,
- to provide information about different aspects of the building,
- to assess trends in consumption and react to them more quickly,
- to calculate specific costs.

In the further description we act on the assumption that the monitoring objective is mainly for the objective of reducing consumption. This is also important because i.e. for the calculation of cost better and more expensive meters and data transmission systems have to be installed (i.e. for cost calculation meters calibrated and the prevention of lost data must be guaranteed).

1.2 Building information

The information regarding the building type is required to allow analysis and assessment of measured parameters in a realistic and useful way. This is often known as the measuring data and may include some or all of the following:

Field	**Comments**
Floor Area (GIA)	For use with heating metered items, usually gross internal area, floor area excluding walls
Heated gross area/volume	To help define between heated and un heated areas – if different
Occupancy levels/ Staff Numbers/ Building users	Figure used to ascertain the number of people using the building services, i.e. water, heating and electricity.
Occupancy usage	Hours/day, days/week, weeks/year – to allow usage patterns to be defined and hence problems identified.
Location sheltered/normal/exposed	Maybe required as part of the heating based information
Building ID/Code	Unique identifier often used when more than one building is being monitored mainly for analysis purposes
Building Name	Potentially required part of the identification process

Building Type/Alias	To allow easier comparison of different building types this may help any analysis software
Building Address	Maybe required as part of the identification of location for external climate information
Date Built	Maybe required in relation to build type, likely levels of insulation, etc
Outside temperature	As part of the heating assessment
Type of service being metered	Electricity, Gas, Mains Water, Oil, Coal, Hot Water Heat, or other (please specify)
Pulse value	Value of one unit in the collected data, i.e. in kWh for energy meters, or cubic metres for water meters.

Table 1: Typical measuring data

Field	**Comments**
Additional activities and date	Critical activities in relation to items that could externally or internally affect consumption profile of metered elements
Larger electrical/heating/water consumption devices	To enable specific losses to be reviewed
Category of usage	May be the same as building type although this may be for specific categories if comparisons are being made, e.g. school
Detailed specification of usage	To allow more detailed analysis on comparison, e.g. extended primary school opening for whole day (?)
Alarm level	Many packages will trigger an alarm if levels vary from “normal” consumption.

Table 2: Typical additional data

This type of information can be found out before or at least during the installation of the hardware because this is necessary for a detailed analysis of the consumption and the user behaviour. During operation changes have to be noticed and updated within the database.

1.3 Monitoring parameters

Almost every parameter could be monitored, however the costs for the device and metering and the need to meter it must be considered.

Typical parameters might include:

- Mains water or sewerage,
- Gas,
- Electricity,
- Steam,
- Hot Water,
- Oil,
- Industrial and medical fluids and gases.

Some parameters to monitor will not be metered but monitoring must be considered in terms of their identification, i.e. unit of the amount (kWh, MWh, etc.), ID number of the metering instrument or building, time stamp (generally given by a main counter, data logger or building management substation). The key parameter is the amount of energy or water used since the last time unit.

Other important parameters are those relating to climate. Temperature is clearly an important parameter since there is often a clear connection between temperature and consumption, i.e. in terms of heating requirements.

For the Intelligent Metering project the scope was to monitor heat, electricity (both in kWh) and water (in m^3). In most situations one counter per object was used.

2 Module 2: Definition of the hardware for the monitoring system and the data transmission

2.1 Necessary Meters

A meter review will allow existing meters to be surveyed. It is also required to identify the need for, and potential location of, additional meters. The basic step is obtaining useful data from the meter, usually a pulse output.

There are a multitude of meter types and choices. Each product range has features which will impact on performance and cost so must be considered in terms of best value for money. Almost invariably, meter size has an impact on accuracy and cost. For more detailed information especially on meters refer to the Intelligent Metering Roadmap.

2.2 Data Transmission

Meters can easily be read manually but this is time consuming and can usually only be done infrequently. There may also be limitations on when this can be carried out, e.g. in schools, during holidays. Automatic meter reading carried out at frequent intervals, typically every 15 or 30 minutes, will allow the data to be used to its full potential.

There are a number of approaches for transferring data from a meter to a computer or similar where they can be analysed. These include using an existing Building Energy Management System (BEMS), dedicated hard wired data logging networks, modems, Local Area Networks (LAN), low power radio, mobile telephone systems and internet based systems. The most suitable option will depend on: the services already available within the building, BEMS, LAN, etc.; and the site layout, i.e. proximity of the meters to the initial data collection point.

A data logger is commonly used to collect data. The collected data are stored in a non volatile memory and read out in certain intervals. The data can be sent to a computer or called by request from the computer (by a remote procedure call). Data shuttle is a system which uses a hand held device for data download from the logger.

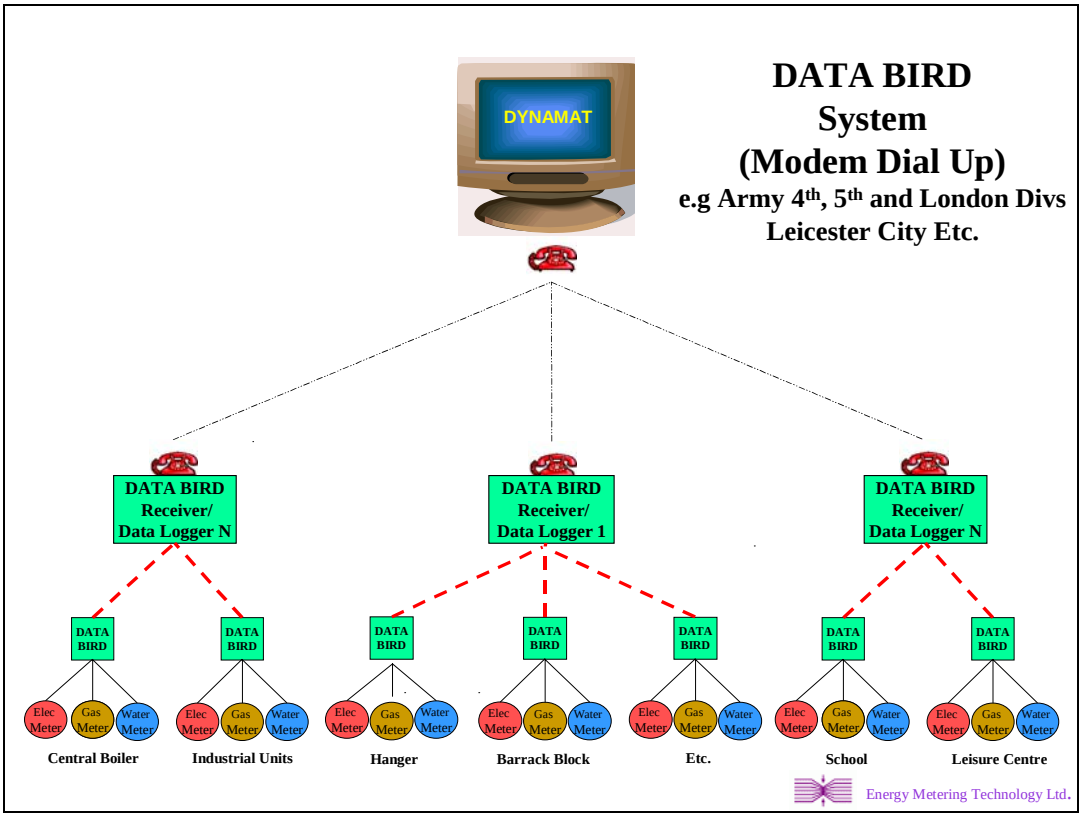

Figure 1: Fully automated energy accounting system with presentation of the data on a local computer.

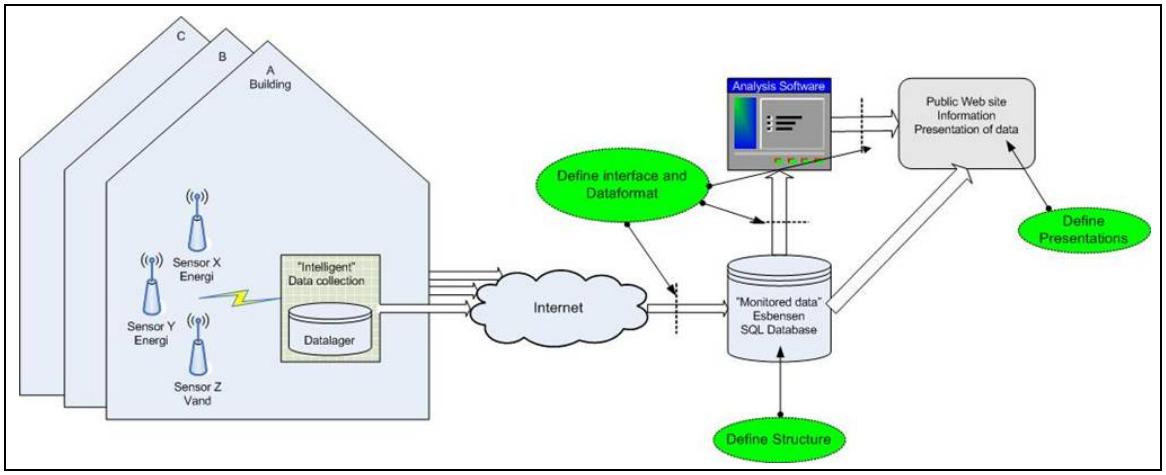

Figure 2: Fully automated energy accounting system with presentation of the data on a public website.

3 Module 3: Selection of the energy accounting approach and the necessary software

As noted previously the choice of software/approach to data analysis is critical to a successful project. The analysis software may be considered the most important part of an intelligent metering and monitoring system, since it is the eyes and brain on the data that provides the user with useful results to help achieve energy savings.

The schema of monitoring is the same for all approaches. Differences are in the degree of automation, in the access of the monitored data (local or public) and in the scalability.

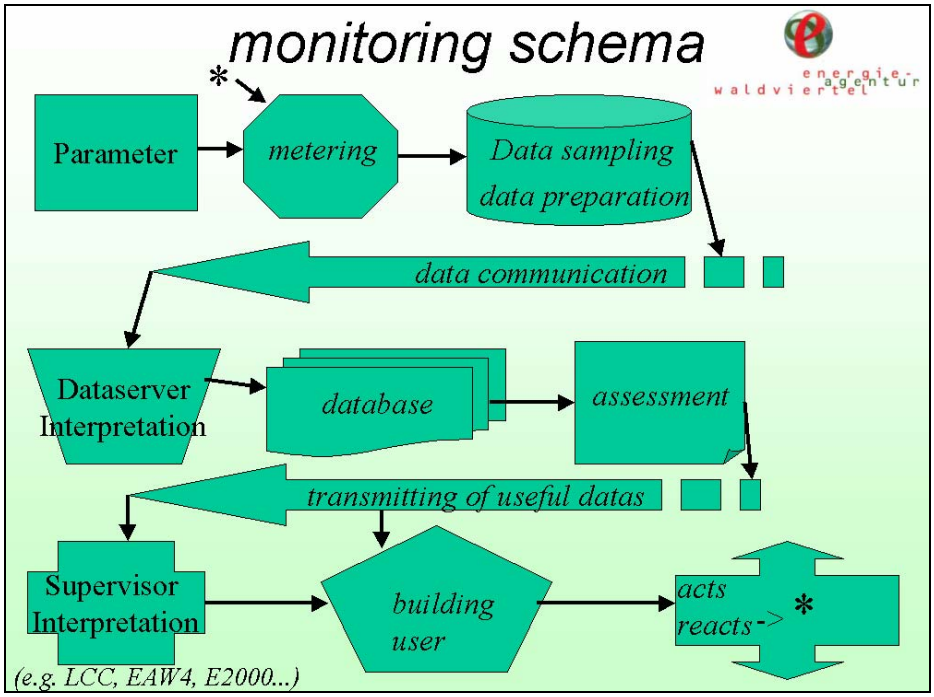

Figure 3: The components for monitoring

3.1 Stand-alone energy accounting programs/software

Some programs allow for remote data transmission and the software programs are more complex than those used in spread-sheet based systems which are basically not applicable for Intelligent Metering projects. There is still a wide range of level of complexity within the stand-alone programs with simple programs intended for the non experienced user and complex programs for skilled professionals.

3.2 Networking

Here a WAN (wide area network) provides all users with access to the energy accounting system. The users log in at the server, where the database for all users/clients is situated. The data of different buildings can be compared easily: Benchmarking is possible. Support and central updates provides more help to the user/client. Data input can be done manually at different places at user/client computers, and remote data transmission is often possible, too.

- **Client's own energy accounting software**

If the user/client also has the energy accounting software on their computer it may be called an Intranet-Energy-accounting system.

- **Energy accounting by application service provision, server based**

The state of the art is to use the Internet for the energy accounting process. The software is installed at the server. The users simply login, with password, via a special website on the internet. This is called Internet-energy-accounting. In this case the user/client does not need his own software programme but uses the standard software browser of his personal computer. The administration may be sold as a service.

- **Energy accounting by application service provision, server based, including automated data input from remote sensors**

The final step to fully automate the energy accounting process is to send the counter/meter reading automatically. This also allows shorter data reading intervals. The software automatically analyses this short interval data and compares it to standard usage. Feedback is only provided if there is a variation/problem detected.

During the Intelligent Metering project the most sophisticated approach was used. A short data interval, 30 minutes, was utilised to recognise deviations from normal operating conditions easily.

After choosing the most interesting possibilities for the buildings which should get metered, the next step is to ask for bids and to buy the software / service for the buildings and install it.

4 Module 4: Training strategy and possible training techniques

Very wide and varied options exist for approaches to training. The purpose of any training should be related to the initial objective. For this reason the training objective for the Intelligent Metering project is to train building occupants in energy and water saving through behavioural change and to encourage and allow the building occupants to relate to the data being provided to support this behavioural change.

4.1 Training strategy

A broad approach to changing behaviour was adopted. Drivers were identified that can help citizens act more sustainably.

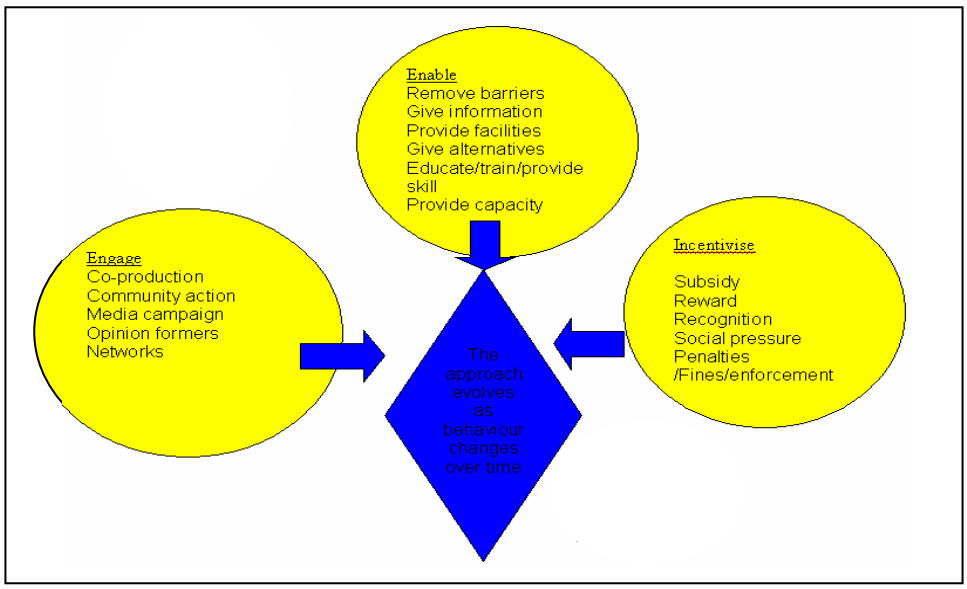

Figure 4: Training approach used in the Intelligent Metering project.

The known factors that impact upon the sustainability of an individual's behaviour and actions are divided into three categories.

- **Enabling** - this is the range of techniques and factors where the intervener provides alternatives to existing unsustainable actions and behaviours.
- **Engaging** - these are the tools available to communicate with and engage in the sustainable development process.
- **Incentivising** - in this case they are municipal authority interventions, for example rewards for reducing energy and water use.

To ensure that these drivers translate into real change the following also needs to happen:

- **Catalysing** - this is where combinations of the three drivers are brought together with one key element that stimulates mainstream change in actions and behaviour.

4.2 Training techniques

Factor 1: Enabling

These are the steps that a project should put in place to encourage and allow the changes required to take place. In the case of the Intelligent Metering Project this would be promoting building users to act more sustainably and hence reduce the consumption of water and fossil fuels. Steps could include:

- Removing barriers - Much unsustainable behaviour is justified by the absence of easily accessible alternatives. Convenience and ease of use are key factors.
- Information giving - accepting that information giving has a role to play, but with an analysis of how it works will make any information supplied have a bigger impact.
- Educating, training and providing skills capacity – for the Intelligent Metering project work it was recognized that training and providing capacity to adults has proven to be one of the real success stories in changing attitudes towards sustainability.
- Staff development - encouraging the involvement of any human resources department should be very beneficial. Their remit after all is to create a motivated workforce.

Factor 2: Engaging

Typically these are actions of groups or individuals that promote citizens to act in the required manner, in this case more sustainably. This includes activities:

- Involving building users in other projects on the key theme, i.e. ‘sustainability’, can have a big impact on engaging stakeholders in the project.
- Community action involving the local community, of which stakeholders may be a part.
- Co-production is intimately involving the stakeholders, i.e. building users, in the process of their development.
- Personal contacts - individuals will listen to those in positions of power and credibility when they communicate a message of power outside their area.

Factor 3: Incentivising

The provision of incentives can be made through:

- Rewards, i.e. for the Intelligent Metering Project there was rapid feedback when intervention strategies were implemented and progress was gratifying for building users.
- Recognition and social pressure which might involve use of a staff newsletter/journal and involvement of staff in support activities.

Factor 4: Catalysing

This is the key driver that makes behaviour change happen on a large scale. It appears that it is the ethical and moral reasons that have underpinned, for instance, the change from recycling being a peripheral to a mainstream activity. If ethics and moral considerations are likely to have an impact on the stakeholders then we should use appropriate information in our posters and literature.

4.3 Training summary

The findings from research and, specifically, the approach used within the Intelligent Metering Project indicate that:

- Single interventions to support building users to change their behaviour are unlikely to be successful. A programme of measures needs to be put into place.
- Information alone e.g. a poster campaign, is unlikely to support municipal staff in actively changing their behaviour.
- Persistence is fundamental. Unsustainable actions will be deep rooted and it will take a long time to change these.
- Any project will lose its impact if it does not have anything to ‘exchange’ with the building user.
- In schools the teacher will become engaged with the project if improved energy efficiency improves the learning environment and thereby the attainment of the pupils.
- In buildings in general the office worker who cares about global issues will become engaged with the project when links are made with climate change and, for instance, the impact on low lying coastal states.

5 Module 5: Training actions and material used during Intelligent Metering

5.1 Training actions

Training has been provided to the building occupants on changing their usage patterns in order to save energy and water. Other work has identified a number of ways in which buildings can make savings. These results have helped in developing training material. Training sessions have been carried out within each building so the occupants can be introduced to the Intelligent Metering system and see the results coming from these. The strategy behind the training can be seen in the figure below.

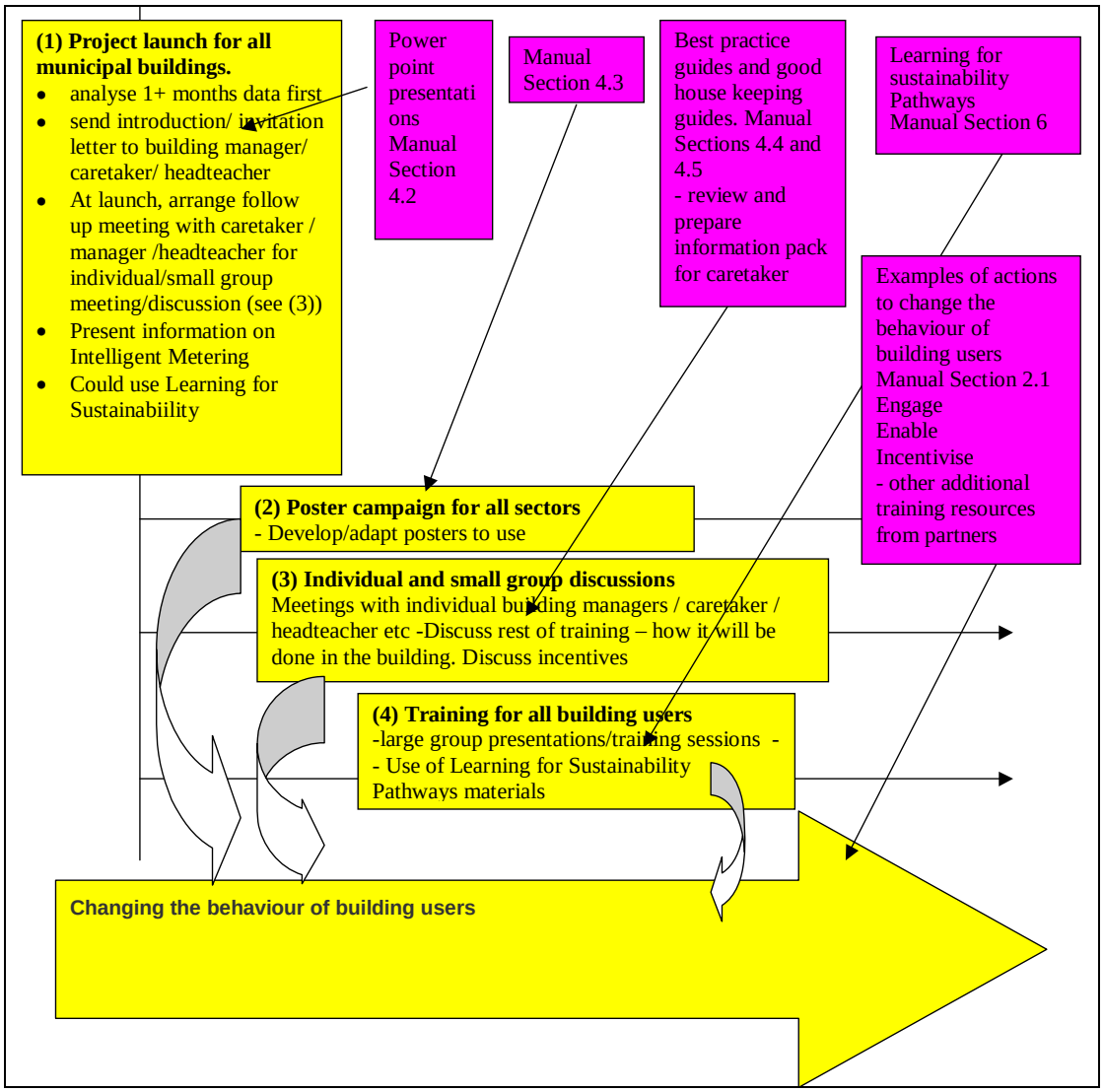

Figure 5: Different training actions were carried out depending on the occupants and the timeline of the project.

In addition to training sessions, posters have been developed or selected to be displayed around the buildings, reminding the occupants of the training they have received and important actions they can implement. Mechanisms for enabling, engaging and incentivising building users have been considered in the training.

Further detailed information on the training actions used within the Intelligent Metering project can be found in the training manual (training handbook) for schools and for non-school-buildings.

5.2 Training materials

To make the training sessions more sustainable quite a lot of training materials have been used and partly newly developed for the Intelligent Metering project.
Within some workshops special importance was given to various presentations and an on-time review of the website www.intelmeter.com with a check of the recent energy usage patterns of the building.
Handouts, flyers and brochures have been developed for the use in workshops and individual meetings. They have a place for notes and are mostly very practically orientated.
Posters, stickers and other reminders were used to increase the chance that the information given at the training session will be remembered afterwards as often as possible.
A special system with red and green dots has been developed and used to highlight good and bad energy consuming devices, e.g. the limited water flush pushbutton at the toilet got a green dot, the unlimited water flush pushbutton a red dot.

Figure 6: Different training materials used in the project: posters and manual

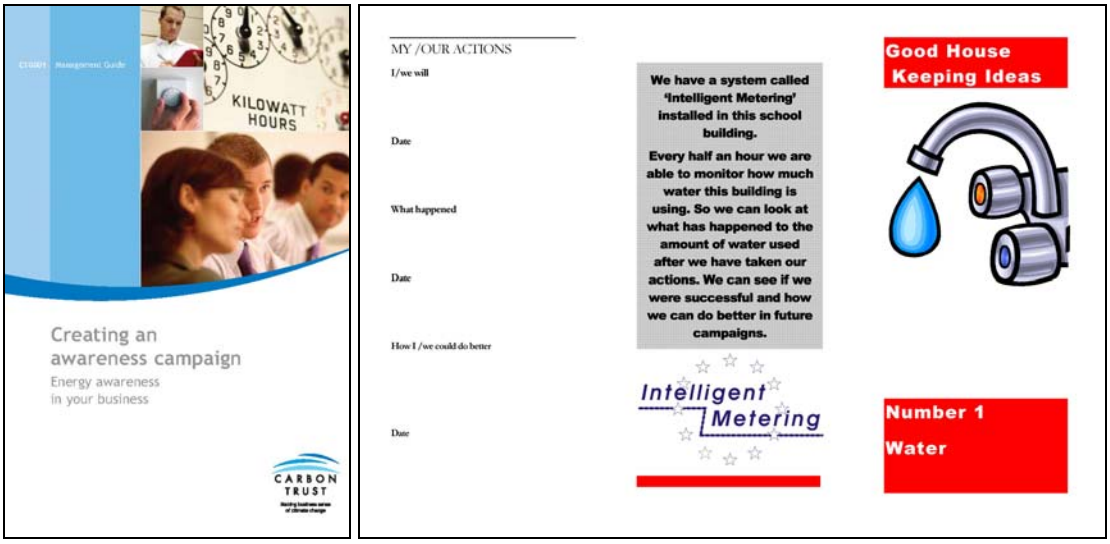

Figure 7: Different training materials used in the project: booklet and flyer

A list of existing training material was produced during the project and is available for interested persons. The training materials developed within the Intelligent Metering project by the project partners are available for download on our website www.intelmeter.com.

6 Module 6: Experienced outcome and payback

6.1 Costs

The main parts of the cost are installation costs for metering hard- and software. These are dependent on the chosen metering system (see Modules 2 and 3) and on the number of buildings metered. Running costs can occur when software has been chosen which has to be paid for monthly. Running costs for electricity are minor. Maintenance must be carried out but when there was a proper installation there isn't much per year. Existing technical staff should be in charge of this.

During the Intelligent Metering project we experienced installation costs of Euro 2.500 to 5.000 per building, strongly depending on the metering system.

6.2 Savings

Experienced savings are of course dependent on various factors: the information level of the users, the quality of training, possible leaks and false settings of the technical systems of the building, the engagement of the users, the climate and the quality of the building, just to point out some important factors.

We recommend starting with buildings where it is known that they are using more energy compared to others. There the impact of an Intelligent Metering system is the strongest because: "If you can't measure it, you can't manage it!"

The following two graphs show, that reductions up to 65 % are possible, depending on the starting level.

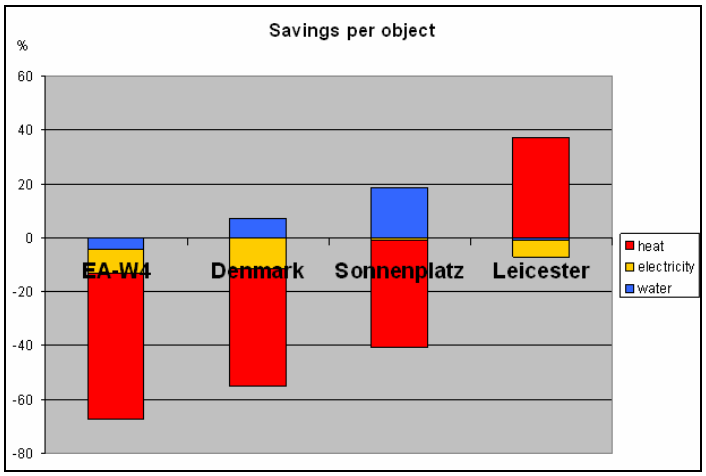

Figure 8: Savings per object in the month after the training compared to the month before.

Figure 8 shows also an increase in heat and water consumption in Leicester respectively at Sonnenplatz. An in-depth analysis of these figures shows, that this is mainly due to climate matters and unfavourable dates of trainings (beginning of heating season…).

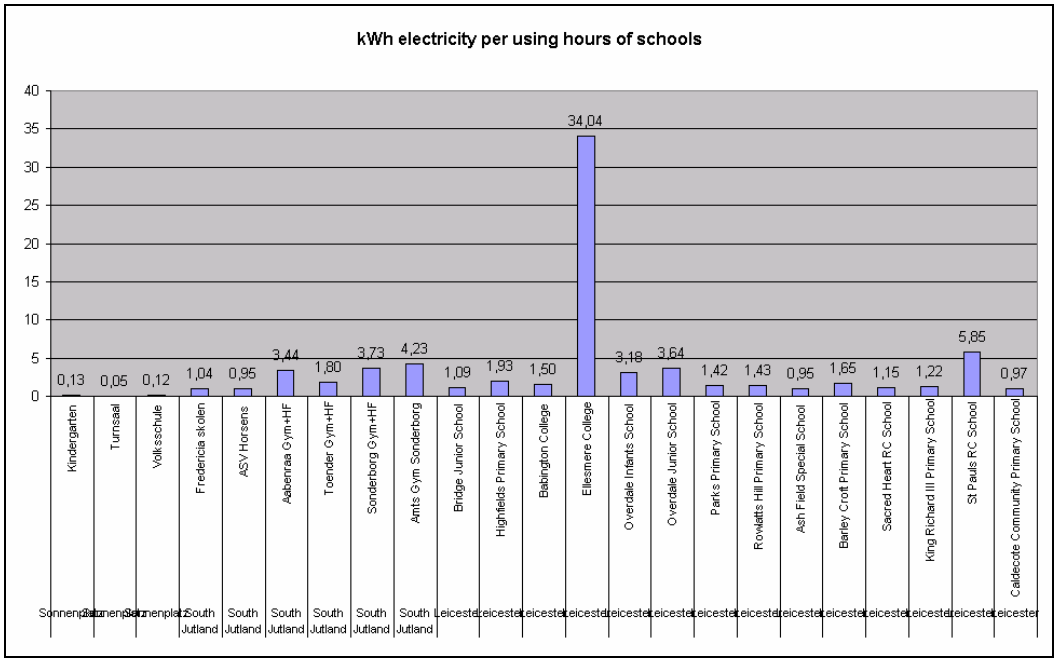

Figure 9: Benchmarking shows need for action.

Figure 9 shows unusual water consumption in one building compared to similar other buildings. Without the data of Intelligent Metering this fact couldn't be highlighted and proper stopped.

An example of a boarding home for older people in Austria shows savings for one year. Therefore we compared the use of electricity and heat in 2002 with the use in 2006. For the heating heat degree days were used to correct climate differences.

with inteligent metering	Electricity	Heating
savings [MWh]	56	175,8
savings [€]	7840	8790
savings [t CO2Eq]	20,4	47,6

Figure 10: Savings in a boarding home for older people in Austria in one year.

6.3 Payback

Some general statements on the payback of Intelligent Metering:

- When there are leaks or false settings in the technical system, Intelligent Metering normally pays back within one year by detecting and solving this problem
- When the level of energy use is rather high, Intelligent Metering is a good way to raise the awareness of the users. Depending on the quality of the training measures and the engagement of the administration the pay back should be granted in very few years, sometime even months.

- When the level of energy use is rather low, Intelligent Metering gives information on the usage pattern in more detail and hints for further optimization. Normally users are well informed in those buildings. So Intelligent Metering there helps to continuously inform about energy consumption and will provide alarms if failures occur. So Intelligent Metering can be seen as a kind of insurance there, which will pay back at least when failures occur.

Furthermore, the installation of Intelligent Metering isn't just an economic matter. People involved in the project are aware of energy costs and energy savings. Therefore Intelligent Metering is an intelligent education measure, too, and will raise the competence and knowledge of all involved building occupants.