Energy Savings from Intelligent Metering and Behavioural Change

Contract N°: EIE/04/107/SO7.38635
January 2005-December 2006

Final report – Project results

2007

Co-ordinator:
Leicester City Council/Leicester Energy Agency (LEA) (UK)
Partners:
County of South Jutland (Denmark),
Energieagentur Waldviertel (EAW4) (Austria),
ENERGIE 2000 e.V. (Germany),
Esbensen (Denmark),
IT Power Ltd (UK),
Sonnenplatz Großschönau GmbH (Austria).

Name of project: **Energy Savings from Intelligent Metering and Behavioural Change (Intelligent Metering)**

Contract number: EIE/04/107/S07.38635

Location of project: Austria, Denmark, Germany, United Kingdom

Duration of project: January 2005 – December 2006

Project value: € 858,814

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Project purpose:

- The project has aimed to demonstrate and promote the savings available from the use of intelligent metering and training occupants in public buildings and to show that these savings can be achieved at little, or no, additional cost.

- The overall objective of the project has been to maximise the energy savings available across Europe through the use of intelligent metering and behavioural changes of building occupants.

Key results of project:

- About 70 public sector buildings in 4 European countries (Austria, Denmark, Germany and the UK) have undergone automatic remote monitoring of energy and/or water consumption.

- Training material has been developed and collected in the project for use in training the occupants of the buildings being monitored. A wide range of training related activities have taken place, with the help of the intelligent metering information, to encourage behavioural change of the building users.

- Energy savings from the use of intelligent metering and behavioural change have been demonstrated.

This report gives details of the results of the IEE supported Intelligent Metering project. It has been compiled by the Leicester Energy Agency using information from the other project partners and individuals involved with the project.

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Summary

The European Commission supported 'Energy Savings from Intelligent Metering and Behavioural Change' project has involved 7 partners from 4 European countries; Leicester City Council (Leicester Energy Agency) and IT Power (UK), Energieagentur Waldviertel and Sonnenplatz Großschönau (Austria), County of South Jutland and Esbensen (Denmark), and ENERGIE 2000 e.V. (Germany).

Introduction

The building sector is responsible for a significant proportion of energy consumption within the European Union, accounting for around 40% of total consumption.

Intelligent metering includes analysing half hourly energy and water consumption data to identify savings opportunities, for example by changing the behaviour of building owners, tenants and occupants to achieve energy and water savings.

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 unusual consumption and problems. 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.

The intelligent metering of energy and water consumption in local public buildings and the half hourly analysis of consumption data can enable savings opportunities to be identified. It has been suggested that savings of up to 20-30% can be obtained with little or no investment.

Objectives

The project has aimed to demonstrate and promote the savings available from the use of intelligent metering and training occupants in public buildings and to show that these savings can be achieved at little, or no, additional cost.

Automatic remote energy and water monitoring can improve the quality of the energy and water consumption data available to an organisation such as a local authority, helping to avoid possible difficulties with estimated bills and billing difficulties. For example, in recent years, the Leicester Energy Agency (Leicester City Council) has established this intelligent metering in many of the Council's buildings. The project has intended to promote how the resulting real data obtained in real time can be used to achieve savings.

The overall objective of the project has been to maximise the energy savings available across Europe through the use of intelligent metering and behavioural changes of building occupants.

The scope for energy savings from intelligent metering and behavioural change initiatives has been investigated in this European Commission supported Intelligent Metering project, involving local authorities and local energy agencies.

Activities and results

- About 70 public sector buildings in 4 European countries (Austria, Denmark, Germany and the UK) have undergone automatic remote monitoring of energy and/or water consumption in the project. The buildings have been typical of a range of types of local authority buildings found across Europe, and have included offices, schools, leisure centres, and community centres.

- Intelligent metering and monitoring requirements have been assessed, different monitoring systems compared, and a common monitoring framework has been established for the buildings.

- Monitoring and data collection arrangements have been implemented to enable half hourly consumption data to be collected from the buildings and transmitted to a common database, from where the data has been processed and displayed in graphs on the project internet site.

- Training material has been developed and collected in the project for use in training the occupants of the buildings being monitored. A wide range of training related activities have taken place, with the support of the intelligent metering information, to encourage changes in the behaviour of building users.

- Analysis of savings from the use of intelligent metering and the training in the project has been carried out. Energy savings from the use of intelligent metering and behavioural change have been demonstrated.

- Numerous activities to disseminate the concept of intelligent metering, and the results of the project, have been carried out.

- A project website (www.intelmeter.com) has been established which provides a range of information on the use of intelligent metering in the project and project results, and displays consumption graphs for the buildings in the project. It is intended that the website will be available for at least 2 years after the end of the project.

- A roadmap for the use of intelligent metering and training elsewhere has been developed and case studies have been produced giving examples of the use of intelligent metering and training experiences in the project. Material has been developed to help other public sector buildings use the training and intelligent metering approach taken in the project.

Further activities

A number of activities are ongoing after the end of the project, including:

- Buildings in the project are continuing to be monitored, with energy consumption information being displayed via the internet.
- Further training opportunities for occupants of buildings in the project, which were identified, are being followed up.
- Partners are extending the use of intelligent metering to further buildings.
- Additional dissemination of intelligent metering information and the results of the project is taking place.

Conclusions

Conclusions from the project include:

The project has shown that energy and water savings can be achieved from the use of intelligent metering and behavioural change of building users.

Where energy or water saving opportunities, which have been identified from the analysis of half hourly consumption monitoring data, have been discussed with a representative in the building and corrective action has been taken savings have been obtained. Savings have been achieved from the training sessions/behaviour change activities in the project.

Detailed energy and water consumption profiles from intelligent metering have been useful in informing the training to be delivered to building users, in communicating energy saving opportunities to building users, in providing feedback on the effect of energy saving measures or changes in behaviour, and in educational activities in schools.

The project has contributed successfully to maximising the energy savings available across Europe through the use of intelligent metering and behavioural changes of building occupants.

Recommendations

Building landlords and premises managers of other public administration and commercial buildings should give consideration to the potential benefits of using a half hourly energy and water remote monitoring system in their buildings.

Decision makers, working to achieve energy savings in buildings, should consider the possible use of behaviour change activities in their programmes.

Energy managers, energy trainers and energy educators in schools should recognise the possibilities for using detailed energy consumption information to support training activities and staff energy awareness programmes.

1. Introduction

The European Commission, through its Intelligent Energy Europe programme, has provided support for the project 'Energy Savings from Intelligent Metering and Behavioural Change' (Contract ref. EIE/04/107/S07.38635, Intelligent Metering), involving partners in Austria, Denmark, Germany and the United Kingdom. The project has run from January 2005 to December 2006.

Background and objectives

About 40% of energy use in the European Union has been related to buildings. The project has aimed to demonstrate and promote the savings available from the use of intelligent metering and training occupants in public buildings and to show that these savings can be achieved at little, or no, additional cost.

The project has aimed to demonstrate and promote the extensive take-up of intelligent metering across Europe. To maximise the energy savings available from the implementation of efficient technologies and products there needs to be an accompanying change to responsible energy behaviour by building users. By changing building occupant behaviour energy use can be rationalised. Intelligent metering analyses half hourly monitored data to identify activities to change the behaviour of building owners and tenants resulting in energy and water savings. Work to date carried out in Leicester has demonstrated savings of up to 30% with little or no investment.

Intelligent metering includes analysing half hourly energy and water consumption data to identify savings opportunities, for example by changing the behaviour of building owners, tenants and occupants to achieve energy and water savings.

Automatic remote energy and water monitoring can improve the quality of the energy and water consumption data available to an organisation such as a local authority, helping to avoid possible difficulties with estimated bills and billing difficulties. For example, in recent years, the Leicester Energy Agency (Leicester City Council) has established this intelligent metering in many of the Council's buildings. How the resulting real data obtained in real time can be used to achieve savings has been promoted in this project.

The overall objective of the project has been to maximise the energy savings available across Europe through the use of intelligent metering and behavioural changes of building occupants.

An important factor for increasing energy efficiency in buildings is through the demonstration of workable approaches to energy efficiency. Therefore this project has included a pilot action to demonstrate the energy savings available at minimum cost through the use of intelligent metering and building occupant training. Local authority buildings including offices, schools, sports centres and community centres have monitored energy and water use half hourly. This data has been processed to identify actions and associated savings. Training has been provided to the building users to achieve energy savings and work has taken place to follow up and monitor actions. Best practice methodologies and approaches for replication of the concept have been developed for dissemination.

Exchange of information, dissemination and promotion are all very important to ensure that take-up of the intelligent metering concept is as widespread as possible. So in addition to the demonstration and building occupant training elements of the project there has been a strong dissemination element including presentations, a website and the development of a framework for on-going training.

The approach in the project

A number of local and regional public administration buildings in the four partner countries have been selected to undergo automatic utility monitoring in the project. Energy and water use in a range of types of buildings including offices, schools, sports/leisure facilities and community centres has been monitored. Initially energy monitoring requirements have been assessed and a monitoring specification was agreed for the project. Data transmission and analysis arrangements have been put in place. Details are given in section 2. Data has been processed to identify actions and associated savings.

Training material has been prepared and various training/behaviour change activities have taken place for buildings users in the project. This is described in section 3.

Consideration has been given to savings obtained from acting on intelligent metering information and from the training activities in the project. For details see section 4.

A best practice methodology and case studies of monitored buildings have been prepared (section 5).

A project website has been set up with energy and water graphs for monitored buildings, and a range of information on the project. Further information is given in section 6.

Dissemination has been carried out to help with the take up of intelligent metering. Information to assist with replication of the concept has been developed. Some details of dissemination activities are given in section 7.

Details of lessons learnt and conclusions in the project can be found in section 8.

2. Monitored buildings, data collection, monitoring and analysis arrangements

Details of the range of public buildings in Austria, Denmark, Germany and the UK that have been undergoing monitoring in the project are given below. Also, the data collection and monitoring arrangements used in the project are described.

Initially energy monitoring requirements have been assessed and a monitoring specification agreed for the project. Data transmission and analysis arrangements have been put in place. This data has been processed to identify actions and associated savings.

Buildings being monitored in the project

About 70 local and regional public sector buildings were selected by the project partners to undergo automatic energy and/or water monitoring in the project (Figure 1).

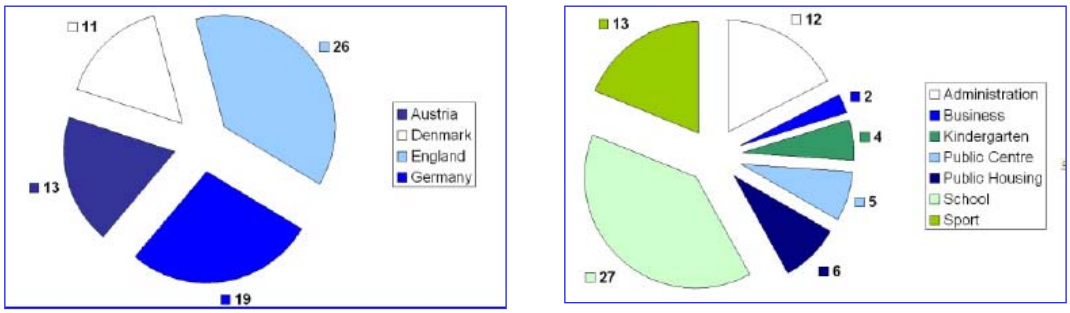

Figure 1 Monitored buildings by country and by type

The buildings included administrative offices, schools, sports facilities, community centres, and nursing/care homes:

- 26 UK buildings were included in the project, including schools, Council offices, sports centres, community centres, and a library and depots.
- 11 buildings from Denmark have been involved in the project, including schools, main Council buildings and sports facilities.
- A total of 13 buildings from Austria were included in the project, including regional government of Lower Austria offices, and nursing homes, and the public buildings in the rural community of Sonnenplatz, including school, kindergarten, gymnastic hall and town hall.
- Up to 20 buildings from Germany have been included in the project, including schools, and sports facilities.

The buildings were considered to be typical of municipal buildings across Europe and so can help with the transferability of results.

Half hourly energy and water consumption data for the selected local public buildings has been obtained through the use of intelligent metering.

Introduction to intelligent metering, and benefits

Intelligent metering, or remote automatic utility monitoring, can be used to analyse half hourly monitored consumption data to identify activities to change the behaviour of building owners and tenants resulting in energy and water savings.

Using suitable metering equipment half hourly consumption information can be transmitted automatically to a central point for analysis and graphical display (e.g. Figure 2).

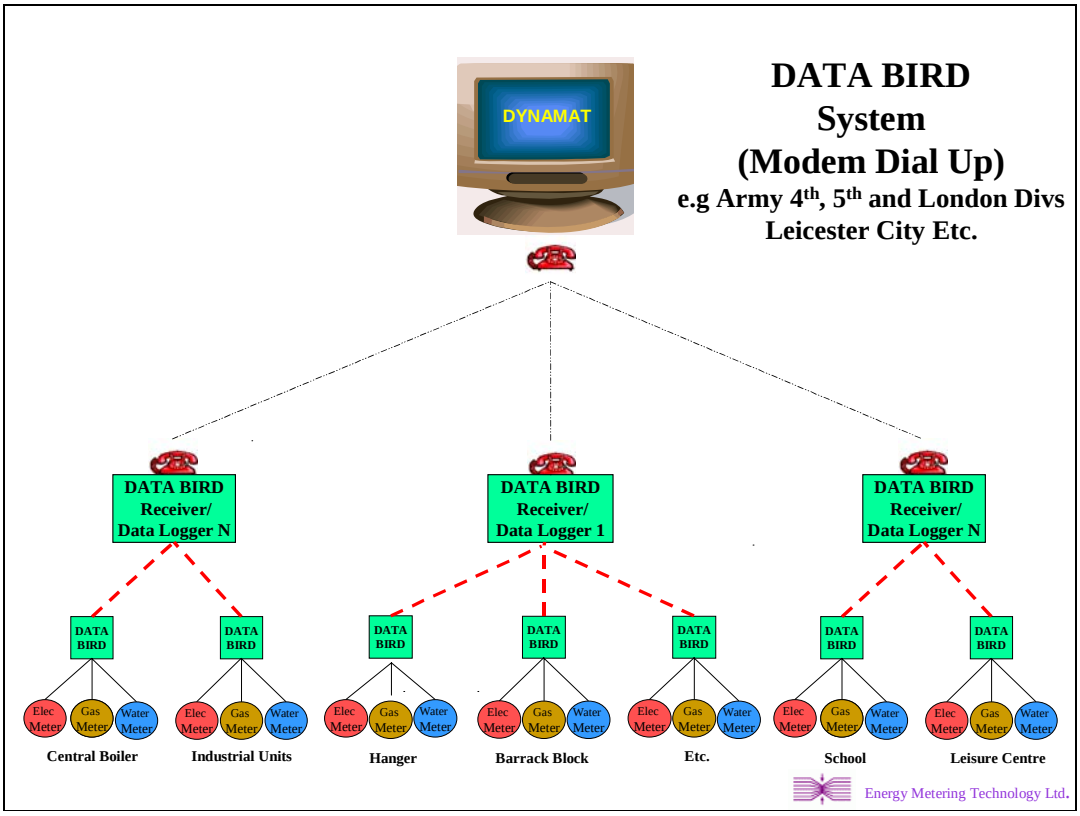

Figure 2 An example of an intelligent metering system as used by Leicester City Council

It is considered that there can be a number of benefits from using intelligent metering. Potential benefits of using an intelligent metering approach include:

- Automatic collection of meter readings
- Automatic analysis of data to identify exceptions
- Simple / Graphic presentation of energy and water data
- Timely & accurate energy management information
- Better information / customised advice
- Verify savings as a result of training and/or energy efficiency improvements
- Bill validation / verification
- Benchmarks
- Financial savings (reduced energy bills) from improved energy management
- Environmental benefits (savings in energy use and related emissions)
- Possibility of helping to change behavioural attitudes with a view to adopting a more sustainable lifestyle
- Educational benefits, from using the information obtained in learning about energy and sustainability for monitored schools
- Staff development (e.g. Training on energy saving and use of sustainability educational material, linked with intelligent metering information, can be used for staff development)

Monitoring objectives

Before the installation of an Intelligent Metering system some background work is necessary. 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.

Before installing an Intelligent Metering system the objectives of the system need to be clarified. For example, monitoring can be required for a number of purposes:

- for 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 this project the purpose has been to obtain energy and water savings through the analysis of half hourly data and training/behaviour change activities. Initially the amount of consumption needs to be measured and this data has to be transmitted to a database/data analysis software where the consumption patterns can be monitored and analysed.

Building information

Some basic background information on the type of the building type can help with the use of information obtained from intelligent metering. For example, in this project background information for a number of parameters has been collected to help with the analysis of consumption, benchmarking and considering user behaviour, such as:

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	May be 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	May be required as part of the identification of location for external climate information
Date Built	May be 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

Monitoring parameters

While a wide range of parameters can be monitored the costs and necessity of metering a particular parameter should be assessed. For example it is possible to monitor parameters such as:

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

However, in this project the main energy types (electricity, gas and heat) (in kWh) and water (in m^3) have been metered. Usually only the main meter has been monitored although it is also possible to use submetering to monitor consumption for areas of different usage more closely. Intelligent metering provides a value for the amount of energy or water used in each half hour time interval. Also, there has been some monitoring of outside temperature which can help with the analysis of energy use for heating.

The hardware for the monitoring system and data transmission

- **Meter requirements**

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. More detailed information on meters is given in the Intelligent Metering Roadmap.

- **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.

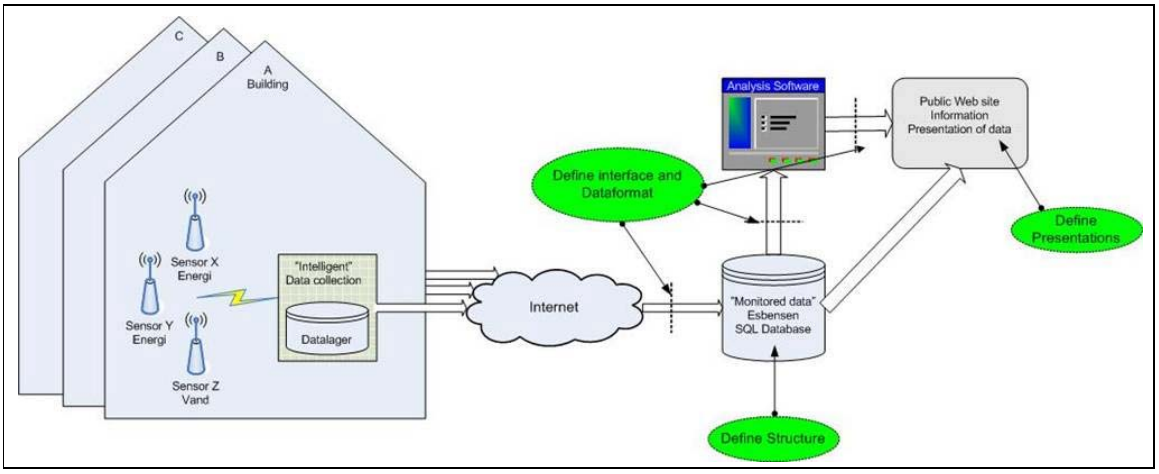

Figure 3 Automated energy accounting system presenting the data on a public website

Selection of the energy accounting approach and the necessary software

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 level of access of the monitored data (local or public) and in the scalability.

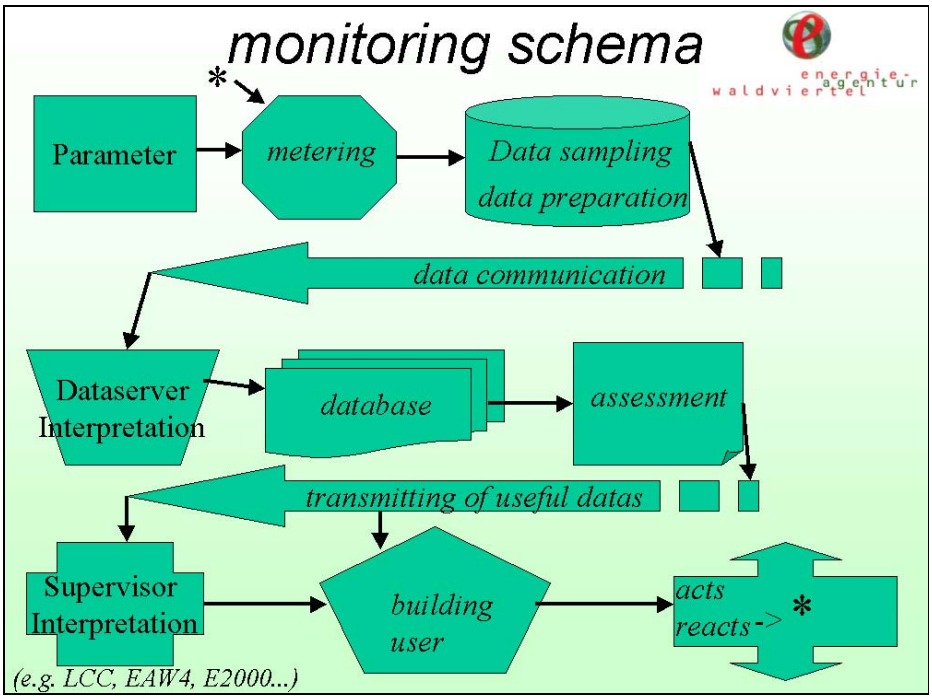

Figure 4 The components for monitoring

- **Stand-alone energy accounting programs/software**

Some programs allow for remote data transmission and the software programs are more complex than those used in spreadsheet 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.

- **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 carried out 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, 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. The approach used in this project is summarised in Figure 5 below:

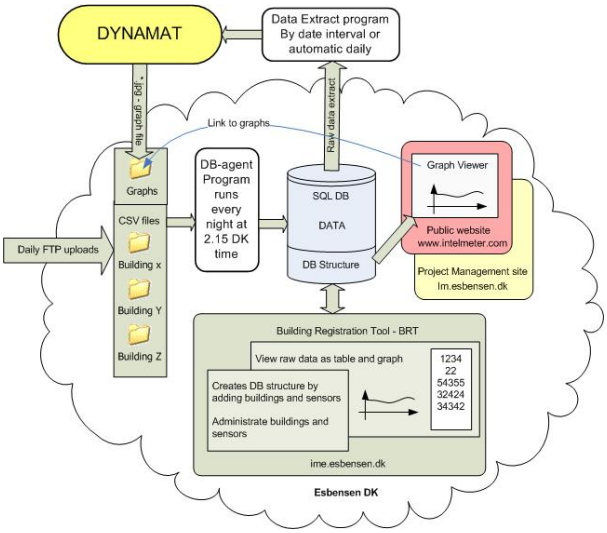

Figure 5 Monitoring/data transmission arrangements in the project

Esbensen developed an SQL database where data could be uploaded automatically via a specially developed web tool. This web tool, called the 'Building Registration Tool', has made it possible for each European partner to register all buildings and sensors connected with their buildings for electricity, heating and water. The Tool has automatically generated an ID code for all buildings and sensors which could then be the link to the monitored data uploaded via an FTP-address. This enabled each partner to

locally ensure that building and sensor information was always correct and updated. At the same time, it has been a central place for viewing monitored data to see the correct data flow on a half-hourly basis.

In order to utilise graphical analysis available through the intelligent metering system (Dynamat) used by one of the project partners (Leicester) arrangements were put in place to transfer the data to Leicester. The manufacturers of the Dynamat software (EMT) carried out some development work to generate daily, weekly and four-weekly consumption profiles from the data. Once transferred, the data has been automatically processed to generate graphs for monitored buildings which are transmitted for display on the project website (e.g. Figure 6).

It has been found that an SQL database is useful for pulling together the range of data collected in a project like this. It has been suggested that, to avoid the additional requirements of transferring the data for analysis, a programme could be used to analyse the data direct on the database. It was felt that end users have a need for on-line data. Also, it has been suggested that, where possible, the graphs should be updated frequently, e.g. daily. It was found that this would be of particular interest to schools in Denmark, for example.

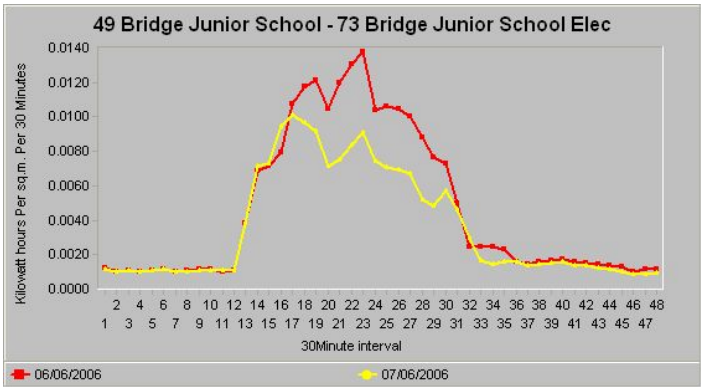

Figure 6 An example of a half hourly intelligent metering graph available on the project website

The intelligent metering information has been used to inform and support the training in the project, as outlined in the following section.

3. Training of building occupants

Work has been carried out to train building occupants in how to save energy and water through behavioural change and to relate to the data being provided to support behavioural change.

Training strategy

A broad approach to changing behaviour was adopted. Drivers were identified that can help citizens act more sustainably. The training considers mechanisms for enabling, engaging and incentivising building users.

A training programme and training material have been developed. Two training manuals have been compiled to help with training building occupants in the project. One manual has been aimed at school buildings and the other has been suitable for use in the other public buildings in the project. A building/organisation- wide approach to the training has been adopted. It has been proposed that in order to achieve effective changes in behaviour additional approaches to the delivery of a single training session are required. The use of 'enabling', and 'engaging' activities and 'incentives' (Figure 7) to help people to act more sustainably were explored.

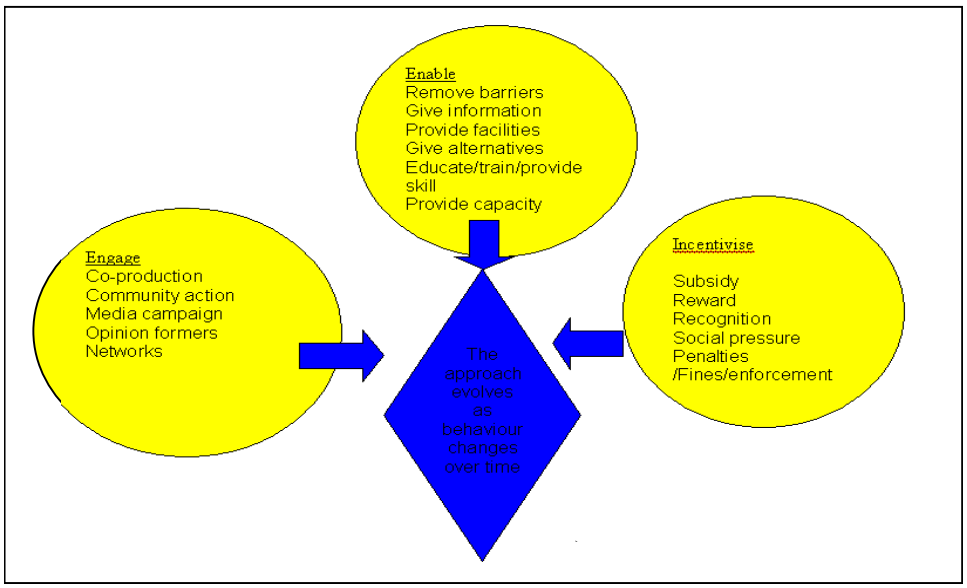

Figure 7: Training approach used in the Intelligent Metering project.

Some factors which can impact on the sustainability of an individual's behaviour and actions can be 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.

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 is encouraging building users to act more sustainably and hence reduce the consumption of water and fossil fuels. Examples of enabling activities 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.

Engaging

Typically these are actions of groups or individuals that encourage citizens to act in the required manner, in this case more sustainably. For example:

- 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 developing interventions/programmes.
- Personal contacts - individuals will listen to those in positions of power and credibility when they communicate a message of power outside their area.

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, or an energy saving campaign week.

Catalysing

This is the key driver that makes behaviour change happen on a large scale. It appears that it may be 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.

The findings from background research suggested 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.

Further details of the enabling, engaging, and incentivising approach are given in the training manuals.

Training plan and training materials

An overview of the training, referring to relevant sections in the training manual, can be seen in Figure 8.

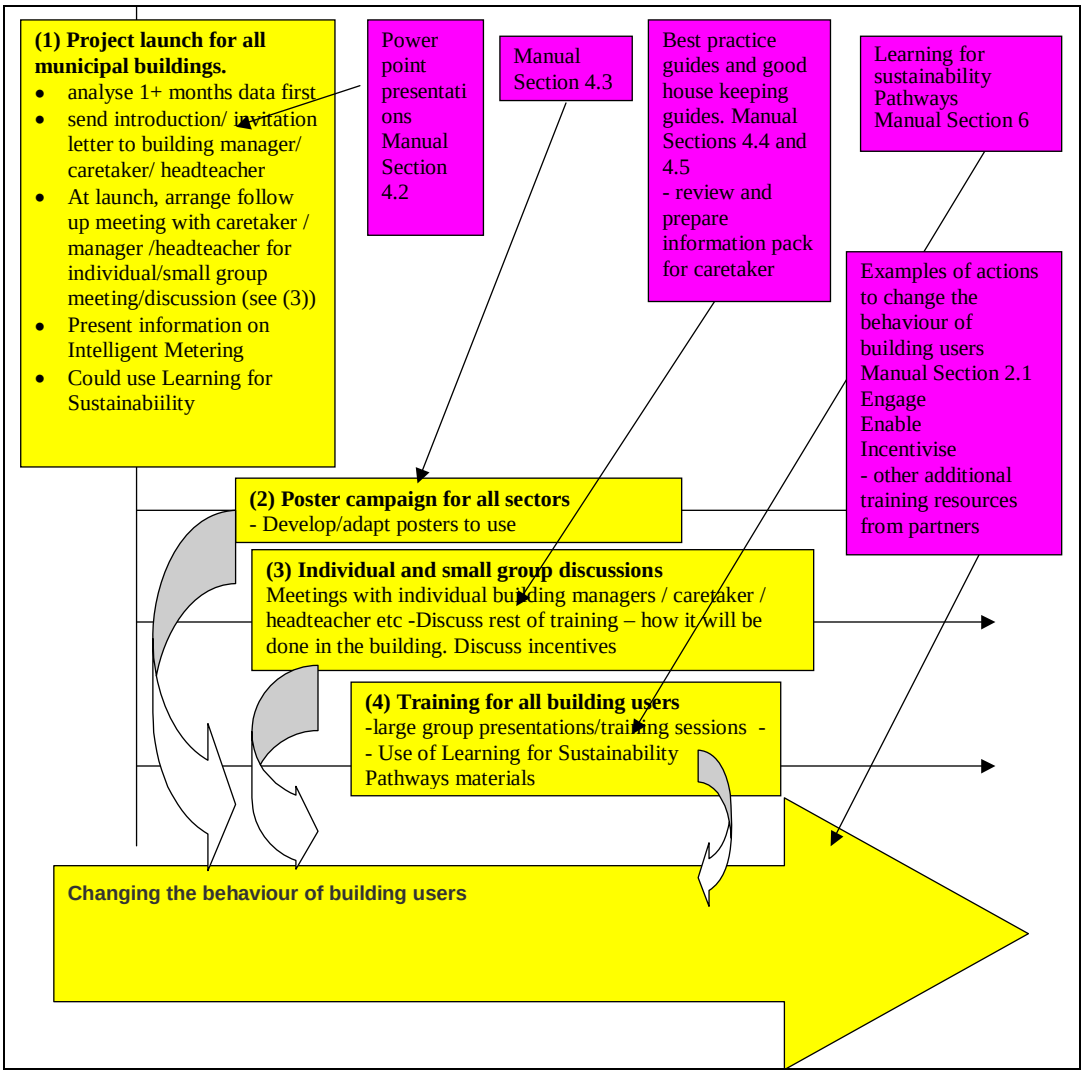

Figure 8 An overview of the training in the project

Before the training, it has been possible for consumption data from intelligent metering for the buildings to be reviewed to identify savings opportunities and inform the training.

Training has been provided to the building occupants on changing their usage patterns in order to save energy and water. The training in different countries has begun with a launch event to introduce representatives of the buildings to the project, intelligent metering and the training in the project.

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. Intelligent metering is able to give consumption information which can be used for benchmarks and can be used with energy performance certificates, such as those produced in the EC supported 'DISPLAY' project (www.display-campaign.org), which are being provided to a number of Leicester City Council buildings (Figure 9), for example.

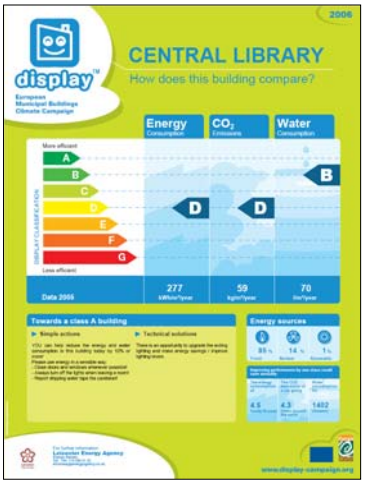

Figure 9 A DISPLAY poster

Some conversations/discussions have taken place with building managers, caretakers and headteachers to discuss how the training will be delivered. Training sessions for the building occupants have been carried out in buildings being monitored in the project, with the help of intelligent metering information. Some information on savings achieved has been fed back to the building occupants.

A range of training resources have been made available in the project. These have included good practice guides, good housekeeping information, case studies, posters and stickers, and WWF Pathways material, and a list of internet sites with relevant training resources. Some training material has been translated to different partner languages and individual partners have used various training material in their own languages. Examples of training materials which have been made available for use in the project (e.g. Figure 10) are listed below:

- 2 training manuals (schools and non schools)
- Pathways- Learning for Sustainability training material
- Posters and stickers (reminding building occupants of the training they have received and important actions they can take)
- Powerpoint presentations (e.g. giving intelligent metering information for use in training)
- Energy best practice guides and good housekeeping information (for different buildings and for different categories of energy use)
- Case studies (showing examples from elsewhere, which can be of interest to building managers)
- Action pamphlets (which can be used with schoolchildren)
- A catalogue of websites with useful training resources
- Handouts, flyers and brochures have been developed for the use in workshops and individual meetings.
- Other training material provided by different partners

Also, in some training sessions it has been possible to access the project website www.intelmeter.com which shows recent energy usage patterns of the building.

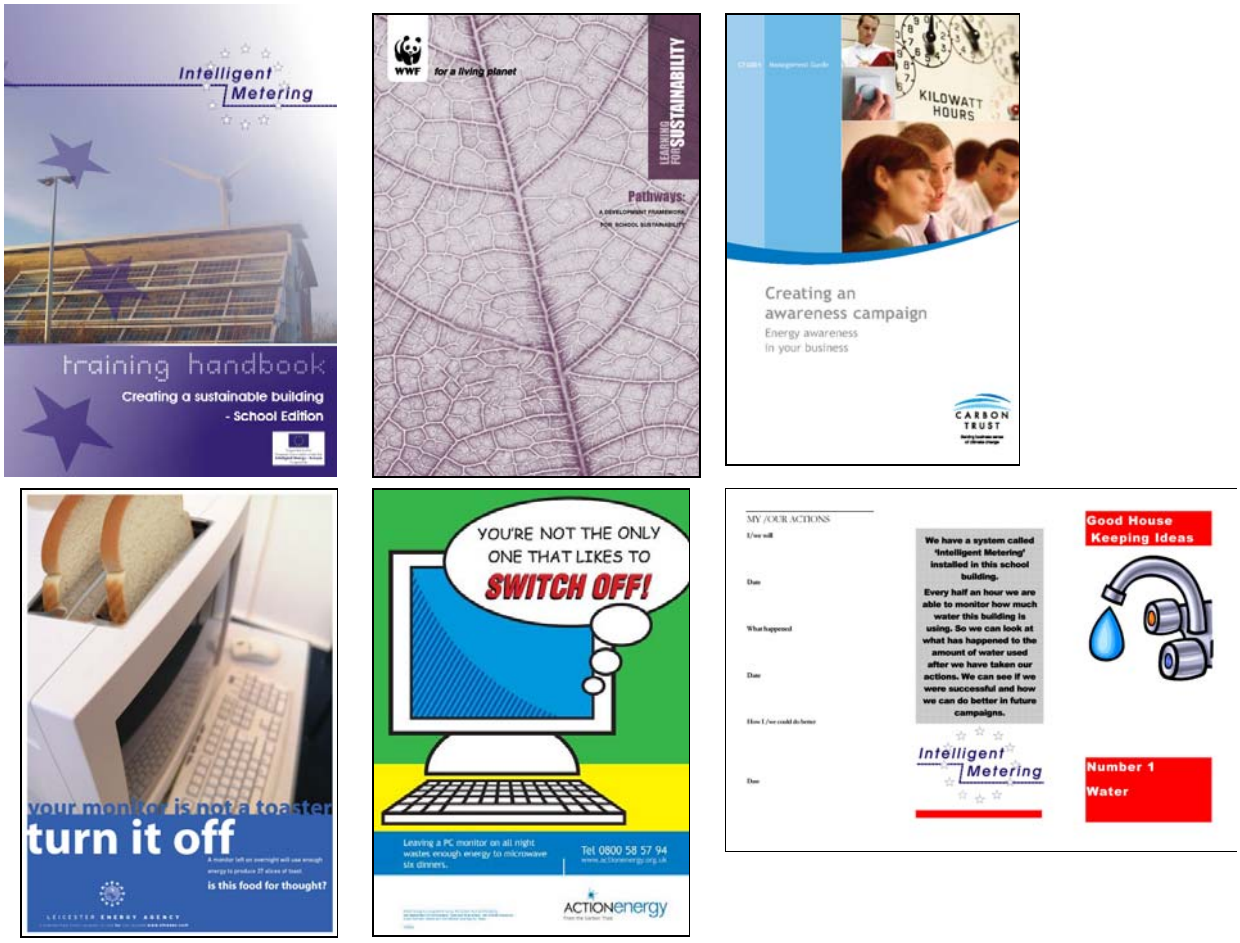

Figure 10: Different training materials used in the project, including training manual, posters and flyer

Further detailed information on the training in the Intelligent Metering project can be found in the training manuals for schools, and for other public sector buildings (see website).

Delivering the training

A range of training activities have been carried out by the project partners in the buildings being monitored. Training sessions have been delivered to building occupants. Various people have received training, including building managers, premises officers, headteachers, teachers and pupils. Intelligent metering data (e.g. available on the project website) has been used to support the training of building occupants, and over 120 training sessions have been carried out. Training activities have involved different numbers of participants from each pilot building, ranging from 1 up to events for a whole school of 300 pupils. In total over 600 people have received some form of training.

Some details of training provided in each partner country are given below.

- **Austria**

Energieagentur Waldviertel and Sonnenplatz Großschönau have carried out a range of training activities for different building occupants in the monitored buildings in Austria. These have included actions to 'engage', 'enable', and act as 'incentives' to help building users to save energy and water. Training

material available through the project has been adapted for the training of building occupants and further training material has been developed, including a presentation and leaflets.

For the building user training in Großschönau different techniques have been utilised. The intelligent metering website has been used, and an introduction to the software has been given. Also, presentations, flyers, stickers, and building tours have been used, and with pupils, an energy game and a certificate has been used. Cleaning staff were provided with warning signs which could be placed on computers or on a teacher's desk if they had not switched the light or computer off.

Figure 11 Poster about participation, at entrance of building in Austria

Energieagentur Waldviertel have used posters (e.g. Figure 11) and have provided personal training. A flip chart and pin board have been used and efforts have been made to involve the participants. Workshops with building users, repeated training, presentations and train the trainer workshops have taken place. Various training materials have been used (e.g. Figure 12).

A wide range of building occupants have received training, including teachers, caretakers, cleaning staff, building and office managers, office and technical staff, nursing staff in nursing homes, and carers in a kindergarten. A special system with red and green dots has been developed and used to highlight good and bad energy consuming devices (Figure 13), for example the limited water flush pushbutton at the toilet was given a green dot, the unlimited water flush pushbutton a red dot.

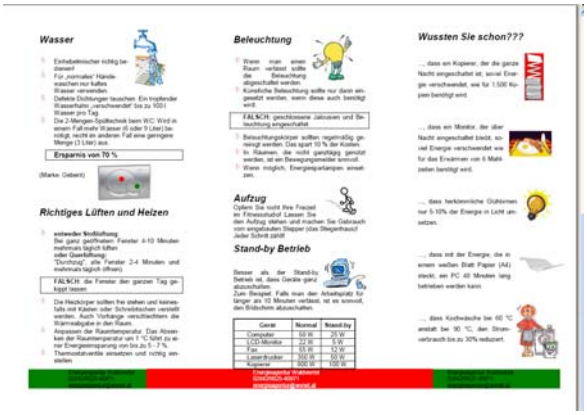

Figure 12 A training flyer used in Austria

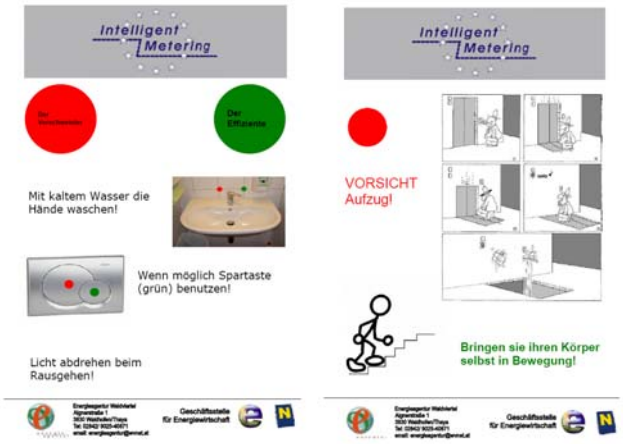

Figure 13 The use of red and green dots for training

Some good feedback on the training was obtained from building occupants.

- **Denmark**

Esbensen and the County of South Jutland have carried out a number of training activities (e.g. Figure 14) related to the Denmark buildings.

Meetings were held with head teachers and buildings administrators for all the high schools. In the summer of 2006 a meeting was held with science teachers from all the high schools to receive input for teaching material and coordinate the autumn teaching. Presentations and teaching material for high schools have been developed.

Figure 14 A training activity in Denmark

The training package using the enabling, engaging, incentivising and catalysing approach, produced as part of the Intelligent Metering project was developed and customised towards Danish buildings and standards. It was then presented at a launch event for the building managers. The training package's aim was to provide support so that building users could change their usage patterns in order to save energy and water.

Following a launch event, individual meeting visits were made by the local authorities, the County of South Jutland and also Vejle Council, to individual buildings to show the graphs for consumption figures

and firstly, to review the immediate and future potential for energy efficiency. Secondly, the visits were made to define the need for training building users to enhance awareness of energy savings and hence cost saving measures, based upon the graphs provided on the website.

It was found that schools were interested in seeing immediate feedback on the effect of measures on consumption, and would be interested in the intelligent metering information being updated daily.

- **Germany**

There have been a range of different types of training activities (including enabling, engaging and incentivising) available for the monitored buildings in Germany, with different training resources being used. For example, posters (e.g. Figure 15) and stickers and good housekeeping guides have been provided (e.g. leaflets of the campaign EnergieEffizienz have been given out). The web resources of intelligent metering, ENERGIE2000's own system s&p, the database of the utility company and the campaign EnergieEffizienz have been shown. A special presentation for training teachers, and caretakers was produced. In the district of Kassel, schools have participated in saving energy since 1998. 50 % of the amount saved goes to the schools, with 50 % of this to be used for ecological measures. Data sheets with the consumption data of all schools of the district have been handed out to the schools every year

In early 2006, ENERGIE2000 held an initial meeting for some buildings to inform them about the project. A number of training sessions were run for premises officers. While in some cases training could not take place because of insufficient interest from the relevant person in the building / users, it was found that the schools were very interested in the project and most of the schools wanted to use the data in future energy-projects.

Figure 15 Poster

Effects of training for schools have been noticed, with electrical equipment being switched off. From ENERGIE2000's experience they have found the most effective training to be that in small groups. They have found that it is necessary that the persons who take part are personally interested in energy savings. They have found that it is very good, for example in schools where you take a small group, containing teachers, pupils and housekeepers, have a dialogue with them, show them the graphs and then carry out a walk around the building.

- **UK**

A range of training activities took place to enable, engage and incentivise building users to encourage behaviour change and achieve savings.

Initially a launch event was held for representatives (e.g. headteachers, business managers, and premises officers) from the 26 Leicester buildings being monitored in the project. Background information was provided, including details of the project and intelligent metering, and a description of the training package was given. In smaller groups there was further discussion with representatives from the schools, and with representatives from the Council buildings in the project.

Each of the buildings in the project was contacted to arrange an individual training meeting. These took place with various representatives in different buildings, including headteachers, teachers, business managers, premises officers, and managers. Intelligent metering graphs for electricity, gas and water consumption, for a period of time before the meeting, were shown and explained. A training folder was provided with a copy of the training manual and other training material from the project (e.g. energy efficiency best practice guides, posters and stickers), and the training approach was explained. A CD-Rom with training resources from the project was made available for schools. An energy walk round of the building took place, usually with the representative from the building. This helped to identify possible areas for energy and water savings. The findings from the visits were summarised in a short action plan for each building. These listed possible energy and water saving actions, focussing on short term no and low cost measures but also mentioning some possible longer term measures. Also, relevant further training activities for the building were listed. Work has been carried out, and is still underway, to follow up some actions, including providing posters and stickers, providing additional training and investigating possible energy efficiency improvements.

To help to engage with building users, two events were arranged based on the WWF's Pathways Learning for Sustainability approach. One was aimed at headteachers and school managers particularly, while the other was designed for building managers, team leaders and other managers and senior officers. This approach can help a school or other organisation/building to explore their understanding of sustainability, consider their current position and help with planning. It was intended to increase involvement and encourage more of a building-wide approach to sustainability. One of the authors of the Pathways training guide delivered the first workshop for school representatives, while in the second workshop the approach was applied to other Council buildings in the project. Both workshops involved significant participation from those attending and received good feedback.

Some further training was provided for building users, including a talk at a staff meeting and some whole school training. One school held a school-wide energy efficiency week and also a sustainability week, which included using intelligent metering graphs from the project website (Figure 16).

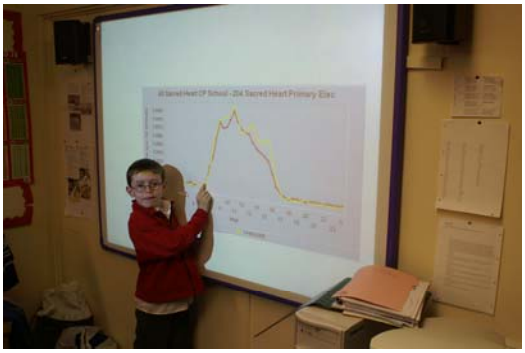

Figure 16 Intelligent metering graphs were used as part of a school sustainability week

As incentives, the project has been mentioned in an article in the Council employees' magazine, and a competition between the buildings in the project has been underway to find the building which makes the largest savings.

Feedback on the training and further activities

Generally the training sessions in the different buildings have been well received by building users. There has been a good involvement of building occupants in the training, with positive feedback being provided. Building occupants have been trained and energy savings achieved in different buildings.

Various activities have been undertaken for occupants of the buildings in the project, during the period of funding from the EC. Where possible, partners can consider their ability to maintain enthusiasm for energy savings in the buildings in the project after the completion of the project, and what further activities may be appropriate or possible.

Training materials developed in the Intelligent Metering project by the project partners are available on the project website (www.intelmeter.com). This includes some training material in different partner languages.

Further information on training provided is given in case studies, available on the project website.

Information on savings identified is available in the project report 'Final Energy Report'.

4. Analysis of training and savings from intelligent metering

Introduction

Consideration has been given to the energy and water savings related to intelligent metering and behavioural change in the project. For example, there have been savings from the use of intelligent metering to identify unusual consumption and energy savings opportunities, which can involve a form of training and behavioural change. Opportunities have been followed up by contacting a representative from the building and discussing the unusual consumption. Also the impact of the range of additional training activities in the project on consumption has been assessed. Energy savings from the use of intelligent metering and behavioural change have been demonstrated.

Savings from the use of intelligent metering

Partners have found savings opportunities from the analysis of detailed energy and water consumption graphs from intelligent metering. The intelligent metering information can highlight unusual and potentially unnecessary consumption. A representative (such as a Premises Officer) in the building can be contacted about the possible saving opportunity to investigate it further. As a result it may be possible to achieve a saving through a technical measure or through behavioural change. For example technical and other measures have been implemented in different buildings over the course of the project following review of intelligent metering information.

Continued monitoring of intelligent metering information ensures any consumption changes which may indicate an area of energy or water waste can be rapidly identified and investigated. It can help with monitoring the operation and related savings of a particular energy efficiency measure which is installed and with monitoring savings from energy saving training activities.

From Leicester City Council's experience, it has been possible to achieve significant savings from acting on intelligent metering information for water, gas and electricity consumption. In one example in Leicester a water leak was identified and corrected, giving a cost saving which has been considered to give a payback of the intelligent metering installation of a few months (Figure 17). Also, in Austria, because of Intelligent Metering, an administration building monitored by EAW4 in Amstetten found that there was a large loss of water over a long period of time (running toilets and a leakage at a valve).

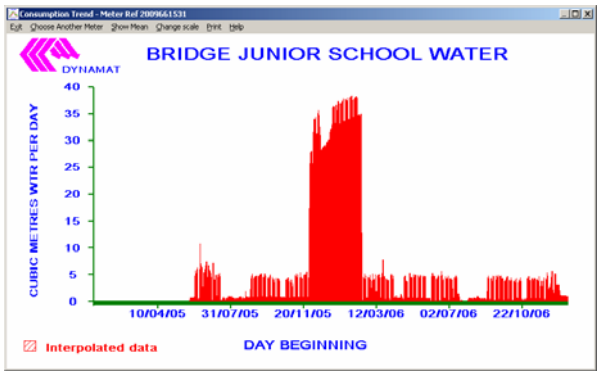

Figure 17 Significant water savings from action from the use of intelligent metering information

At Sacred Heart Primary School in Leicester a high water consumption baseload was identified from intelligent metering information. After further investigation it was found this was due to faulty toilet flush sensors. After new controls were installed the decreased baseload is estimated to have given a saving of over £3000/year (Figure 18).

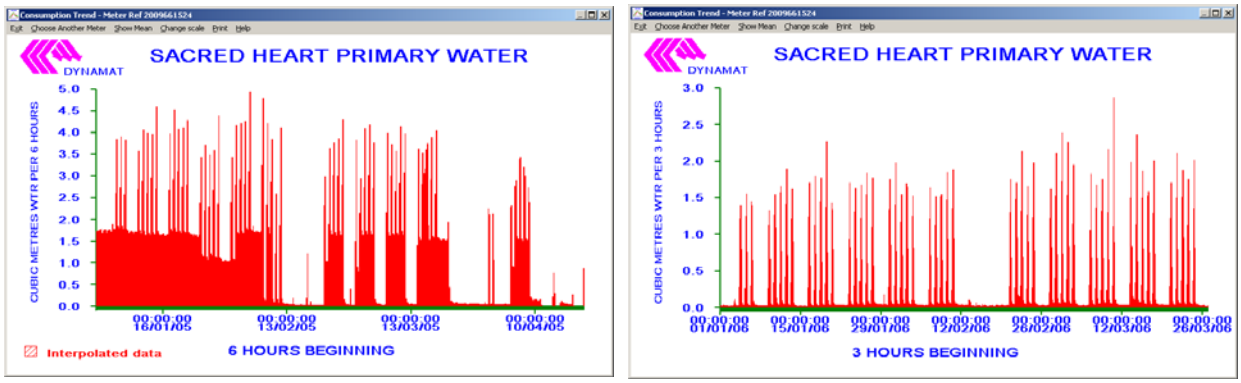

Figure 18 Water savings from action based on intelligent metering information at Sacred Heart School

Also Leicester City Council has made good savings for gas and electricity consumption. For example, it has been possible to identify and address out of hours consumption, faults, and heating control improvements.

Review of intelligent metering information can indicate savings opportunities through unnecessary out of hours energy use. For example, while heating was well controlled during term time at Bridge Junior School it was left on over the Christmas holiday period (Figure 19). The wastage was reported. Intelligent metering information can provide evidence which could help lead to changes in behaviour.

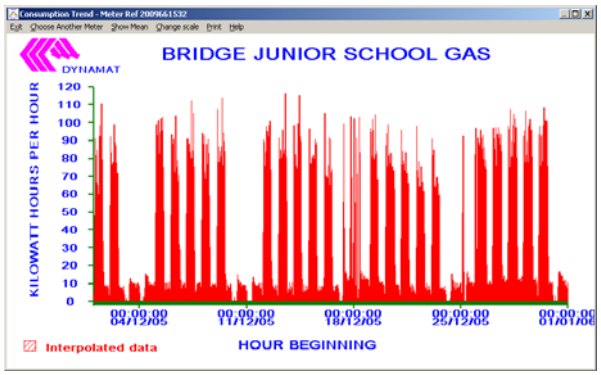

Figure 19 Gas saving opportunity identified from intelligent metering graph

Some further information on savings from acting on the review of intelligent metering information are given in case studies available on the project website, and in one of the training manuals.

Savings opportunities identified from intelligent metering information can be addressed through training activities. Energy and water consumption information from intelligent metering can be regularly displayed or provided to building occupants helping to raise their energy and water awareness and to motivate them to use energy and water efficiently. Details of savings from the training on energy and water provided in the project with the help of intelligent metering information are discussed below.

Savings and benefits from training in the project, with intelligent metering

- **Savings identified from training activities**

Numerous savings opportunities were identified through the training activities in the project, such as discussions with building users and energy walk rounds. Some examples are given below, with further details in the Final Energy Performance Report.

Heating: Much of the training was carried out in the summer or near the beginning or end of the heating season in 2006. It is considered that as a result the training may have had less impact on heating consumption after the training event than if it were carried out during the main part of the heating season. A few examples of heating savings opportunities identified in each partner country are listed in Table 3:

Austria	Energieagentur Waldviertel found the hot water circulation could be optimised and the time control was adjusted, minimising losses. In the Sonnenplatz gymnastic hall it was found the ventilation system settings were incorrectly set and these were adjusted.
Denmark	A Building Management System control system did not reduce the heat for the weekend until Saturday which could be changed to the Friday afternoon
Germany	The start of the heating time on Mondays was changed to a later time, and the usage time of the warm-water circulation systems were reduced.
UK	It has been found that windows may sometimes be left open when heating is on, and in some buildings some outside doors were being left open. In one building checks could be made to ensure the Building Management System was set correctly (e.g. to avoid overheating).

Table 3 Examples of heating savings identified

Electricity: Several savings opportunities for electricity were found in each partner country from the training visits in the project. Some examples are shown in Table 4:

Austria	Energieagentur Waldviertel noticed higher than expected out of hours consumption. This has suggested an area for possible saving opportunities. Sonnenplatz found almost no one was aware of the actual costs of a kWh or 1W of continuous energy use for a year, which helped to show the cost of stand-by energy use. In the school it was found there was some refrigeration which was running continuously, even in holidays.
Denmark	Students now turn on classroom lights themselves on arrival instead of the administrative staff saving almost an hour of electricity use. The possibility of setting up computers to switch off automatically, avoiding the need for students to have to remember to switch off, has been discussed.
Germany	Computer equipment is turned off after lessons by using the main room switch when available, and electrical hot water systems are to be switched off during holidays.
UK	In some buildings it could be possible to not switch all lights on at the start of the day, and in some buildings users thought it was best to leave fluorescent strip lighting on all day rather than switch it off when not needed.

Table 4 Examples of electricity savings identified

Water: Some examples of savings opportunities for water identified from the training visits in the project are given in Table 5.

Austria	Energieagentur Waldviertel were able to advise the use of flow limitation, to waste less water, providing low cost water savings. Sonnenplatz found water use to be very good in general, with savings opportunities not being found.
Denmark	Water use was generally acceptable, with a possible saving being from investments, e.g. in water saving toilets.
Germany	A rainwater using plant for toilets was reactivated in one school.
UK	In some cases, some taps have been left on when not needed. There have been some opportunities for using water saving push taps and for some toilet controls.

Table 5 Examples of water savings identified

- **Method of monitoring training savings**

In order to help assess the effect of particular training interventions (such as individual training visits) project partners have completed Training Action Data sheets (Figure 20) for different training sessions they have carried out in their buildings being monitored. These have allowed details of the particular training activity to be recorded, such as who was trained, the number of people trained, the date of training, and the type of training delivered, including consumption data, climate-related data, and feedback from people trained. Using information provided by intelligent metering, these have been used to compare energy and water consumption for the week and month before and after the training. This has been used by Energieagentur Waldviertel to calculate possible savings related to the training. Also, intelligent metering graphs have been used to identify changes in consumption.

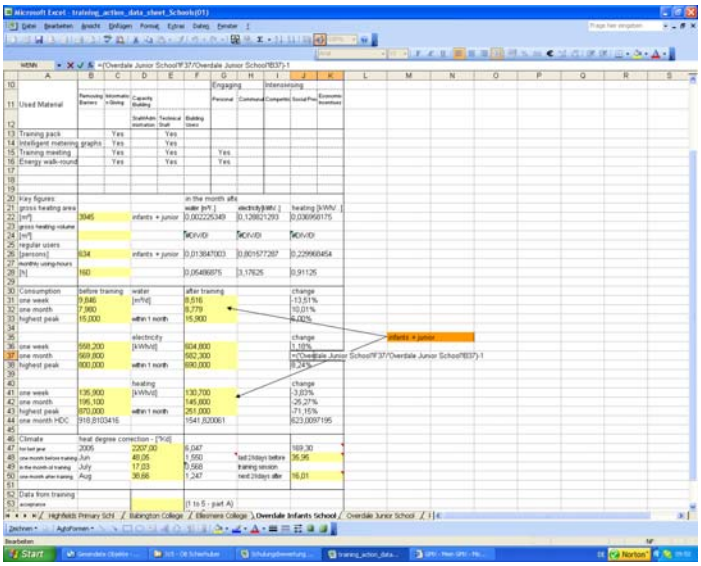

Figure 20 Training action data sheet

Possible savings of various sizes for electricity, gas/heat and water were found for different buildings from comparing consumption a month before and a month after a training event.

In assessing savings related to the training there are a range of influences on energy and water consumption which should be recognised. For example, for heating, the external temperature can have a

significant influence on building heating consumption and so a form of heat correction has been used with heating data. It is possible that further monitoring and investigation is needed to help assess savings for heating, as much of the training was carried out around the start or end of the heating season or in the summer when there was little or no space heating which may have affected the use of the heat correction. Also, there can be holiday periods and special events which can affect the consumption. For example, some training sessions in schools took place shortly before school holidays meaning it is less straightforward to compare consumption immediately before and after the training event.

- **Training-related savings in each building**

Using data from training action data sheets for a range of training events in different buildings in the project, Figure 21 shows the average change in energy and water consumption, comparing the month before and the month after a training event.

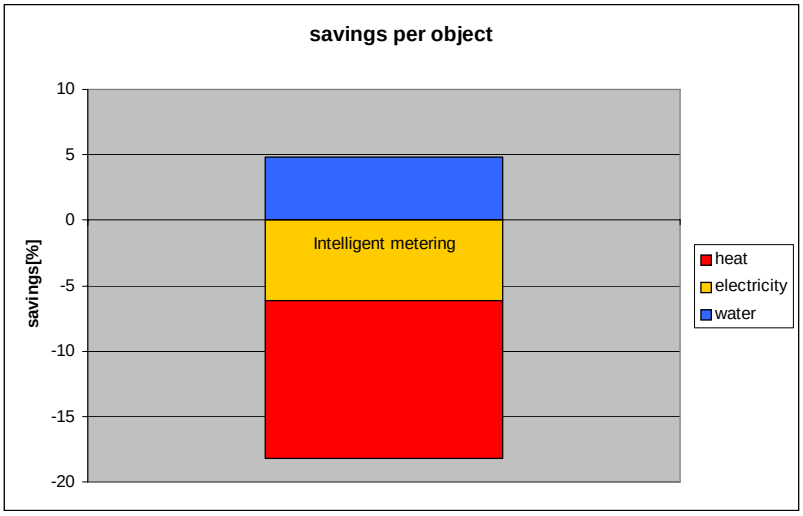

Figure 21 Average of the % changes in consumption from comparing the month before and the month after individual training sessions (without heat correction)

From comparing consumption for the month before and after training sessions good average savings around training sessions have been obtained for electricity. While the effect of the training on heating has not yet been so clear, which is likely to be related to the delivery of much of the training in the summer which may have caused heat correction difficulties, heating savings have been achieved. (The heating savings in the chart above do not include a heat correction.) Some water savings have been achieved in individual buildings, but the effect of large increases in consumption in certain buildings (perhaps related to the timing of the training and special events) has affected the average savings figure shown in the chart. Monitoring is ongoing and further training opportunities are being investigated where possible.

Intelligent metering graphs can be used to show possible savings related to training in the project. Changes in consumption patterns around individual training visits are shown on intelligent metering graphs on the project website. The graphs below (Figure 22) show a comparison of electricity consumption for the week of the training meeting, and the week after, for two schools. This information can be fed back to the building user. They show a reduction in hourly peak electricity demand at Bridge Junior School and a reduction in consumption at Caldecote School following training visits. The effect of not switching as many lights on at the start of the day following the training visit to Caldecote School can be seen.

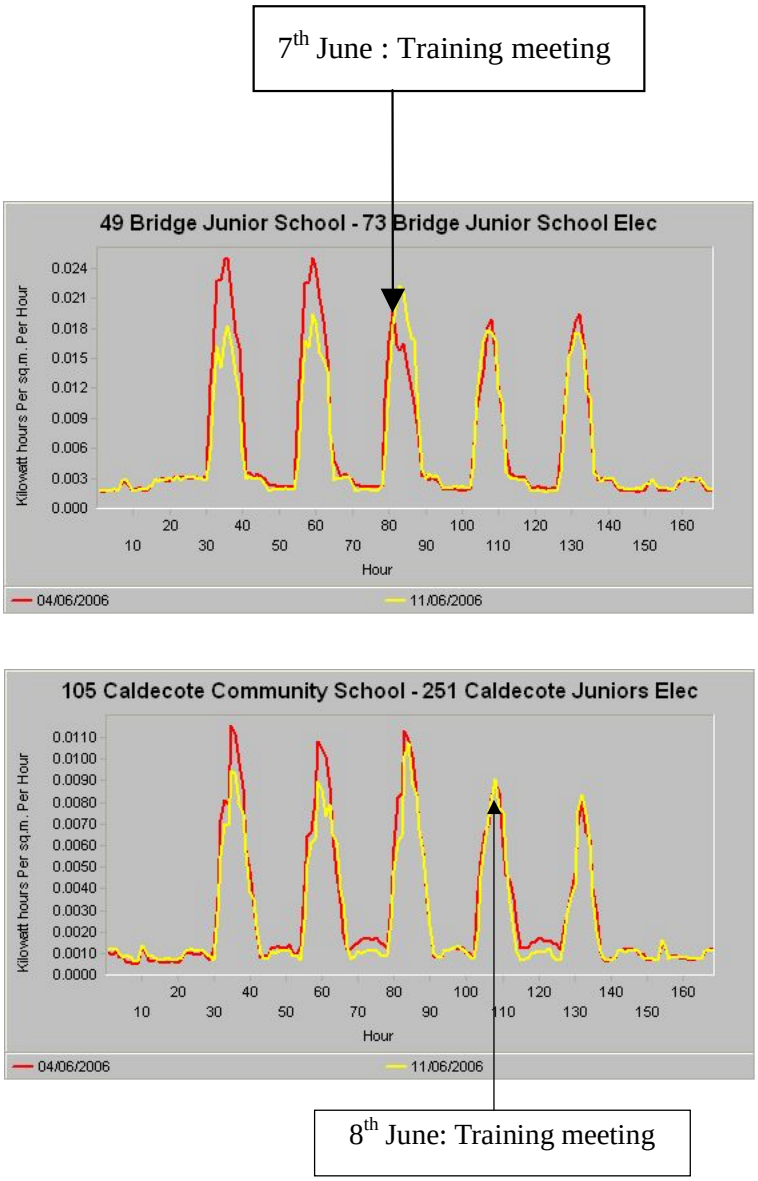

Figure 22 Examples of changes in consumption following training visits to two schools

A longer term analysis can also show savings (e.g. Figure 23). With the help of intelligent metering information monitoring of the buildings in the project is ongoing.

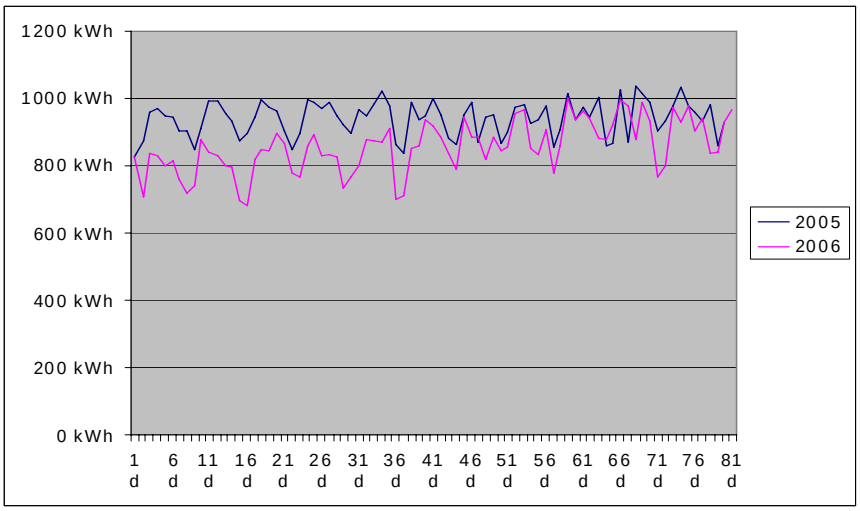

Figure 23 Example of electricity savings in an administration building (Energieagentur Waldviertel)

An example of savings for one year for a residential home for older people in Austria is shown in Table 6. Here Energieagentur Waldviertel 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.)

	Schrems	older people & nursing homes					
key figure		**water [m³]**		**electricity [MWh]**		**heat hdc [MWh]**	
		2002	2005/06	2002	2005/06	2002	2005/06
	consumption	4846	4858	352	296	647,93	472,147
5694	m² gross (heating) aera	0,85	0,85	0,062	0,052	0,114	0,083
12.600	m³ gross (heating) volume	0,38	0,39	0,028	0,023	0,051	0,037
124	Persons	39,1	39,2	2,84	2,39	5,23	3,81
8760	using hours/year	0,55	0,55	0,040	0,034	0,074	0,054
	% change with inteligent metering		+0,24		-16		-27

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

Table 6 Savings in a residential home for older people in Austria in one year.

Full details of the analysis of changes in energy consumption around training sessions are given in 'Report on the analysis of the results of training'.

Some consideration has been given to how long the savings last. For example, the change in energy and water consumption has been compared for the week and month before and after training activities. Further investigation of the duration of the savings is possible using intelligent metering information. To help to maintain savings it has been suggested that it can be beneficial to provide further training after a period of

time. Also, the public display of intelligent metering graphs, the use of energy awareness posters, or building energy performance certificates such as those produced in the EC supported DISPLAY project, could potentially have a role in helping maintain energy savings.

- **Feedback from building users**

Feedback forms were provided to people who received training in the project, collecting information on:
- how interesting the training activity was,
- how easy it was to understand the content of the training, and
- what suggestions from the training session would be used.

Overall, there has been a positive response to the training activities in the project. From feedback from people in the buildings who have been trained, the training visits were found to be interesting, the training provided was considered to be understandable, and it was intended to use some of the suggestions from the training.

Overall savings

Savings have been obtained from actions taken to follow up possible savings opportunities identified from the review of intelligent metering consumption information and liaising with a representative from the building. In some buildings significant savings have been achieved in this way (e.g. Bridge Junior School case study). Generally, these savings are additional to those around training sessions given in many of the savings figures below.

Savings related to the training sessions and other behaviour change activities have been achieved. An analysis of monthly consumption before and after training sessions has been used with the savings figures below. (It should be noted that there are various factors which could influence consumption changes, including holiday periods and special events. Much of the training has been taking place at the start or end of the heating season or in the summer when there has been less scope for heating savings, also possibly causing unclear results with the heat correction. Data has not been available for some buildings for each of electricity, heat and water.)

Further consideration of savings has been taking place.

26 UK buildings have participated in the project. Considering savings alone, from comparing consumption for the month before and the month after training sessions savings in electricity, gas (with heat correction) or water were recorded in 22 buildings. Electricity savings have been recorded in 19 buildings (from 0.5% up to about 40%), water savings in 14 buildings (from 1% up to 39%), and gas savings (with a heat correction) in 7 buildings (from 11% to about 55%). There have been savings in either electricity, gas (with heat correction) or water of 20% or more in 12 buildings, with savings of 10-20% in 3 other buildings.

13 Austrian buildings have been involved in the project. Considering savings alone, from comparing consumption for the month before and the month after training sessions savings in electricity, heat (with heat correction) or water were recorded in 12 buildings. Electricity savings have been found in 12 buildings (from about 2% up to 80%), water savings in 8 buildings (from 1% up to 82%), and heat savings (with a heat correction) in 3 buildings (from 3% to about 96%). There have been savings in either electricity, heat (with heat correction) or water of 20% or more in 5 buildings, with savings of 10-20% in 3 other buildings.

11 Danish buildings have taken part in the project. Considering savings alone, from comparing consumption for the month before and the month after training sessions savings in electricity, heat (with heat correction) or water were recorded in 10 buildings. Electricity savings have been recorded in 8

buildings (up to 27%), water savings in 5 buildings (from 5% up to 49%), and heat savings (with a heat correction) in 5 buildings (from about 10% to 78%). There have been savings in either electricity, heat or water of 20% or more in 4 buildings, with savings of 10-20% in 2 other buildings.

20 German buildings have been included in the project. To compare changes in consumption before and after training sessions further analysis is required. However, comparing total savings for 2005 and 2006 to a reference annual consumption from earlier years shows savings in either electricity, gas or water for 16 buildings. There have been savings in either electricity, heat or water of 20% or more in 2 buildings, with savings of 10-20% in 4 other buildings. (There are various factors which are considered to have influenced energy consumption, e.g. increases in consumption from the use of more computers and changes to whole day lessons. Data has not been available for all buildings for each of electricity, heat and water.)

Monitoring is continuing, for example with the help of the graphs on the project website. For some buildings it is intended that some further training can be provided, which can draw on results of the training analysis.

5. Best practice methodology and case studies

Experience gained in the project has been used to prepare a best practice methodology for the implementation of intelligent metering, and to develop case studies of monitored buildings.

Best practice methodology

A roadmap (best practice methodology) on intelligent metering has been prepared by IT Power working with the project partners. This gives guidance which can be used by other organisations in setting up a similar intelligent metering and behavioural change project. It includes looking at the requirements of an intelligent metering system, the specification of a monitoring system, data analysis, managing the monitoring programme, and training. It has been summarised in a number of steps. An overview is given below.

- **Needs assessment**

The needs assessment aims to support identification of the requirements of an intelligent metering and monitoring system in relation to the requirements of the building, its users and the outputs needed. It examines what parameters should be monitored based on the needs of the data user. For any monitoring system, including those in buildings, the decision must first be made as to why the monitoring is required before the monitoring parameters can be set. The main steps in this needs assessment process are:

Step 1: Define the monitoring objectives or reasons for monitoring.

Step 2: Define the level of detail required in terms of building information; this will also be affected by the choice of analysis tool/software.

Step 3: Choose the parameters to be monitored

Step 4: Choose the approach and review the implementation needs (meter review/enabling, installation of automatic remote metering, meter data collection and analysis software)

- **Monitoring systems**

Once the monitoring needs have been defined then the intelligent metering and monitoring system can be specified. This involves the definition of the actual system inputs and outputs required and the approach to be used. Hence the hardware, data transmission system and analysis software can then be identified. It should be noted that when including a number of buildings in any project then the specification must be checked to ensure that it is applicable to all sites. The main steps in the specification of the monitoring systems are:

Step 5: Define the system inputs and outputs and the level of additional data/information required.

Step 6: Select the monitoring system which will include hardware, for metering, for data transmission and data flows/storage.

- **Data analysis**

Then, the selection of the software/approach to data analysis has to be considered. 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.

It should be remembered that the demand for monitoring may originate from differing groups with different motivations and approaches. For example, reasons can include load management, to control the

energy demand peaks; building management in general and from the economic or accounting view point. An intelligent metering and monitoring system and its supporting data analysis tools should try to support all of these differing needs. The main steps in the selection of the data analysis process are:

Step 7: Choose the energy accounting approach to be utilised.

Step 8: Select the software, by considering the parameters and the analysis output needs.

- **Monitoring, data, and outputs management**

Managing the monitoring programme, the data and reviewing the outputs is the next process in the intelligent meeting roadmap. It may be the responsibility of an outside agency but it will still directly involve a large number of people. There are different people involved in the intelligent metering and monitoring of any building or plant, and in the different forms of energy accounting. To all of these people the intelligent metering system will often be required to provide different information, depending on their needs. For this reason these people also interact with the management of the system in different ways. The main steps in the Monitoring, data and outputs management are:

Step 9: Consider the roles and responsibilities of all of the groups involved with the project (e.g. Premises Officer, building owner, etc). Ensure that any system meets their needs in terms of information/data supply.

Step 10: Ensure that procedural responsibility is defined, as to who deals with monitoring data and follows up savings opportunities (e.g. abnormal consumption, high baseload when not needed)

- **Training package**

Finally, a training process needs to be implemented. Very wide and varied options exist for approaches to training. The roadmap focuses on the approach, including the background to the choice of approach, and the results of that approach, as used in the Intelligent Metering project. The purpose of the training process 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.

Step 11: Consider the proven training techniques which will provide the most impact for the monitoring objectives and required outcomes

The full roadmap document can be found on the project website. There has been some translation of the roadmap to Danish and German/Austrian.

Case studies

A number of case studies (Table 7) have been prepared for buildings in the project. In Austria, EAW4 have drafted case studies for 3 of their monitored buildings and Sonnenplatz have prepared a case study for their buildings. ENERGIE 2000 have drafted case studies for two of the buildings in Germany, and Esbensen and the County of South Jutland have provided case studies for two Denmark buildings. Also, the Leicester Energy Agency and IT Power have drafted 2 case studies for UK buildings. The case studies give details of experiences in the project, help to show advantages and opportunities available from intelligent metering and are useful for dissemination.

Austria	Local government of Gmünd
	Local government of Hollabrunn
	Schrems nursing home
	Monitored buildings in Großschönau - Town Hall (Gemeindeamt), Community Centre (Gemeindehaus), Kindergarten (NÖ Landeskindergarten), Elementary School (Volksschule) , Gymnastic Hall (Turnsaal)
Denmark	ASV Horsens educational centre
	Aabenraa Gymnasium, High School, Aabenraa
Germany	Elisabeth- Selbert Schule Zierenberg
	Elbetalschule Naumburg
UK	Bridge Junior School
	Braunstone Leisure Centre

Table 7 List of case studies

The case studies are available in English and some are also in the language of the individual partner. They can be accessed through the project website.

Success factors

Some possible success factors for an intelligent metering project of this kind include:

Monitoring/data

- Initially careful consideration of monitoring requirements, ensuring correct monitoring equipment is used
- Availability of funding for monitoring hardware
- Access to expertise on metering/data systems
- Use of data management software enabling various analysis of data to be carried out

Ongoing monitoring

- Ability to give rapid feedback to building contact on unusual consumption
- The ability to set alarms to highlight unusual consumption is useful in ongoing monitoring of consumption
- Energy/water management support available to help building contact to follow up savings opportunities identified from intelligent metering monitoring

Training

Some factors which possibly can influence the savings related to the training sessions include:

- how energy aware and how well informed the building users are already
- what possible savings which have been identified from review of intelligent metering graphs and which can be followed up in a training activity, e.g. possible leaks and false settings of the technical systems of the building,
- Potential for savings from staff behavioural actions (e.g. staff may have limited control of lighting, etc.)
- the existing level of energy and water performance of the building
- how engaged the users of the building are, e.g. the level of interest and cooperation from building managers and building representatives in the project and training.
- the quality of the training provided, which can be affected by the level of resources available (e.g. staff, time and material)
- not staff changes for trained staff.

Also, it is considered that:

- Practical actions/tips for building users can be helpful
- Availability of detailed energy monitoring information as graphs can be easy to understand and helps with training
- Combination of training approaches can be helpful (e.g. engaging, enabling and incentivising).

Costs and payback

The main parts of the cost are installation costs for metering hard- and software. These are dependent on the chosen metering system 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 correctly installed this is not large each year.

During the Intelligent Metering project installation costs were about 2,500 to 5,000 Euro per building, depending on the metering system.

There have been short payback periods (e.g. up to 1 year) for the intelligent metering in some buildings, for example where savings opportunities have been identified from the half hourly intelligent metering consumption information and have been implemented through following them up with a contact in the monitored building.

The use of intelligent metering information with training in the project has helped to raise energy awareness of building users. Various levels of savings have been achieved. Depending on the existing level of consumption and factors such as the level of engagement of the building users, the training provided, and depending on whether savings can be maintained could give a fairly quick payback. Further monitoring and analysis of consumption in the buildings can help to quantify paybacks related to training in the project.

In addition to the financial savings which are possible from the use of intelligent metering, intelligent metering can help to increase the awareness of building users of energy costs and savings. Intelligent metering can have an educational role for building occupants.

6. Project website

The project website (Figure 24), set up by Esbensen, gives general information on the project, allows access to training material used in the project and helps to disseminate the results of the project. The website is the public entrance to monitored data from the different European partners. It has been possible to see intelligent metering graphs showing energy consumption in different buildings, and use these as further inspiration for the improvement of energy consumption. The website contains 4 partner sites for each of the countries represented in the project, with parts of the website in Danish, English and German languages.

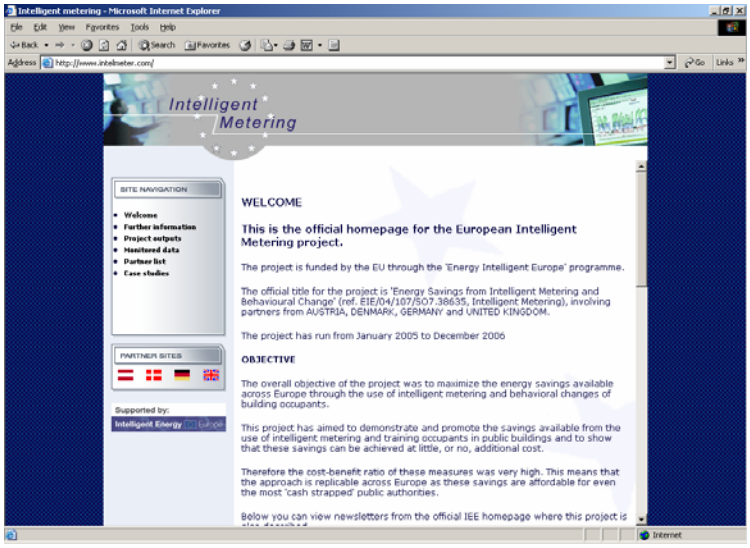

Figure 24 The project website at www.intelmeter.com

Website content

Some details on the content of different parts of the website, and resources which are available, are given below:

- **Welcome and Further Information**

General information on the project is held on the website, giving the objective of the project, an introduction to the project and the stages which have been followed.

- **Project outputs/ Training material**

A wide range of training material which has been collected and prepared in the project can be accessed through the website. Details of the training strategy and different training resources can be downloaded. Training material in different languages is available on the different partner sites on the website. Training material available on the website includes:

- information on the training manuals developed in the project
- posters and stickers
- Powerpoint presentation
- a catalogue of websites with useful training resources
- Pathways- Learning for Sustainability material (training material which can help building users in the project understand the project in the wider context of sustainable development)

- energy best practice guides and good housekeeping information (for different buildings and for different categories of energy use, e.g. for use with building managers and caretakers)
- action pamphlets (which can be used with schoolchildren)
- case studies (showing examples from elsewhere, which can be of interest to building managers)
- individual partner resources

- **Project outputs/ Project deliverables**

A number of reports from the project can be accessed through the website. For example, bulletins giving an overview of the project at different stages are available, as are project reports with information on intelligent metering and project results.

A guide to setting up a similar intelligent metering project which has been produced in the project, an intelligent metering 'roadmap', is available.

Train the trainer material is available which provides a resource for others to use to help to run similar projects. Together with the training resources in the project, this helps to provide a training structure which can be used to help train others.

- **Project outputs/ Building details**

A short description of the buildings being monitored in the project in each partner country can be obtained.

- **Monitored data/ New data**

The project website enables the half hourly energy and water data collected from the buildings in the project to be viewed as graphs (daily, weekly or monthly key figures). This has enabled building users in the project to view and compare consumption graphs for their buildings.

- **Partner list**

Contact details for each of the project partners are given.

- **Case studies**

Case studies for a number of buildings monitored in the project are available. These give examples of experiences with intelligent metering and behavioural change in buildings in the project.

The website has run during the project and helps with providing ongoing resources. Through the website various resources from the project will continue to be available after the duration of EC funding for the project finished at the end of 2006. It has been intended that the website will run for the 3 years following the end of the project.

7. Dissemination and training

The project has included dissemination activities, and further training activities. Sonnenplatz have led this work, with individual partners carrying out dissemination in the different partner countries.

Dissemination
It has been the intention that the ongoing results of the project should be disseminated to as many people as possible, who may be able to carry out intelligent metering projects themselves, e.g. public authorities (municipality, county, regional and national), and industry.

A wide range of dissemination activities for different target groups have been carried out by the partners in the project, helping to increase public awareness of the possibilities for low cost energy and water savings and sustainability, and to help stimulate growth in the market. For example, dissemination activities have included networking, workshops for replication (8), presentations at relevant events (over 25), and press releases (23), flyers/brochures/leaflets (10), papers (7), and project bulletins (3). There has been various press coverage, including on local TV in South Jutland in Denmark, in the regional press in Austria, and since the project has finished on an East Midlands regional radio station in the UK. It has been intended that experiences from the project can be replicated more widely in Europe.

Three project bulletins have been produced giving an overview of progress and results from the project at different stages, and a range of leaflets and a flyer have been produced (Figure 25). The bulletins and some leaflets/flyers have been available on the project website.

Figure 25 A project bulletin and Danish intelligent metering leaflet

There have been a number of networking activities in the project. A number of articles have been produced including articles in Austria, and an article on intelligent metering in the newsletter of the UK Home Energy Conservation Association (Figure 26), which is distributed to home energy officers in UK local authorities.

Figure 26 Article in the UK

8 workshops to help with replication of the intelligent metering concept have taken place including a workshop at the Hessian Ministry of Economics by Energie 2000, participation by Energieagentur Waldviertel in a workshop with the IEE funded ENERinTOWN project, Beacon Council workshops for local authorities in the UK and a visit from representatives of the Austrian Society for Environment and Technique to Sonnenplatz Großschönau.

There have been a number of press releases during the project (e.g. Figure 27) including articles in regional newspapers in Austria, articles in newspapers in Germany (Figure 28) and the UK and a TV presentation on local TV South Jutland (Figure 29). A press release was included on the webpage of the Austrian Press Agency. By using TV, radio and newspapers it has been possible to disseminate intelligent metering information to a wide range of people, not only the public sector but also private households and businesses.

Figure 27 Press Releases in Austria

HNA, Do, 21.12.2006

Sparen mit Energie 2000

Untersuchung über Reduzierung von Betriebskosten an öffentlichen Gebäuden

Figure 28 Press coverage in Germany

Figure 29 TV coverage in Denmark

Over 25 presentations have been provided at relevant events in the different partner countries, giving information on intelligent metering to a range of groups including local authorities, planning and building experts, facilities managers, sustainability experts, local politicians and energy consultants.

Articles on the project have been provided to the Intelligent Energy Executive Agency, which have been used with IEE newsletters (e.g. IEE Newsletters 2 and 5). Also, information on the project has been made available as a fact sheet and presentation slides, which have been available on the IEEA website.

It has been found that there has been a good amount of interest in intelligent metering and the project.

Since the end of the project further dissemination activities have been taking place.

Training trainers

Training has been carried out for people in the public sector to enable them to repeat intelligent metering projects and to carry out training of occupants by themselves. 11 Train the Trainer workshops have been carried out. A Train the Trainer work module has been prepared for use in introducing others to the approach in the project.

The Train the Trainer work modules and training resources in the project can be used in training programmes in each partner country for training building occupants. These can be found on the project website.

8. Lessons learnt/Conclusions

Key results

About 70 public sector buildings in 4 European countries (Austria, Denmark, Germany and the UK) have undergone automatic remote monitoring of energy and/or water consumption in the project. The buildings have been typical of a range of types of local authority buildings found across Europe, and have included offices, schools, sports facilities, and community centres.

Monitoring and data collection arrangements have been implemented to enable half hourly consumption data to be collected from the buildings in a common database, processed and displayed in graphs on the project internet site (www.intelmeter.com).

Training material has been developed and collected in the project for use in training the occupants of the buildings being monitored. The partners have ensured that a wide range of training related activities have taken place, with the help of the intelligent metering information, to encourage behavioural change of the building users. Over 120 training sessions have been carried out with over 600 people trained.

All the project partners have increased their experience of the use of intelligent metering and the opportunities available.

Analysis of savings from the use of intelligent metering and the training in the project has been carried out. A range of energy and water savings from the use of intelligent metering and behavioural change have been demonstrated. Savings in water and energy from acting on intelligent metering information have been found, and savings from other training activities in the project have been achieved.

A roadmap for the use of intelligent metering and training elsewhere has been developed and case studies have been produced giving examples of the use of intelligent metering and training experiences in the project. Material has been developed to help others (e.g. in the public sector) use the training and intelligent metering approach taken in this project in other buildings.

A project website (www.intelmeter.com) has been established which helps with the dissemination of information on the use of intelligent metering in the project and project results. It includes information on the project and reports from the project, with pages in the language of each partner. It is intended the website will be available for at least 2 years after the end of the project.

Numerous activities to disseminate the concept of intelligent metering, and the project, have been carried out, for example with press releases, a TV appearance, presentations at a range of events, and project bulletins being produced.

A framework for replication of the approach and for on-going training has been developed.

Lessons learnt

It is possible to collect half hourly energy and water consumption data for a number of public sector buildings (e.g. offices, schools, sports centres, and community centres) in 4 European countries in a common database, and for it to be processed and displayed in graphs on an internet site (www.intelmeter.com).

Some initial preparation work is necessary to ensure that data from the different intelligent metering data collection systems being used is in the required format for computer analysis software.

The intelligent metering data collected helps with the use of the bespoke training package, which was developed specifically for use with occupants of the buildings using intelligent metering.

The project has shown that energy and water savings can be achieved from the use of intelligent metering and behavioural change of building users. For some buildings being monitored in the project, energy or water saving opportunities have been identified from analysis of half hourly consumption monitoring data. In cases where these opportunities have been discussed with a representative in the building and corrective action has been taken savings have been obtained.

Energy savings have been obtained from training sessions and related behaviour change activities in the project. For example following some training sessions it has been possible to identify at least short term savings from the intelligent metering information collected.

Staff training is not a “fit and forget” option, but needs to be reinforced and re-emphasised, for example annually.

Impacts achieved

Intelligent metering is being extended to other buildings. For example, Energieagentur Waldviertel intend that intelligent metering will be extended to 16 buildings of the regional public administration. Leicester City Council are continuing to extend intelligent metering to other Council buildings.

Further dissemination activities are being followed up. Dissemination of intelligent metering and the results of the project is ongoing, beyond the end of the project. It is intended to continue to provide presentations at relevant events and to use further networking opportunities.

There is continued investigation of opportunities for additional training in the buildings in the project, and further investigation of potential savings opportunities in buildings in the project. For example, in Leicester, further training opportunities have been identified in the project, and also some energy saving projects are being followed up, such as possible lighting improvement projects. In Leicester closer links have been developed with the team at a local environmental charity who are undertaking EMAS work in a number of Leicester schools. Intelligent Metering graphs are now being provided regularly to all the schools on the intelligent metering system in Leicester.

Conclusions

The project has shown that energy and water savings can be achieved from the use of intelligent metering and behavioural change of building users. For some buildings being monitored in the project, energy or water saving opportunities have been identified from analysis of half hourly consumption monitoring data. Where these opportunities have been discussed with a representative in the building and corrective action has been taken savings have been obtained. For example, in Bridge Junior School in Leicester unusually high water consumption was identified from monitoring data. Following investigation a water leak was located and corrective action taken, giving significant water consumption and cost savings. Details are given in a case study.

Also, energy savings have been obtained from the training sessions and related behaviour change activities in the project. For example following some training sessions it has been possible to identify savings. Some examples are described in case studies.

The use of intelligent metering information is a useful approach in the delivery of energy saving training for building users. Energy and water consumption profiles have been useful in informing the training to be delivered to building users and have been useful in communicating energy saving opportunities to

building users, in providing feedback on the effect of energy saving measures or changes in behaviour, and in educational activities in schools.

The project has contributed successfully to maximising the energy savings available across Europe through the use of intelligent metering and behavioural changes of building occupants.

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