Energy savings from intelligent metering and behavioural change in local and regional public sector buildings

P. Webber
Leicester Energy Agency (Leicester City Council)
Leicester Energy Efficiency Centre
United Kingdom
webbp900@leicester.gov.uk

S. Conway
Leicester Energy Agency (Leicester City Council)
Leicester Energy Efficiency Centre
Stewart.Conway@leicester.gov.uk

P. Patel
Leicester City Council
Leicester Energy Efficiency Centre
Prakash.Patel@leicester.gov.uk

M. Fleming
Leicester, United Kingdom
margaret.fleming@ntlworld.com

Keywords

automatic utilities monitoring, behaviour change, dissemination, energy savings, local, metering, training

Abstract

The intelligent metering of energy and water consumption in local and regional public buildings and the half hourly analysis of consumption data can enable savings opportunities to be identified, including the detection of faults. From Leicester City Council's experience with intelligent metering it has been found that in some buildings savings of up to 20-30 % can be obtained with little or no investment. The scope for energy savings from intelligent metering and behavioural change initiatives has been investigated in a recent European Commission supported project, involving local authorities and local and regional energy agencies.

Up to 70 local and regional public sector buildings, including offices, leisure centres, community centres and schools have been selected by project partners in 4 European countries (Austria, Denmark, Germany and the UK) for monitoring using intelligent metering equipment. Intelligent metering and monitoring requirements have been assessed, different monitoring systems compared, and a common monitoring framework has been established for the buildings. Half hourly monitoring data has been transmitted to a central database from where the data has been processed by automatic utilities auditing software, with the generated consumption profiles being displayed on the project website.

The detailed consumption data has been analysed to identify savings opportunities, and a training package has been developed which uses the intelligent metering information to support activities to encourage changes in the behaviour of occupants of the buildings being monitored. Training activities have been carried out with building users and the savings resulting from intelligent metering, and behaviour change of building users, in the project have been considered.

Introduction

A significant amount of European Union energy consumption is building-related (e.g. EC, 2002). This is an important target area for energy savings and efforts to manage greenhouse gas emissions in Europe. The EU has a target of reducing greenhouse gas emissions by 8 % of 1990 levels by 2008-12 under the Kyoto climate change agreement. By improving energy efficiency in their buildings local and regional public authorities can contribute to energy and climate change targets at a range of levels, in addition to achieving cost savings for their authorities.

It is recognised that the use of the technique of automatic utilities auditing in monitoring consumption can help savings to be attained (e.g. DETR, 1996; The Carbon Trust, 2005; Ferreira et al, 2007). The application of this technique to energy and water consumption in local and regional public buildings and the half hourly analysis of consumption data can enable savings opportunities to be identified. Also, changes in energy use behaviour by building users can contribute to reductions in energy consumption. From Leicester City Council's experience with automatic utility auditing it has been found that for some buildings savings of up to 20-30 % can be obtained with little or no investment. Various work has looked at energy and behavioural changes, at international (e.g. the European Commission supported Energy Trophy project) and national levels (e.g. in the UK, OFGEM's current Energy Demand Reduction pilot). A recent European Commission Intelligent Energy Europe supported project ('Energy Savings from Intelligent Metering and Behavioural Change'), involving local authorities and local and regional energy agencies, has investigated the scope for energy savings from intelligent metering and behavioural change initiatives and helping to maximise these savings.

Leicester City Council has a target of reducing its energy consumption and carbon dioxide emissions to half of 1990 levels by 2025. It has established Energy and Climate Change Strategies (Leicester City Council, 1994; Leicester Partnership, 2003) and reports on energy consumption in its buildings under the Eco Management and Audit Scheme (e.g. Leicester City Council, 2006). The City Council has monitored the energy use of the council's buildings for a number of years. For example it has used a computerised Energy Accounting System to store, process and analyse billing information, and it has used computerised Building Energy Management Systems (BEMS) to provide sophisticated on-line monitoring of selected remote sites to provide up-to the-minute reports of consumption and operating status.

The City Council's energy monitoring systems have traditionally been based around billing data provided by the utilities. This type of system enables an increase in consumption to be detected two or three months after it occurs. It was found that the deregulation of the energy markets had made it more difficult to obtain accurate, reliable energy data and manual reading of meters presented a practical problem. Therefore the City Council investigated intelligent metering systems that could capture real time data. In recent years Leicester City Council has been installing automatic utility monitoring equipment in its buildings on an ongoing basis. By using this equipment the City Council has been able to identify energy and water saving opportunities from analysing the resulting data and has been able to monitor half hourly consumption on an ongoing basis. The intelligent metering system uses low power radio to automatically transmit meter readings to a central receiver/data logger. The meter reading data is then automatically downloaded to a computer within the local authority, where it is analysed (*Figure 1*). This approach has been successful in identifying savings and the Council has been continuing to install monitoring equipment in more buildings, with over 250 Council buildings currently using this intelligent metering technology.

Leicester City Council's Energy Management Team have reported the following benefits from intelligent metering:

- Automatic collection of meter readings
- Automatic analysis of data to identify exceptions
- Simple / graphic presentation of energy and water data
- Timely and accurate energy management information
- Better information / customised advice

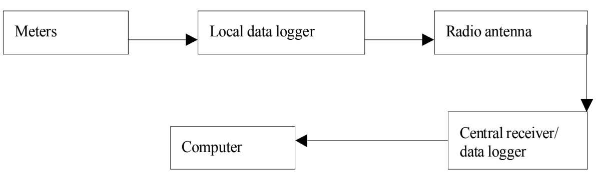

Figure 1. An example of the layout of an intelligent metering system

- Verify savings as a result energy efficiency improvements
- Bill validation / verification
- Benchmarks

The European Commission Intelligent Energy Europe supported Intelligent Metering project identified savings available from using intelligent metering and training users of public buildings, and demonstrated that savings coming from behavioural change can be obtained with no or little extra cost (beyond monitoring and training costs). The project involved 7 partners from 4 European countries, including local and regional energy agencies and local authorities. The Leicester Energy Agency (based at Leicester City Council) coordinated the project, which involved Energieagentur Waldviertel (Austria), Sonnenplatz Großschönau GmbH (Austria), County of South Jutland (Denmark), Esbensen (Denmark), ENERGIE 2000 e.V. (Germany), and IT Power Ltd. (UK) as partners. The project investigated the energy savings from intelligent metering and behavioural change in local and regional public sector buildings. Through the project Leicester shared its experience with intelligent metering with local partners from other countries, as well as learning from international experiences, and disseminating the potential for the use of intelligent metering.

Methodology

Initially, monitoring requirements for the project were looked at, and buildings to undergo monitoring in the project were identified. About 70 local and regional public sector buildings, including offices, leisure centres/sports halls, community centres and kindergartens, primary and secondary schools, small business units, an entertainment venue and library were selected by the project partners (*Figure 2*). Efforts were made to select local authority buildings which were typical public sector buildings to help with the transferability of the results and it was intended that buildings would be included that either had no intelligent metering or had intelligent metering installed but no analysis of the data had been carried out. Buildings selected for inclusion in the project were not necessarily those thought likely to be most interested in energy efficiency, although in Denmark efforts were made to select buildings where users were interested in their energy use and where it was felt behaviour change of users was needed.

In total 13 buildings from Austria were included in the project (including local government offices, and nursing homes, a school and a kindergarten), 11 from Denmark (including high schools,

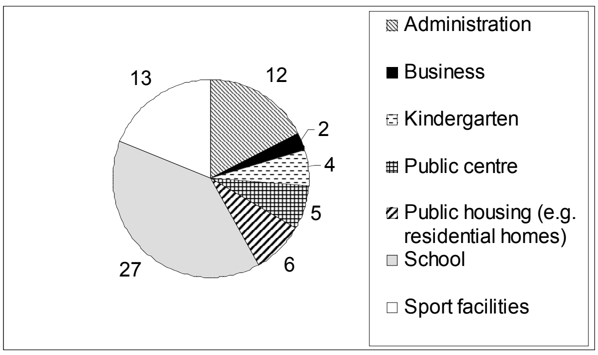

Figure 2. Mix of local/regional authority buildings being monitored in project (e.g. Sonnenplatz, 2006a)

main local authority buildings, residential homes for the handicapped), 20 from Germany (including primary and secondary schools, gymnastic halls and public rooms) and 26 buildings from the UK (including administrative offices, business units, community centres, sports and leisure facilities and schools).

The monitoring requirements and a common specification for the project were researched. Intelligent monitoring equipment was established on the buildings participating in the project. Electricity, gas, heat (district heating), or water were the utilities monitored. Data transfer arrangements were put in place so that the data from each building could be transferred to a common database and processed to enable graphs showing consumption profiles to be displayed on the project website (www.intelmeter.com).

Project partners arranged for existing meters to be reviewed (electricity, gas, heat, or water) and work was carried out to ensure pulse outputs could be provided as a measure of consumption (which might involve the installation of a customer interface by the utility as in Leicester). Also, some temperature sensors were used by partners to give information on external temperatures. Data loggers were used and data was transferred to a computer for analysis. For example, in Leicester low power radio is used to transfer meter data to a data logger, from where it can be downloaded to a computer for analysis (e.g. DETR, 2006). Typical installation costs for intelligent metering equipment in a building to monitor electricity, gas or heat, and water in the project have been about 2 500-5 000 Euros (Sonnenplatz, 2006b). (Overall software costs for an analysis system might be about 1 000-5 500 Euros, depending on the size of the system.)

Detailed energy monitoring information was displayed as graphical profiles and made available over the internet. Efforts were made to ensure that there was a period of data collection from buildings in the project before training began in order to provide baseline information which could be used to identify savings opportunities, inform the training to be provided and to help with assessing changes in consumption. This information has been used with the training of building occupants.

A training programme for use with occupants of buildings in the project was devised, and training manuals and training material were prepared. These helped with training activities which took place for the buildings in the project.

Intelligent metering information on energy and water consumption in the participating buildings has been analysed to assess energy and water savings, including savings following the training.

An important part of the project has been to disseminate intelligent metering and the results of the project. This has been facilitated through the use of a dedicated project website (www.intelmeter.com), and also presentations, newsletters, and press releases.

Monitoring strategy

Early in the project, intelligent metering and monitoring requirements for the project were assessed. This involved summarising monitoring needs (Energieagentur Waldviertel, 2005a), specifying a common monitoring framework for the buildings (Energieagentur Waldviertel, 2005b), and comparing different monitoring systems (Energieagentur Waldviertel, 2005c).

Consideration was given to the parameters to be monitored, and the outputs required from the system. An arrangement was devised for monitoring data for the buildings in the different countries to be sent to a central database from where the data is processed, with the resulting intelligent metering information being displayed on the internet.

ASSESSMENT OF MONITORING REQUIREMENTS

The monitoring requirements to be able to collect intelligent metering data for analysis from the approximately 70 buildings in the project using different energy monitoring systems, and graphically display the information on a common website, were assessed. A common format for the data to be sent to the database from different partners was established.

Arrangements were agreed in order that half hourly monitoring data could be transmitted to a central database from where the data would be processed by automatic utilities auditing software, with the generated consumption profiles being displayed on the project website.

Different monitoring approaches and systems were compared in order to inform the use of monitoring systems in the project (Energieagentur Waldviertel, 2005c).

MONITORING AND DATA TRANSMISSION ARRANGEMENTS

Having arranged for the installation of monitoring hardware and software, project partners arranged for the transfer of the data to a common project database, developed by Esbensen (Denmark). This SQL database enabled data from the different buildings to be uploaded automatically by an internet-based tool. Partners were able to register their buildings and meters which were assigned identification codes. This provided a link to data uploaded using 'ftp'. Also, it was possible to use this to view monitored data for the buildings. Data from the database has been processed by energy analysis software from Energy Metering Technology (UK) and graphs generated and displayed on the project website. An overview of the monitoring and data transmission arrangements is given in *Figure 3*.

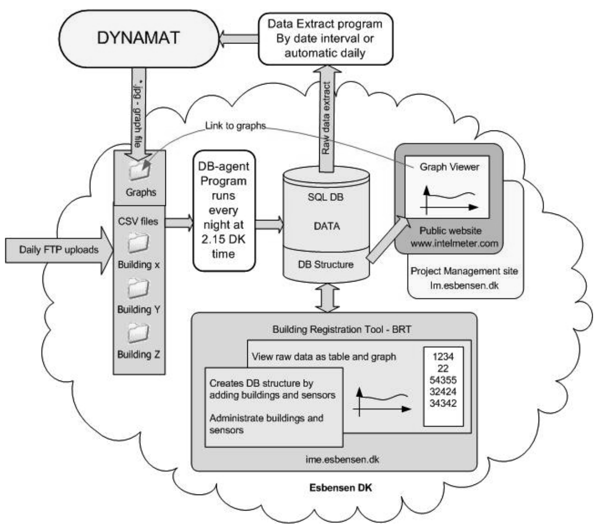

Figure 3. Overall monitoring/common database arrangements in the project, as outlined by Esbensen (Intelligent Metering, 2006)

Monitoring and analysis

Detailed energy consumption data can be analysed to identify possible savings opportunities (e.g. Ferreira et al., 2003; Stuart et al., 2007). From a quick initial review of the energy and water consumption profiles produced for the buildings in the project it has been possible to obtain background information on consumption patterns which can enable savings opportunities to be identified and inform the training to be delivered in the building. For example, review of such graphs can show unusual consumption such as water leaks or faults (e.g. with the heating system), excessive out of hours energy use (e.g. at weekends or in holiday periods), or unusual baseload consumption. These features can be discussed with a representative from the building and investigated further, and can enable savings to be achieved. Also, they can highlight areas on which training can focus.

DISPLAY OF DETAILED ENERGY MONITORING INFORMATION

Requirements for displaying the detailed energy monitoring information in the project were discussed. The purpose of displaying the information was considered. Graphical display of the information should be able to be used by the local energy agencies and other partners in identifying saving opportunities and looking at patterns in consumption, but also it should be suitable for use with the occupants of the buildings being monitored in the project, enabling them to view readily understandable consumption information for their building. A range of graphs can be generated by different proprietary automatic detailed utilities monitoring software, such as half hourly consumption profiles for energy and water, consumption graphs showing target consumption and alarm limits, and CUSUM graphs showing the changes in consumption.

In the project, graphs were produced which would enable a comparison of change in consumption which could be viewed by building users through a project website (e.g. *Figure 4*). Graphs were produced to show (per unit of floor area):

- half hourly day on day consumption,
- hourly week on week consumption, and
- daily consumption for a 4 weekly consumption profile compared to that of the previous 4 weeks.

Providing information on a per unit floor area basis enables some comparison of the buildings, for example across countries. Other graphs were available to those partners using their own automatic utilities monitoring software.

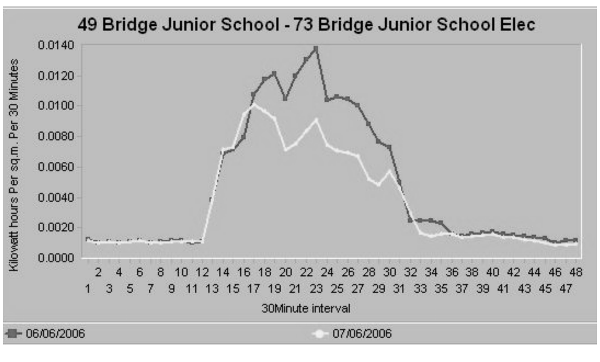

Figure 4. Example of the graphical display of intelligent metering information

Training for building occupants

A training package has been developed which uses the intelligent metering information to support activities to encourage changes in the behaviour of occupants of the buildings being monitored. Background research was carried out into means of changing behaviour of building users, and consideration was given to the different types of building users to be trained and the approach to be taken for each group. For example, suitable training was selected or developed for headteachers and business managers, teachers, and pupils in schools, building managers, general staff, premises officers, and cleaners. A training strategy for the project was set out, giving a framework for the training activities which have been carried out with building users.

PROGRAMME

There is a range of potential actions available to local and regional public authorities to encourage change in behaviour of users of their buildings in relation to energy and water use. It was considered that in order to achieve the most impact on changing behaviour additional approaches to the delivery of a single training session were required. For example it was proposed that activities to engage people (e.g. communicate with and involve), enable (e.g. provide information) and provide incentives (e.g. financial rewards) should be used together (e.g. *Figure 5*). Also, it was considered that encouraging a building/organisation-wide approach to the training would be valuable. The project partners exchanged details of training approaches and tools used in the partner countries. A range of resources and ideas has been made available for use in the project. Training manuals (e.g. Fleming, 2006) were developed for the buildings in the project (a schools manual and one for other local authority buildings) explaining this approach, and a range of resources were made available for use with the users of buildings in the project.

Graphs showing half hourly energy and water consumption information from intelligent metering were available for use with building users, and other resources including case studies, energy awareness posters and stickers, presentations, good practice guides (e.g. Carbon Trust, 2005), good housekeeping information, and material to support an organisation-wide approach to sustainable development, which could be used with the building/organisation's leadership (WWF, 2004) were available. Country-specific resources were also used as appropriate.

An overview of the training is given in Figure 6. 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. 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

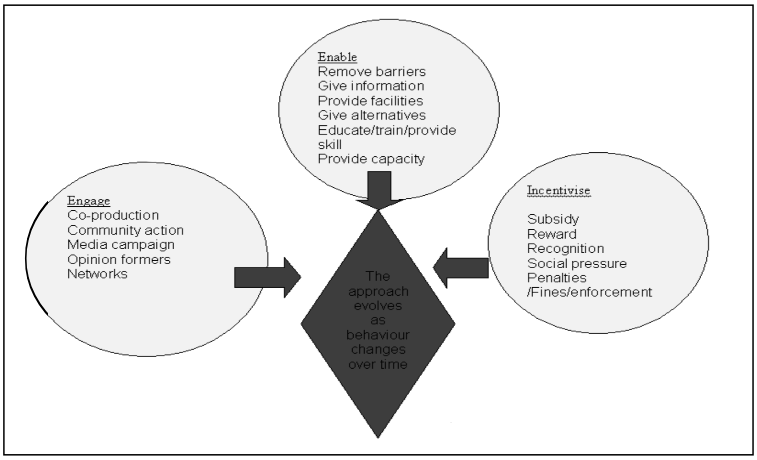

Figure 5. Training approach used

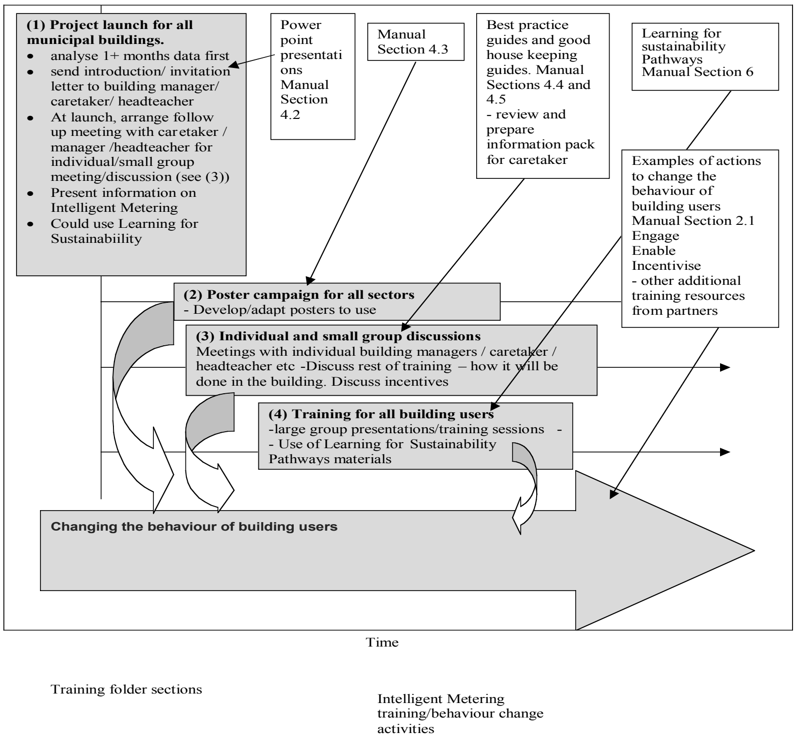

Figure 6. An overview of the training in the project

and can be used with energy performance certificates, such as those produced in the EC supported 'DISPLAY' project. Some conversations/discussions have taken place with building managers, caretakers and headteachers to discuss how the training would 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.

IMPLEMENTATION

The training approach was used by partners in each country, with a range of training resources and training techniques being used. In total there have been over 100 training sessions, with over 600 people receiving some training in the project.

In Austria, various training activities have been carried out for users of the 13 buildings (Intelligent Metering, 2007). These have included the use of posters, and information sheets, and talks to various staff members and pupils. Emails have been sent with newsletters to buildings. Energieagentur Waldviertel considered that it was more effective to frequently provide small amounts of information rather than a large amount in one go. Personal training meetings have taken place with technical staff in Danish buildings in the project. Meetings were held with headteachers and science teachers to contribute to training material for pupils. Training has been provided to buildings being monitored in Germany.

UK

In the UK, a launch event for representatives from buildings in the project was held, setting the context for the project, and introducing intelligent metering and the project itself. In smaller groups there was further discussion with representatives from schools, and with representatives from Council buildings in the project. Individual training visits were arranged to each building (for example meeting with the building manager, head teacher, business manager or premises officer) where a training pack was provided, and graphs of intelligent metering information for the buildings were shown. In many cases a short energy walk round of the building was carried out with the building representative where energy and water saving opportunities were considered.

Through the individual meetings further training and savings opportunities have been identified. Following the visit possible actions were listed in a short action plan which was forwarded to the 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. For example they mentioned relevant further training activities such as talks at staff meetings, possible low cost energy efficiency improvements, and the provision of an energy performance certificate, as appropriate. The detailed intelligent metering information has enabled the impact of training actions to be fed back rapidly to building users and sometimes the action plan included a further intelligent metering graph showing any change in consumption following the training visit.

To help to engage with building users, two events were arranged based on the WWF's Pathways Learning for Sustainability approach, aimed particularly at the leadership in the buildings. 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. 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.

Also, as an incentive, a competition between the buildings in the project has been operating to identify the building which achieves the largest amount of its potential savings. Information on intelligent metering and the project has been mentioned in the Council's employee magazine and also in a newsletter which was distributed to households in Leicester.

Results and savings analysis

The savings resulting from intelligent metering, and behaviour change of building users (e.g. Energieagentur Waldviertel, 2006), in the project have been considered.

A range of criteria can be used for assessing the success of an intelligent metering/behavioural change project, including the availability of energy use data for the building users, energy and water savings achieved, the number of training sessions provided, the nature of the feedback from training workshop participants/building users, and an increase in energy awareness among building users (e.g. IT Power, 2007). The project has enabled building users to view half hourly energy or water consumption data for their building and energy and water savings of various magnitudes have been achieved in different buildings. Following training of building occupants positive feedback has been received from trained building users showing a good awareness of intelligent metering and what it can achieve.

A number of approaches have been considered to investigate the results and savings in the project, e.g.:

- To analyse the effect of the training half hourly consumption graphs before and after training have been compared.
- A feedback questionnaire has been available for building users trained.
- Weekly and monthly consumption before and after a training activity have been compared.

EXPERIENCES IN DIFFERENT COUNTRIES

Partners have found savings opportunities from the analysis of detailed energy consumption graphs. For example in Leicester a water leak at a school was identified and corrected (e.g. Ferreira, 2007), giving a cost saving which has been considered to give a payback of the intelligent metering installation of a few months. Some results for different countries, particularly related to the training are given below.

From comparing a building's weekly and monthly consumption before and after a number of training activities an indication has been gained of possible savings related to the training (Energieagentur Waldviertel, 2006). A temperature correction has been used with heating-related consumption data around training activities. Because of the timing of much of the training (around the start or end of the heating season or in the summer when there was little or no space heating) the overall results for heating may be unclear so far. Excluding possible heating savings, the largest average savings from this comparison for a sample of training activities have been from electricity (about 6 % on average per training session, but ranging from about 3 % on average in Austria to about 11 % on average per building in Denmark), from analysis by Energieagentur Waldviertel. From comparing consumption around training sessions, water savings following training sessions have been variable, ranging from an 11 % increase on average per training session for buildings in one country (where there were water savings in different buildings but large increases after training sessions in a few buildings) to average savings per training session of 1 % in another (which would have been larger but for the effect of one building where there was a large rise in consumption). In relating the change in consumption to the effect of the training it should be noted that there are other factors which could influence consumption changes, for example holidays and special events.

From comparing consumption for the month before and after training activities the Austrian partners found average savings of over 8 % on electricity and about 4 % on water for one partner's buildings (Energieagentur Waldviertel, 2006). It was felt by Energieagentur Waldviertel that larger savings have been from where there has been greater interest from the building users.

From reviewing savings following training sessions in the Denmark buildings most of the buildings achieved a saving in electricity, with about an 11% average saving per building

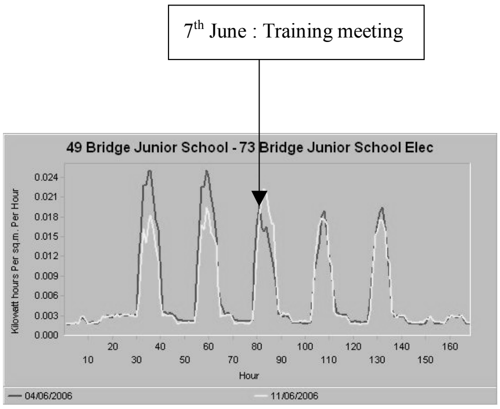

Figure 7. An example of a change in consumption following a training visit to a school

(Energieagentur Waldviertel, 2006). While there have been consumption increases for 2 buildings, water consumption decreased for most of the buildings where data has been available. The Danish partners 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.

In Germany, an initial meeting was led for some buildings to inform them about the project, and some training sessions were run for premises officers. The level of interest of the relevant person (or users) in the building was particularly important in facilitating the training, and ENERGIE 2000 found that there was particular interest from schools in the project, with interest in using the data in future energy projects. Effects of training for schools have been noticed, with electrical equipment being switched off. A good form of training was considered to be small group training, e.g. with teachers, pupils and premises officers, where a conversation took place, graphs were shown and a walk round the building was carried out (Intelligent Metering, 2007).

UK

It is possible to use intelligent metering graphs to show consumption changes around individual training activities in the project. For some buildings, possible savings following individual training visits have been observed on half hourly consumption profiles from intelligent metering, particularly for electricity. For example, *Figure 7* shows a comparison of electricity consumption for the week of a training meeting, and the week after, at a school. Overall, comparing consumption for the month before and the month after training visits, using data from intelligent metering there has been an average saving of about 6 % for electricity and 1 % for water (Energieagentur Waldviertel, 2006). Further training opportunities have been identified which have the potential to lead to further savings.

The scope for energy savings opportunities varied between the buildings in the project. In some buildings immediate energy savings were possible from, for example, switching off unnecessary lights (e.g. some schools). Rather than switch on all lights at the start of the day only those which are needed could be switched on. In other buildings there was less scope for lighting savings as a large number of lights were switched together and building users had limited control over which lights could be switched off (e.g. a community centre). In some premises lighting sensors have already been installed to automatically switch off unneeded lights.

Intelligent metering of some buildings in the project has enabled unusual water consumption, resulting from a water leak, to be identified. The correction of these leaks enables significant savings to be achieved. In schools there is potential for taps in toilet areas to be left running at times, which the Premises Officer can monitor.

For heating, the use of intelligent metering information has enabled incorrectly set heating controls to be identified, and faults to be recognised. Opportunities for keeping obstacles such as furniture and stored material away from radiators have been noted.

Further investigation is needed to assess the long term effect of training. However, monitoring using intelligent metering is ongoing and can help to quantify the savings over the longer term.

There have been short payback periods (e.g. up to 1 year) for the intelligent metering in some buildings, particularly where the reason for unusual consumption has been identified and corrected following the review of half hourly consumption data and its ongoing monitoring.

Discussion

BARRIERS AND SUCCESS FACTORS AFFECTING THE OUTCOMES OF THE TRAINING

Feedback from project partners, and experience in Leicester in the project, has suggested a number of barriers/success factors which possibly can affect the savings obtained from the provision of training activities in this type of project (Intelligent Metering, 2007). Some examples of possible success factors for savings from buildings undergoing training in the project include:

- Possible savings have been identified from review of intelligent metering graphs and which can be followed up in the training activity, e.g. possible leaks and false settings of the technical systems of the building.
- Good potential for savings from staff behavioural actions in the building (e.g. staff may only have limited control of energy using equipment such as lights).
- Building is not already highly energy efficient with very good energy housekeeping practises in place already. For example, the building has scope for further improving its existing level of energy and water performance. There are good possibilities for building users to become more energy aware and better informed.
- Good levels of interest and cooperation from building managers and building representatives. Good level of engagement of the building representative with the project and training.
- Good quality training, which can be affected by the level of resources available (e.g. staff, time and materials) to provide training.
- Limited staff changes for key trained staff.

COMMON EXPERIENCES AND FINDINGS

Local agencies and administrations have been able to monitor consumption information for local buildings. When unusual consumption has been identified efforts are made to investigate this by contacting a representative for the building.

The project partners have demonstrated the potential for using intelligent metering to identify energy and water savings opportunities in local and regional public authority buildings. For example, potential savings have been identified from the review of half hourly intelligent metering data, and from the delivery of training to building users in the project. Savings have been achieved from following up savings opportunities with building representatives identified from the review of intelligent metering graphs, and from changes in behaviour by building users related to the training.

One application of intelligent metering information is to contribute to educational work in schools. Its ability to contribute to broader sustainable energy and sustainable development-related education has been observed in work with schools in the project. For example, intelligent metering graphs have been used to support sustainable energy education activities in schools, with a range of sustainable energy activities being demonstrated in one school, with a special assembly, energy efficiency week, and 'suspended curriculum' event. In Leicester, a number of schools are taking part in the Eco Management and Audit Scheme (EMAS). As several of these schools use intelligent metering this information is being linked now with EMAS related work. There are opportunities to use intelligent metering information to help with a whole school approach to sustainable energy.

Automatic half hourly utilities auditing can provide information which complements the implementation of the European Energy Performance of Buildings Directive. In Leicester, intelligent metering can help to provide information for energy performance certificates being produced in the EC supported DISPLAY project (www.display-campaign.org), which help to raise energy awareness of building users.

The effectiveness of the project has been dependent on the close cooperation and links between local administrations and local energy agencies and other organisations in each country as well as overall cooperation between project partners in different countries.

It has been highlighted by Esbensen that the SQL database used in the project has been a useful means of bringing together the data from a range of different monitoring systems from the different countries in the project (Intelligent Metering, 2007).

DISSEMINATION/APPLICABILITY TO OTHER BUILDING SECTORS

The partners have recognised the possibility for replicating the approach in other local and regional public buildings. There are plans for extending the application of intelligent metering to other local authority buildings, for example in Austria and Leicester. There is good potential for the uptake of intelligent metering for local/regional public sector buildings in other areas, helping them to manage their energy costs.

Information on the project is available to help other local and regional public organisations set up their own intelligent metering systems and the project's training resources are available for other public bodies to establish their own training for occupants of their buildings (e.g. IT Power, 2007; Sonnenplatz, 2006b).

AREAS FOR FURTHER WORK

Through experiences at the City Council in Leicester with the use of intelligent metering the Energy Management Team has highlighted potential future opportunities, including:

- Ability to self-bill for energy and water
- Negotiate better rates for energy and water
- Identify buildings that require energy efficiency improvements
- Encourage and stimulate energy efficiency investment
- Pro-active maintenance using energy data
- Streamlining of energy and water monitoring
- Change behavioural attitudes with a view to adopting a more sustainable lifestyle.

Further work related to the project could look at developing the website graphs further to make available graphs showing additional analysis (e.g. including a degree day correction for heating) providing information to compare current consumption to a target consumption. This would provide all partners and building users with additional readily available information.

There is scope for further work to be carried out to help with detecting savings opportunities from intelligent metering information for use when delivering training activities.

Further monitoring of consumption in the buildings in the project will be valuable to help with assessing the effect of training and savings from intelligent metering. For example, an area of future work is for longer term monitoring using intelligent metering which can help to monitor the duration of savings related to behaviour change. There is scope for further work to explore extending the approach to small/medium businesses to achieve savings from intelligent metering and behaviour change. Also, an area of possible future work is the further investigation of ways of feeding back energy consumption information from intelligent metering to building users to encourage behaviour change.

Conclusions

A common intelligent metering/monitoring system has been established enabling half hourly data on energy and water consumption in up to 70 local and regional public sector buildings from 4 European countries to be collected and held in a common database, and consumption profiles on a daily, weekly and 4 weekly basis to be displayed graphically on the internet.

The data has helped with the use of a training package developed for use with occupants of the buildings using intelligent metering. Over 100 training sessions have been held in the project. Intelligent metering information has been used to help with the delivery of training in the project. Intelligent metering information on energy and water can contribute to educational programmes in schools. A framework and resources are available for use in other areas to enable ongoing use of the training approach.

The potential for using intelligent metering to identify energy and water savings opportunities in local and regional public authority buildings has been demonstrated. Savings have been achieved from the intelligent metering of energy and water consumption and from behavioural change of building users. It has been possible to change the behaviour of some building users, through training and related information. In some buildings, following training activities in the project possible savings have been noticed using intelligent metering. It is possible to use intelligent metering information to help to quantify savings over time.

In recognition of the benefits from using intelligent metering partners are intending to further extend the application of intelligent metering to other buildings. The approach has good potential for replication in other local and regional public buildings to help to achieve energy and water savings.

References

Carbon Trust, 2005, Creating an awareness campaign. CTG001, Carbon Trust, London.

DETR, 1996, General Information Leaflet 49 Low-cost automatic meter-reading system, Energy Efficiency Best Practice Programme.

Energieagentur Waldviertel, 2005a, Energy Savings from Intelligent Metering and Behavioural Change. Summary of monitoring needs (Deliverable 1). (www.intelmeter.com)

Energieagentur Waldviertel, 2005b, Energy Savings from Intelligent Metering and Behavioural Change. Monitoring Specification (Deliverable 2). (www.intelmeter.com)

Energieagentur Waldviertel, 2005c, Energy Savings from Intelligent Metering and Behavioural Change. Comparisons of existing monitoring systems (Deliverable 4). (www.intelmeter.com)

Energieagentur Waldviertel, 2006, Report on analysis of the results of training (work-package 4). (www.intelmeter.com)

European Commission, 2002, Directive 2002/91/EC of the European Parliament and of the Council of the European Union on the energy performance of buildings, Brussels.

Ferreira, V., Alves, L., Fleming, P., Stuart, G., Patel, P., Webber, P., and Conway, S., 2007, “Low hanging fruits” or cost-effective energy and water savings using intelligent metering and monitoring systems? Proceedings 2007 ECEEE Summer Study, European Council for an Energy Efficient Economy, Paris, France.

Ferreira, V., Fleming, P., and Ajiboye, P., 2003, Identifying energy saving opportunities in buildings by the analysis of time series data. Proceedings 2003 ECEEE Summer Study, pp.417-427, European Council for an Energy Efficient Economy, Paris, France.

Fleming, M., 2006, Intelligent Metering training handbook. Creating a sustainable building-School Edition.

Intelligent Metering 2006, Energy Savings from Intelligent Metering and Behavioural Change. Interim report.

Intelligent Metering, 2007, Energy Savings from Intelligent Metering and Behavioural Change. Final report- Project results.

IT Power, 2007, Energy Savings from Intelligent Metering and Behavioural Change. Roadmap for an Intelligent Metering, Monitoring and Training Programme. (www.intelmeter.com)

Leicester City Council, 1994, The Leicester Energy Strategy, Leicester City Council, Leicester.

Leicester City Council, 2006, Leicester City Council’s Environmental Statement. An Environmental Statement for the Eco-Management & Audit Scheme (EMAS), April 2004-March 2005, Leicester City Council, Leicester.

Leicester Partnership, 2003. City of Leicester. Climate Change Strategy, Leicester City Council, Leicester.

Sonnenplatz Großschönau, 2006a, Intelligent Metering bulletin Nr. 01/06. (www.intelmeter.com)

Sonnenplatz Großschönau, 2006b, Energy Savings from Intelligent Metering and Behavioural Change.Train-the-Trainer Work Modules. (www.intelmeter.com)

Stuart, G., Fleming, P., Ferreira, V. and Harris P., 2007, Rapid analysis of time series data to identify changes in electricity consumption patterns in UK secondary schools. Building and Environment. 42 (4): 1568-1580.

The Carbon Trust, 2005, The Carbon Trust’s Advanced Metering field trial update, The Carbon Trust, UK.

WWF, 2004, Pathways. Learning for Sustainability, WWF-UK, Godalming, Surrey.

Acknowledgements

The authors would like to acknowledge the contribution of the project partners to the project:

County of South Jutland (including P. Bennetsen, and County of Vejle (M. Mortensen and K. Christiansen)), Energieagentur Waldviertel (including Dr. H. Lunzer, and R. Riemer), ENERGIE 2000 e.V. (M. Schaub), Esbensen (including T. Esbensen, L. Bushby and H. Heidemann), IT Power (including Dr. M. Fuentes, F. Crick, P. Reed, D. Brewer, and R. Gunning), and Sonnenplatz Großschönau (including H. Bruckner).

Also, thanks are due to J. Edmonds (Energy Metering Technology), J. Odell, T. Taylor and N. Morris (Leicester City Council), and D. Lack, and V. Ferreira, and Professor P. Fleming and G. Stuart (De Montfort University).

The support of the European Commission’s Intelligent Energy Europe programme for this project is gratefully acknowledged.