SCOPING STUDY FOR MEASURING PEAK ELECTRICITY DEMAND IN NON-DOMESTIC BUILDINGS

FINAL REPORT

Report for Department of Energy & Climate Change

Restricted Commercial
ED47637
Final Report
28th May 2010

Title	Scoping study for measuring peak electricity demand in non-domestic buildings
Customer	Department of Energy & Climate Change (DECC)
Customer reference	CCE09-02
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File reference	K:\Projects\ED47637 DECC Peak Elec Demand
Reference number	ED47637

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Executive summary

AEA is pleased to submit this Final Report to The Department of Energy & Climate Change (DECC) for contracted project entitled 'Scoping study for measuring peak electricity demand in non-domestic buildings'. The main aim of this study was to scope out a project for measuring peak electricity demand in non-domestic buildings. The purpose of measuring this peak demand is to identify discretionary demand, i.e. demand that could be shifted to non-peak times.

The UK profile of energy use sees greater activity during peak hours which results in high loads between 6am-9am and 5pm-8pm during the working week. Whilst domestic energy use peaks during these times, although outside of traditional 9am-5pm working hours, the non-domestic sector also contributes significantly to these peaks. Whilst patterns in the domestic sector use can be easily identified within the peak times (e.g. returning home from work), the non-domestic component of peak loads often comprises unusual consumption, specific items of plant or 'all-at-once' use of numerous small items (such as at change of shift/daily switch on). The activities and loads have considerable variation in the non-domestic area. These peak loads put augmented pressure on electricity generation, supply companies and infrastructure and may also eventually affect the security and continuity of supply if demand continues to increase. Furthermore, there is potential for these high peak loads to impact the economy negatively through increased distributor/supplier charges.

This scoping study seeks a greater understanding and depth of insight into the various and numerous factor affecting non-domestic peak loads. Further activity informed by this study, could lead to economic gains by various players in the electricity provision and consumption market.

We undertook research determine sources of non-domestic energy data available and highlight gaps that exist. In order to meet this objective we researched a variety of potential and reliable data sources, collected, critiqued and collated available datasets and supporting information, and undertook analysis of collated datasets to highlight any trends/gaps in the data. Table S1 below summarises the resulting insights. Sectors named as categories are based on the Non-domestic Buildings Stock database (NDBS).

Table S1. Summary findings on sectoral analysis.

	Do profiles indicate contribution to Peak 1?	**Do profiles indicate contribution to Peak 2?**	**Can energy management be employed to reduce this?**	**Can energy management be employed to move this demand out with peaks?**	**Energy management measure types**		
					Behaviour change	Automated controls	Specific large plant measures
Retail	Yes	Consumption declines over Peak2	Yes	Yes	Yes	Yes	
Offices	Yes	Consumption declines over Peak2	Yes	Yes	Yes	Yes	
Factories and workshops	Yes, but less so	Yes, but less so	Yes	Yes	Yes	Yes	Yes
Healthcare	Yes	Consumption declines over Peak2	Yes, sensitive to medical needs	Yes, sensitive to medical needs	Yes	Yes	
Education	Yes	Consumption declines over Peak2	Yes	Yes	Yes	Yes	
Sports and Leisure	Yes, where 9-5 component exists	Yes	Yes	Yes	Yes	Yes	Yes, where swimming pools are present

We note that the relevant data required to make a larger study worthwhile does exist and is being collated, particularly as a result of the driver for AMR through the CRC, but the acquisition of this data will likely prove difficult.

We also designed a technical specification for the measurement of the components of peak electricity demand in the non-domestic sector. The resultant specification is feasible and defensible, and may be able to be tendered as per the guidance set out. We set out the tenderable work in three lots based on the following:

- Database Design and Maintenance
- Data acquisition
- In-situ Measurement and Monitoring

These lots are described in more detail, with key issues for consideration in development of a final project specification. We include equipment specifications, an estimate of budget, and a proposed initial timetable estimate.

During the project, it became clear that more in-depth information surrounding the datasets than first anticipated would be beneficial to the project. Specifically, the Work Package 1 and Work Package 3 questionnaires were modified to include questions on the following:

- Sub-metering
- Identifying components of peak loads
- Available capacity and maximum demand

We sought to establish what constitutes 'best practice' for energy management within the non-domestic sector, particularly in relation to peak electricity demand. We aimed to gauge energy managers' experiences of measuring peak electricity demand and measures taken to reduce peak electricity demand; specifically, how much money has been invested in such measures, any savings achieved, and the tariffs they are using. We carried out this aspect via a questionnaire, data collection and analysis and production of outputs based on these. The most popular measures that energy managers indicated they have implemented are staff awareness campaigns, installation of more efficient appliances (including lighting), installation of intelligent motor controls (such as variable speed drives) and automatic building controls.

We set out our conclusions and recommendations that include:

- Half hourly consumption and building background data are difficult to obtain. As such, increased participation in the scoping study would have been beneficial and further consideration should be given to a larger public SQL database in order to obtain data for future projects. Consideration should be given to providing incentives to energy managers and mandatory enforcements of energy suppliers to ensure future data supply.

- There may be seasonal potential to reduce peak demand. Data analysis showed that for many participants the total energy use drops in the summer months, however consumption for two of the highest energy users (both offices) remains relatively constant throughout the year. This suggests that there may be an opportunity to reduce energy demand at peak times to coincide with seasonal changes e.g. reducing artificial lighting levels during summer months. However, regardless of how energy is used and at what time of year, Peak1 and Peak2 consistently remain at the specified 'windows', so any potential means of tackling peaks must address these. It is possible that tariffs could be structured to reflect this pattern also.

- For the data gathered on industrial consumers, there are no indications that peaks occur necessarily during either Peak1 or Peak2. Responding to productivity needs or business needs rather than set schedules, industrial examples' peaks could affect either peak and measures to avoid this should be considered in this context. Leisure centres are most likely experience peak demand during Peak2. However, because of the sample size further data collection is recommended before it these trends can be deemed as representative of the sectors.

- It is possible that a single Consortium of different parties will be able to provide sufficient coverage of the sample sizes. Consideration could be given to letting more than one tender, however, the data from each would need to be collated into a common form for DECC analysis.

- Phase 3 highlights that knowledge and education of peak demand is an issue and by investing in subject education, it may be possible to influence discretionary demand at peak times.

- Financial incentives and penalties were found to be the most effective drivers for influencing change, therefore greater implementation of 'Time of Use' tariffs would potentially reduce peak demand. This is supported by comments that 'Time of Use' tariffs would encourage greater uptake of demand reduction measures and technological investment. However, if any changes are implemented in this area, it will be essential to support these changes through user education.

- Financial implications were also the main reason for not currently reducing peak demand. Therefore, it is important that before any changes to 'Time of Use' tariffs are enforced, that non-domestic organisations are given the appropriate financial support through funding, grants and greater accessibility of technology to allow them to be able to respond to their full potential

Glossary

DECC	Department for Energy and Climate Change
Peak Electricity demand	The highest point on a graph charting electricity use in a given time period
Peak hours	The hours between which peaks in electricity demand nationally historically occur, for the purpose of this study the two peak periods are 6am-9am and 5pm-8pm during the working week.
High Loads	Loads which are higher than average and that could contribute to peaks in demand
Maximum Demand charge	A charge levied monthly on the half hourly metered use. It is levied on the point of maximum demand in that period.
Capacity charge	A charge levied on the capacity made available for supply, that is agreed between supplier and end user. Usage must always remain below this agreed level or the integrity of the nearby grid could be affected, and punitive charges could be levied.
Load Management	Managing the pattern of use at a site to avoid or minimise peaks and high loads via a number of options. These include switching other non-essentials off, waiting to use high use equipment until non-peak times, or use of building energy management systems for these or timers.
Power Factor	Power factor is defined as the ratio of real power (resistive) to apparent power, where the apparent power is the vector sum of the real power and the reactive power. This definition is often mathematically represented as kW/kVA,. In an electric power system, a load with low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor.
Power Factor correction	Utilisation of equipment that increases Power Factor to nearer a value of 1.
(kVA)	Kilovolt Amps
(kW)	Kilowatts
(kWh)	Kilowatt Hours
Inductive power	Inductive loads require the current to create a magnetic field, and the magnetic field then produces the desired work. Commonly used electrical equipment that provide an inductive load include lighting circuits, heaters, arc welders, distribution transformers and electric motors
Reactive power	Power that feeds a load that has inductive or capacitive reactance – i.e. portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current equipment.
Greenhouse Gas emissions	Greenhouses gases (GHGs) are generally considered gases that trap heat in the atmosphere and are emitted as a result of human activity
Sub-metering	A meter connected after the main revenue meter. It may or may not be a revenue meter and is typically used for information monitoring purposes.
Tariffs	The rate of fees imposed on electricity consumption
Smart Metering	Smart meters are intelligent digital energy meters that allow remote readings and make energy consumption for the user transparent and directly manageable.
Non-Domestic	Energy users over a certain usage threshold, and which have business in a sector out with the domestic sector. These sectors will include, Industrial, Commercial, and Service sectors

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1 Introduction

AEA is pleased to submit this Final Report to The Department of Energy & Climate Change (DECC) for contracted project entitled 'Scoping study for measuring peak electricity demand in non-domestic buildings'.

1.1 Background

The UK profile of energy use sees greater activity during peak hours which results in high loads between 6am-9am and 5pm-8pm during the working week. Whilst domestic energy use peaks during these times, although outside the traditional 9am-5pm working hours, the non-domestic sector also contributes significantly to these peaks.

Whilst patterns in the domestic sector use can be easily identified within the peak times (e.g. returning home from work), the non-domestic component of peak loads often comprises unusual consumption, specific items of plant or 'all-at-once' use of numerous small items (such as at change of shift/daily switch on). The activities and loads have considerable variation in the non-domestic area by categories such as:

- Building or non-building use
- Process or non-process activities
- Sector – commercial or industrial
- Prevalence of unusual loading or specific single large loads
- Weekday/weekend and other inter-temporal variations such as seasons, weeks of the month, or calendar related production targets that factories may have e.g. Easter/Christmas.

These peak loads put augmented pressure on electricity generation, supply companies and infrastructure and may also eventually affect the security and continuity of supply if demand continues to increase. Furthermore, there is potential for these high peak loads to impact the economy negatively through increased distributor/supplier charges.

The costs that face a commercial or industrial energy user are not solely dependent on unit price on their bill. Other charges include Capacity Charge and Maximum Demand charge, and in some instances a charge for low power factor. Capacity Charge is levied by the electricity supplier as a through cost from the District Network Operator (DNO), based on the capacity of the supply line that provides electricity to the site. This charge is negotiated on commencement of supply to a site, and provision is made by the DNO to supply sufficient electricity. Any site which has been constructed and has supply lines in place often experiences relatively high costs if it needs to increase/decrease capacity. These arrangements are of more concern at industrial sites with intensive energy use.

Maximum Demand Charge is levied monthly using half hourly data and is based on the highest recorded usage level in any particular half hourly period. If a site has particularly high energy using plant items, or has an unusual load at certain half hourly periods, then maximum demand charges can be lowered by effective load management - spreading out the times when these unusually high loads occur, or moving particularly high loads to off-peak times can have a significant impact in saving on costs.

Load management can, when effective, minimise monthly maximum demand charges without compromising performance of the electrical plant. This management may involve non-technical fixes such as training and awareness of staff and operators to operate major equipment during off-peak times. If this is implemented over a long period, and loads are reduced consistently with the behavioural change instilled in the staff/workforce as custom and practice, then a negotiation of a reduced Capacity Charge might potentially be worthwhile.

Another aspect of Load Management is Power Factor correction. The energy delivered to the site is measured in Kilovolt amps (kVA) but the energy used is measured in kilowatts. The power factor is a measurement of the ratio between the two. It is a ratio and has no units.

Unusual loads can increase the kVA for the same kW consumption due to the equipment or plant operating 'out of phase' with the supply to the site. For example, if the kW used at the site is 90% of the incoming kVA supply then power factor will be 0.9. The more unusual or non-uniform the operations at a site - then the greater likelihood of operations being out of phase, and the higher likelihood of a low power factor. From industry wide rule of thumb, a power factor lower than 0.9 usually means that some form of correction is worthwhile, but this is site dependent as energy uses at sites can vary widely.

The billing/supply company will charge based on the kVA supplied. Thus it makes financial sense for the energy user to have the kW usage as close to the kVA supplied as possible, to avoid paying for energy that it does not use. Power Factor correction takes the form of an installed piece of equipment at or near the main incoming supply line, on the users side, which 'corrects' the phase of the usage to be nearer that of the supply. In severe cases of low power factor, the supplier will also make a further charge to recoup the kWh losses that they are experiencing.

Sites that have a tendency to experience low power factors are those with a significant reactive power requirement from a large inductive or capacitive load – e.g. a high proportion of electric motors, transformers, solenoid valves, lamp ballasts etc. Inductive loads require the current to create a magnetic field, and the magnetic field then produces the desired work – the current used to create the magnetic field is effectively 'lost' and is known as the reactive power. An increase in reactive power causes the power factor to decrease.

A greater understanding and depth of insight into the various and numerous factor affecting non-domestic peak loads could lead to economic gains by various players in the electricity provision and consumption market, facilitated by DECC.

1.2 Project Aims

The main aim of this research is to scope out a project for measuring peak electricity demand in non-domestic buildings. The purpose of measuring this peak demand is to identify discretionary demand, i.e. demand that could be shifted to non-peak times. When applied at a large scale, this shifting of demand would even out energy demand profiles, enabling more efficient production of electricity and savings in greenhouse gas emissions.

1.3 Project Objectives

The key objectives of this research project are:

1.3.1 Investigation of existing data sources

The purpose of this objective is to determine all sources of non-domestic energy data available and highlight gaps that exist. In order to meet this objective the following tasks were undertaken

- Research a variety of potential and reliable data sources
- Collect, critique and collate available datasets and supporting information
- Undertake analysis of collated datasets to highlight any trends/gaps in the data

1.3.2 Technical Specification for Measurement

The second objective of this project is to design a technical specification for the measurement of the components of peak electricity demand in the non-domestic sector. The resultant specification should be feasible and defensible, and be able to be tendered at the earliest opportunity.

1.3.3 Best Practice Stakeholder Consultation

The third objective of this project is to establish what constitutes 'best practice' for energy management within the non-domestic sector, particularly in relation to peak electricity demand.

1.4 Additional Project Aims

During meeting with DECC, it became clear that more in-depth information surrounding the datasets than first anticipated would be beneficial to the project. Specifically, the Work Package 1 and Work Package 3 questionnaires were modified to include questions on the following:

- Sub-metering
- Identifying components of peak loads
- Available capacity and maximum demand

1.5 Project Management and reporting

Throughout the study, robust project management has been provided in order to achieve the aims and objectives set by DECC. Email has been the primary route of communication between DECC and AEA, allowing all queries to be dealt with quickly and efficiently.

Several face to face meetings with the DECC project steering group have also allowed the progress of the project to be reviewed throughout and to tackle any issues which had arisen.

- The project inception meeting was held on Monday 12th October 2009 at the DECC offices in London. At this meeting the project aims and requirements were clarified and agreed.
- A steering group meeting was held on Monday 23rd November 2009 at the DECC offices in London to discuss project progress and direction
- An update and data prospecting meeting was held with AEA, DECC and the Carbon Trust on Wednesday 6th January 2010, at the Carbon Trust Offices in London. The purpose of this meeting was to ascertain what research in this area had already been conducted by the Carbon Trust, issues they had encountered and what, if any, data they could make available for this study.
- A presentation and review of the progress of the Draft Final Report was held with the Steering Group on Thursday 25th March 2010 at the DECC offices in London

Whilst project reporting delays have occurred as a result of various issues that were encountered during the data collection stages (please see sections 2.3 and 2.4 for further information), the AEA Project Manager has liaised with DECC throughout. Through prolonging the data collection phase, we have been able to maximise on the available data to ensure DECC the best possible outcome based on the time and budget available.

1.6 Report Structure

This Draft Final Report is structured as follows:

- Section 1 – Introduction
- Section 2 – Work Package 1 – Investigation of existing data sources
- Section 3 – Work package 2 – Technical Specification for measurement
- Section 4 – Work package 3 – Best practice stakeholder consultation
- Section 5 – Conclusions and recommendations from the scoping study

2 Work Package 1: Investigation of Existing Data Sources

2.1 Introduction

This section discusses the range and method of the collection of half hourly datasets and highlights issues that were encountered during the data collection process. The design and range of questions asked which support each dataset has been discussed in detail, as has the quality of the data received. Finally, this section of the report covers the analysis of the aggregated dataset and highlights the key findings.

2.2 Questionnaire Design

In order to be able to understand each dataset and the influencing factors which affected energy consumption at peak times, participants were asked to complete a questionnaire for each different dataset submitted. The design of the questionnaire was based on:

1. Discussions with DECC and AEA energy experts
2. Requirements of the project and ITT

A short introduction and explanation of the study was attached to each questionnaire to improve understanding and participation. Additionally, the questionnaire was designed to be as coherent and easy to complete as possible. Both MS Word and Excel versions of the questionnaire were made available. The MS Excel based questionnaire proved to be the most popular as it allowed for respondents filling information on multiple sites to use one form but have different responses for each of the sites, making the process fairly quick and straightforward.

The information collected through the questionnaires covers the following categories:

- Building type by usage
- Building type by sector in industry
- A breakdown of energy consumption by end uses
- Time of consumption and applicable tariffs
- Voltage connection and floor area of building
- Type of energy usage
- Data collection methods (e.g. smart metering)
- Location of buildings

The questionnaire was designed to get information on variables such as type of industry, size of building/installation etc, in order to determine their correlation to energy consumption and demand. Further details on the timings of the business and the various uses of energy were also included to understand the energy demand patterns for certain businesses. Following advice from DECC, we were particularly interested in questionnaires which highlighted that a participant had sub-metering as this allowed these organisations to be targeted further as part of the Work Package 3 Best Practice Stakeholder Consultation. Please refer to Appendix 4 to view the questionnaire and the full range of questions asked.

2.3 Energy Supplier Consultation

Initially, the best route for maximum data collection was anticipated to be via Energy Suppliers. 21 Energy Suppliers were all contacted and asked to provide non-domestic half hourly data for the study and to complete the accompanying dataset questionnaire.

A variety of responses to the request for data were received, the primary response being that client confidentiality would not allow this data to be disclosed and time/ resources restricted any further action. Another common response was that the suppliers did not hold the level of data required (including at half hourly level) and in general, the only way data could be possibly provided would be in an aggregated format with no indications available of the types and numbers of businesses which contributed to the dataset, least of all any further information as to how the site energy was consumed. A number of suppliers failed to respond to any communications, despite several attempts and channels. We would suggest that DECC undertake a direct supplier consultation to discuss and improve the provision of data, for this purpose and other future assessments, as suppliers were keen to support investigations but did not feel that they could usefully contribute in the format required.

20 further organisations were contacted which comprised of energy management, advice and research organisations. Upon consultation with energy management organisations, it became apparent that although individual site level half hour electricity data was held, it was not accessible without prior permission from the account client. The energy management organisations were not willing to pass on study details to their clients or forward client database's due to data protection. Similarly, whilst Elexon did send one spreadsheet of data, it was for an aggregated dataset for which there was no explanation given or indication of the number/ type of component organisations for which the load was comprised. The National Grid was keen to provide any available information, but only held data at a national level and very little data about the business sectors which made up the national load profile. ESTA were interested in the study but felt limited in ways in which they could help. In the meeting with the Carbon Trust and DECC, the Carbon Trust appeared keen to provide a variety of useful background information and data sources, but unfortunately these were not provided within the timescales of the project.

Following these responses from the suppliers and energy management organisations, it was deemed necessary to contact the energy managers of organisations directly in order to collect the quality of data required.

2.4 Data Collection

The questionnaires used for data collection were distributed using three distinct approaches. These included, targeting AEA's existing list of contacts for energy managers totally approximately 768 organisations. This comprised of 543 local government organisations and 225 private sector organisations (often multiple contacts), across a range of sectors (please see Appendix 2, 3 &5 for a full list of organisations contacted by AEA). Each of the contacts were sent email requests asking if they would be willing to participate in the study. The organisations that responded positively were sent questionnaires and instructions by email. The emails specified that the completed questionnaire should be returned with numerical data on energy consumption.

The second route to contacting appropriate individuals and organisations utilised was through the marketing company '2degrees'. 2degrees has a working history with AEA and was effective in providing 500 further contacts for energy managers in industry. Requests for participation were then sent out to all individuals on this list. Taking the total number of energy managers and organisations contacted to 1268 (the number of individuals contacted exceeds this number, due to multiple contacts at the same organisation).

The third approach used for data collection was also through the relationship with 2degrees. They printed a short description of the study on their newsletter and invited readers to participate. As the readership of the newsletter is over 5000 organisations, such a notice considerably enlarged the outreach of our potential pool of participants.

At the end of this phase, 1268 energy managers in non-domestic enterprises had been directly contacted and a further 5000 organisations had been reached indirectly through the 2degrees newsletter, covering all of the organisations stated in the proposal as well as many others. In addition to initial email requests the data collection phase also included several reminder emails and follow up phone calls.

An email account DECC_Peak_Electricity@aeat.co.uk was set up to manage all correspondence relating to questionnaires and data sets for this project. Organisations indicating a willingness to participate were sent the relevant information and their responses were received via this email account. All questionnaires and datasets were therefore received at a central point and were easy to manage and upload into the central database for analysis.

2.5 Data Cleaning and Issues Encountered

Once datasets and supplementary questionnaires were received, the data cleaning stage began, during this process the data collection team encountered significant challenges whilst sorting and uploading the information to the database. The majority of the issues encountered were either due to missing data or data being presented in the variable formats. In order for the database to be able compare datasets, they had to be uploaded in a standardised format such as in the example shown below:

Figure 2.1: Example half hourly electricity dataset

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	MPAN Core	Date	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	05:30	06:00	06:30	07:00	07:30	08:00
2	1710000000000	01/04/2008	64.4	63	63	62.8	63	62.4	59	57.4	58.4	74.2	80.6	82	88.6	89.2	97.8	[illegible]
3	1710000000000	02/04/2008	69.4	78.6	84.2	81.6	72.6	72.4	70.6	69.4	69.2	78.4	86.4	87.8	98.6	121.8	144.2	152.2
4	1710000000000	03/04/2008	69	70.6	70.2	69.4	68.8	64.8	64.6	64.2	66.6	74.6	81	85.8	22.6	0	0.6	6.2
5	1710000000000	04/04/2008	72.4	74.2	74.8	74.2	74.6	73	73	71.8	74.6	82.4	88	90.2	26	0.4	6.4	13.6
6	1710000000000	05/04/2008	90.6	90	89.4	89.4	89.6	88.2	84.6	84.8	84	83.4	77	78.2	21.8	0	1.6	11.6
7	1710000000000	06/04/2008	73.4	72.8	72.2	73.4	74	73.6	73.6	72.8	72.2	75	76.8	88.6	24	2	5.2	12.4
8	1710000000000	07/04/2008	71.4	71.6	70.6	70.8	70.6	70.6	71.2	70.8	72.2	86.4	91.2	91.8	26	0	2.4	10.8
9	1710000000000	08/04/2008	74	78	82	81.2	81.4	78	76.4	77	79	91.2	88.4	86.4	12.6	1	4.6	14.6
10	1710000000000	09/04/2008	84.2	83.8	85.6	74.6	70.2	66.4	65.4	64.8	65.8	78.2	83.2	79.8	13.4	0	0.4	6
11	1710000000000	10/04/2008	88	87.2	83.6	83.8	84.6	84.6	80	80	81.2	82.6	85	78.8	11.8	0	0	2.8
12	1710000000000	11/04/2008	75.6	75	73.8	70.2	70.2	70	68.8	68.6	72.4	80.4	84.2	87.4	15	0.6	4.8	11.2
13	1710000000000	12/04/2008	122.4	122.6	117.8	117.6	117.6	117.6	118.4	118	119.4	122.6	121	120.2	37.4	12.8	2.2	10.4
14	1710000000000	13/04/2008	62	61.4	65	65.2	62	60.8	61	60.8	61.4	67.6	68	72	10.2	11.2	1	14.4
15	1710000000000	14/04/2008	62.2	62	62	61.8	61.6	62.6	62.4	62	63.4	81.6	84	88.2	27.2	16.4	20.6	19.8
16	1710000000000	15/04/2008	92.8	96.2	96.2	85	84.4	83.8	84.2	84.2	84.8	97.4	87.4	86.8	14.2	1.4	3.6	30
17	1710000000000	16/04/2008	81	81	80.8	71.4	71.8	71.4	71	72	73.4	87.8	89	97	17.2	16.4	11.6	24.2
18	1710000000000	17/04/2008	75.6	74.4	74.8	74.2	74.2	73.2	69.4	70	69.4	86.8	85.4	92.6	23.8	6.8	8.2	18.6
19	1710000000000	18/04/2008	89.6	90.2	89.4	89	90	90.2	90.2	87.8	87.2	95.4	93.6	95.6	23.8	8.8	8	10.2
20	1710000000000	19/04/2008	89.8	84.2	78.8	78.8	78.4	78.6	78.6	78.8	79	83.4	81	84.6	13.6	9.8	30.8	30.4
21	1710000000000	20/04/2008	64.2	64	64.4	64	65	64	65.6	64.6	65	70.6	68	77	13	1.6	10	7
22	1710000000000	21/04/2008	71.4	73.2	72.8	71.6	73.2	72	72.6	73.6	72.8	85.8	86	98	46	38.8	11.2	20
23	1710000000000	22/04/2008	91.4	91.4	90.6	91.4	91.8	90.2	87.2	86	85.8	92.2	89.8	94.6	18.2	2.2	13.6	21.6
24	1710000000000	23/04/2008	80.6	78.6	78.4	78.6	79	77.8	74.2	72.6	76	86.8	91	89.8	14.4	0.8	7.2	15.6
25	1710000000000	24/04/2008	84.4	83.2	82.6	82.8	82.4	79.6	77.6	76.2	79	84.6	84.4	83	14.4	0	1.6	7.6
26	1710000000000	25/04/2008	76.6	76	74.6	73.8	74	73.8	69	69.4	72	85.2	88.2	91	97.8	103.8	112.4	134
27	1710000000000	26/04/2008	70	70	70.4	70.6	70.2	69.8	69.8	70.2	70.4	74.6	75.8	75.2	84.4	98.2	103.2	111.8

Example data set

Uploading in a standardised format considerably slowed the process of preparing and uploading due to the variability of the information received. For each of the datasets and questionnaires that had inconsistencies, it was necessary to go back to the respondents through email and/or phone and ask for further clarification.

Throughout the data collection and cleaning stages of the study, the most commonly encountered issues from energy managers and their data are detailed in Table 2.1.

Table 2.1: Work Package 1 data collection issues and resolutions

Issue	Resolution
Suspicions/concerns about releasing data	All participants were reassured that the data used in this study would remain confidential.
Lack of perceived benefit to participate	It was communicated to all participants that they would receive an overview of the results of the study.
Lack of time/ resources to collect the data	Where possible, the AEA team obtained energy management portal log-in details and downloaded the information on the participants behalf. Once this was complete, the questionnaires were started by AEA and sent to the participation for completion and verification.
Unable to answer all of the questions in the questionnaire	AEA supported participant queries where possible and to allow for questionnaire entry which included unknowns 'N/A' and 'Don't Know' options were added to a selection of questions.
Datasets were sent without questionnaires or vice versa	The participants were contacted again to obtain the missing data. Where questionnaires were not received, in order to encourage responses the questionnaires were started by AEA and sent to the participation for completion and verification.
Data sets sent with missing MPAN core numbers,	The database was designed to include the MPAN core numbers within datasets, as a means for sanity checking data. Where these were missing, participants were contacted to provide.
Datasets were not supplied in a consistent format e.g. energy data was supplied in 2 columns with everything running vertically, instead of the required 48 columns for each half hour of the day.	Because of the labour and time intensive implications of this issue, macros were created and applied which allowed some automation, thus speeding up the data cleaning process
Several different sets of values were assigned to the same dates and MPAN numbers	Participants were contacted for clarification. This was usually the result of a data transfer error.
Missing/ gaps in the data	Where necessary, participants were contacted for clarification. Some datasets had legitimate data gaps.
The data covered multiple sites	Participants were asked to provide individual site datasets, where this was not possible the data could not be included in the database, without skewing the data results for individual sites.
The data provided was not current or updated.	More current information was requested. In some cases, upon noticing discrepancies AEA went back to the respondents with questions, who then divulged that the site in question had been closed down or been sold.
Each half hourly period had multiple entries.	Through questioning respondents and closely examining supporting information, it was revealed that the readings were listed in various units of measure, KVarh, KWh etc. However, once highlighted, removing the irrelevant values from a number of large datasets was time consuming.
Datasets had some values that were "expected" and others that were "actual",	Where necessary, participants were contacted for clarification. Only actual values were retained in the datasets.

2.6 Half Hourly Data Analysis: Background

As previously discussed, although energy suppliers were initially targeted for half hourly electricity data, this route was unproductive due to client confidentiality and data quality issues. However, half hourly electricity data was successfully collected from a selection of public and private sector organisations. Although in total approximately 6000 organisations were contacted requesting data, only 134 fully usable datasets have been included in the analysis. Although a small number of further datasets were received, they were unsuitable for entry. As a direct result of this, traditional statistical techniques such as drill-down, time-series, pivot and multi-dimensional analysis were not recommended as they would not provide any significant insight into trends in the data. The AEA statistical experts advised that the best way to interpret the data collected was through a series of specifically designed database reports.

The following section of the report highlights examples of the type of reports that can be generated from the data within the database. It should be noted that although the database was used to generate the background data, the charts in this section have been compiled using excel in order to allow better manipulation of the data and formatting of the charts. The charts shown in this report are not exhaustive of further analysis which could be undertaken with this data. The full database and an accompanying user guide will be provided to DECC at project completion, enabling future manipulation of the datasets and new data to be added.

For ease of recognition, the two peak times identified by DECC, the hours of 6am-9am and 5pm to 8pm (referred to as Peak1 and Peak2 retrospectively from here-on) have been highlighted on each of the following charts which show a half hourly energy breakdown. This enables easy identification of peak demand trends. All datasets in the database have been anonymised (as communicated to participants) and a Unique Reference Number (URN) has been applied which links each dataset to its questionnaire data. This URN is applicable in the database and in data analysis but in addition an anonymisation key has been applied. This has categorised the organisations as Private (PV) or Local Authority (LA) on which sector the buildings data relates to. A further sub-category anonymiser is used depending on whether the data is from office (off), retail (ret), industrial (ind) primary school (psc) secondary school (ssc), hospital (hos), sports centre (spc), arena (arn), etc. Any numbers then following are where there is more than one from that category, i.e. data from our 2nd private organisation on their 4th set of office data would be anonymised as ‘PV2, off4’. A full key to organisations and data is available for DECC separately – to keep information provided anonymous as agreed.

2.7 Peaks in demand

The data collected allows us to analyse for instances that may be contributing to either Peak1, Peak2 or both. Daily demand profiles are analysed to find patterns that provide insights on electricity uses and peaks. Use patterns may vary in a number of ways:

- Seasonal variation between summer and winter
- Variation between weekdays and weekends
- Likelihood of 24 hr operation where demand varies generally with production
- Indicative homogeneity or heterogeneity – are the equipment or practices that cause higher demand points likely to be large single items or a large number of smaller items
- Any other occurrences that offer notable insights reflective of activities or trends in a particular sector or user type

Where any of the profiles show an increase in demand during Peak1 hours, such as within a typical profile shown in chart 2.1 below, this indicates that they have ‘started-up’ many appliances or items of equipment. This start-up phase of the daily use, can be often unnecessary consumption and may have an effect on peak demand causing spikes that are not recognised in half hourly recorded data. These profiles provide the main insight on Peak1 contributors.

Chart 2.1 A typical electricity profile with a start-up phase in Peak1.

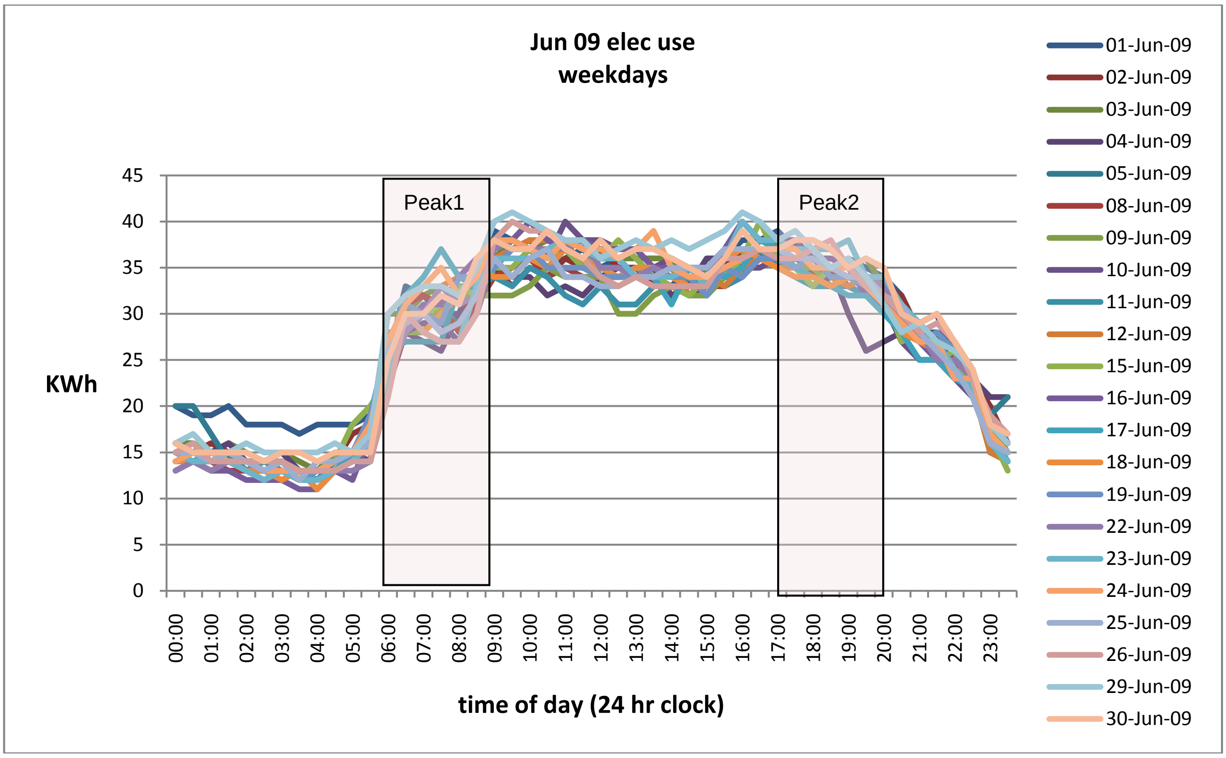


Chart 2.1 is formulated from information we have on a leisure centre, but this is unimportant for this illustration. It is the significant increase of consumption between about 0500hrs and about 0900hrs that is notable, as this type of profile contributes to peak demands on the grid.

The following charts and paragraphs illustrate and discuss further this aspect of analysis. The analysis takes examples from the main sectors as set out in the Non-Domestic Buildings Sector model (NDBS), which is discussed in section 3.5. These are:

- Retail & Commercial Services
- Offices
- Factories & Workshops
- Warehouses & Storage
- Transport
- Hotels & Catering
- Social & Community
- Religious Buildings
- Healthcare
- Education
- Arts, Sports & Leisure

Datasets were collected from respondents in a number of these sectors, allowing us to gain insights on indicative behaviours, trends, demand profiles and peak occurrences in them.

2.7.1 Retail

Our main respondent in this sector operated a number of supermarkets. The profiles show a general homogeneity of use, with typical days having increased demand during the start of office hours affecting Peak 1.

Chart 2.2 daily profiles in December (PV4, ret5).

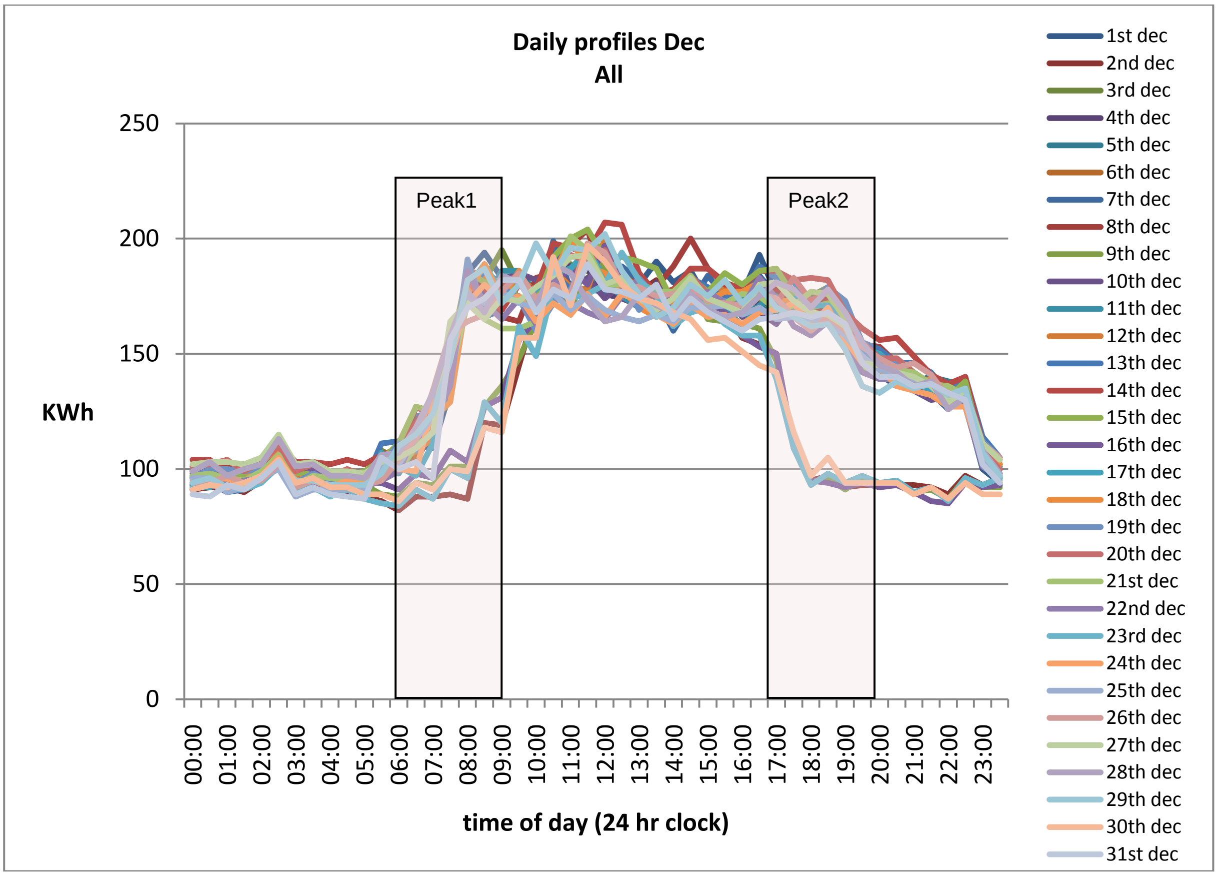
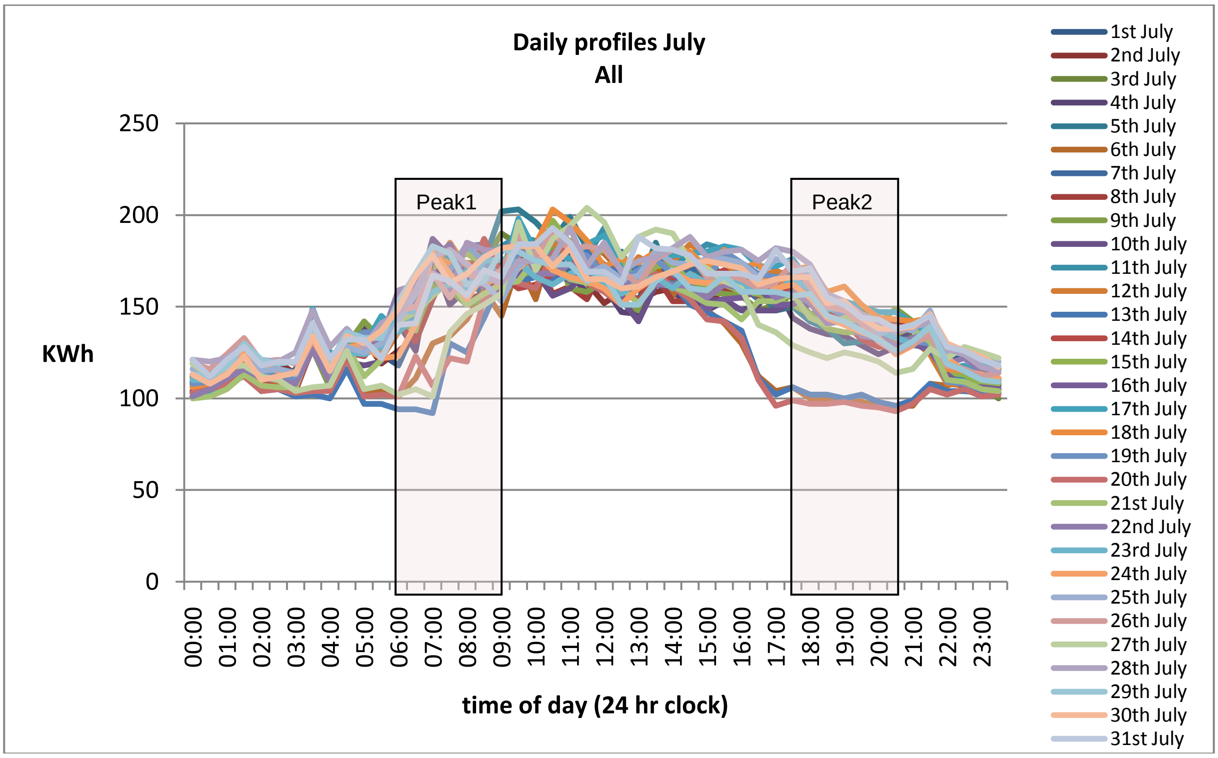


Chart 2.3 Daily profiles in July (PV4, ret 5).



The two charts above (2.2 and 2.3) contrast use profiles in winter vs. summer. The baseload is slightly higher in summer and the gradient of the increase during Peak1 is slightly shallower. This could be due to a greater cooling load generally, and more need to start up many cooling items earlier in the day. Lighting loads, which are variable loads, will be required less in summer and the reduced variable load seen in chart 2.2 concurs with the logic of a lower lighting requirement.

Typically, electricity uses in supermarkets will be for lighting, appliances, cooling activities and will also include numerous refrigeration and ventilation systems. Heating may also play a role but this is more likely to be from gas in urban areas. Electrical plant will therefore be lights, fans, pumps, compressors, control systems and appliances and possibly heating elements. These items of electricity consuming equipment should be targeted for any future guidance provided to this sector.

Chart 2.4 Daily profiles in Jan (PV3, ret 4).

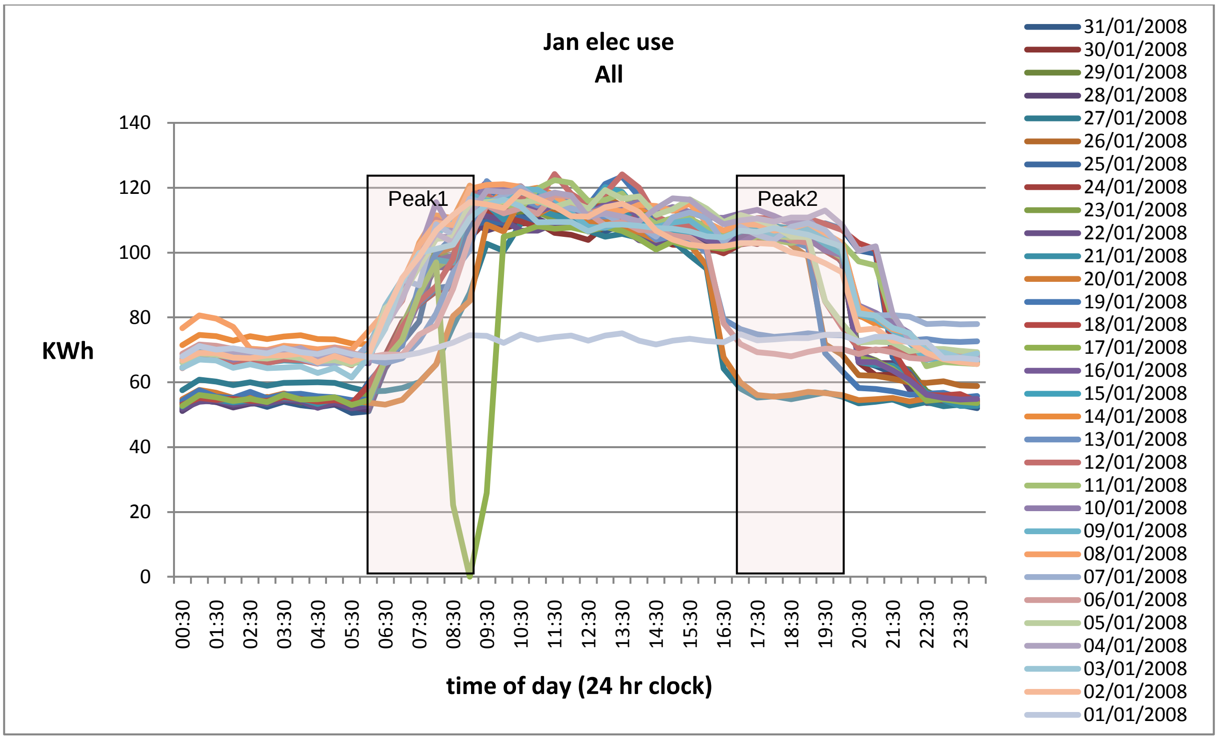
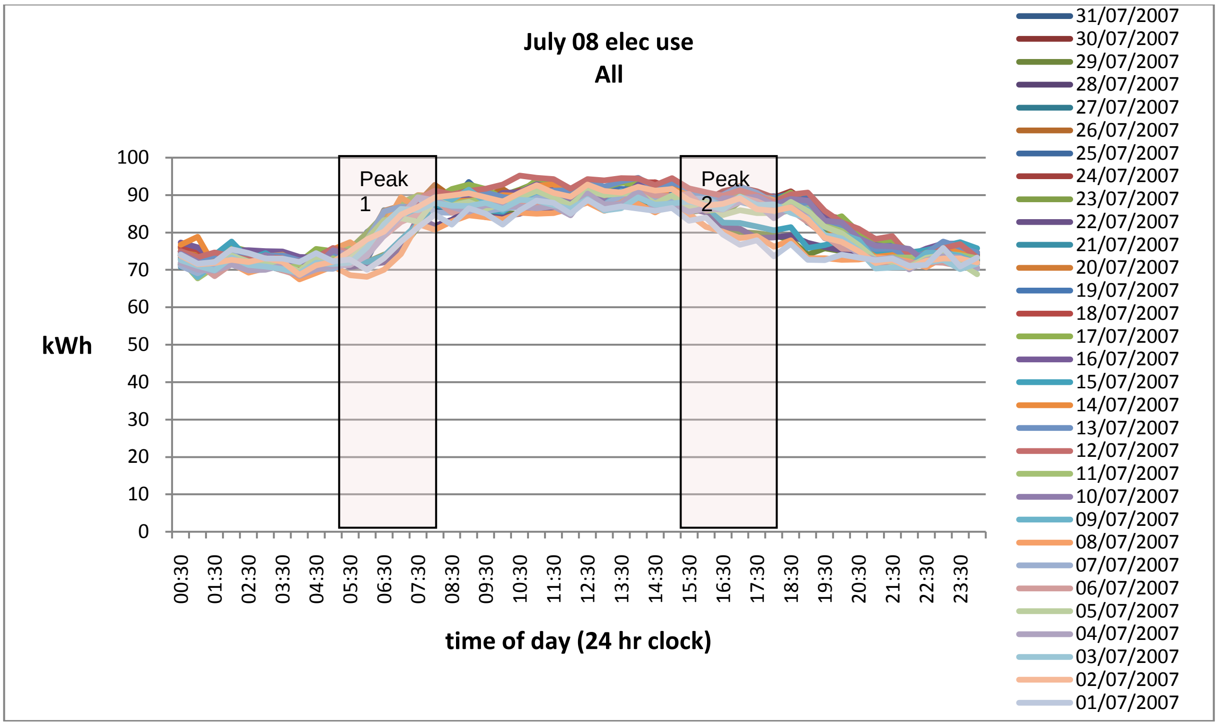


Chart 2.5 Daily profiles in July (PV3, ret 4).



A different retail store with similar business activities (chart 2.4) generally shows the same ramping of demand during Peak 1. One profile has a notable drop which is likely due to a power failure that day, and the single level line is for 1st January when the store was closed. Chart 2.5 above shows a summer profile for the same business.

Again it can be seen that baseload is higher in summer with the variable load ramping up demand smaller, as a proportion of the total. This indicates that a higher refrigeration load is present in baseload in summer, with a lower lighting variable load.

Peak demand effects in the retail sector.
Considering the indicative information above in terms of load that could be avoided or moved out with Peak1, there may be a case for having lighting controlled by daylight sensors. This could have the effect of varying switch-on throughout the year (assuming current situation is that the lights are manually controlled or timer controlled), and so smoothing out the ramping of the profiles. Also, a BEMS could operate to switch off refrigeration load whilst lighting switch on occurs which could also have a reducing effect on Peak1 contribution.

Summary.
In summary, in the retail sector operations are 7 days a week, profiles are homogeneous, with ramping up of major equipment occurring in Peak1 contributing to peak demand. Demand increases during Peak1 and decreases during Peak2 and demand remains at a relatively continuous level to that reached at the end of the peak period until starting to decrease around the start of the Peak2 period. No major single items cause this, but instead a number of smaller electrical uses make up this demand. Some relatively straightforward energy management techniques could alleviate the situation, further investigations on a larger scale are recommended to draw firm conclusions.

2.7.2 Offices

Many of our respondents provided information on their office premises. The charts below are typical across the sample received and it should be noted that these tend to be predominately '9am-5pm' weekday operations.

Peak effects in offices.
Offices will very commonly have no large plant, except where the buildings are large and old with HVAC provision via large plant room. It is common practice to start HVAC kit and appliances or equipment such as IT(including desk top computers), ready for the working day; as a result offices contribute to Peak1 in the UK. The following charts contrast the profiles of 'start-up activities' on weekdays with the profiles of all days including weekends.

On the 'Daily Profiles November 2009 All' chart 2.6 below, some of the profiles remain flat. These are weekend days, where the energy consuming equipment does not engage to meet the demands of the working day. The weekdays only profiles show that every working day in a 9am-5pm operation contributes to Peak1.

Chart 2.6 DECC example office Nov 2009

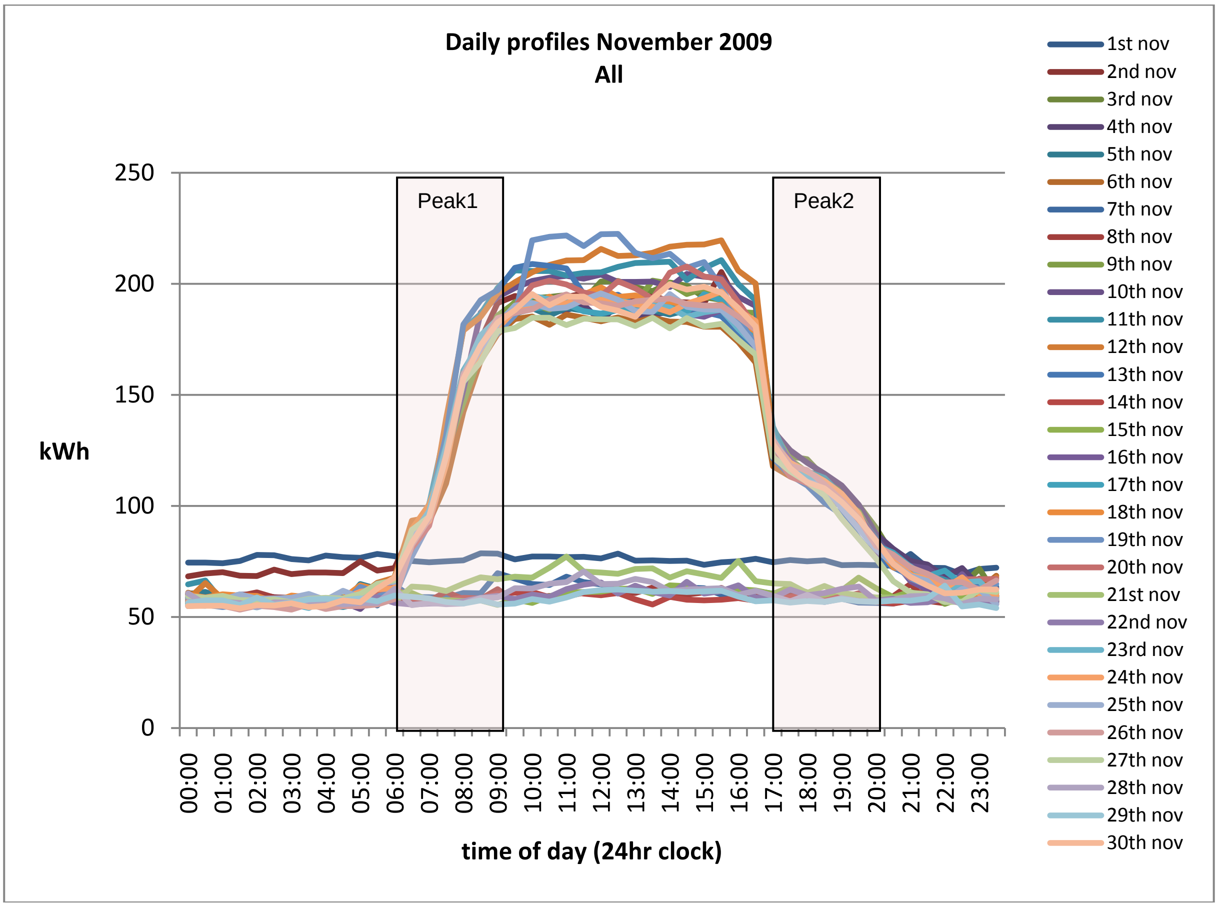
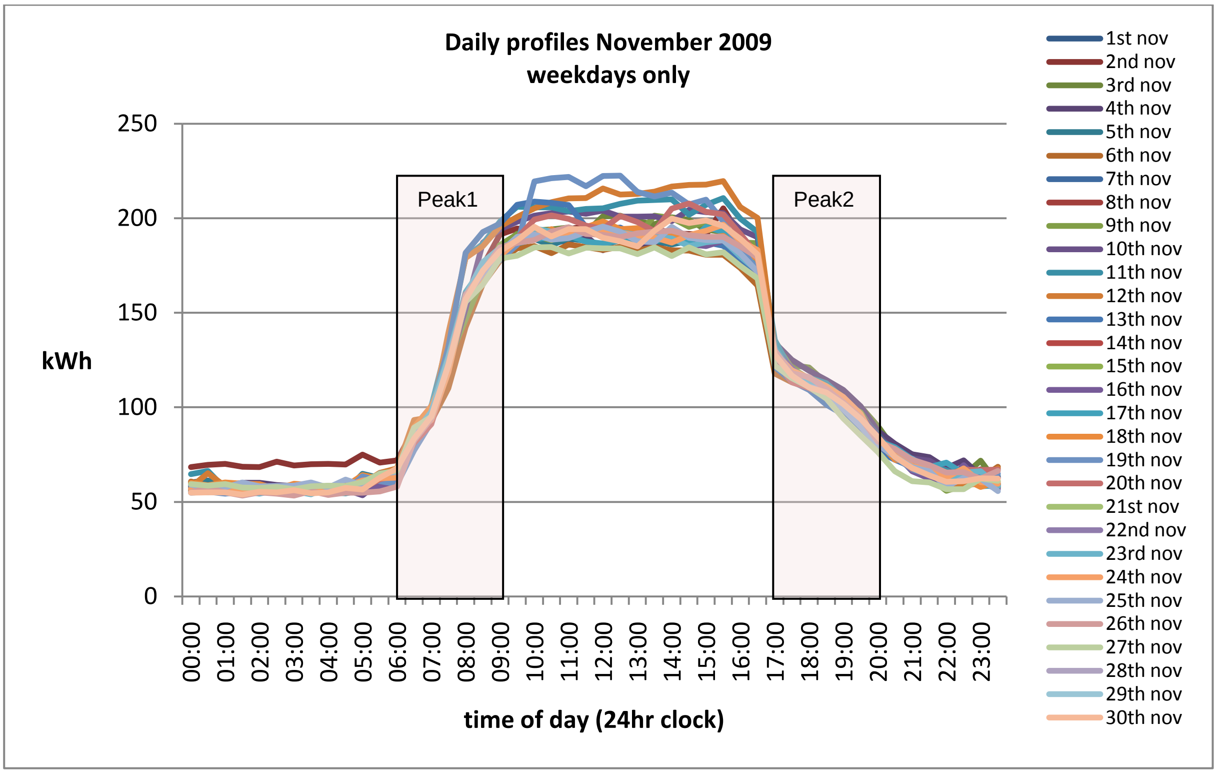


Chart 2.7 DECC example office Nov 2009 – weekdays only



Similar to the retail sector, electrical plant in offices will consist of lights, fans, pumps, compressors, control systems, appliances and possibly heating elements. Again, similar to the retail sector, electrical uses will be numerous and small, with the combined consumption from each contributing to higher use profiles or profiles ramping up during Peak1. This indicates that measures to reduce this or move it from Peak1 are likely to be around behavioural change, via automated timer or photosensitive controls for lighting, or via a BMS following an overall strategy. Focussing on large plant is unlikely to alter profiles or practices. Although demand during Peak2 is higher than baseload, it declines steadily from the

Summary.
In summary, electricity use in office operations is predominantly over 5 days a week, and profiles are highly homogeneous, with ramping up of major equipment occurring in Peak1 which contributes to national peak demand. Again similar to the retail sector, demand increases during Peak1 and decreases during Peak2 and demand remains at a relatively continuous level to that reached at the end of the peak period until starting to decrease around the start of the Peak2 period. It is unlikely that any major single items cause this, but instead a number of smaller electrical uses make up this demand. Some relatively straightforward energy management techniques could alleviate the situation. A broader study could provide further insights.

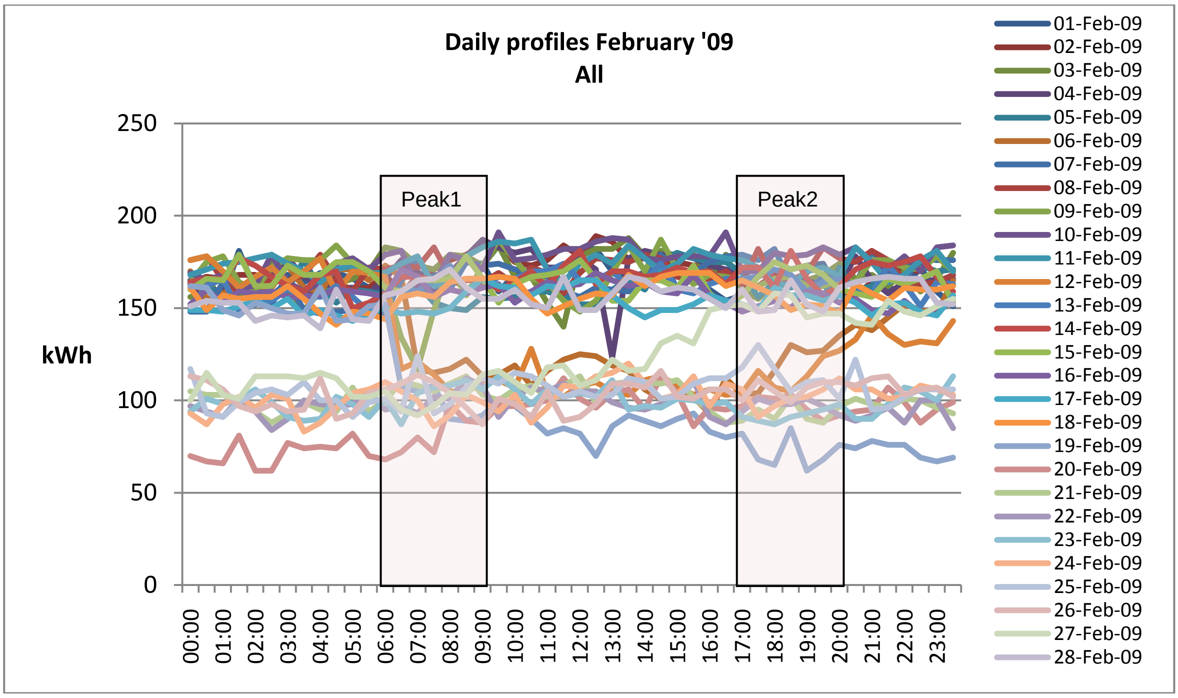
2.7.3 Factories/workshops

These respondents had profiles which reflected 24 hour/7 day a week operations where the electricity consuming equipment is increased/decreased in response to business/production requirements. As a result, profiles differ day by day and week to week with baseload, as a portion of overall load to be higher due to the continual readiness of the infrastructure.

Numerous factories across the country will have a 9am-5pm weekdays working week operation, but in line with many factory operations having responded to business needs for more varied operations in the past decades, this area of the economy is more likely to have varied times of operation than for example, offices.

Peak effects in factories and workshops.
A common practice in this sector that affects electricity use profiles is ‘just-in-time’ (JIT) delivery. This practice involves a factory receiving goods to their stores just in time for provision to the production line or area, which minimises time goods are held in stores, thus minimising storage costs. This profile of activity usually involves 3 hour cycles – once delivery has been received, the goods and raw materials are provided for 3 hrs worth of production and stocks in ‘work in progress’ deplete to near zero as the next delivery cycle begins. This practice will affect electricity profiles – various equipment used for production (which will likely be appliances, motors, drives, fans, pumps and compressors etc) will be in use in line with these cycles. It is not known if any of the respondents follow JIT.

Chart 2.8 Typical factory profile, 24/7 operation (PV7, ind1).



The chart above shows no indication of ramping up at any particular time of the day or week but instead shows a steady use profile varying within a band. Generally this band is, in the example, between 140 and 190 kWh earlier in the month and between 60 and 120 kWh later in the month. This use profile which is most likely varying with production needs indicates that lower production levels occurred later in the month shown. Precise production data was not collected as part of this scoping study.

In a number of areas of this sector, some specific equipment may incur high energy use. Information on this could be used to affect behavioural change amongst equipment operators to reduce effects on Peak1 or Peak2. Examples might be in steel or metal fabrication, energy intensive production lines which use high levels of electricity, and ceramics production using kilns.

Specific targeting of electricity using equipment could be employed as well as behavioural change and energy management automation could have an effect of avoiding peaks and generally reducing demand. Without a broader study, this is difficult to quantify but there is a degree of uncertainty around how much detail might be needed to obtain useful outputs.

Summary.
Although largely occurring within a band of consumption, these profiles here are more heterogeneous, with variation in their shapes dependent on production or business needs. Single items may cause this, in conjunction with a number of less significant smaller electrical uses, making up overall demand. A combination of specific targeted management of these larger items and some relatively straightforward energy management techniques could have an effect on reducing demand at peaks. A broader study could provide further insights.

2.7.4 Healthcare

Hospitals have similar energy uses as other sectors such as retail or offices and typically electricity uses will be for lighting, appliances, heating and cooling activities and ventilation. Main heating sources will be from gas in urban areas. Electrical plant will therefore be lights, fans, pumps, compressors, control systems, appliances and possibly heating elements.

The main notable difference will be the types of appliances, of which, many will be medical equipment that needs to have a guaranteed power supply, as well as in many cases, a state of readiness. With a need in the medical environment for well lit rooms and a need for a multitude of electrical medical appliances, electrical loads will be high per sq.m of floor area. Not only will baseload be high but variable loads from these appliances and equipment during working hours (for office activities as well as medical needs) will also contribute to high energy use in the sector.

Charts 2.9 and 2.10 below show typical hospital profiles for both all days and weekdays only. There are a few profiles that are anomalous, but the reason is unknown without further investigation.

Chart 2.9 Daily profiles for a typical hospital (LA4, hos2).

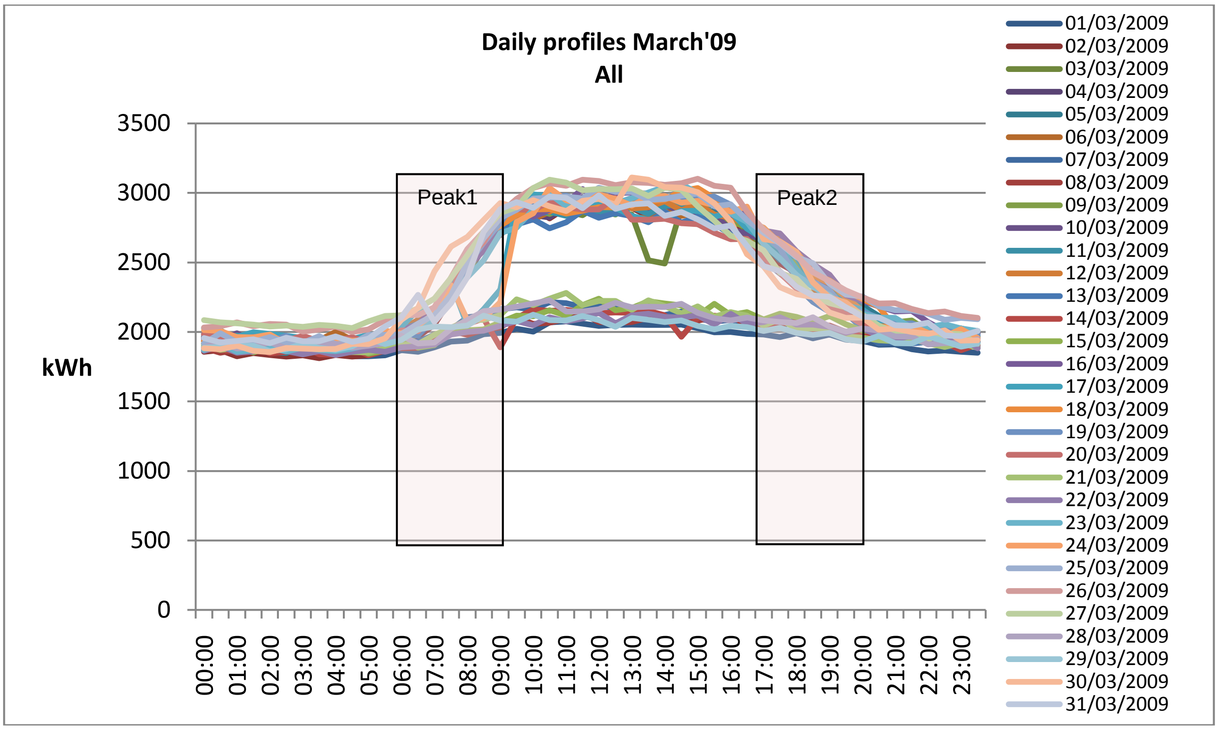
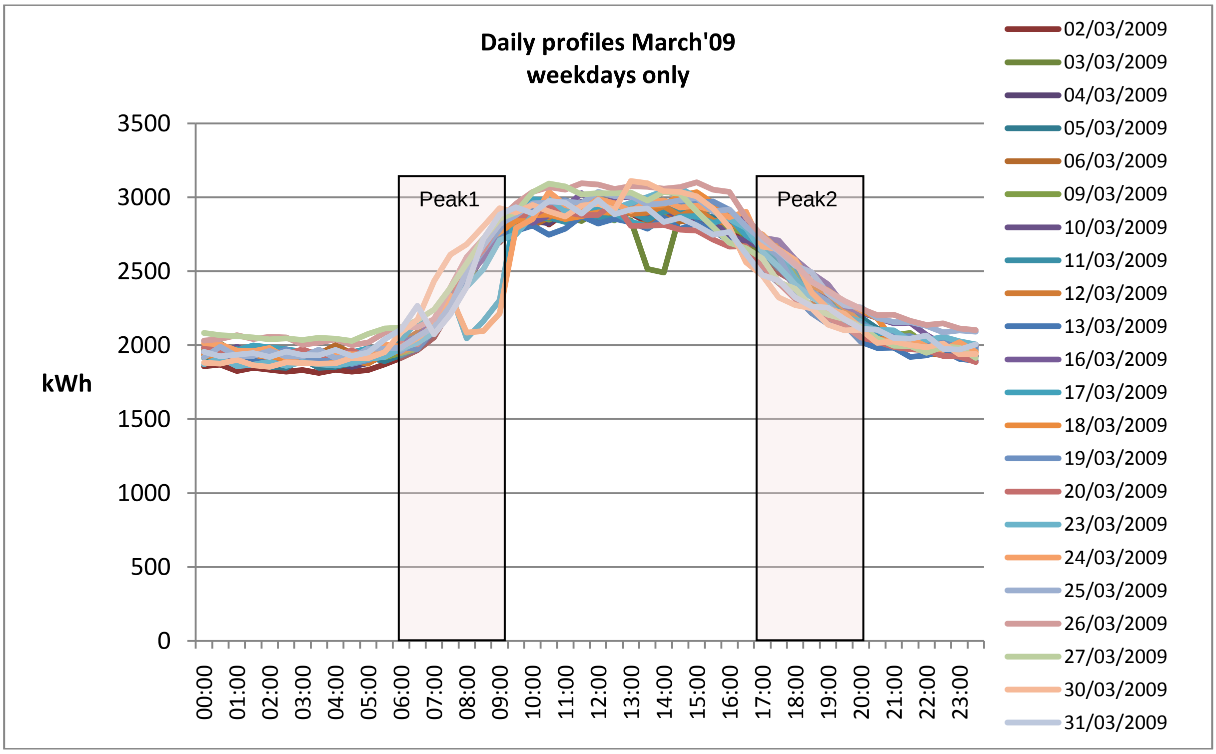


Chart 2.10 Daily profiles for a typical hospital (LA4, hos2) weekdays.



The two charts contrasted clearly show that variable load is significant during weekdays. This type of profile is similar to retail and offices with generally a 9am-5pm operation. Similar measures could have an effect on electricity demand during peak hours. However, the need for supply to medical equipment and states of readiness make electrical loads very sensitive to energy management measures – more so than other sectors.

Summary.

In summary, electricity use in healthcare operations is predominantly 5 days a week, profiles are highly homogeneous, with ramping up of major equipment occurring in Peak1 contributing to peak demand. No major single items cause this, but instead a number of smaller electrical uses make up this demand with much of the appliances in use for medical purposes. Some relatively straightforward energy management techniques could reduce loads and move these out with peak periods, but electricity uses in hospitals and healthcare are sensitive to needs and usually require to always be on/ready. These needs mean that practical energy management measures must be applied with care. A broader study could provide further insights.

2.7.5 Education

Schools and other educational buildings will very commonly have no large plant, except where the buildings are large and old with HVAC provision via large plant room. The practice of starting lighting, HVAC kit and appliances or equipment such as IT ready for the working day is the norm. This means that the education sector electricity use does contribute to Peak1 in the UK. The following charts contrast the profiles of start-up on weekdays with the profiles of all days including weekends.

The profiles of All includes some that remain flat. These are weekend days, where the energy consuming equipment does not engage to meet the demands of the working day.

Chart 2.11 Daily profiles for a typical school (LA6, ssc1).

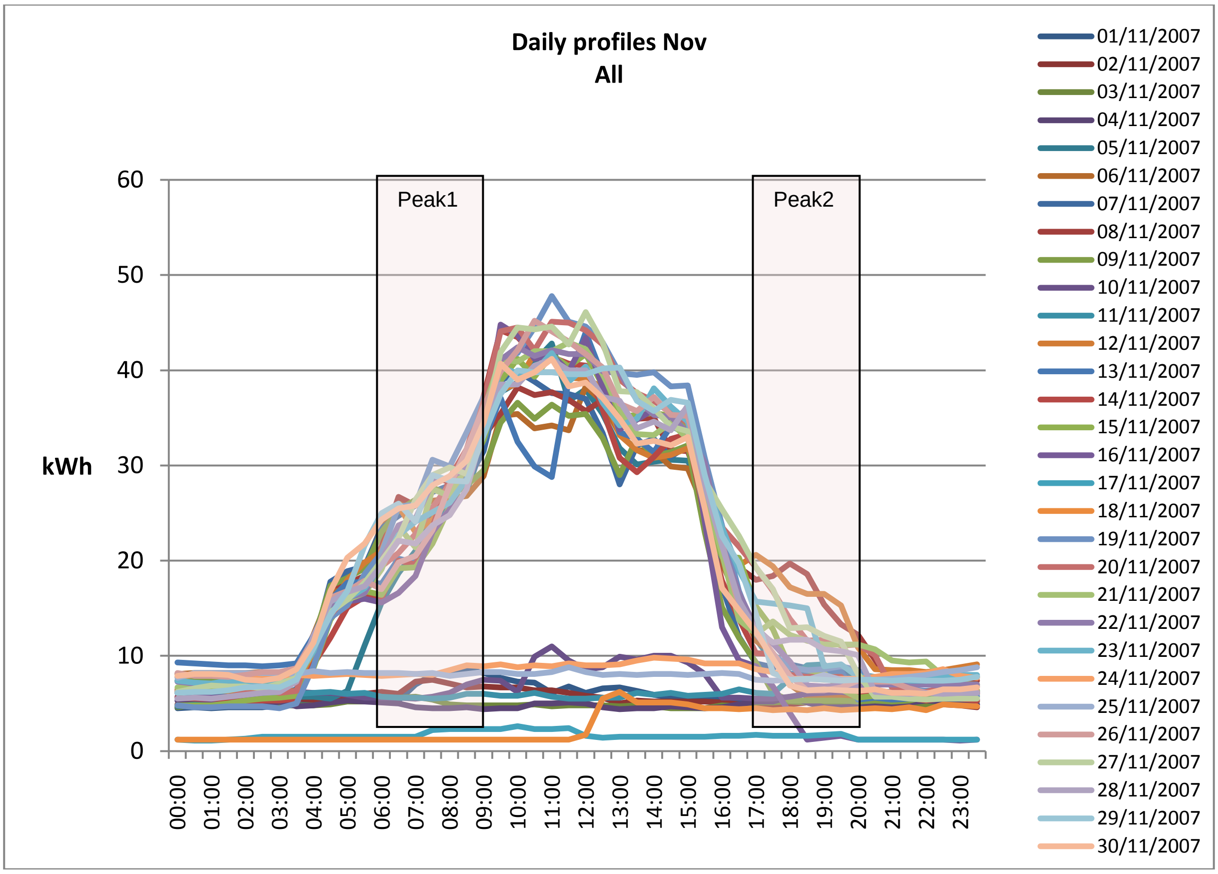
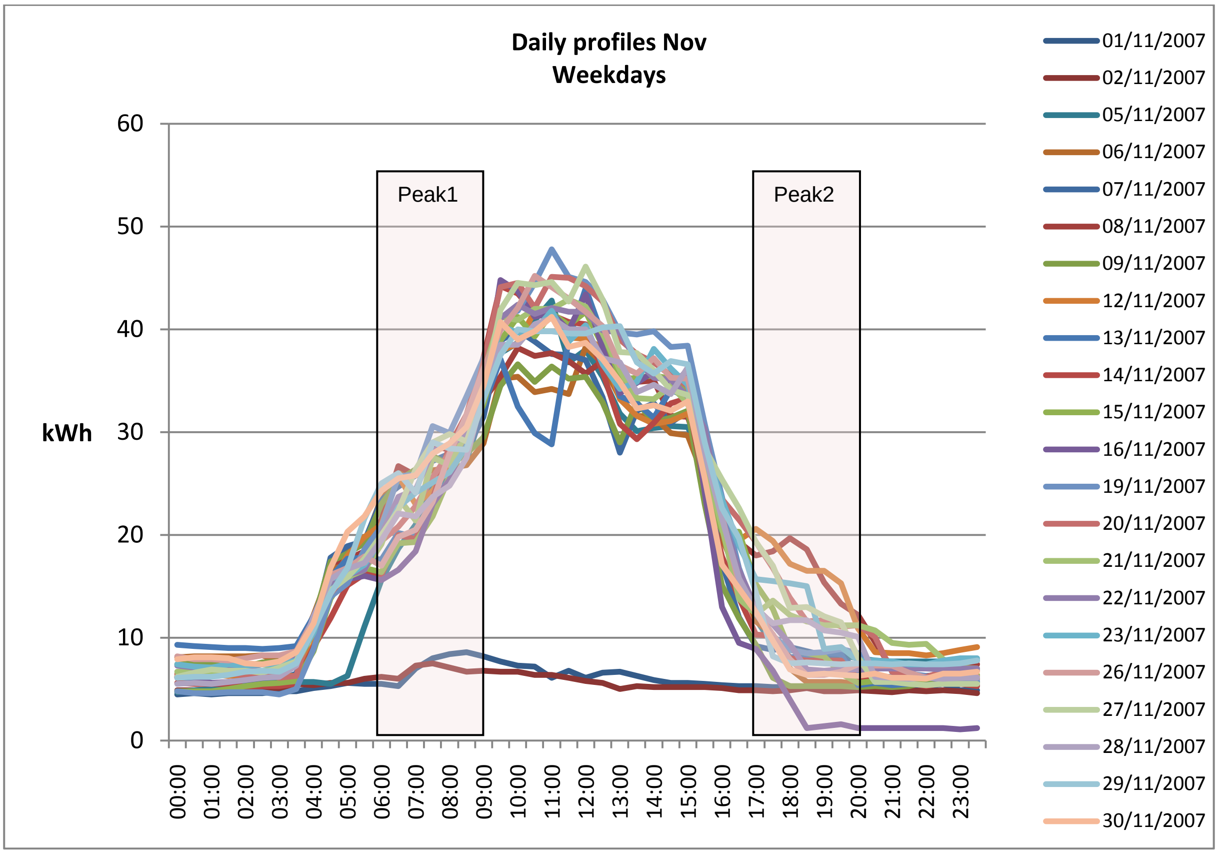


Chart 2.12 Daily profiles for a typical (LA6, ssc2) weekdays.



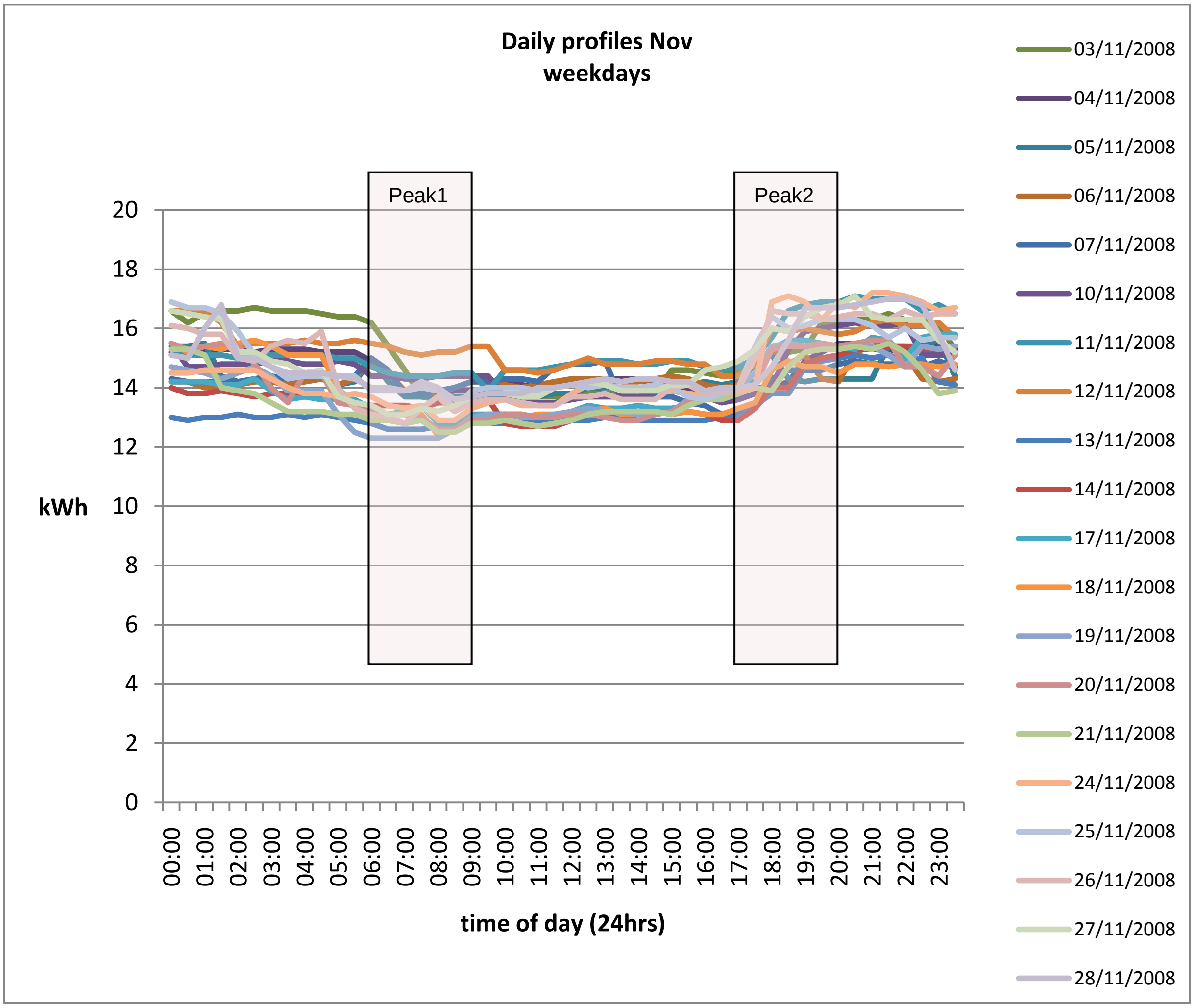
The above charts illustrate that electricity demands increase within Peak1 contributing to peak demand during that period. There is little indication of Peak2 contribution. Weekends and weekdays are contrasted and the profiles have a similar homogeneity as other sectors with a predominate 9-5 operation. In chart 2.12, two 'flat line' profiles occur. It is assumed that these days were non-operational days, such as in-service days at the school, but no data to confirm this was collected.

Summary.
In summary, electricity use in educational operations are predominantly 5 days a week, profiles are highly homogeneous, with ramping up of major equipment occurring in Peak1 contributing to peak demand. No major single items cause this, but instead a number of smaller electrical uses make up this demand. Some relatively straightforward energy management techniques could reduce loads and move these out-with peak periods. A broader study could provide further insights.

2.7.6 Sports and Leisure

The respondents had profiles that reflected operations driven by activities outside of office hours. The electricity consuming equipment tends to consume more in early evening in response to business requirements of leisure users attending sports centres in their non-work hours. This means that profiles differ day by day and week to week with any activities in the leisure centres based on their programmes of activities. Numerous centres across the country will have a profile such as this and of the non-domestic sectors, this is the main contributor to Peak2, which is usually driven by domestic consumption.

Chart 2.13 Daily profiles for a typical sports centre weekdays (LA6, spc1).



The chart above shows evening activity increasing and the contribution to Peak2 is clear. Weekend activities will also have an impact during peak hours periods but as a proportion of overall peak demand concerns, weekends are not significant.

Chart 2.14 Daily profiles for a typical sports centre weekdays (LA6, spc3).

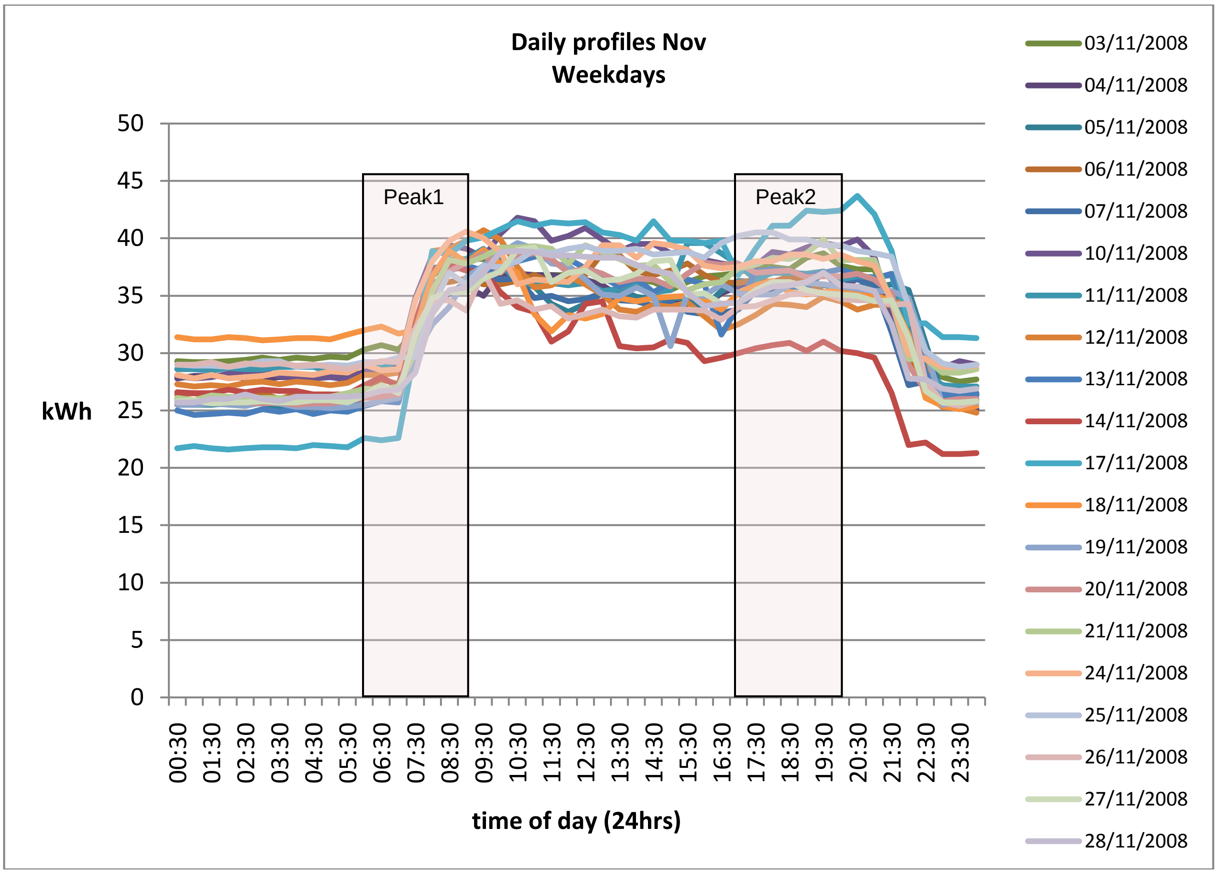


Chart 2.14 above shows moderate increase affecting Peak 2, with the profiles slightly increasing instead of a drop off. The affect on Peak1 period is also evident so activities here must have an 'office hours' component too. This is an example where both Peak 1 and Peak 2 are contributed to.

Electrical plant will typically be lights, fans, pumps, compressors, control systems, appliances and heating elements. These uses will mainly be numerous and small, with the combined consumption from each contributing to higher use profiles or profiles ramping up during Peak2. This indicates that measures to reduce this or move it from Peak2 are likely to be around behavioural change, via automated timer or photosensitive controls for lighting, or via a BMS following an overall strategy. The exception in this sector would be where centres have swimming pools. These will have some larger plant to deal with water circulation, replenishment and purification. Some bespoke energy management might be appropriate in these cases.

Summary.

In summary, electricity use in sports centre operations is during leisure hours, 7 days a week. Predominantly, profiles are somewhat homogeneous, but not as much as other sectors, with ramping up of electricity use occurring in Peak2 contributing to peak demand. No major single items could cause this, but instead a number of smaller electrical uses make up this demand. Some relatively straightforward energy management techniques could reduce loads and move these out with peak periods. Some bespoke energy management may be appropriate for swimming pools.

The summarised insights gained from each of the sectors are provided in table 2.2 below.

Table 2.2 Peak Demand summary table

	Do profiles indicate contribution to Peak 1?	Do profiles indicate contribution to Peak 2?	Can energy management be employed to reduce this?	Can energy management be employed to move this demand out with peaks?	Energy management measure types		
					Behaviour change	Automated controls	Specific large plant measures
Retail	Yes		Yes	Yes	Yes	Yes	
Offices	Yes		Yes	Yes	Yes	Yes	
Factories and workshops	Yes, but less so	Yes, but less so	Yes	Yes	Yes	Yes	Yes
Healthcare	Yes		Yes, sensitive to medical needs	Yes, sensitive to medical needs	Yes	Yes	
Education	Yes		Yes	Yes	Yes	Yes	
Sports and Leisure	Yes, where 9-5 component exists	Yes	Yes	Yes	Yes	Yes	Yes, where swimming pools are present

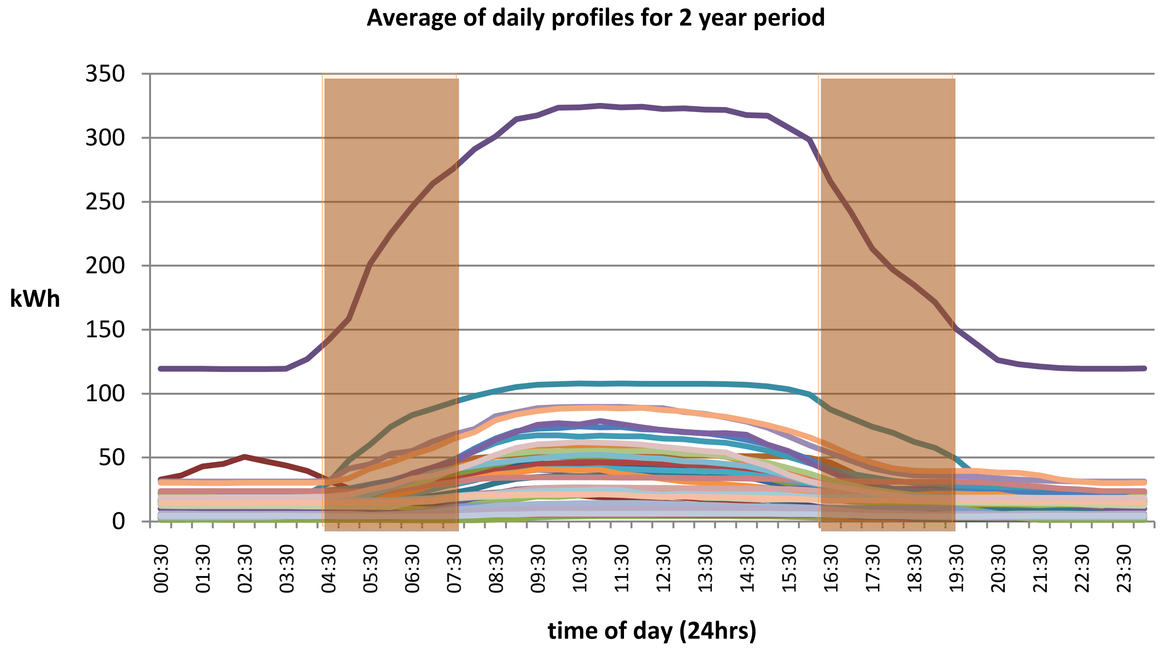
2.8 Database Reporting

2.8.1 Database Reporting Option 1: Average Daily Profile

This allows the user to view the specified buildings energy use at a specific time of the day. The average energy use for all selected days is shown for each dataset individually. By showing the average daily profile, it enables repetitive energy use trends to be identified. Both single and multiple datasets can be included and the data can be filtered by day of the week or by period of dates (subject to the date range of the supplied database).

LA6 was the single largest contributor to this project with 37 individual usable datasets. These included: 17 Secondary schools, 2 primary schools, 5 offices, 3 sports centres, 2 sports grounds, 3 nursing homes, 3 workshops, a retail space and a community centre. Due to the diversity of the dataset from this participant, it has been used to highlight trends/ differences seen across a typical selection of public sector buildings. Chart 2.15 below shows the average daily profile for the 2 year period 01/11/2007 – 31/10/2009 all of these datasets, this is in kWh at each specific time of day.

Chart 2.15 Average Daily Profile of LA6 01/11/2007 – 31/10/2009

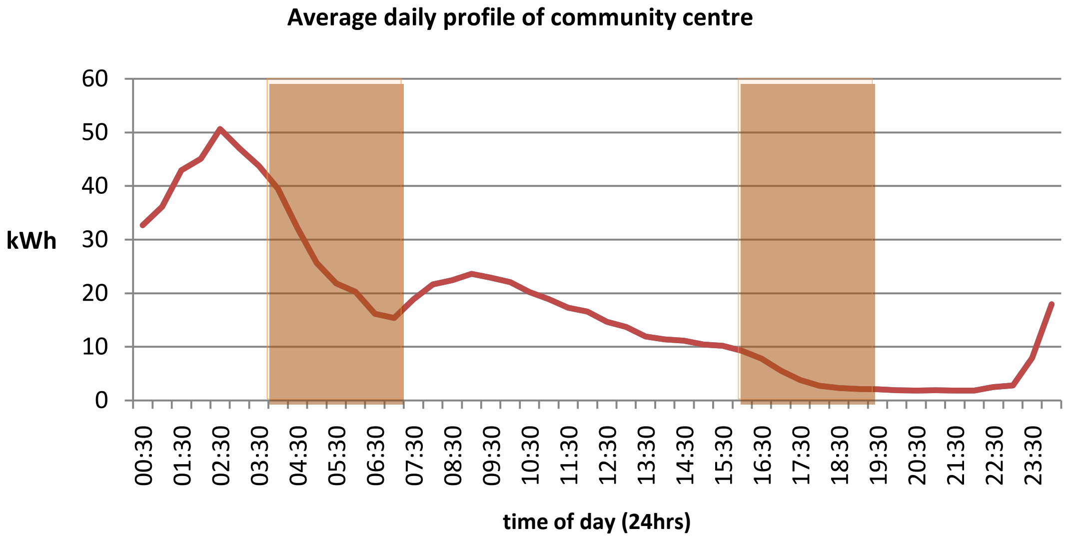


As expected due to the hours of business operation, the peak energy use for all types of buildings within LA6 is primarily between 08:30 and 16:00 and remains relatively constant within this time frame. The two larger consumers are both offices, **URN 20856-10** is open 9am-5pm, 7 days-a-week while **URN 20856-11** is in use 9am-5pm Monday to Friday.

Energy use can be seen to steadily increase during Peak1 and decrease during the Peak2. It should also be noted that the energy use during the peak times is for the majority of datasets, higher than pre Peak1 and post Peak2 times, which suggests there may be potential to reduce demand to match the off-peak base-load. The only slight variation to this trend is the Community Centre (2336501342016) which has a peak at around 02:30 this individual profile is shown in chart 2.16 below.

Database Reporting Option 1 can also be used to analyse single datasets as is displayed in chart 2.2 below.

Chart 2.16 Average Daily Profile of LA6 cdc1 (2336501342016) 01/11/2007 – 31/10/2009



This data, combined with knowledge on how the centre is used, could help the council highlight anomalies and therefore target inefficiencies in energy use and potentially reduce peak demand. AEA propose that there may be some form of storage heating system which uses off-peak electricity. However, without more background information, such unusual loads will remain unexplained. This chart does reveal that consumption, although decreasing from the dataset's average peak over Peak1 and Peak2 periods, is still significantly higher at these times that at than base-load, suggesting possible potential to shift discretionary demand.

Looking at the same group of datasets, if the average daily profile for winter is compared to that of a summer average, as is shown in Charts 2.17 and 2.18 below, the peak time usage period remains fairly constant with the greatest energy use remaining largely between the hours of 08:30 and 16:00, which suggests energy consumption is closely related to building occupancy as opposed to seasonal demands.

The total energy use drops in the summer months apart from the two main energy users (both offices) and which remain relatively constant consumers throughout the year. This suggests that there may be an opportunity to reduce peak energy demand to coincide with seasonal changes e.g. reducing artificial lighting levels during summer months. It also indicates that the winter electricity use does not correlate to increased heating demands, suggesting gas or similar is the primary heating fuel source.

Chart 2.17 Average Daily Profile of LA6 01/12/2007 – 28/02/2008 (Winter)

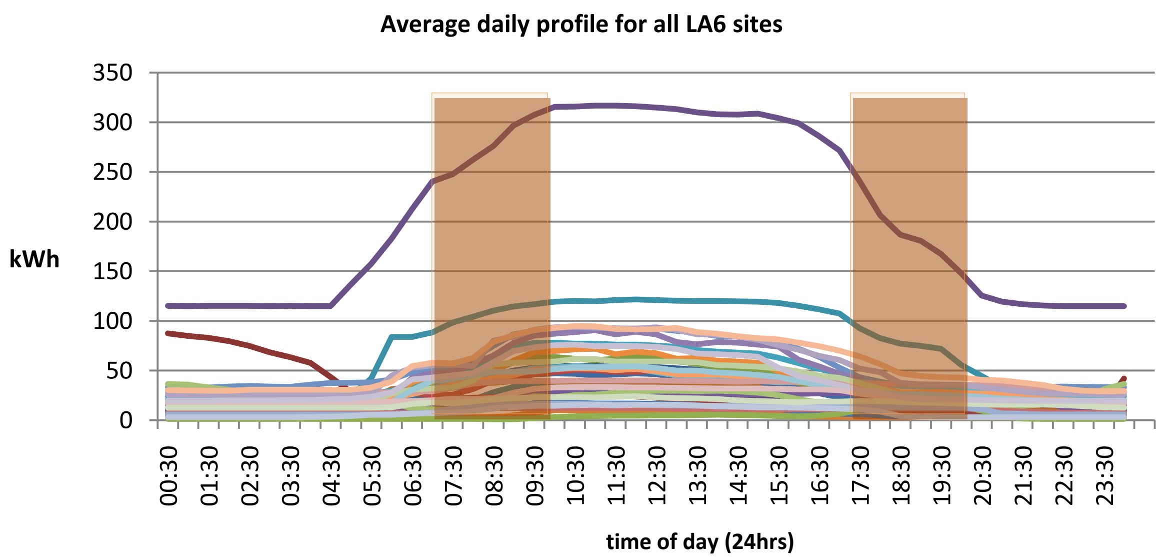
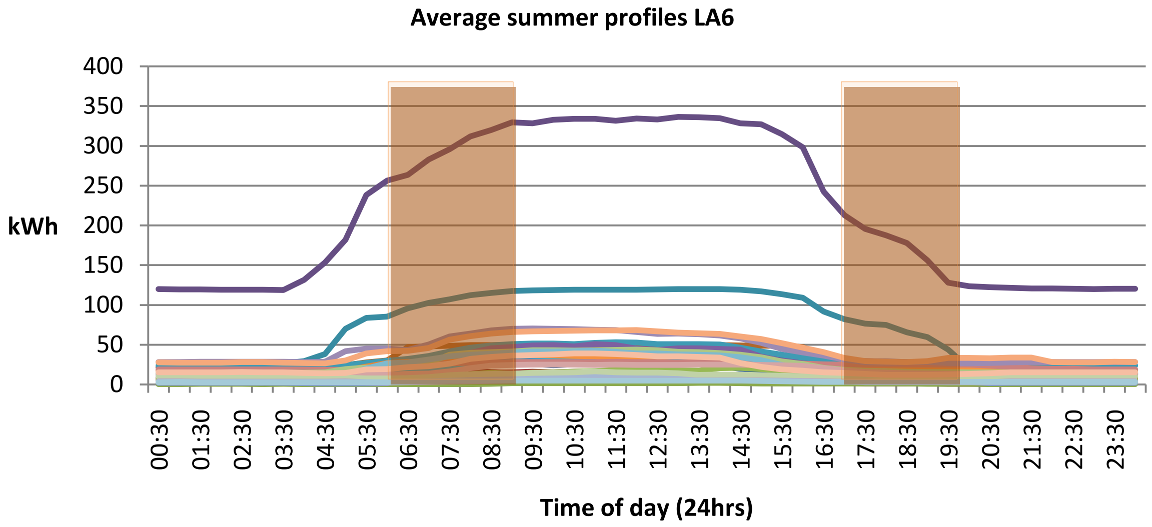


Chart 2.17 above presents the average daily profile for all 37 LA6 sites for the period 01/12/2007 – 28/02/2008, generally the coldest and darkest, that is the least number of daylight hours, 3 month period of the year. Whereas, Chart 2.18 below presents the average daily profile for all 37 LA6 sites for the period 01/06/2008 – 31/08/2008, generally the warmest and lightest months of the year.

Chart 2.18 Average Daily Profile of LA6 01/06/2008 – 31/08/2008 (Summer)



Charts 2.17 and 2.18 above indicate that (within this dataset) seasonal demands have little impact on the energy use profile, only maximum demand levels. The hypothesis that building occupancy is the main contributing factor can be tested by comparing weekday and weekend profiles, as investigated in Chart 2.19 below shows

Chart 2.19 Average Weekday Profile of LA6 01/12/2007 – 31/10/2009

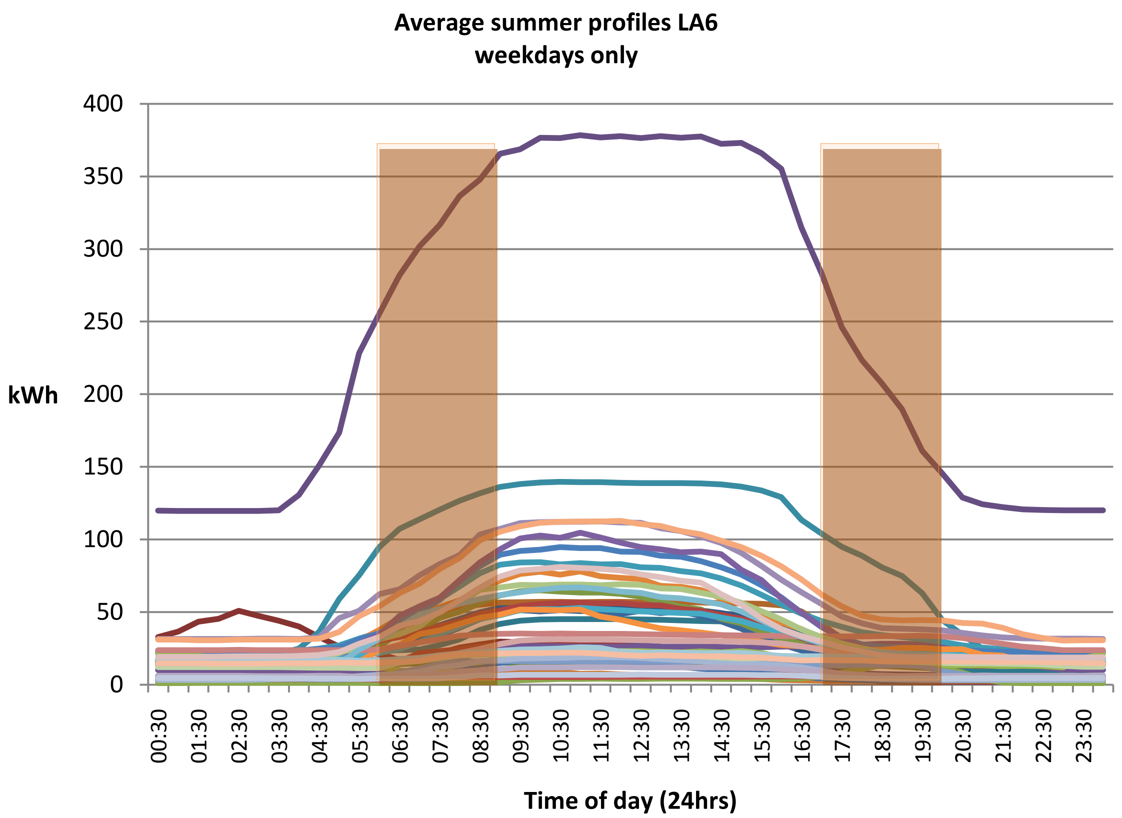
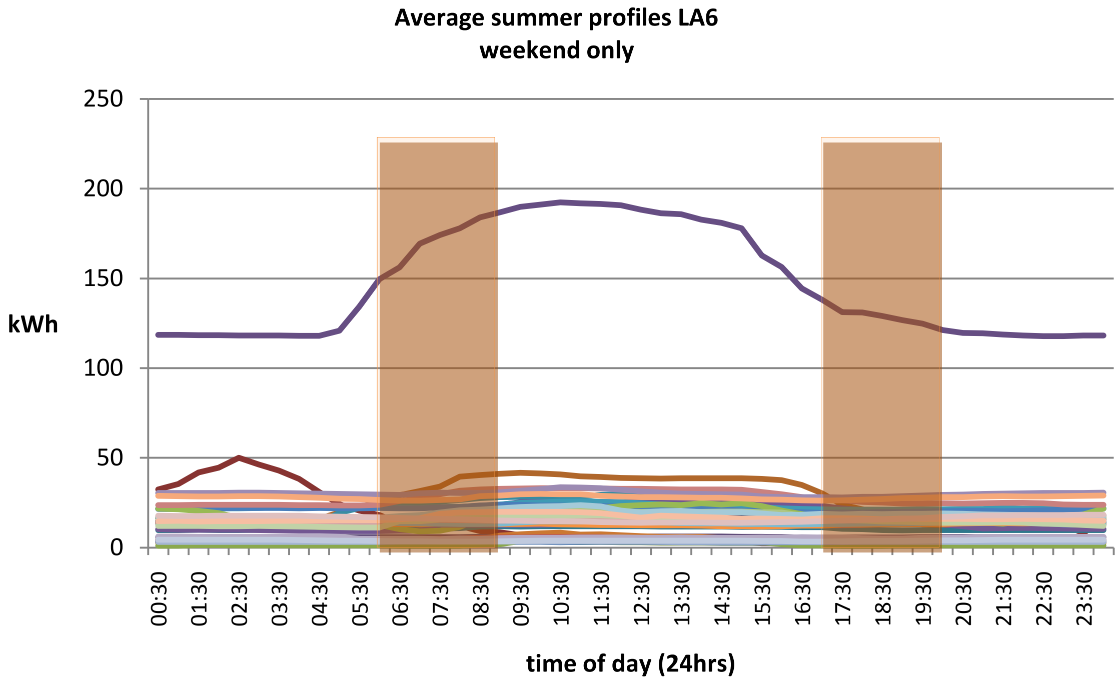


Chart 2.20 Average Weekend Profile of LA6 01/12/2007 – 31/10/2009

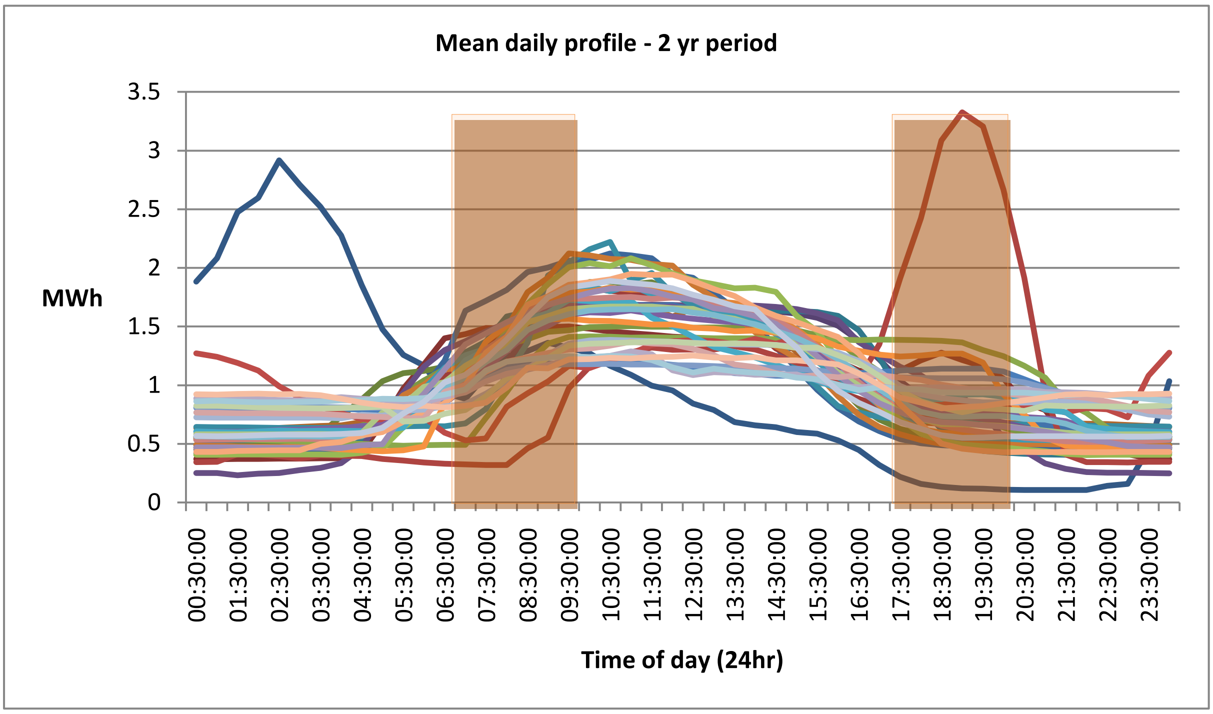


Apart from the large office dataset weekend electricity use is far flatter than the profiles seen during the week, apart from the same peak use in the community centre. Database Report 3: Total Daily Energy Consumption examines the weekday vs. weekend patterns further.

2.8.2 Database Reporting Option 2: Normalised Average Daily Profile

This option shows all selected datasets as a single average plot (at a given time of the day) normalised against the overall mean. This Mean average energy use for all selected days is shown for each dataset individually. This option was developed for cross sector comparisons. Whilst Report option 1 displays the total average energy use in kWh, this reporting option displays the energy use as a percentage of the average. In order to demonstrate the difference between this and reporting option 1 the same dataset has been used for Table 2.21 below. Both single and multiple datasets can be included and the data can be filtered by day of the week or by period of dates (subject to the date range of the supplied database).

Chart 2.21 Mean Daily Profile of LA6 01/11/2007 – 31/10/2009



As can be seen above, the leisure centre is the only LA6 building whose peak demand consistently falls within the Peak 2 usage period.

2.8.3 Database Reporting Option 3: Total Daily Energy Consumption

Database Report 3 allows the total daily energy use (in MWh) of individual datasets to be plotted over selected dates. This allows patterns such as higher energy use on weekdays in comparison to weekends, or lower energy consumption on a Friday in comparison to a Monday due to shorter working hours to be clearly highlighted.

Offices are the most prevalent building group within the overall dataset with 45 individual office sites supplying data. The period 01/01/2008 – 31/12/2008 (2008 calendar year) had the most collective data, for which there were 33 datasets from a selection of UK wide participants.

Charts 2.22 and 2.23 gives the daily energy use (MWh) of these 33 sites for January and July 2008 respectively, this allows a seasonal differences between the sites to be compared.

Chart 2.22 Total Daily Consumption of 33 Individual Office sites for January 2008

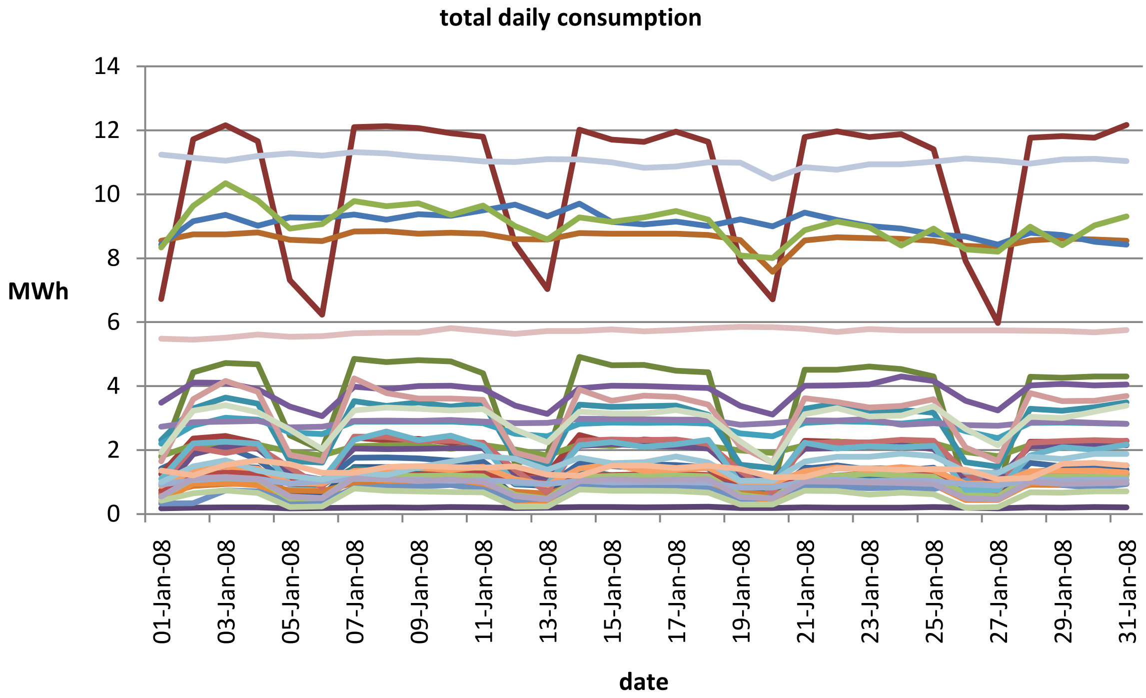
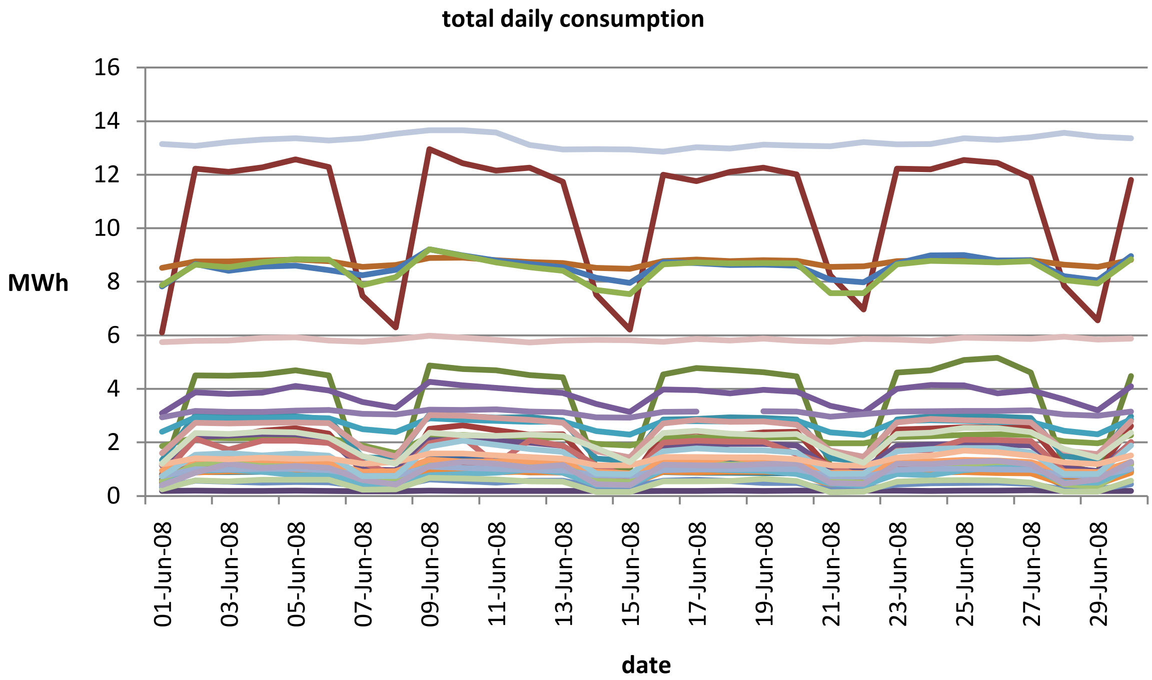


Chart 2.23 Total Daily Consumption of 33 Individual Office sites for July 2008

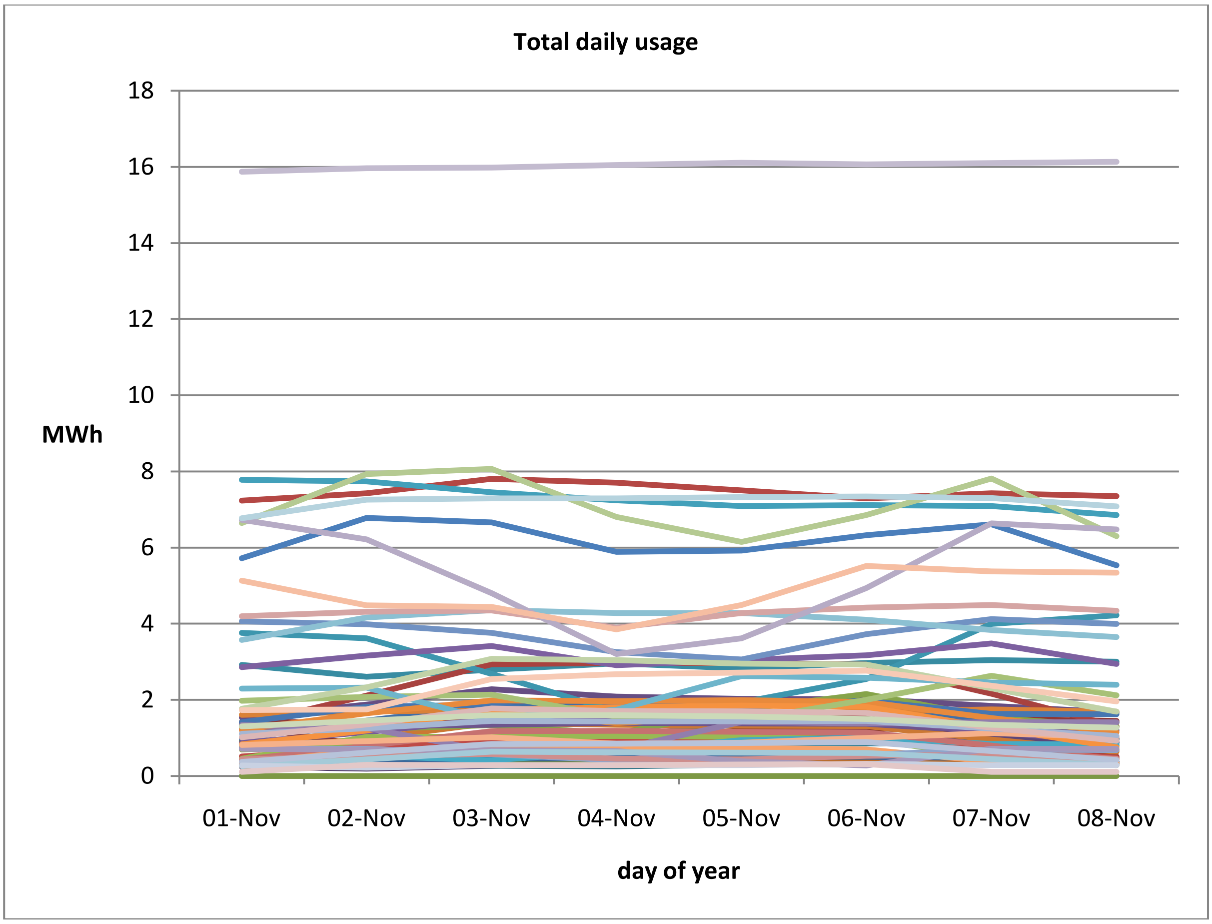


For the most part, the profiles for both winter and summer energy consumption for office units are similar, with energy consumption through the week considerably higher than at weekends which is to be expected for typical office premises. The noticeable differences are highlighted by the West Malling offices dataset 1 and 2 and the Basildon data centre which are all relatively flat. All three of which are open 24hrs a day, 7days a week.

2.8.4 Database Reporting Option 4: Yearly Consumption

Similar to option 3, option 4 plots the total daily energy use (in MWh) of individual datasets but instead of specific dates it does this against the day of the year. Chart 2.24 shows the total daily energy use for all buildings between 1000 and 5000 m^2 across all sectors. Due to the volume of data this involves the dataset example shown have been edited to only include consumption for 1st to 8th November.

Chart 2.24 Total Daily usage by Day of the year.

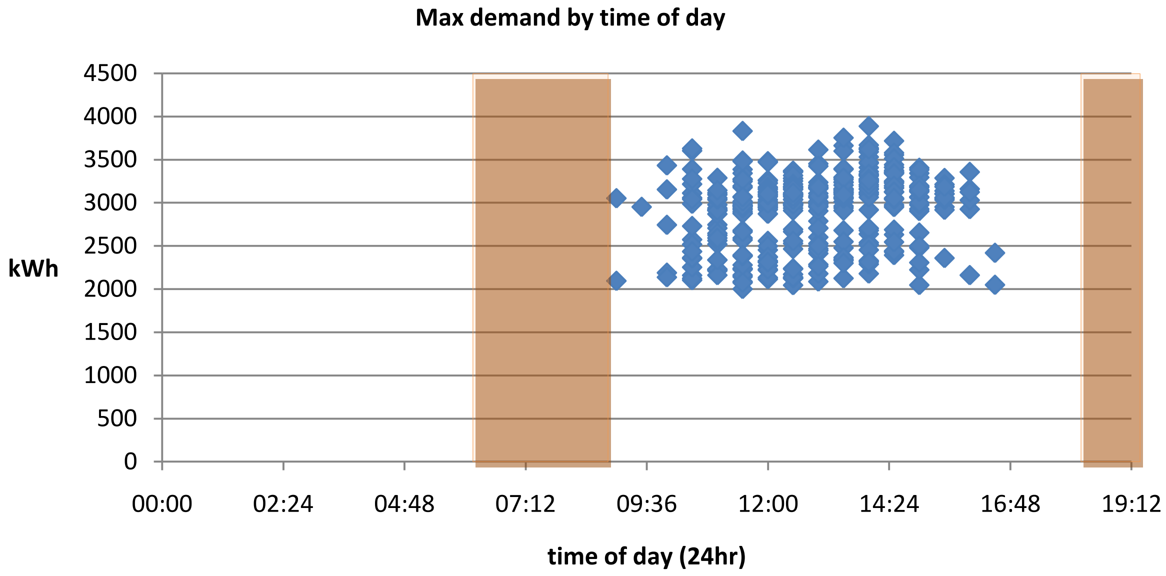


The results above show a fairly steady energy use throughout the week for most of these sites. Some notable exceptions are **URN 30199-25** and **URN 30199-26** which are both manufacturing industrial sites. Through using this chart to compare different datasets, in the database it is possible to quickly see which individual datasets you might like to examine in more detail.

2.8.5 Database Reporting Option 5: Time of Minimum and Maximum Energy Demand

Reporting option 5 plots the times of the maximum and minimum energy use for a single dataset for a given period. There are a number of data points generated for this option so it's recommended that filters are used to limit the amount of data. For this reason the maximum and minimum points for the hospital sector, the single largest energy peak demand (Maximum demand of 3,886 kWh compared to the second largest at 3,398 kWh) are displayed in separate charts below with the peak usage periods highlighted. It should be noted that there is only one dataset for this sector meaning it is unknown whether this is a representative consumption pattern.

Chart 2.25 Time of Maximum Energy Demand for 'Hospital' Sector



This particular chart shows the point of maximum energy demand each day for the period 18th December 2008 to 17th December 2009. None of the maximum demand points occur at peak times, instead consumption is, as might be expected of a hospital, largest between 09:00 and 17:00. Despite operating 24hrs a day, 7 days a week, this is when much of the activity would tend to take place, i.e. administration, most operations etc.

Chart 2.25 Time of Minimum Energy Demand for 'Hospital' Sector

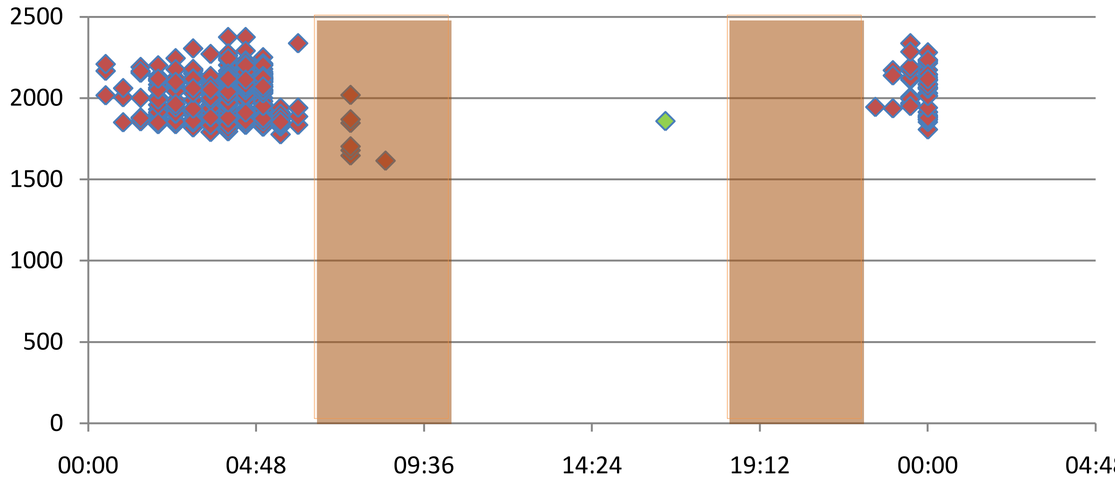


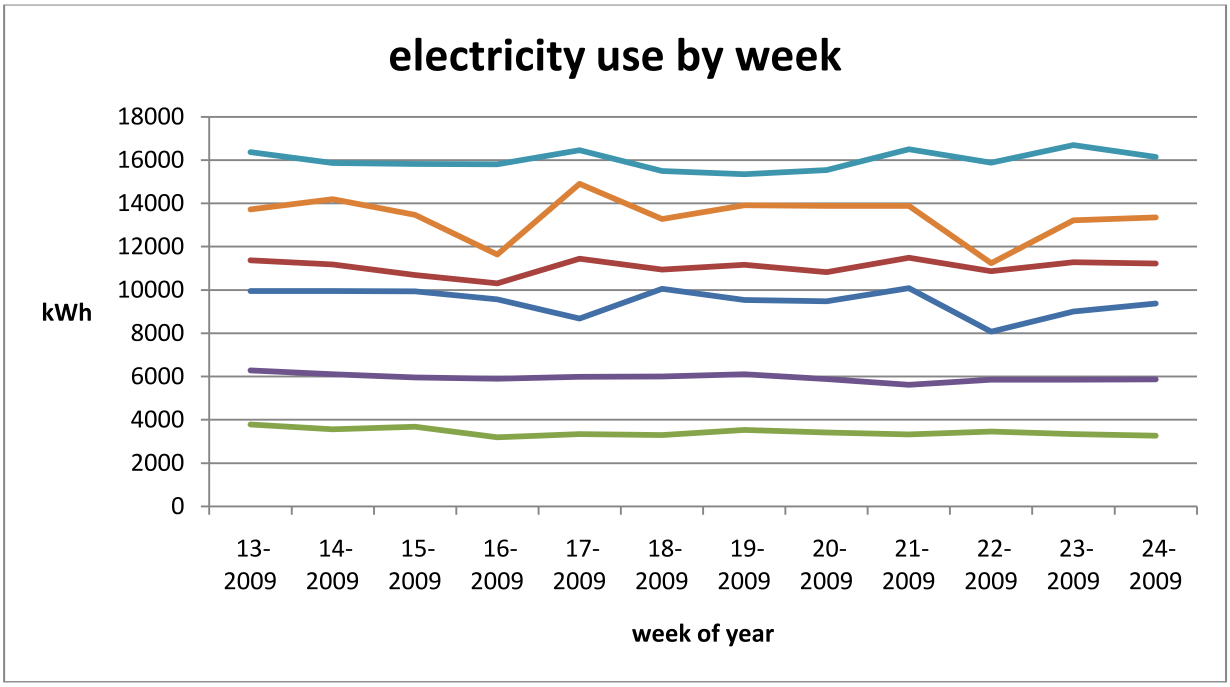
Chart 2.25 above shows the point of minimum energy demand each day for the period 18th December 2008 to 17th December 2009. Minimum energy use seems to complement the maximum energy use points above. The 'slowest' point of the hospital day appears to be early morning from just after midnight until, in some cases, just before peak usage time meaning that consumption is likely to spike quite dramatically after around 09:00. Conversely these charts suggest consumption tails off slowly from ~17:00 to a minimum of around 00:00. It would be useful to compare this max and min consumption against charting option 1, average daily profile. The anomalous reading highlighted in green occurred on 7th February 2009 at 16:30. Further investigation may highlight what, if anything happened on that day to cause the minimum demand to occur at that time i.e. a powercut.

2.8.6 Database Reporting Option 6: Weekly Profile

Option 6 allows energy use in kWh to be compared against time (over a weekly period), for either single or multiple datasets.

Chart 2.26 below shows the consumption of the six biggest consumers in the 'industrial process' sector on a weekly basis (for weeks 13, w/c 2nd March 2009 – 24, w/c 8th June 2009).

Chart 2.26 Industrial Process Consumption (weeks 13-24)



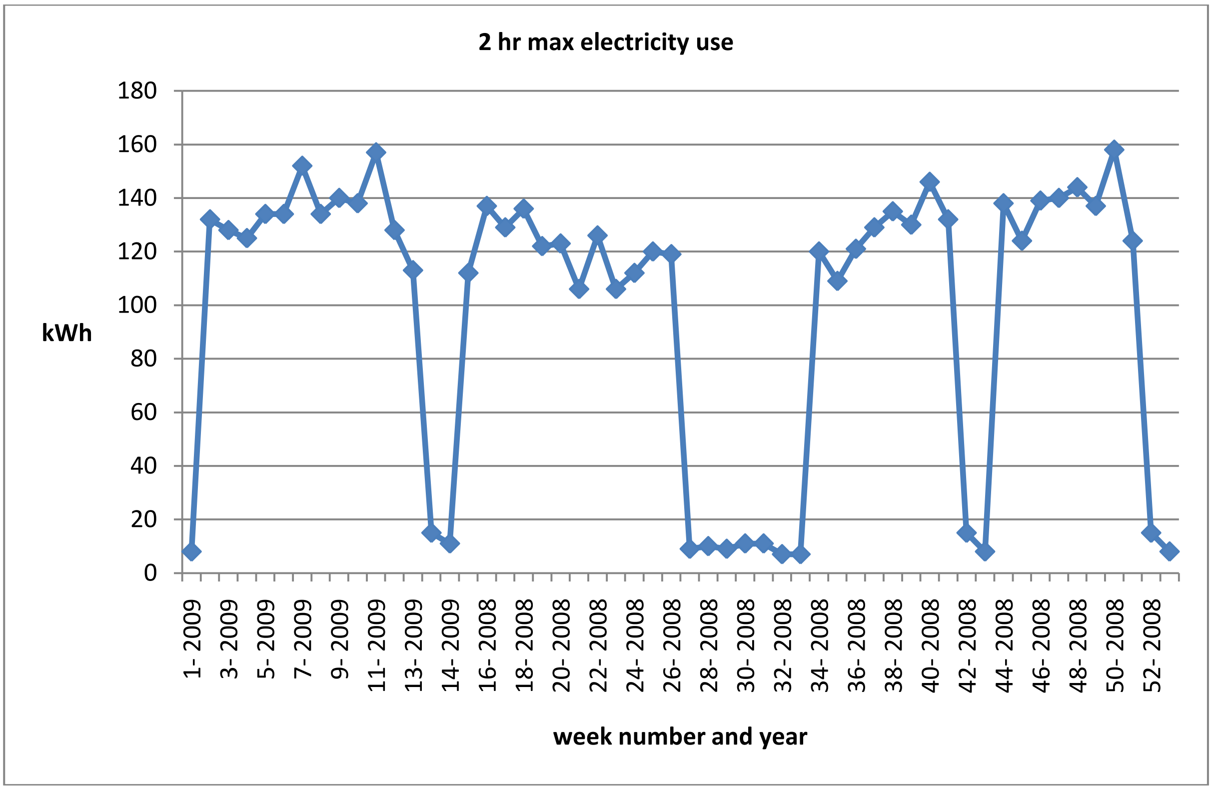
URN 30171-04, PV5, ind4, has two dips in consumption in weeks 16 and 22, which correspond to w/c 23rd March 2009 and w/c 25th May 2009 respectively. This is similar to URN 30171-01, PV5, ind1, both sites operate 24 hours a day, seven days a week. This is in contrast to URN 30171-03 PV5, ind3, (24/7 operation) and URN 30199-03, PV4 ind3, (5 days a week operation) which suggests consumption is in line with production rather than time of the year or weather, although further details would be required. This may provide an opportunity with many businesses to 'flatten out' production to avoid peaks in consumption, although it's understood there are business practicalities that may prevent this.

2.8.7 Database Reporting Option 7: Max 2hr Energy Use by Week

Reporting option 7 displays the maximum energy consumption (kWh) that occurs over any 2 hour block of time, each week. This report is designed to be used for single datasets so comparisons would require the generation of multiple charts.

Chart 2.27 displays the maximum 2hr block of consumption per week for a high-school URN 20002-02 for a period of a year (the charting option automatically arranges the data for a calendar year). This chart enables us to see how the points of maximum two hour demand vary over different days of the month.

Chart 2.27 2hr Maximum Consumption per week for typical high school



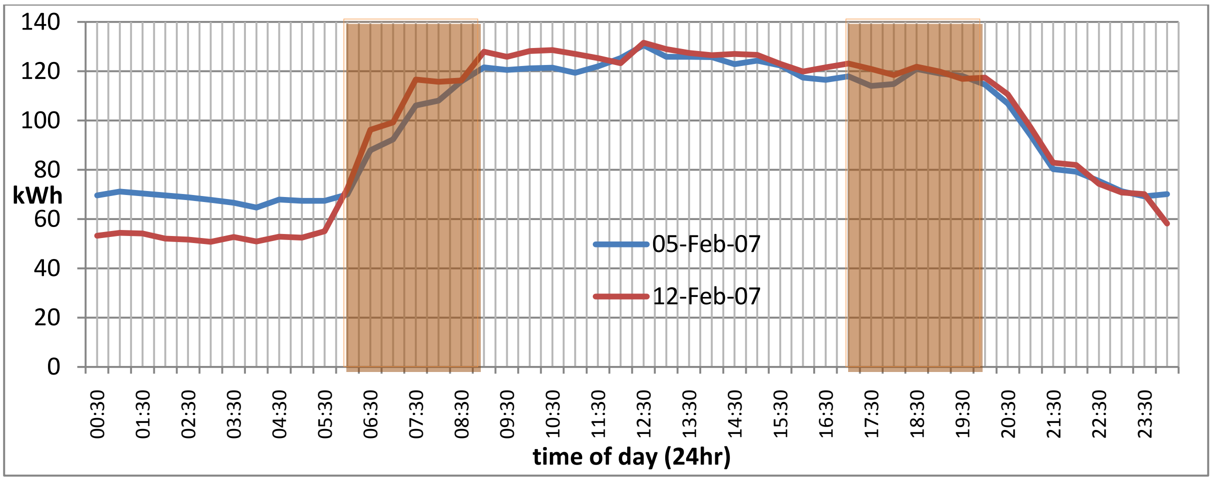
Week 13 corresponds to Easter while Weeks 28 – 34 correspond to summer holidays.

2.8.8 Database Reporting Option 8: Individual Meter Values by Day

This option charts energy use (kWh) by time of day, with each day being plotted as a separate line. It's recommended that a day or date filter be used to limit the data. This charting option would be particularly useful to further investigate days which have highlighted unusual trends in other charting options e.g. Report Charting Option 3

Chart 2.28 below demonstrates this chart using the dataset URN 30020-03 for two consecutive Mondays.

Chart 2.28 Comparison of individual meter values by day (5th Feb 07 vs. 12th Feb 07) for URN 30020-03, PV3, ret3.



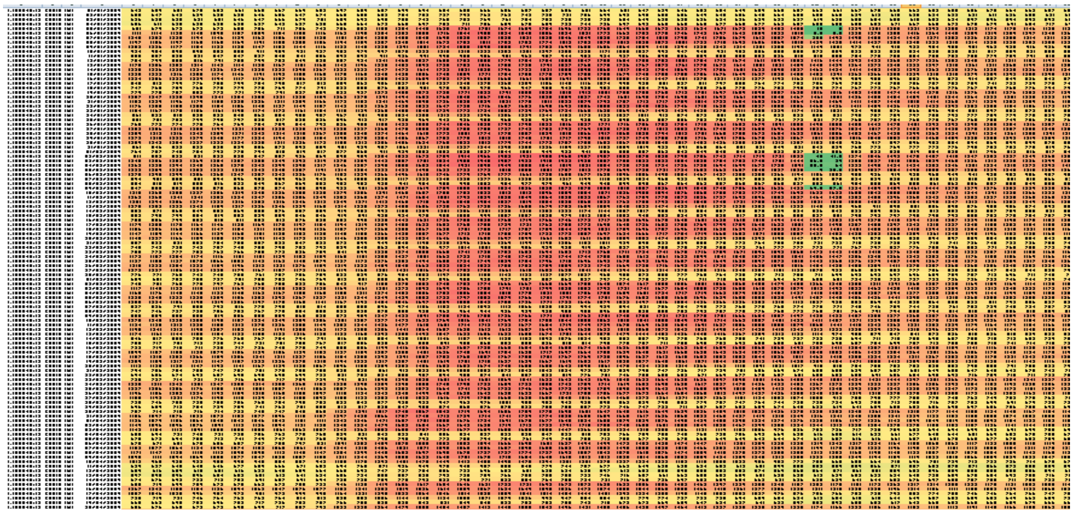
As is demonstrated above the consumption is very similar for both days as would be expected with similar building use pattern (opening times are 08:00-20:00) at the same time of year.

Although consumption remains high during Peak2 there isn’t a spike in consumption meaning it remains fairly predictable. In contrast consumption begins to rise from off-peak to peak usage for the store during Peak1.

2.8.9 Further analysis options

The export of the access database data to excel allows for some useful presentation of the data. One such option that DECC may want to investigate further is a Maximum Demand (MD) footprint. This type of chart highlights periods of high and low consumption according to the values in each cell, giving a good overview of total consumption for a single or multiple datasets for any given period of time. In the example below, the redder the cell shading, the higher the half-hourly reading is, whereas low readings are shown in green colours. If required AEA would be happy to discuss any future project requirements DECC may have for further analysis of the data collected.

Chart 2.29 further analysis option example



3 Work Package 2: Technical specification for measurement of peak electricity demand

The aim of this work package is to develop a technical specification to measure the components of peak electricity demand in the non-domestic sector.

3.1 Background and Context

Following on from this scoping study, DECC would like to undertake a more detailed project to measure the components of peak electricity demand in the non-domestic sector. The overall aim of such a project would be to collect electricity demand data from a range of commercial and public premises to enable a determination of the components of peak demand. As such, component sub-metering will be required.

An ideal scenario would be to install smart sub-metering across a statistically valid sample of non-domestic buildings and record half-hourly electricity demand for a year-long monitoring period. However, the cost of sub-metering and logging equipment would be prohibitively expensive over a large number of buildings. This would be coupled with the logistics of recruiting suitable buildings and health and safety concerns regarding equipment installation.

From AEA’s investigations under Task 1 of this study, the relevant data does exist and is being collated, particularly as a result of the driver for AMR through the CRC; it is the acquisition of this data that is difficult and requires input from DECC. Also, although a large number of non-domestic buildings will have half-hourly metered data, and a significant number will have some level of sub-metering (e.g. by floor area, by tenant), fewer will have component sub-metering installed.

3.2 Sub-Metering

It is a requirement of Part L2A of the Building Regulations 2006 (England and Wales) that all new non-domestic buildings have “*sufficient energy meters and sub-meters*”2.

The Regulations go on to state that:

“Reasonable provision would be to enable at least 90% of the estimated annual energy consumption of each fuel to be accounted for”.

For all new buildings, the Regulations state that sub-metering is required on the following plant items

- Boiler installations/ CHP plant >50kW
- Chiller installations >20kW
- Electric humidifiers >10kW
- Motor control centres (power to fans/ pumps) >10kW
- Final electrical distribution boards >50kW

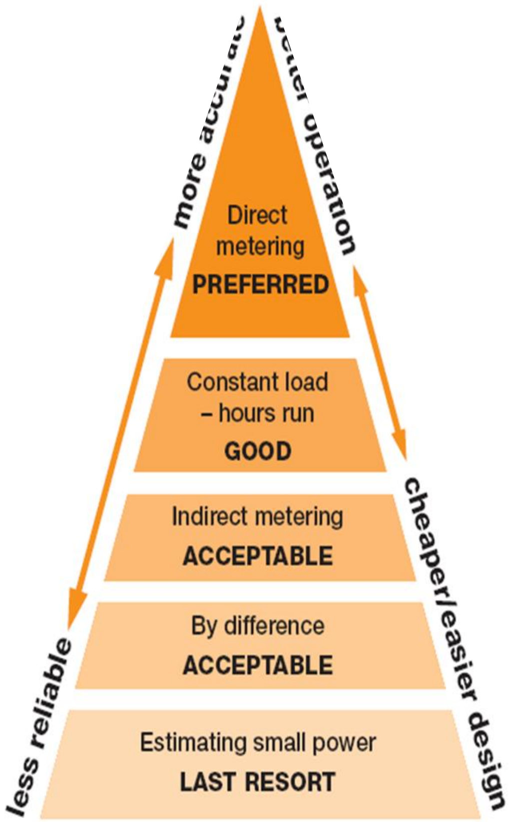
In addition, there must be separate tenant metering and on multi-building sites, separate metering for every building >500m^2.

In the context of the proposed project, the above Regulations seem encouraging and suggest that all non-domestic buildings constructed since 2006 would have the relevant data available. However, the following points should be noted:

2 *Building Regulations (England and Wales): Approved Document L2A: Conservation of Fuel and Power in New Buildings other than Dwellings*, Department for Communities and Local Government, 2006

- There is no requirement for the installed sub-meters (or indeed fiscal meters) to log readings. Many buildings will be able to provide instantaneous meter readings only.
- Sub-metering (in the context of the Building Regulations) may not mean the actual installation of physical meters. Other metering methods are acceptable (as illustrated in Figure 3.1)[3]. Where these methods have been used, half-hourly logged data is unlikely to be available.
- Only a building's fiscal energy meter is required to take half-hourly electricity demand readings (and then only if the site has a maximum demand of 100kW or more). Sub-meters may record data less frequently or in different units (e.g. kWh, hours run).
- Sub-metering to this extent has only been a requirement in recent versions of the Building Regulations. There is a risk that any data collection based on applicable buildings will be biased towards newer buildings only.

Figure 3.1 Approved Sub-Metering Methods for Building Regulations



3.3 Required Project Outputs

In an ideal scenario, the new project should produce the following outputs:

- Half-hourly metered electricity demand data (covering at least one calendar year) for a statistically valid sample of non-domestic buildings.
- Half-hourly sub-metered electricity demand data for the same buildings, linked to specific components, and covering the minimum requirements of the current Building Regulations. The sub-metered data in this context should be from direct physical meters.
- Site surveys of each monitored building. As a minimum, this should include information on building floor area, location, orientation, primary business activity, annual energy expenditure, operational hours, occupancy levels and building age. There may be some merit in evaluating

3 *GIL 65: Metering Energy use in Non-Domestic Buildings*, Carbon Trust, 2002

more detailed construction data (for example, producing a full Energy Performance Certificate and SBEM modelling). Unusual loads from large plant or equipment should be included.
- Questionnaire survey for building energy managers (covering issues such as demand-reduction measures undertaken/ considered, energy investment budgets available, etc.)
- SQL database of data obtained, with online functionality that enables bespoke reporting, uploading of new datasets, etc.

There are potentially 3 individual project components that could be let as a single project or as 3 separate lots:

- Database Design and Maintenance
- Data acquisition
- In-situ Measurement and Monitoring

These lots are described in more detail below, with key issues for consideration in development of a final project specification.

3.4 Lot 1: Database Design and Maintenance

Whatever method of data collection is used, there will be a need to develop a robust database for presentation of the data and ongoing data analysis and interrogation. The successful contractor should develop an online database with the following functionality:

- SQL (or equivalent) platform
- Initial dataset format, with coding
- Capability for third party users to upload datasets directly (from CSV format)
- Data checking and data cleansing of uploaded datasets
- Background information checklist for each dataset (for users to record building type, etc.)
- Live 'tally' of datasets for each organisation/ building type
- Automatic reporting
- Appropriate data protection

3.4.1 Additional functionality

The online database could form the public 'front end' of the project with an ongoing capability of uploading data as it becomes available. The successful contractor could be required to carry out marketing activities to encourage use of the database and be set targets for data collection (in addition to that carried out from other parts of the overall project).

The successful contractor should also provide information on hosting and maintaining the database for a defined period. They should be prepared to provide an exit strategy at the end of the project period to enable the whole database and background IT-protocols to be transferred to another host organisation.

3.4.2 Requirements for successful contractor

Essential
- Experience in designing and hosting complex SQL databases with web-based front ends
- Ability to host and maintain public-facing websites with approved DECC branding

Desirable
- Experience of relevant environmental/ buildings issues
- Marketing capabilities

3.4.3 Estimated Budget

The estimated budget for this lot is circa £100,000 fixed price to cover database development, testing and first year marketing, hosting and maintenance. Thereafter, an annual fee of circa £20,000 will be required for ongoing hosting and maintenance.

3.5 Lot 2: Data Acquisition

As AEA has demonstrated in Task 1 of this scoping study, the data required does exist. Utility companies store this data for clients and will keep historical records. For sites with a maximum demand of more than 100kW, half-hourly fiscal meters are required and have the capability of being read remotely (although not all site managers choose to receive the data in this format). Energy monitoring and targeting software packages, e.g. TEAM, STARK, will draw half-hourly data from on-site meters and store them in a database format for interrogation. External bill verification organisations, e.g. IMServe, will store half-hourly data for clients and provide a range of data analysis services.

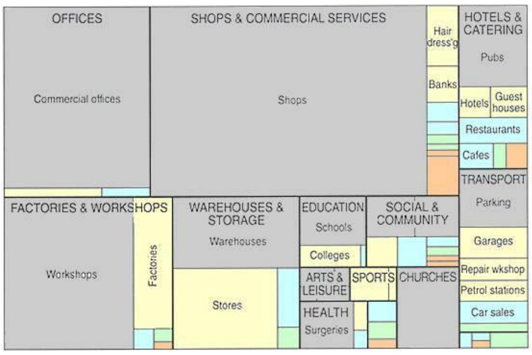
The availability of good quality component sub-metered data is more questionable. The most reliable source of this information is likely to be Building Energy Management Systems or Automatic Monitoring and Targeting systems. However, the length of time that such data is stored will vary from site to site. The increase in uptake of the Carbon Trust Standard and AMR as part of the early action metrics for the CRC may improve the quantity of data available.

The overarching issue is authorisation from clients to release suitable data and data confidentiality. Whilst utility companies and other data management organisations will hold extensive energy consumption data, they will not release it to a third party without authorisation from individual clients. There will also be concerns from clients surrounding data protection and client confidentiality.

It should be possible to overcome authorisation issues by DECC working directly with utility companies, BEMS manufacturers/ bureau services and energy data management companies, and issuing requests for authorisation to clients. Data protection and confidentiality issues can be covered by the set up of the resultant database. Some basic site information will be required, but actual organisation names and addresses can be excluded.

The aim would be to collect data that forms a representative snapshot of the non-domestic building stock in the UK. The Non-Domestic Building Stock Model (NDBS) being developed by UCL is collating information on non-domestic building types in the UK for aligning with BRE's N-DEEM model. Unfortunately, the data from the NDBS is not yet in the public domain. Information from the NDBS website suggests that the non-domestic building stock profile in the UK is proportioned as follows:

- Retail & Commercial Services 32.3%
- Offices 15.4%
- Factories & Workshops 14.4%
- Warehouses & Storage 10.8%
- Transport 6.9%
- Hotels & Catering 6.4%
- Social & Community 3.7%
- Religious Buildings 2.9%
- Healthcare 2.7%
- Education 2.6%
- Arts, Sports & Leisure 1.9%



1,000 premises

Diagram to represent the entire non-domestic building stock of England and Wales, in terms of numbers of hereditaments or premises. The area of each rectangle is proportional to the number of premises of the given type. The complete diagram represents some 1 685 000 hereditaments/premises.

There was no information available as to the breakdown of the non-domestic stock by size. There are also figures available on sub-categories of the bulk categories listed above, but again, this information is not in a readily available public format.

The overall aim of this Lot should be to collect good quality half-hourly and sub-metered data for around 1000 buildings, with a proportional split as shown above. For some data management companies and utility providers, the collation of that number of datasets should be relatively simple (assuming authorisation from customers is received).Organisations with no direct access to such data, e.g. AEA, will have more difficulty in obtaining data (as evidenced by Work Package 1) and would probably end up contacting utility companies themselves, adding another layer of complexity to the data acquisition process.

Each dataset delivered would need to be accompanied by a completed information sheet. This could be automated via the database with drop-down selections to save input time. As a minimum, the following information should be gathered for each dataset:

- Type of organisation
- Type of building (construction)
- Location
- Size of building
- Number of employees
- Start/ finish dates of collected data
- Component type (for sub-metered data)

3.5.1 Estimated Budget

It is difficult to estimate the cost of this Lot as it is questionable whether DECC should be seen to be paying for such data. There is also the question as to *who* should be paid: the data collector or the organisation itself.

However, without a statutory obligation, many organisations will be unwilling to invest the manpower into generating suitable datasets, and uploading onto the database, without some form of incentive. It may be possible to contract multiple organisations to deliver suitable datasets with DECC paying for manpower costs only and with finance-linked KPIs built into each contract. Suitable KPIs could include:

- Number of datasets uploaded (with quality checks) for different time periods
- Diversity of organisation types from uploaded datasets

The use of KPIs would require some form of quality checking to be built into the Lot 1 contract.

DECC could set up a framework of contractors for this Lot, each with a dataset delivery target.

The manpower costs associated with each dataset will be broken down into:

- Gaining authorisation from customers
- Collation of data into correct format
- Uploading of dataset onto database and completion of information checklist

AEA estimates that no more than 2 man-hours per dataset should be required. Costs will be dependent on the grade of staff involved and the tendering companies' overhead rates.

The DECC in-house costs associated with marketing and, if necessary, developing statutory guidance for data collection (perhaps linked to the CRC), are estimated at circa £50,000 per annum (assuming £400 per day, 100 man days and £10,000 for marketing/other expenses).

3.6 Lot 3: In-Situ Measurement and Monitoring

A sub-set of the building types listed above in section 3.5 should be selected for in-situ electricity measurement. AEA recommends that one contractor (or consortium) be appointed for this Lot.

AEA recommends that for Lot 3, only office buildings are considered. There are a number of reasons for making this recommendation:

- The practicalities and cost involved in sub-metering a building to the standard required will be extensive. Therefore, only a small number of sites will be able to be monitored. Some building types, e.g. industrial premises, will have bespoke equipment, and so only monitoring one or two buildings would not lead to representative results.
- The typical sub-metered components within an office building will be found across other building types, e.g. air conditioning equipment, server rooms, lighting circuits, etc.

Should the in-situ monitoring prove to be successful, the focus could move to other sectors in later years. The Retail & Commercial Services sector could follow given that it represents 32.3% of the UK non-domestic building stock profile. All sectors will have some potential and so could be monitored. These could be categorised as per NDBS database or CIBSE categories, or existing market categorisation such as SIC codes.

Where possible, AEA would recommend that DECC have a prior selected list of potential project participants. This could be generated from the datasets acquired under Lots 1 and 2, or via another government programme (e.g. CRC). The details below have assumed an initial sample size of 50 buildings, however the successful contractor should be required to provide costs for monitoring additional buildings (so that the maximum number of buildings can be monitored for the budget).

The successful contractor would be required to carry out the following tasks.

3.6.1 Identification of Premises

The contractor must identify 50 suitable buildings for in-situ monitoring of component peak electricity demand. The 50 buildings should be office buildings, but other aspects such as size, location, etc are not defined.

For each building, the contractor should record:

- Type of organisation
- Building size
- Location
- Building age
- Construction type
- Number of occupants
- Operational hours
- Servicing strategy

The contractor should receive appropriate authorisation from the building owner/landlord to carry out the study.

3.6.2 Site Survey

For each identified building, the contractor must arrange for a full site survey to be carried out by *qualified personnel*. A suitable qualification would be one of the following:

- NICEIC Approved Contractor
- ECA Registered Member

The survey should identify the components to be sub-metered and monitored. The following components should be identified (in common with the Part L Building Regulations):

• Boiler installations/ CHP plant	>50kW
• Chiller installations	>20kW
• Electric humidifiers	>10kW
• Motor control centres (power to fans/ pumps)	>10kW
• Lighting circuits	>50kW
• Final electrical distribution boards	>50kW

The contractor should prepare wiring diagrams and drawings showing the location of each component or circuit, and how the component would be measured. Direct metering only should be considered.

The contractor should determine whether permanent hard-wired metering should be installed, or whether portable sub-metering is more appropriate.

In addition, DECC may wish the contractor to carry out a full Energy Performance Certificate (EPC) assessment to establish a baseline energy efficiency rating for each monitored building. However, this will substantially increase cost (between £2,000 and £10,000 per office building, depending on size and complexity).

3.6.3 Equipment Specification

As a minimum, any metering solution should meet the following criteria (adapted from the Enhanced Capital Allowance Energy Technology Criteria List).

Fixed electricity meters must meet the Class 2 accuracy requirements of one of the following standards:

- BS EN 61036:1997, "Alternating current static watt-hour meters for active energy (classes 1 and 2)".
- BS EN62053-21:2003, "Electricity metering equipment (a.c.) – Particular requirements - Part 21:Static meters for active energy (classes 1 and 2)".
- DD 8431:2005, "Electrical static metering for secondary or sub-metering – Specification" (BSI, ISBN 0 580 451178).

Portable electricity meters should meet the following criteria:

- Measurement accuracy of +/- 3% of meter reading (or better) across the product's entire operating temperature range, for all measurement ranges relevant to the metering of electricity use.
- CE Marking

The contractor should ensure that electricity demand for each component is measured at half-hourly intervals (aligned with fiscal half-hourly meter reading). This will require some form of automated meter reading and data storage. As a minimum, such a system should have the following functionality:

- Automatic collection of metered data at regular intervals and transmission of data to a suitable data processing platform
- User-adjustable collection intervals to enable alignment with fiscal meters.
- Automatic identification of data collection failures, missing data and the failure of communication to any meter or other sensing device
- Delivery of data in standard format for use in other applications (e.g. ASCII, CSV, etc)
- For pulse outputs from meters, the accuracy of integration and transmission should be within 0.5% of the total variable measured.
- Data other than pulse outputs shall be transmitted to the data processing platform with no loss of accuracy.

It is likely that a combination of fixed and portable metering solutions will be required, particularly for more complex office buildings. It may also be possible to fulfil the project requirements via an installed **Building Energy Management System (BEMS)**. Where such a system is to be used, the contractor should confirm that the above accuracy requirements and reporting intervals will be met.

The contractor should provide collated data on a monthly basis for one calendar year. The contractor should also establish a communications route with the monitored building to ensure that any additional components are identified and measured, and any major operational changes in the building recorded.

Whilst DECC should pay for the purchase or lease of the necessary monitoring equipment, ownership should revert to the contractor (or leasing organisation) on conclusion of the project.

For hardwired meters, it may be beneficial for the building being monitored to retain ownership of the meters used. However, there may be legal implications if DECC are seen to be giving capital funding to private, commercial organisations. Except in the case of a pre-existing BEMS, the building owners should be informed that all metering installed for the purposes of the project will be removed at the project's conclusion. Should the organisation wish to retain the metering, then they should discuss this with the successful contractor. The full legal implications of this will need to be reviewed by DECC's legal team.

Contractors should be encouraged to provide innovative solutions to measuring the necessary data, as long as accuracy and reporting requirements can be met.

3.6.4 Estimated Budget

Again, it is difficult to predict a definite budget for this Lot as it will be dependent on the number of buildings measured, their size and complexity. It will also depend on existing metering technology available in the buildings.

We would not anticipate a contractor being able to fulfil the requirements of this Lot for under £10,000 per building. So a minimum budget of £500,000 should be anticipated for this Lot.

3.7 Potential Contractors

A list of potential organisations who may wish to tender for the lots is given in Appendix 6. This list is not intended to be exhaustive and we would recommend that DECC follow the standard OJEC tender procedure.

3.8 Project Timetable

The timetable below give the *latest* dates for the tender process and project start to ensure that physical measurement of peak electricity demand can occur during Winter 2011/12.

We have assumed that DECC will go through the standard OJEC procurement process.

- Call for Expressions of Interest: Week commencing 22nd November 2010
- EOIs returned: 23rd December 2010
- EOI evaluation meeting: Week commencing 10th January 2011
- Invitations to Tender sent: Week commencing 17th January 2011
- Tenders returned: 18th February 2011
- Tender evaluation meeting: Week commencing 21st February 2011
- Interviews: Week commencing 7th March 2011
- Contract award: 17th March 2011
- Project start: 1st April 2011
- Project completion: 31st March 2013

The tender process is illustrated in the Gantt chart below.

Task	Week commencing: 22 November 2010	29 November 2010	06 December 2010	13 December 2010	20 December 2010	27 December 2010	03 January 2011	10 January 2011	17 January 2011	24 January 2011	31 January 2011	07 February 2011	14 February 2011	21 February 2011	28 February 2011	07 March 2011	14 March 2011	21 March 2011	28 March 2011
Call for Expressions of Interest	■																		
Preparation of EOIs	■	■	■	■	■														
EOIs returned (23rd December 2010)					♦														
EOI evaluation meeting								■											
Invitations to Tender sent									■										
Prepation of tenders						Christmas Break			■	■	■	■	■						
Tenders returned (18th February 2011)													♦						
Tender evaluation meeting														■					
Interviews																■			
Contract award (17th March 2011)																	■		
10-day Standstill period																	■	■	■
Project start (1st April 2011)																			♦

The Gantt chart below shows how the different Lots might be developed over the course of the project. Exact timescales will be dependent on contractor tenders.

Task	Months: April 2011	May 2011	June 2011	July 2011	August 2011	September 2011	October 2011	November 2011	December 2011	January 2012	February 2012	March 2012	April 2012	May 2012	June 2012	July 2012	August 2012	September 2012	October 2012	November 2012	December 2012	January 2013	February 2013	March 2013
Lot 1: Database development	■	■	■																					
Lot 1: Ongoing database management				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lot 2: Data acquistion				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lot 3: Identification of buildings	■	■	■																					
Lot 3: Site surveys			■	■	■	■																		
Lot 3: Equipment specification/ ordering						■	■																	
Lot 3: Measurement and monitoring							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Data analysis and reporting																			■	■	■	■	■	■

4 Work Package 3: Best Practice Stakeholder Consultation

4.1 Introduction

This phase of the study aimed to gauge energy managers' experiences of measuring peak electricity demand and measures taken to reduce peak electricity demand; specifically, how much money has been invested in such measures, any savings achieved, and the tariffs they are using. The following sections outline the methods used to collect this information and the resulting findings from our research.

4.2 Questionnaire Design

Working with DECC we produced a questionnaire that aimed to gauge energy managers' experiences of measuring peak electricity demand; specifically, which measures have been implemented, why these were selected, how much money has been invested in the measures, any savings achieved, and the tariffs the organisations are using.

The questionnaire was designed to capture the experiences of those that had been actively reducing peak demand, as well as those that had not. For those who had not, we were interested in hearing reasons for not reducing demand and suggestions for possible incentives to encourage them to do so.

The questionnaire focused on the following areas:

- Measures taken to reduce peak demand, and associated costs and payback periods
- Reasons for undertaking/not undertaking any measures
- Measures considered and not implemented, and for what reasons
- What would encourage greater consideration of peak demand reduction within an organisation
- Experiences of time-of-use tariffs and load management

A copy of the questionnaire can be seen in Appendix 7

Further to those areas listed above, the telephone and face to face interviews sought to delve into the impacts of each measure, specifically focusing on:

- Temperatures
- Humidity
- Indoor air quality (CO_2 levels)
- Reductions in energy consumption and carbon emissions from fuel bills or captured meter readings
- Changes in peak demand
- Details on any unsuccessful measures
- Further information on load management -which type of load is easiest to displace and what time of day is it displaced to?

4.3 Communications

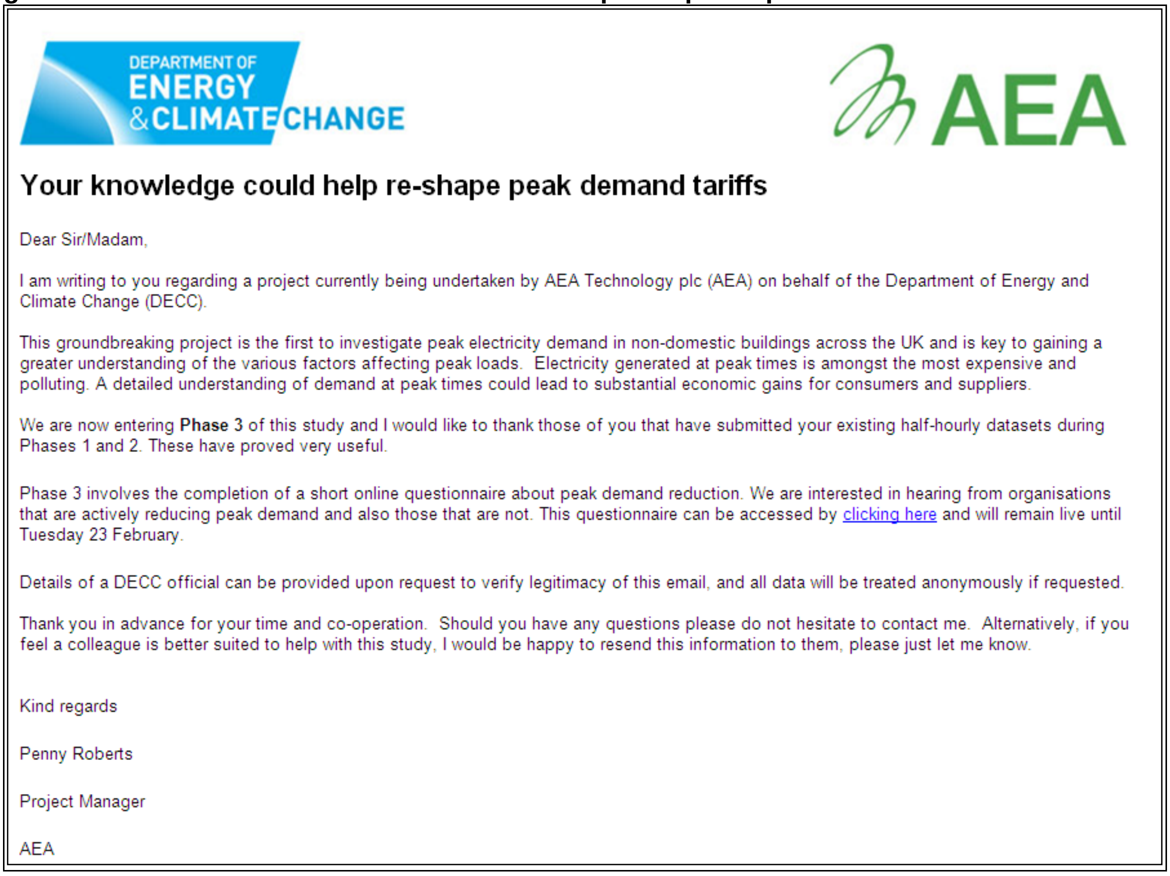
To promote the online questionnaire we adopted a two point communications strategy:

1. Direct email campaign
2. Adverts in relevant e-bulletins

4.3.1 Direct email campaign

To communicate the online questionnaire to the contacts on our internal distribution list we utilised dotMailer, a powerful email marketing platform. dotMailer is a highly intuitive, easy to use email platform which allowed us to produce a professional email using a design that complemented that of the online questionnaire. A screenshot of the email is included below.

Figure 4.1 Screenshot of the email sent which requests participation



DEPARTMENT OF ENERGY & CLIMATE CHANGE

AEA

Your knowledge could help re-shape peak demand tariffs

Dear Sir/Madam,

I am writing to you regarding a project currently being undertaken by AEA Technology plc (AEA) on behalf of the Department of Energy and Climate Change (DECC).

This groundbreaking project is the first to investigate peak electricity demand in non-domestic buildings across the UK and is key to gaining a greater understanding of the various factors affecting peak loads. Electricity generated at peak times is amongst the most expensive and polluting. A detailed understanding of demand at peak times could lead to substantial economic gains for consumers and suppliers.

We are now entering **Phase 3** of this study and I would like to thank those of you that have submitted your existing half-hourly datasets during Phases 1 and 2. These have proved very useful.

Phase 3 involves the completion of a short online questionnaire about peak demand reduction. We are interested in hearing from organisations that are actively reducing peak demand and also those that are not. This questionnaire can be accessed by clicking here and will remain live until Tuesday 23 February.

Details of a DECC official can be provided upon request to verify legitimacy of this email, and all data will be treated anonymously if requested.

Thank you in advance for your time and co-operation. Should you have any questions please do not hesitate to contact me. Alternatively, if you feel a colleague is better suited to help with this study, I would be happy to resend this information to them, please just let me know.

Kind regards

Penny Roberts

Project Manager

AEA

The email was sent from a dedicated DECC Peak Electricity email address, which was set-up on the initiation of the contract. One week after the initial email had been sent a follow-up reminder email was issued to the distribution list to thank those that had already responded and invite further submissions. The following week a third and final email was distributed to announce the extension of the deadline for responses.

dotMailer provides a reporting function that can supply instant and updated feedback on email readership statistics. This allows us to see how many contacts have opened the email and how many have clicked through to the online survey. The following table summarises the results for all three emails and shows that the emails resulted in 58 organisations clicking though to the online questionnaire. Please note that the table lists the number of organisations contacted. In some instances the email was sent to more than one contact within an organisation to maximise the likelihood of receiving a response.

Table 4.1 Break down of Phase 3 email statistics

	Number of organisations contacted	Number of emails opened	Number following link to survey
Initial email	535	136	25
Follow-up email	535	98	20 (5 overlaps)
Deadline extension email	535	107	24 (6 overlaps)

A full list of the organisations contacted, with a breakdown of those viewing the questionnaire and those that provided contact details on the questionnaire are provided in Appendix 5.

4.3.2 Adverts in relevant e-bulletins

To further enhance the response rate to the online questionnaire our Marketing team contacted 14 trade journals and requested that an advert be placed in the next edition of their publication. A list of these journals is provided in the following tables along with a summary of our success in this exercise.

Table 4.2 Trade journal responses to publication requests

Publication title	Response
Edie.net	Press release included on website.
Energy Economist	Unable to reach contact.
Energy Engineering	Initial interest expressed and copy provided for publication.
Energy Management Briefing	No suitable publication within project timescales. Interested in publishing press release of results.
Energy Policy	Following discussion, decided not key target market.
Energy Resource Environmental and Sustainable Management	Initial interest expressed and copy provided for publication.
Energy Risk	Link included on Twitter and LinkedIn pages and text included within news emails.
Engineering & Technology	Initial interest expressed and copy provided for publication.
Energy in Europe	Unable to reach contact.
Utility Week	Copy included on website.
Carbon Finance	Following discussion, decided not key target market and most readers are Europe-wide.
Sustain	Unable to reach contact.
Sustainable Business	No suitable publication within project timescales.
Sustainable FM	Unable to reach contact.

Figure 4.2 Screenshot of project publicity by Edie.net

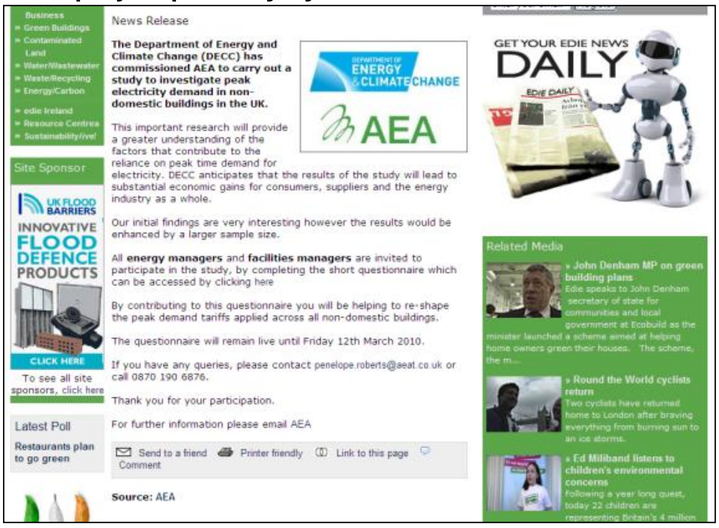


Figure 4.3 Screenshot of project publicity by Utility Week

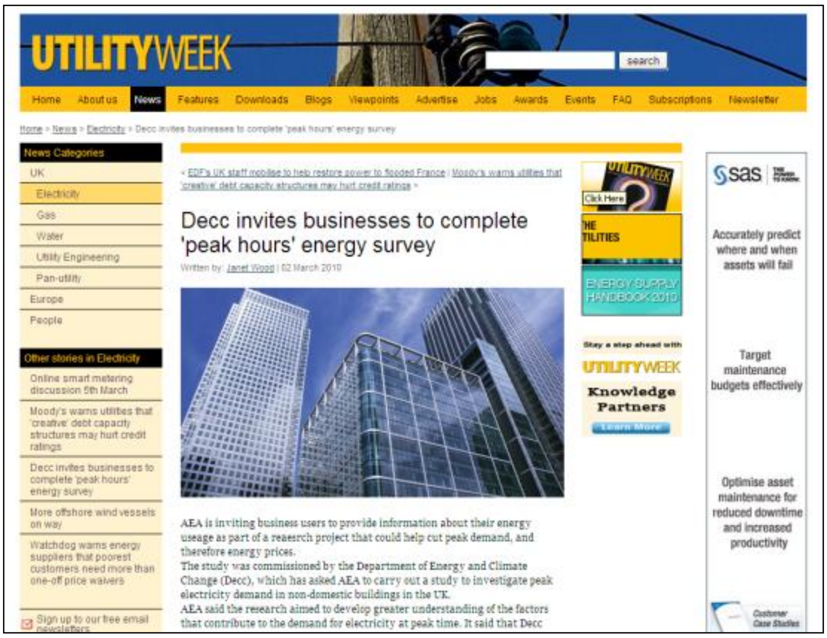
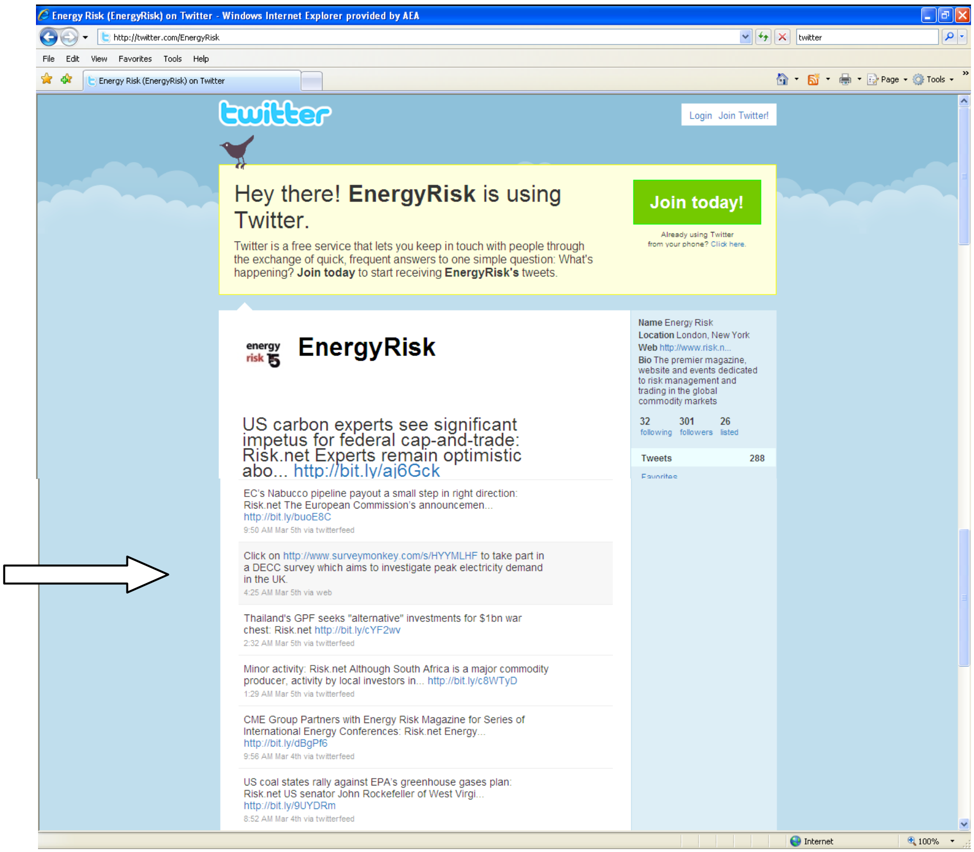


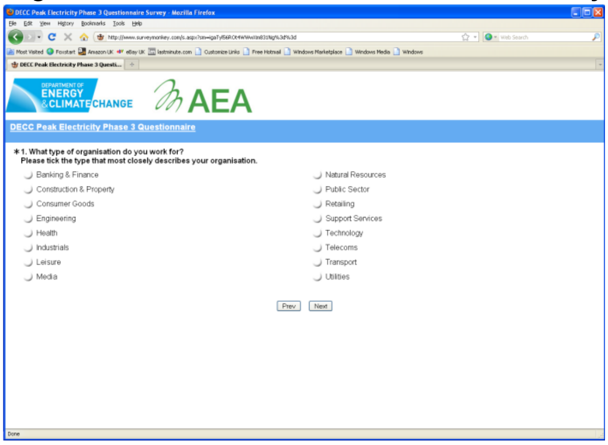
Figure 4.4 Screenshot of project publicity by Energy Risk



4.4 Data collection and analysis

4.4.1 Online survey

Figure 4.5 Screenshot of Phase 3 online survey



To make the questionnaire available online we utilised Survey Monkey, an online survey platform. The interface allowed users to progress through the survey with ease. Where appropriate, options were provided for participants to select, thus allowing fast quantitative analysis of the results.

Some questions were categorised as essential for completion and participants were not allowed to progress through the survey unless they entered an answer. A number of more open questions were asked to collect more qualitative responses.

4.4.2 Telephone and face-to-face interviews

Further to the questionnaire responses received online, we contacted 13 organisations directly to conduct more in-depth interviews via telephone and face to face. The organisations that were available and willing to participate are listed in the following table.

Table 4.3 Participants of further in-depth Phase 3 research

Organisation name	Interview format
O2	Telephone
Scottish Water	Telephone
Great Ormond Street Hospital	Telephone
Marshalls	Telephone
BAA	Telephone
Fife Council	Face to face

A similar questionnaire was used for the interviews however some areas were investigated in greater detail, such as project successes.

4.4.3 Analysis

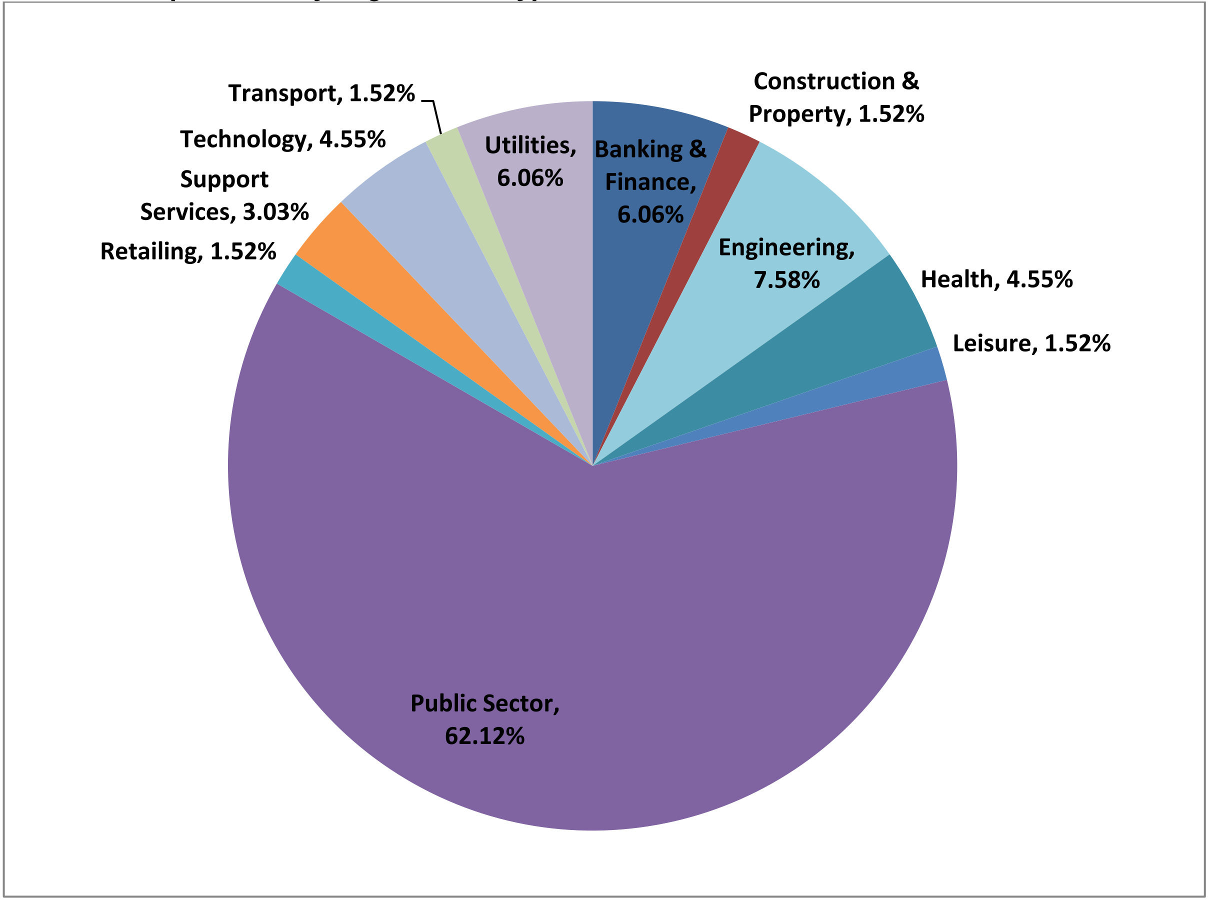
The online survey responses were downloaded from Survey Monkey into an Excel worksheet. Quantitative analysis techniques were then utilised to draw out trends and produce charts of the key findings. These findings were then supplemented by qualitative analysis of the open questions. The findings are presented in the following section.

4.5 Results

4.5.1 Survey sample

A total of 66 responses were received through the online survey. Two thirds of these were from public sector organisations. The remaining organisations fell within a variety of sectors, as shown in Chart 4.1 below.

Chart 4.1 Respondents by Organisation type



4.5.2 Building type

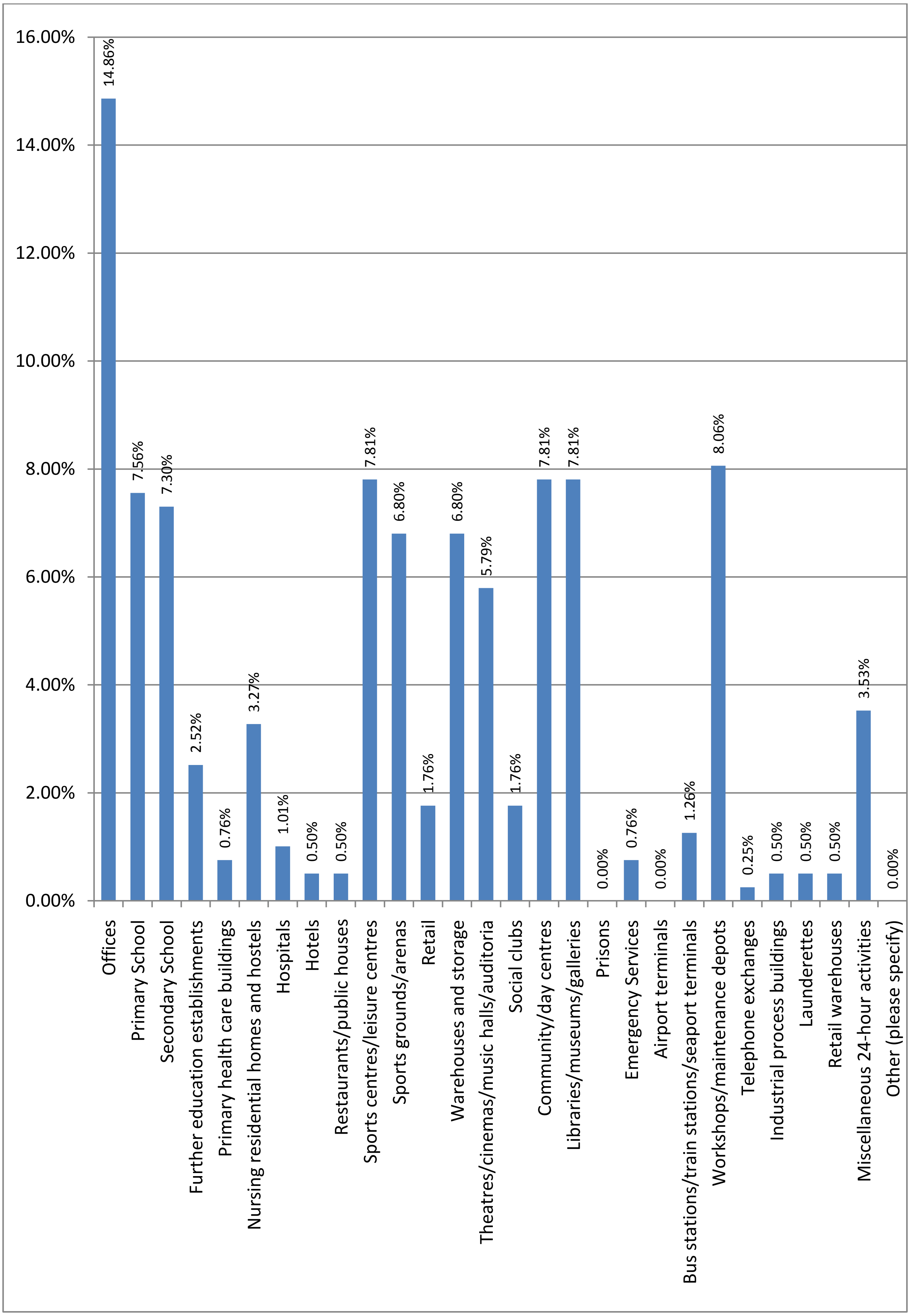
18% of respondents to the online survey listed one type of building in response to the question "What type of non-domestic buildings does your organisation use?" Two organisations did not specify any building type. Both of these organisations categorised themselves as Utilities. The remaining organisations listed between two and 15 types of building each. The non-public sector organisations tended to list fewer numbers of buildings, demonstrating the breadth of the public sector property portfolio. This is shown in Table 4.4.

Table 4.4 No. of buildings correlated with organisation type

0	Utilities	3	Public Sector	9	Public Sector
0	Utilities	3	Retailing	9	Public Sector
1	Banking & Finance	3	Support Services	9	Public Sector
1	Banking & Finance	4	Health	9	Public Sector
1	Banking & Finance	4	Public Sector	9	Public Sector
1	Banking & Finance	4	Public Sector	9	Public Sector
1	Engineering	4	Public Sector	10	Public Sector
1	Health	4	Public Sector	10	Public Sector
1	Public Sector	4	Utilities	10	Public Sector
1	Support Services	5	Engineering	10	Public Sector
1	Technology	6	Public Sector	10	Public Sector
1	Technology	7	Public Sector	10	Public Sector
1	Transport	7	Public Sector	11	Public Sector
1	Utilities	7	Public Sector	11	Public Sector
2	Engineering	8	Public Sector	12	Leisure
2	Engineering	8	Public Sector	12	Public Sector
2	Public Sector	8	Public Sector	13	Public Sector
2	Public Sector	8	Public Sector	13	Public Sector
2	Technology	8	Public Sector	13	Public Sector
3	Engineering	8	Public Sector	13	Public Sector
3	Health	8	Public Sector	14	Public Sector
3	Public Sector	9	Construction & Property	15	Public Sector

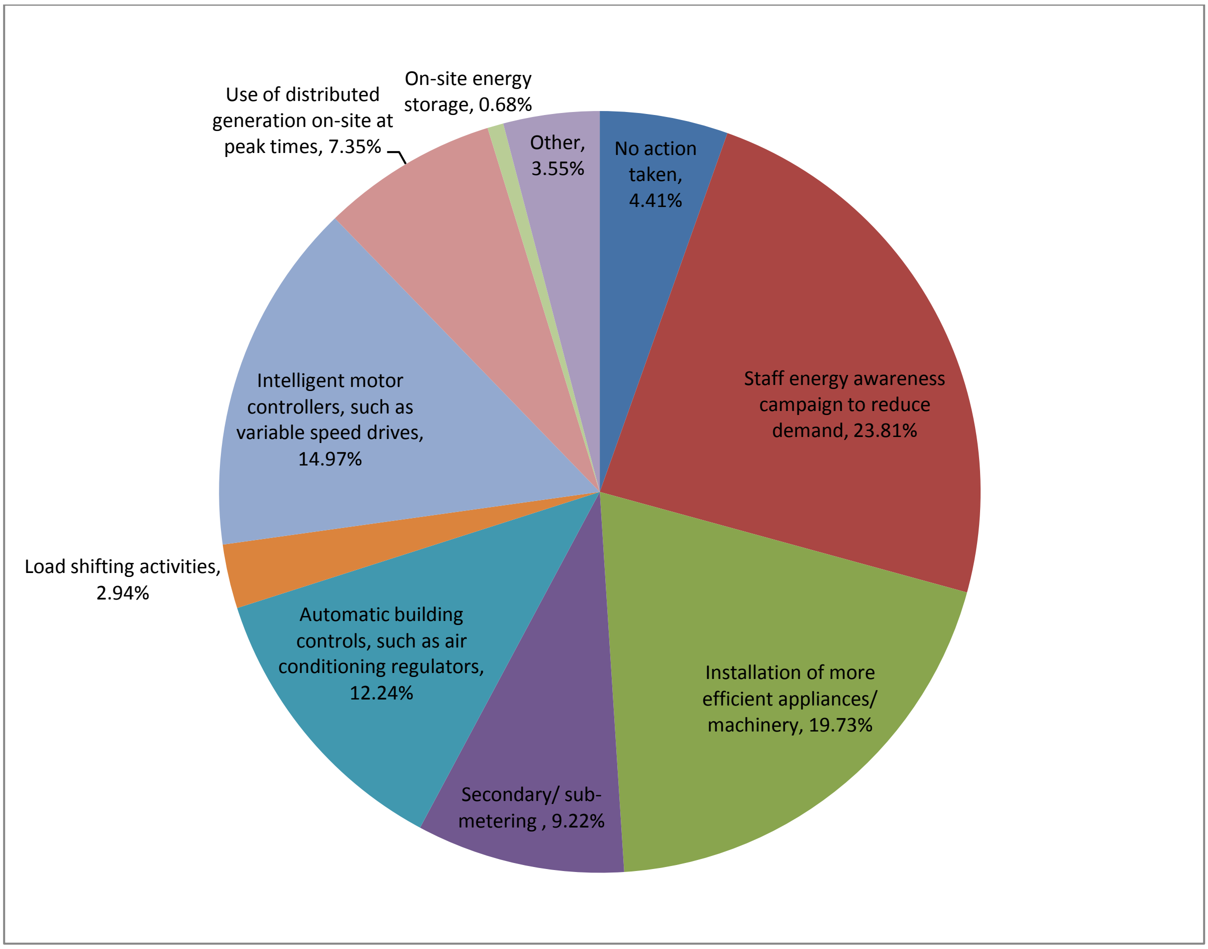
The overall distribution of building types can be seen in Chart 4.2.

Chart 4.2 Break down of respondents by building type



4.5.3 Peak demand reduction measures

Chart 4.3 Peak demand reduction measures



The most popular measures that the online survey participants have implemented are staff awareness campaigns, installation of more efficient appliances (including lighting), installation of intelligent motor controls (such as variable speed drives) and automatic building controls. Within the 'other' category, three organisations cited voltage optimisation. Six organisations stated that no action had been taken to reduce peak demand. 19 others did not list any measures but did not specifically state that no action had been taken. Interestingly, one of our telephone interviewees stated they did not have any implemented measures as such, as reducing demand is business as usual so not a dedicated project.

Of those that did list measures, most listed more than one, as shown in 4.5.

Table 4.5 Number of measures implemented by each organisation

No. of measures	No of organisations
0	27
1	2
2	9
3	10
4	9
5	3
6	4
7	2
Total	66

4.5.4 Costs of measures implemented

Table 4.6 Implemented measures and cumulative implementation costs

Staff Awareness Campaign	Efficient Appliances	Sub-metering	Automatic building controls	Load shifting	Intelligent motors	Distributed generation	Other	Cumulative cost
■								Less than £50K
■			■					Less than £50K
■	■							Less than £50K
■	■							Less than £50K
■	■							Less than £50K
	■		■		■			Less than £50K
■	■		■		■			Less than £50K
■	■	■			■			Less than £50K
							■	£50 - 100K
	■				■			£50 - 100K
■	■		■					£50 - 100K
■	■		■		■	■		£50 - 100K
■	■							£100 - 250K
■							■	£100 - 250K
■							■	£100 - 250K
■	■				■			£100 - 250K
■	■	■						£100 - 250K
■	■					■	■	£100 - 250K
■	■	■			■			£100 - 250K
	■	■			■	■		£100 - 250K
■	■	■	■	■	■			£100 - 250K
■	■	■	■		■	■		£100 - 250K
■				■				£250 - 500K
■			■		■			£250 - 500K
■	■		■		■			£250 - 500K
■	■	■			■			£250 - 500K
■	■	■	■		■			£250 - 500K
■	■	■	■		■	■		£250 - 500K
■	■	■	■	■	■	■		£250 - 500K
■	■	■	■		■		■	£250 - 500K
■	■		■		■			£500K – 1million
■	■				■	■		£500K – 1million
■	■	■			■	■		£500K – 1million
■			■			■		More than £1million
■			■			■		More than £1million
■	■					■		No costs
■	■				■			
■			■				■	
■	■	■	■	■	■			

As respondents were asked to provide an overall cost figure for all measure, in most cases it is not possible to break this down to review the costs of the individual measures. It is possible, however to look for patterns, as shown in Table 4.6. For example, sub-metering, load shifting and distributed generation occur most frequently in those organisations citing larger levels of financial investment.

Six organisations provided a breakdown of the level of spend on each measure. This is provided in Table 4.7 and shows that the level of spend varies greatly between organisations, even for the same peak demand reduction measures. For example, one organisation invested £20,000 in building controls and another (which listed more types of building within its portfolio) claims to have spent £100,000/annum on the same measure. Similarly investment in staff awareness campaigns and motor controls varies.

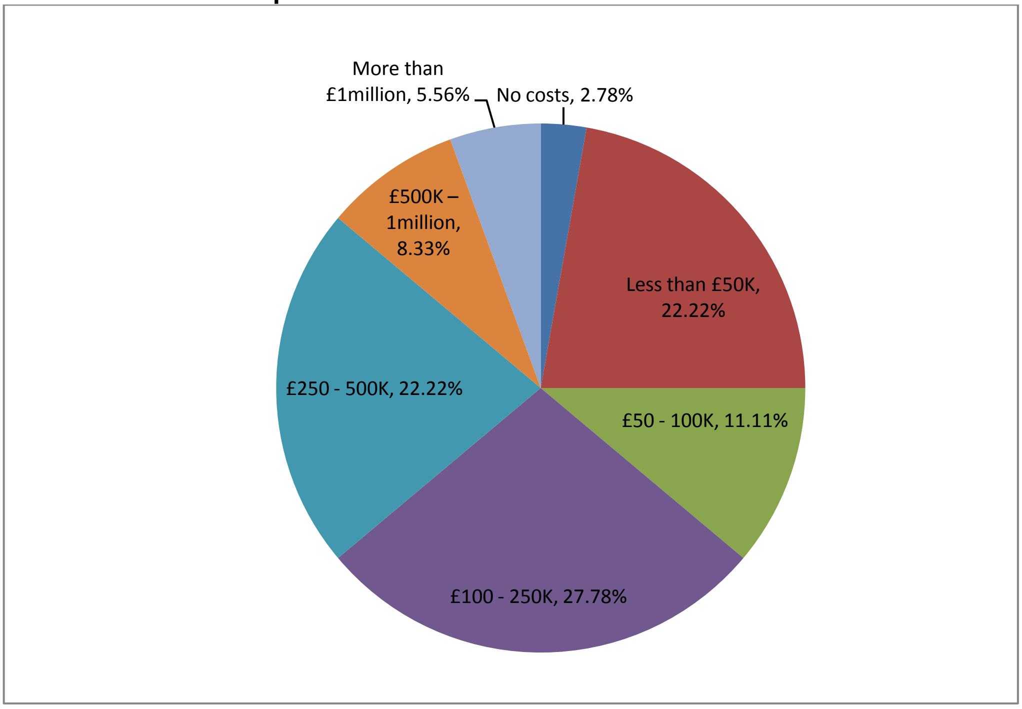
The organisation that stated it had not incurred any costs for the three measures that it implemented received funding from a DECC capital grant. Three other organisations were unable to provide cost data. One organisation stated that this was because the projects had taken place over a number of years. Another stated that most of the measures were part of a wider refurbishment scheme.

Table 4.7 Cost breakdown for peak demand reduction measures

	Measure	**Cost**
Organisation 1 (Public sector, 7 building types)	Staff awareness	£100 (most materials were available free of charge)
	Lighting upgrade	£10,000
Organisation 2 (Public sector, 9 building types)	Energy efficient appliances/ machinery	£150,000
	Sub-metering	£25,000
	Building controls	£20,000
	Pre-cooling	£0k (built this into air handling via the Trend BMS)
	Intelligent variable speed drives	£0k (built into Plant contract)
Organisation 3 (Public sector, 13 building types)	Staff Awareness	£50,000
	Building Controls	Approx £100,000/annum
	Motor Controls	£90,000
Organisation 4 (Public sector, 3 building types)	Voltage optimisation	£100,000
Organisation 5 (Public sector, 8 building types)	Staff energy awareness	£2,000
	Installation of energy efficient technologies	£150,000
	Variable speed drives	£197,000
	CHP	£250,000

The sixth organisation provided a complete breakdown of all activities, which can be viewed in Appendix 8. It is a public sector organisation and has nine types of building. The overall level of investment across the responding organisations is as shown in Chart 4.4.

Chart 4.4 Cumulative cost of peak demand reduction measures



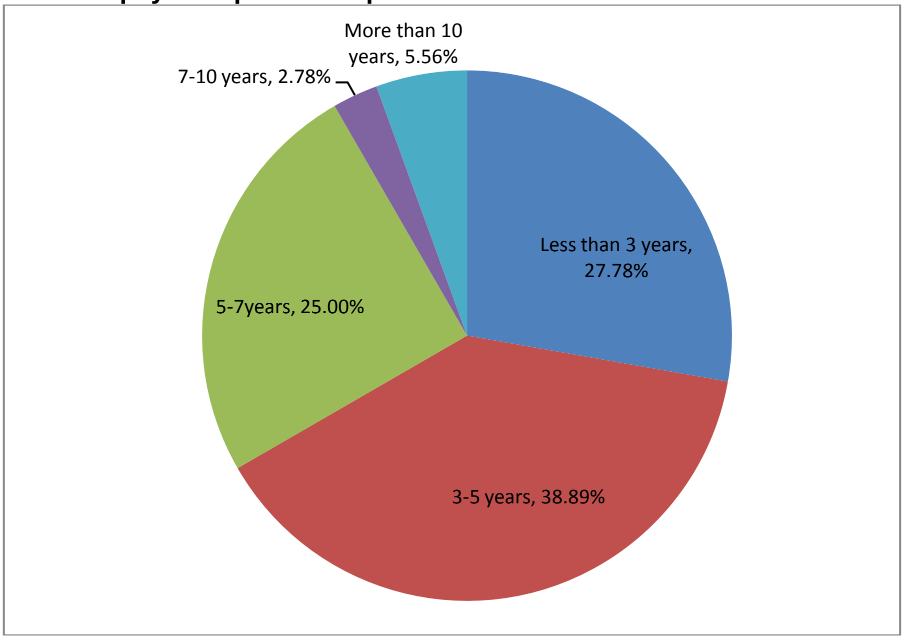
4.5.5 Payback period

As shown in Chart 4.5, the largest grouping of respondents stated that the measures they implemented had a cumulative payback period of 3-5 years. Nearly equal numbers of respondents gave payback periods of less than 3 years, and 5-7 years.

It is not possible to establish average payback periods per measure, as only two respondents were able to give this information. However, a pattern can be seen when looking at payback periods together with measures implemented. For example, the two respondents who selected a payback period of more than 10 years had installed measures for the use of distributed generation on-site at peak times, such as on-site generators, CHP, waste heat or other renewable energy generation.

One of our telephone interviewees stated that payback periods are the deciding factor in whether or not to implement a measure – any project with a payback period of more than 4 years is automatically ruled out.

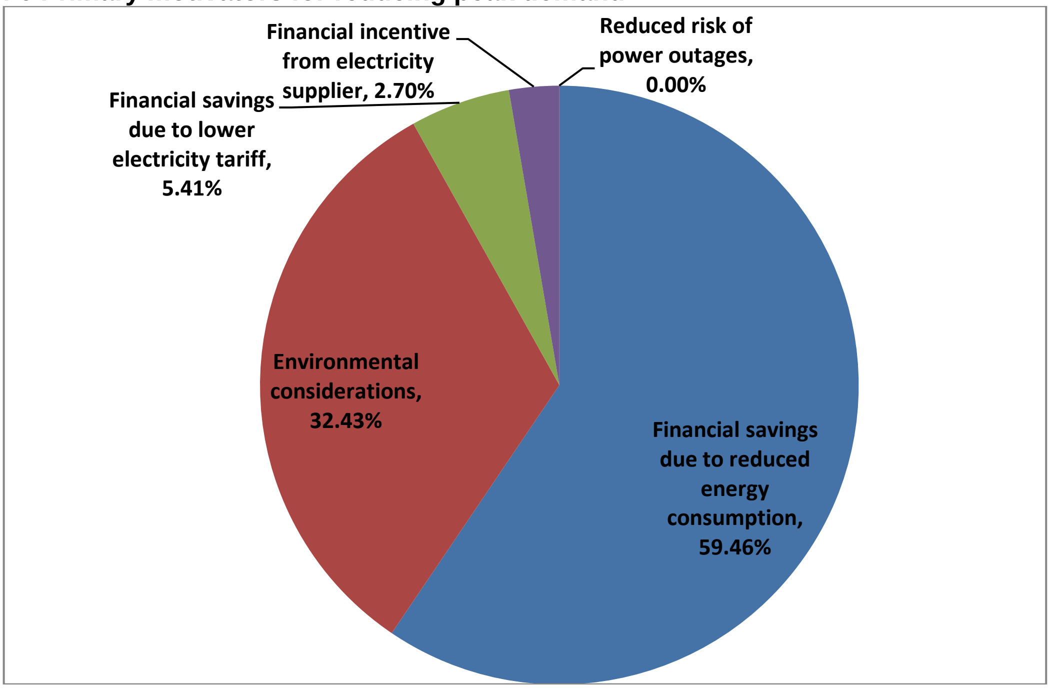
Chart 4.5 Cumulative payback period for peak demand reduction measures



4.5.6 Motivations

As expected, and as shown in Chart 4.6, more than half of responding organisations cited ‘financial savings due to reduced energy consumption’ as the main reason for their implementation of peak demand reduction measures. A further third cited ‘environmental considerations’ as their main motivator. None of the organisations cited ‘reduced risk of power outages’ as their top reason for reducing peak demand. The one organisation that listed ‘financial incentive from electricity supplier’ as its main incentive was an Engineering company. The other two Engineering companies listed ‘environmental considerations’ as their incentive. These were the only two non-Public Sector organisations to select this option.

Chart 4.6 Primary motivators for reducing peak demand



4.5.7 Experiences of implementing peak demand reduction measures

The general feedback regarding staff awareness campaigns is that these achieved an initial reduction in energy consumption however this reduced over time and was difficult to maintain. In terms of the automatic building controls, one respondent confirmed that the outcome of the installation had been successful. A second participant stated that installing their Building Energy Management System (BEMS) had posed technical challenges due to the multiple inter-connected processes and settings that needed to be correctly identified.

With regards to variable speed drives (VSDs), one respondent reported that changing to VSDs was expensive. Another stated: “In the first phase of this project pump motors and air handling units (AHU's) of over 7.5kW had inverters installed. Following this we installed inverters on the remaining AHU's and pumps. This was a relatively straightforward project as our leisure centre operates 365 days a year for 16 hrs a day. Energy savings exceeded both our and the contractors’ expectations and payback was achieved in under 18 months. There were some problems in identifying the correct settings, particularly around the AHU's in the main swimming pool and ice rink. These were easily resolved and now the VSD's have been connected to the BEMS to enable greater CO_2 and energy savings.”

Three respondents referred to funding streams used to fund their projects: two utilised SALIX funding and one the DECC capital grants scheme. Feedback from two of the respondents on these schemes criticised the strict criteria, claiming that it limited the measures that could be undertaken, the timescales and the potential suppliers that could be used.

One individual that had installed voltage optimisation technology reported a £25,000 and 150t CO_2 saving in the first year. One telephone interviewee stated that although they had installed measures, in some areas they had less influence due to rental agreements.

More generic experiences include difficulty with long payback periods and difficulty in collecting data and analysing it to assess successes.

4.5.8 Measures considered but not implemented

Chart 4.7 Measures considered but not implemented

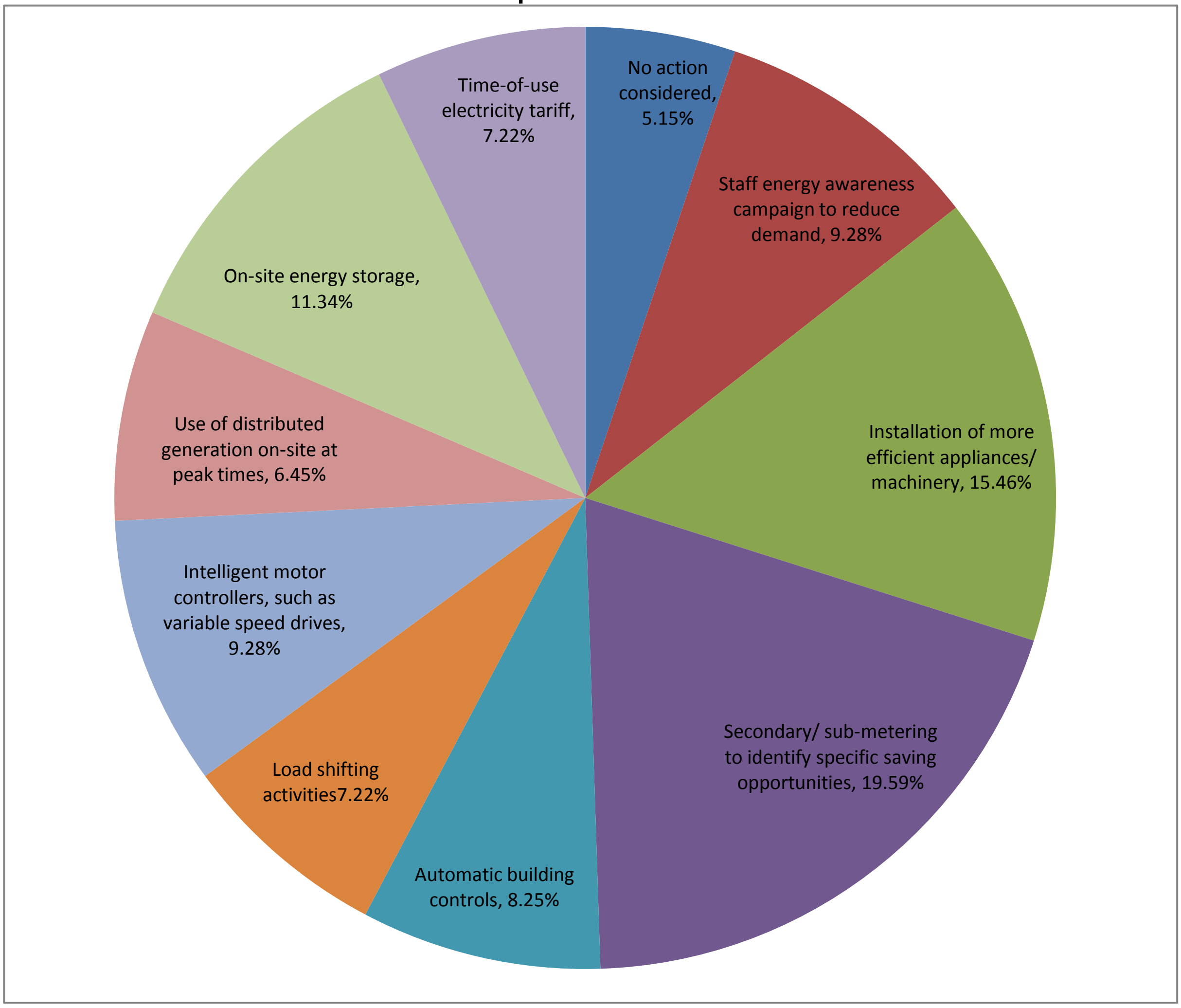


Chart 4.7 highlights the measures which were considered by respondents, but not implemented. The measure considered, but not implemented, by the largest number of respondents was secondary/sub-metering. This was followed closely by installation of more efficient appliances/machinery. Chart 4.8 highlights reasons for non-implementation.

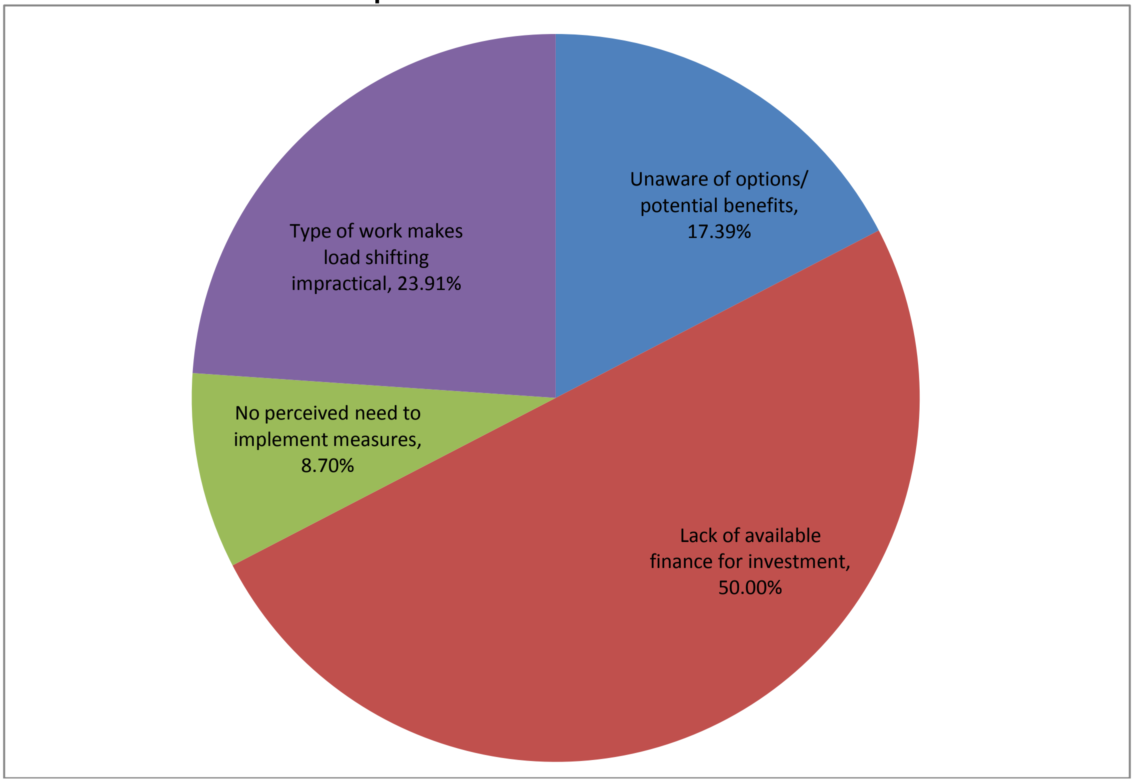
4.5.9 Reasons for non-implementation

Lack of available finance was cited by half of the responding organisations as a reason for not implementing some measures. A further 24% of participants claimed that the type of work that they do makes load shifting impractical. 17% were unaware of the options/potential benefits of implementing peak demand reduction measures. Other reasons given included a lack of knowledge and resources to implement measures, and no clear information on financial payback/ long payback periods.

One respondent stated: “As we are one of several tenants served by a single half hour meter (although the largest user) we could not easily agree to reduce the availability for the whole site. Hence there is no financial incentive to reduce maximum demand.”

The results are presented in Chart 4.8

Chart 4.8 Reasons for non-implementation



4.5.10 What would encourage greater consideration of peak demand reduction?

24 respondents listed financial considerations as sources of encouragement. This included greater financial rewards (either through cost savings or incentive payments) for reducing peak demand, higher electricity costs and time of day pricing and signals, shorter payback periods for measures, easier access to financial support schemes, and cost penalties for not reducing peak demand. One respondent suggested using procurement frameworks to make purchases easier. Another proposed that small scale shedable load equipment be made more widely available and that organisations receive remuneration for having it and making it available to the generators. A notable aspect of responses is the absence of drivers that are sometimes given for energy management, such as security of supply as an issue, or business continuity

Other factors that would encourage greater consideration included increasing awareness of potential measures and the benefits of reducing peak demand in order to raise awareness. One respondent suggested that technology demonstrations and case studies about different building types would be useful. And, although it does not specifically encourage the reduction of demand during peak periods, three organisations listed the Carbon Reduction Commitment Energy Efficiency Scheme (CRC) as encouragement. Two further organisations would be spurred on if they had better metering.

4.5.11 Scope to change behaviour/ work patterns

The majority of respondents stated that there is limited, or no, scope to change work patterns. Chart 4.1 showed that the majority (67.8%) of people who responded were from the public sector. It is feasible, considering the nature of the premises owned by the public sector (for example, schools), that there is no scope to change work patterns, as opening and closing times are fixed. There is, however, some scope for behavioural change. Two public sector respondents highlighted this potential, through switching off appliances (for example lights) at lunchtime, and staggering lunch breaks.

Likewise within the private sector, there seemed to be more potential for behavioural change rather than a change in working patterns. For example, a respondent from the Banking & Finance sector stated that there is potential for behavioural change within their organisation, providing it did not disrupt business activities. A respondent from the Utilities sector felt there is scope for behavioural change, but raised concerns over the long payback periods associated with this type of change. However, one of our telephone interviewees from the private sector did outline work that had already been carried out to change working patterns, through the closure of one of their building during the winter months, which resulted in substantial savings.

4.5.12 Time of use tariffs

43% of organisations could report that they use time-of-use (TOU) tariffs. 43% also reported that they did not use TOU tariffs and the remaining 14% of organisations did not know one way or the other. Of those that do you use TOU tariffs, only two believed that these result in behaviour change/changed energy usage patterns. Both of these organisations utilise load management to respond to their TOU tariffs. Interestingly one other organisation reports using on-site generation to respond to its TOU tariff, however this organisation did not believe that the TOU tariff resulted in changed energy usage patterns. Of these three organisations, one uses fully automatic load management, another partially automated and the third manual load management.

Only two of the organisations reported receiving any information/advice from their utility companies regarding TOU tariffs or load management. One participant listed this information as usage profiles and information about ways to reduce peak loads. The remaining respondents either stated that they have never received this type of information (31 organisations) or did not respond to the question.
Those organisations that do not use TOU tariffs were asked what impact they thought such a tariff would have on energy use within their organisations. Six organisations stated that they did not know due to a lack of knowledge about TOU tariffs. Two organisations believed it would be difficult to use TOU tariffs within their organisations, with one stating that the service nature of their business (e.g. schools and youth centres) made it hard to change working practises.

One organisation stated: “The impact would depend upon the scale of the difference in charges at varying times. Any change would take a long time to have an impact due to the need to learn what we can do to reduce the cost and then implement changes.”

Three others recognised that a TOU tariff could reduce their energy consumption. One organisation stated that it would assist in building a business case to justify implementation of peak demand reduction measures. Another claimed that it could prompt investment in an air conditioning controller.

5 Conclusions and Recommendations from the Scoping Study

The following conclusions and recommendations have been noted throughout the duration of this scoping study:

- Half hourly consumption and building background data are difficult to obtain. As such, increased participation in the scoping study would have been beneficial and further consideration should be given to a larger public SQL database in order to obtain data for future projects. Consideration should be given to providing incentives to energy managers and mandatory enforcements of energy suppliers to ensure future data supply.

- Licence obligations on Suppliers to provide data (aggregated and made anonymous to protect consumer concerns (if any)) should be considered as a potential future method for improving data capture.

- Similarly, additional data provision requirements could be placed on customers in the CRC as the majority of sites will be HH metered; some existing sub-metering will exist in addition to new installations as a result of the CRC.

- Placing impositions on the public sector may also improve data collection for example using the Office of Central and Local Government to provide data

- Any enforcement or provision of incentives to encourage data provision should be supported by engagement of trade associations e.g. CBI; FSB

- Of the datasets that were collected for the purposes of this study, although consumption was often high or rising during the two peak times of 6am – 9am (Peak1) and 5pm – 8pm (Peak2), is was very unusual for the peak load of an organisation to occur during the specified peak times.

- There may be seasonal potential to reduce peak demand. Data analysis showed that for many participants the total energy use drops in the summer months, however consumption for two of the highest energy users (both offices) remains relatively constant throughout the year. This suggests that there may be an opportunity to reduce energy demand at peak times to coincide with seasonal changes e.g. reducing artificial lighting levels during summer months. However, regardless of how energy is used and at what time of year, Peak1 and Peak2 consistently remain at the specified ‘windows’, so any potential means of tackling peaks must address these. It is possible that tariffs could be structured to reflect this pattern also.

- Based on the above, it may be beneficial to target organisations with electric heating and summer mechanical ventilation/ cooling for the field trial.

- For the data gathered on industrial consumers, there are no indications that peaks occur necessarily during either Peak1 or Peak2. Responding to productivity needs or business needs rather than set schedules, industrial examples’ peaks could affect either peak and measures to avoid this should be considered in this context.

- Leisure centres are most likely experience peak demand during Peak2. However, because of the sample size further data collection is recommended before it these trends can be deemed as representative of the sectors.

- For the field trial it would be beneficial to involve stakeholders (especially metering installers, data collectors and energy suppliers) from the start of the project. As such, a consortium approach should be recommended to ensure the best results

- It is possible that a single Consortium of different parties will be able to provide sufficient coverage of the sample sizes. Consideration could be given to letting more than one tender, however, the data from each would need to be collated into a common form for DECC analysis.

- The suggested tender approach for a call for data provision would seem to have a lot of merits. AEA suggests that any tender:
  1. Has strict targets for data acquisition – in accordance with prescribed sample sizes
  2. Is enduring (5 years + rolling) to ensure developments are tracked
  3. Follows defined presentation and analysis formats (as progressed by AEA in this project)
  4. Provides a clear basis for any "sub-metering" loads – distinct components; HH; class accuracy
  5. Doesn't allow charging for any public sector data

- Phase 3 highlights that knowledge and education of peak demand is an issue and by investing in subject education, it may be possible to influence discretionary demand at peak times.

- Financial incentives and penalties were found to be the most effective drivers for influencing change, therefore greater implementation of 'Time of Use' tariffs would potentially reduce peak demand. This is supported by comments that 'Time of Use' tariffs would encourage greater uptake of demand reduction measures and technological investment. However, if any changes are implemented in this area, it will be essential to support these changes through user education.

- Financial implications were also the main reason for not currently reducing peak demand. Therefore, it is important that before any changes to 'Time of Use' tariffs are enforced, that non-domestic organisations are given the appropriate financial support through funding, grants and greater accessibility of technology to allow them to be able to respond to their full potential

- Of the study respondents, very few considered shifting any demand during Peak1 and Peak2 to be a practical possibility. Therefore, it is recommended that the field trial investigates a selection of case studies from the types of organisation who did not think it would be possible to shift demand to confirm that no demand is discretionary.

- Whilst communicating the results of the scoping study to participants, it may be worth while trying to ascertain if they would be interested in participating in the field trial.

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