Department for
Business, Energy
& Industrial Strategy

SMART METERING NON-DOMESTIC 'EARLY LEARNING'

Annex 2: Cluster 2 - Small Public Sector Sites (Schools)

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School House, Norbury
Bishops Castle
Shropshire SY9 5EA
Phone: 020 8567 6974
www.creativeresearch.co.uk

Chiswick Gate
598-608 Chiswick High Road
London W4 5RT
Phone: 020 8742 2211
www.accent-mr.com/

Author: Ros Payne, Creative Research

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The views expressed in this report are those of the authors, not necessarily those of the Department for Business, Energy & Industrial Strategy (nor do they reflect Government policy).

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Introduction

This is one of seven cluster specific annexes which, together with the main report and the technical report, sets out the findings and conclusions from research designed to provide 'early learning' in relation to the installation and use of smart meters in non-domestic premises[1]. This annex focuses on Cluster 2 - a sample of small public sector sites (schools).

Background

Smart Meters are the next generation of gas and electricity meters. They offer a range of intelligent functions and provide consumers with more accurate information, bringing an end to estimated billing. Consumers should have access to near-real time information on their energy consumption to help them control and manage their energy use, save money and reduce emissions.

The Government mandate technically defines a smart meter as one that is compliant with the Smart Meter Equipment Technical Specification (SMETS) and has a specified range of functions including being able to transmit meter readings to suppliers and receive data remotely. Energy suppliers are required to take all reasonable steps to install smart meters in domestic and smaller non-domestic sites by the end of 2020. The exception to this is in smaller non-domestic sites where advanced meters may remain in place for their lifetime if they were installed before October 2017 for larger suppliers and February 2018 for smaller suppliers.

As a minimum, an advanced meter can store half-hourly electricity and hourly gas data, to which the customer can have timely access and to which the supplier can have remote access. The vast majority of meters installed at sites included in this research were likely to be 'advanced meters' rather than SMETS compliant meters, as at the time the roll-out was still at an early stage and the majority of meters being installed in affected sites were still 'advanced meters'. These meters would have had some, but not all, of the additional functions found in a smart meter that meets the Government's technical specification. For ease of reference, the term 'smart meter' is used to refer to both 'advanced' and SMETS compliant meters in this report unless otherwise specified.

The non-domestic roll-out will cover around two million sites. These sites are very varied; they include private and public sector organisations, and range from small shops to chain stores, from small industrial units to schools.

[1] A list of the full set of reports is provided in the appendices; see List of Reports, p43

Aims and Objectives

The aim of this work was to improve the evidence base on how and why smart meter data is or is not being used for energy management in relation to non-domestic sites, as well as the pathways, enablers and barriers to energy saving using such data.

The objectives of the research were specifically to;

explore how 'smaller non-domestic sites' use energy and make energy related decisions

understand the ways in which smart meter data is being used for energy management in relation to 'smaller non-domestic sites', as well as the current types of benefits being realised

develop an understanding of the (actual or potential) pathways, enablers and barriers to energy saving in smaller non-domestic sites using smart meter data; and what further action may be required to maximise benefits.

Method[2]

In summary, 107 organisations took part in the research. The research involved 41 case studies of sites, the majority of which had smart meters installed. The aim was to include only organisations that had had smart meters (advanced or SMETS compliant) installed and to provide breadth in terms of geography, organisational size and cluster, tenure, energy use and experiences of using information from advanced or smart meters. There is further detail on sampling below and in the Technical Report.

Each case study consisted of a site visit and one or more interviews with key individuals from, or associated with, the organisation to which the site belonged. In addition 91 organisations took part in a telephone interview to add breadth to the findings (25 of these also took part as a case study).[3]

A typology of nine clusters was developed before the start of this research and this guided the case study selection. This was based on nine broad clusters of sites which are defined with respect to a number of key characteristics – those most important characteristics which help to differentiate the clusters are: public vs. private sector; relative energy intensity; independent vs. multi-site organisation; whether or not customer facing.

In designing the case studies, some clusters were grouped together where the similarities were greater than the differences (e.g. low and high energy consuming, small customer facing independents). In addition, two clusters (e.g. lower energy consuming, employee only, limited use sites, such as warehouses, and non-buildings, such as phone masts)

[2] A fuller description of the research methodology can be found in the Technical Report.
[3] A further interview was conducted with an energy consultant employed by a landlord whose portfolio included ports, airports, shopping/retail malls, offices, retail and studios. The interview focused on a site that provided private sector businesses with professional office-based services. The aim had been to arrange a case study visit with one or more of the tenants but this proved impossible within the timeframes of the research.

were excluded entirely based on a combination of assumed low prevalence within the actual non-domestic population and practical considerations about ease of access, given time and budget constraints.

The research was conducted in two stages; this allowed the methodology to be refined after Stage 1 to reflect lessons learned. The phasing also helped with practical constraints around resourcing and recruitment, for example those clusters that were more difficult to recruit were covered in Stage 2 of the research. The two stages of research are illustrated in **Figure 1**.

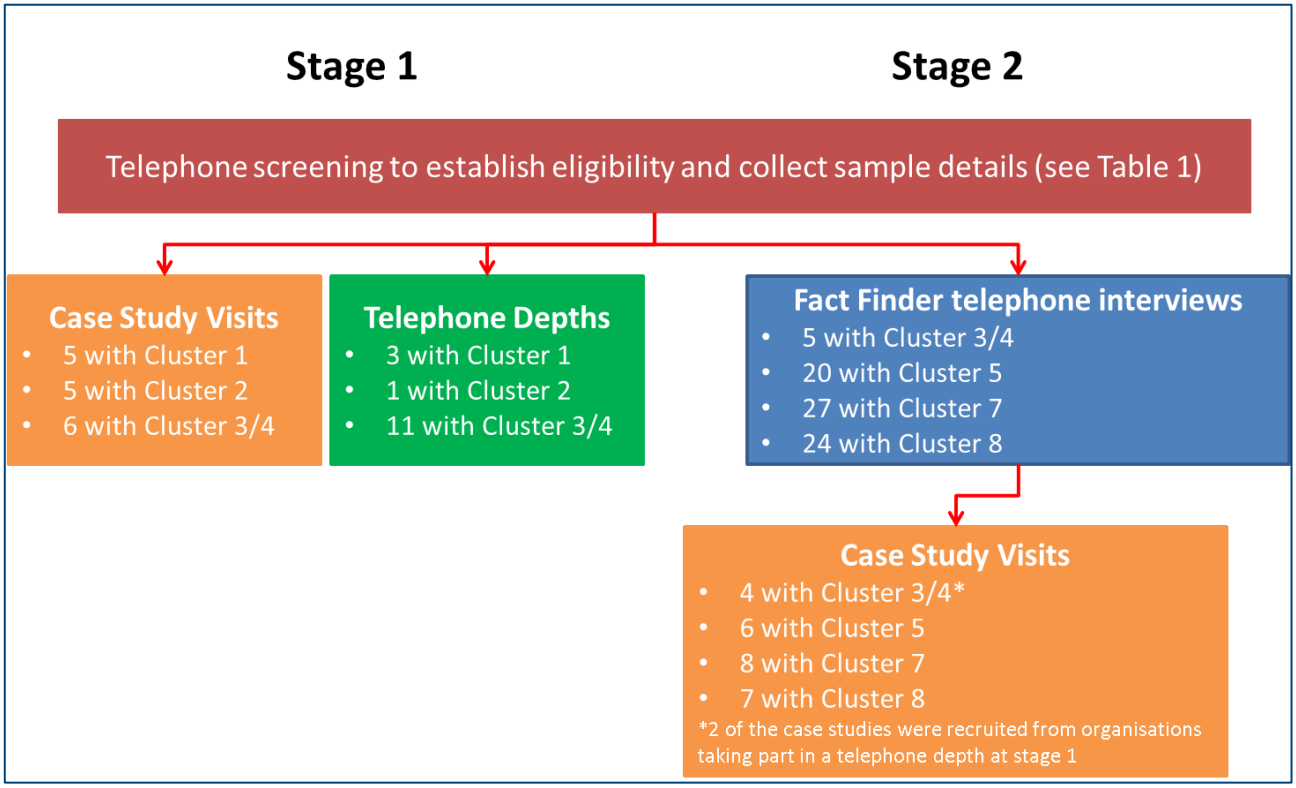


Figure 1: Flow chart of research method

Stage 1 comprised:

initial **telephone screening** with decision-makers for an organisation's use of energy to establish their eligibility and collect basic sample details.

case studies with clusters 1, 2 and 3/4. Each case study involved a visit to the case study site during which observations and interviews were carried out with a mix of internal and external actors. Internal actors included decision makers, implementers of energy management decisions, and users of energy. External actors included landlords, managing agents and energy consultants. These interviews lasted between half and two hours.

15 telephone **depth interviews** of 1 hour duration were conducted with energy decision makers from additional organisations spread across clusters 1, 2 and 3/4[4]. These interviews were conducted to provide additional information to support the case studies.

Stage 2 comprised:

- initial **telephone screening** with decision-makers.
- 76 **fact finder interviews** with decision-makers spread across clusters 3/4, 5, 7 and 8[5], including some landlords; this involved a 30-40 minute telephone interview to gather factual information from a wider sample to add breadth to the findings, and to recruit sites for the case study stage.
- **case studies** with clusters 3/4, 5, 7 and 8.

The main difference between Stage 1 and Stage 2 in terms of the method was that Stage 2 began with fact finder interviews designed to gather factual information by telephone in advance of the case study depths, enabling the research team to achieve more focused case study interviews. The fact finders also had the additional benefit of allowing a wider range of organisations to be covered, providing a broader picture of each cluster targeted.

The case study approach enabled an in-depth exploration of how different organisations manage their energy and the various factors that influenced this. It involved the use of semi-structured discussions so that issues could be explored as appropriate.

Cluster 2 Sample

Broad quotas were set to ensure the sample included a spread of schools in terms of region, school type (primary vs. secondary), tenure (local authority controlled vs. academy), and the number of students. Information was also recorded about the size of the school (based on number of employees), the number of sites each school was located at, how energy bills were paid, the types of energy and meters in use, and the perceived importance of reducing energy consumption. A summary of the Cluster 2 sample is provided in below. The individual cells of the table show both the overall number of schools in the cluster 2 sample and, in brackets, the number of these taking part as a case study.

[4] Cluster 1 – higher energy, customer facing chains; Cluster 2 – schools; Cluster 3/4 – Small, customer facing independents.
[5] Cluster 3/4 – Small, customer facing independents; Cluster 5 – Lower energy, customer facing chains; Cluster 7 - Higher energy, employee only sites; Cluster 8 - Offices

Table 1: Sample summary Total sample: six, of which, five were case studies					
Region			**School type**		
East	-		Primary	1	(1)
E Mids	-		Nursery/lower/middle	1	(1)
London	-		Secondary	4	(3)
N East	-		**Tenure**		
N West	-		LA controlled/local payment	3	(3)
S East	2	(2)	Academy	3	(2)
S West	4	(3)	**Energy bills**		
W Mids	-		Paid direct	5	(4)
York & Humber	-		Paid via LA	1	(1)
Scotland	-		**Energy types**		
Wales	-		Electricity	6	(5)
Size of school (total employee number)			Gas	6	(5)
Sole trader	-		Other	4	(4)
Micro (<10)	-		**Type of meter**		
Small (<50)	1	(1)	Smart/advanced electricity	6	(5)
Medium (<250)	5	(4)	Smart/advanced gas	5	(4)
Large (250+)	-		**Importance of reducing energy use**		
Number of sites			High	5	(4)
Single	6	(5)	Medium	-	
2 or more	-		Low	1	(1)

A total of six schools took part in the research. Five case studies were carried out and these were supported by one telephone depth interview. Thirteen participants from the schools were interviewed. Eight interviews were conducted with decision makers and five with implementers. Interviews were also conducted with two local authority representatives in the role of supporting schools with energy management generally, and smart meter implementation specifically.

Two of the case studies had been nominated by a participant in a workshop run by DECC[6] as examples of schools that were 'leading the way' in terms of their approach to energy management. These have been termed 'pathfinders' in this report

Interpreting the Findings

The findings in this report provide insights into how different schools in the sample were currently managing their use of energy, the things that get in the way of them being more energy efficient, and some of the ways of trying to overcome these barriers. As such, they are indicative of the broader picture in terms of schools. Nevertheless, care is needed when trying to generalise to the wider population.

[6] this research was conducted before DECC was merged into the Department for Business, Energy and Industrial Strategy (BEIS) in July 2017

This is a qualitative study which means the opinions of a relatively small number of people have been explored in considerable depth. Not only is the sample small, it is not designed to be representative of the full range of organisations that meet the criteria for each cluster. Some organisations were purposively selected to learn from examples of best practice, and although a range of more 'typical' organisations were also included in the research, the sample was not designed to be statistically representative of the wider population.

During the case study visits and the telephone depth and fact finder interviews, the researchers used topic guides and supporting stimulus materials to ensure that the relevant issues were covered; they also followed up particular points to ensure the point being made was understood, and they may also have explored relevant additional points that were made by the participants. In addition, they used an observational record sheet to observe how energy was being used.

Each case study was written up in detail using an analysis template. The answers to the fact finder and depth interview questions were cast into a matrix with the rows as the questions and the columns as the organisations. Findings from both data sets were used to identify the key themes and issues.

The views of different actors from the same case studies and fact finder/depth interviews have been used to 'triangulate' the findings from individual case studies. A similar triangulation process was used to compare and contrast the findings both within and between the different clusters.

With a few exceptions, answers were not recorded in the form of tick boxes or head counts since the aim was to explore the range of opinions expressed and actions taken rather than to 'measure' how many participants had expressed a particular view. One reason for this is that people do not always express their answers in black and white terms. Another reason is that it is not possible to explore every issue in every interview. Some issues may only have arisen in certain interviews.

In analysing the data, one of the things that has been looked for is where there is a consensus of opinion or a similar view on an issue and this is expressed using language such as 'all', 'most', 'widespread', 'widely held', 'many people', etc. However, it is also important to look for the range and variety of opinion that is expressed; these might be opinions offered by just 'a few' participants as well as those opinions mentioned by 'some' of the sample (i.e. more than a 'few' but less than 'many'). It is also useful to report things that may only be mentioned by one or two people if these seem to offer relevant and insightful observations. This would normally be made clear by stating something along the lines 'one participant said…'

Use of terms such as 'most' or 'few', etc., relate only to the sample under consideration and should not be taken to imply 'most of members in the total population'.

Report Structure

The next chapter (Key characteristics, energy use and the role of potential influencers) provides a summary of the key characteristics of the sample, how energy was being used, and who was influencing its use. This is followed by a consideration the energy efficiency culture found within the schools, along with the range of energy efficiency measures that

had been adopted. The factors that were driving energy efficiency, the potential triggers and the barriers to (greater) efficiency are also set out (Energy Management). The chapter headed Smart Meters summarises the reasons why smart meters had been installed, why some schools were not using their smart meter data, and the experiences of those that were using their smart meter data. The reactions of non-users to a number of products and services intended to help organisations get the most from their smart meter data are considered, along with possible ways of encouraging greater engagement with smart meter data among non-users. The final chapter sets out the conclusions of the research (Conclusions).

Verbatims are used to illustrate some of the findings and are shown with the cluster number, the type of organisation and the role of the individual providing it (DM: decision maker; I: implementer; U: user; LL: landlord/managing agent; EC: energy consultant)

Key characteristics, energy use and the role of potential influencers

This chapter provides a summary of the key characteristics of the sample, how energy was being used, and who was influencing its use.

The findings provide a description of what was found in the case studies and wider interviews, illustrate the diversity of different behaviours and views, and provide a more in-depth explanation compared to a quantitative survey. This information provides important context for the findings in later chapters which describe energy management activity and associated influences, and experiences of smart meters.

The research was not designed to provide answers to 'how many' type questions and the findings should not be interpreted as indicating the prevalence of such behaviours and opinions within the wider population of schools. References to the sample refer to the six schools that took part in the research. Where findings only relate to one or more of the five schools which also took part in a case study, this is indicated in the text.

Nature of Schools

School type and size

The sample comprised four secondary schools, one primary school and one nursery, lower and middle school. Three of the schools were academies and three were maintained by the local authority, including the two pathfinders. One of these had been a 'local payment' school for some years which it said meant it had as much financial autonomy as an academy. It was now becoming part of a Cooperative Trust with other local schools.

Five of the schools were classed as 'medium' size organisations, that is, they employed in total, between 50 and 250 staff. The other school was 'small' because it employed fewer than 50 staff. Pupil numbers ranged between 200 and 1,400. The school settings were varied; a village, small and large towns and the suburbs of large cities.

School operating hours

As schools, all the members of this cluster mainly operated during term time. However, particularly in the secondary schools, facilities were often available for hire after school hours and at weekends, and during holidays when they might be used for summer schools, sports or by the schools themselves for revision classes. The secondary schools in particular consumed energy over a long day, sometimes starting at 7.00 am and continuing until about 10.00 pm. School halls, sports facilities (sports hall and outside pitches) and dance studios (in one school) might particularly be in use until this late hour.

Nature and Management of Buildings

All schools were on a single site although this could be very large and even extend across both sides of a busy road.

Condition and management of buildings

All the schools had buildings of different ages, some dating back to the nineteenth century. Two of the schools had been built in the 1960's or 70's but here too, there had been some major refurbishment work.

Schools typically had one or more caretaking staff looking after the site that were generally managed by a site manager. School administrators, business managers and the energy manager in one of the pathfinder schools also contributed to the management of the facilities. Five of the schools had Building Management System (BMS)[7] for at least part of their site and it was being installed in a new building under construction in the sixth.

Energy audit and environmental policy

Most of the schools had either had an energy audit at some point or had considered it. Only one school referred to an environmental policy which the local authority had produced and which the school did not adhere to.

Energy Use

Types of energy and meters

All the schools were using both electricity and gas and most had a number of meters as well as a mix of traditional and smart/advanced meters[8]. In at least two cases, there was uncertainty over which meters were smart and what areas of the school they covered. Two of the secondary schools had some sub-meters although the respondents from one of these were unsure which meters were in use.

Four of the six schools were generating energy themselves, typically using solar PV but also in two cases using a wind turbine and, in one case, a biomass boiler. The other two schools were in the process of installing, or planning to install solar PV.

Energy intensity and main uses of energy

Heating and lighting were thought to be major consumers of energy, along with a range of other pieces of equipment. While any one item might be of low intensity, the numbers of such items across a school, especially IT equipment, meant that cumulatively, the energy requirement was high. This was particularly the case in those schools in the sample where they were often left on for long periods. The case study schools were asked to provide

[7] A Building Management System is a control system that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.
[8] For ease of reference, the term 'smart meter' is used to refer to both 'advanced' and SMETS compliant meters in this report unless otherwise specified (please see Background, p1 for further details).

details of their energy consumption; accurate figures were often difficult to obtain however because of the number of meters and because bills were sometimes not available for all the meters. Based on figures provided, the range was 150,000 kWh in the case of the primary school to 1,500 mWh for one of the secondary schools. It should be noted that consumption does not equate to size of bill due to the different contribution of energy generated by renewables. Bills ranged from less than £17,000 to about £100,000 p.a.

A similar range equipment was being used across the schools although the number of items varied and the secondary schools operated a greater range of energy consuming equipment than the primary school. The main uses are shown in Table 2. All schools except the primary were preparing school meals on-site.

Some of the secondary schools had a large number of boilers, as many as 40 in one school, for heating and hot water. Boilers represented a large capital cost and two of the secondary schools bemoaned the need to replace some of their old inefficient 'work horses' because of this. In a couple of schools, the boilers installed in recent years were compared to domestic style boilers which were cheaper to maintain and replace.

Just one school had a swimming pool (another used to have one but it had been removed); this was used by the school and outside groups. Heating costs applied mainly in the winter months since the solar thermal on the pool roof heated it to a large extent in the summer.

Table 2: **Main uses of energy**

Lighting	LEDs (some with sensors), fluorescent tubes (some low energy), halogen e.g. for floodlights
Heating/cooling	Air conditioning (21 units in one school), multiple boilers (heating and hot water - in one school 40 boilers), under floor heating electric heaters, water heaters over sinks, fans
IT	Computers (800 in one school), tablets (recharging), servers, projectors, printers/photocopiers
Food/drink preparation	Kitchen/catering equipment, water heater for drinks (staff room), hot cupboard (where school meals are brought in and kept warm)
Workshops	Design and technology equipment e.g. lathes, milling machines, food technology equipment
Other	Swimming pool
Renewables	Solar PV, solar thermal, wind turbines, biomass boiler

Variation in energy consumption

While a reduction in energy consumption would be expected outside the school day, in the evening, at weekends and during holidays, use of at least some parts of the schools meant that some energy continued to be consumed at these times; some schools acknowledged some energy was also used unnecessarily. Heating was generally not used from late spring to early autumn and while there was some air conditioning, this was not used to the same extent.

Energy as a proportion of total operating costs

Three of the six schools considered that their energy costs represented a 'medium' proportion of their total operating costs; for one such secondary school it was estimated to take up about 2%. The other three thought energy was a small or tiny proportion.

> It's a very high priority now, mainly for financial reasons. One of our electricity bills comes to £10,000 to £13,000 per month, we haven't got the number of students we are capable of (800 students to 1,300 places) and the grants are very different now to when we started. We get money from the government per student and the amount we get compared to our energy costs could cause us problems in the future. (C2; secondary (Academy); DM)

Importance attached to reducing energy consumption

All but one of the schools considered reducing their energy consumption to be of 'high' importance as they needed to save whatever they could to increase the budget for learning. This was particularly the case since changes in school funding and reductions in the capital budget.

Perceived level of control over energy use

The extent to which they felt in control of their energy consumption varied. The pathfinder schools felt that they were in control to the extent that the smart meter data gave them a good grasp of how energy was being used and when, where and why there were issues. They also used their BMS proactively and had active energy management programmes in place.

> I have phone calls from [energy manager] weekends, I have phone calls from him in the middle of the night saying, 'somebody has switched something on. The sports hall lights are on'. I say 'yeah, well there's somebody using it' but it's that level of monitoring we put into it really. (C2; secondary (LA); DM)

The extreme level of control in one pathfinder was in large part due to the dedication of the energy manager who monitored usage in the evenings, at weekends and during the holidays.

The question of control was sometimes interpreted as the pieces of plant over which an individual had control so gas boilers were seen as items which only the site manager or caretaker dealt with and were therefore under control. These contrasted with the air conditioning, projectors and computers which staff and students might turn on and not turn off and over which there was no centralised control.

> You've got overhead projectors and computers on, they are supposed to, as they leave, turn them off. They are supposed to do it individually because the site is just far too big - it would take probably a couple of hours to turn everything off and we just don't have that time and it would cost too much. We'd have to employ somebody to do that and it would cost too much. (C2; secondary (Academy); DM)

Lower levels of control were put down to caretakers being unavailable or unable to make adjustments e.g. on boilers; or to check that lighting or computers were switched off; to technology such as sensor-controlled lighting which did not operate as expected (and had to be overridden); to timers being set to the wrong times; and sensors that were not working.

An internal Decision Makers and Key Influencers: Internal Actors

actor is anyone employed within the organisation who may influence energy management.

Role of decision makers

Five of the decision makers were business managers; others in this role were a chair of governors, an estates manager and an energy manager. The last of these was a former science teacher at the school who had offered to take on a full-time energy management role with the aim of saving the school money.

Decision making about energy, for the most part, followed the pattern used for all decision-making in the schools. In terms of expenditure, typically, at least in the secondary schools, the business manager could decide on small items (such as the repair of a domestic type of boiler) or do so in association with the head teacher on larger items (an example was given of up to £10k); with other levels of management being brought in as expenditure increased (e.g. above £50k requiring full governing body approval). Specific committees might decide on different issues. Where, for example a change of supplier was being contemplated, this typically involved the governing body because it was judged on the annual spend. The Senior Leadership Team was also extremely important in terms of securing the commitment of the school to energy efficiency and making the changes in the culture that would support energy management.

Implementers

Other roles that might contribute to discussions about energy were the site manager and possibly the caretaker; both of whom might typically have knowledge of, and responsibility for, the plant. In one school, the site manager had an interest in energy efficiency and had been trying out various measures such as sensors and new forms of lighting.

In one of the pathfinder schools, it was the site manager who went out to other schools to help them with things like boiler settings and occupancy sensors. The primary school had a part-time caretaker who was not based at the school and for whom notes were left to identify priority tasks. Other types of implementers were teachers and students who took on the responsibility of supporting the energy manager in encouraging efforts to conserve energy.

> He's [the site manager] gone in and had a look at their boiler settings. They've got lighting and some of them don't know how to work their sensors. Their sensors haven't been on or they've been on constantly, so he's gone out and done some of that for them. (C2; lower & middle (LA); DM)

Users

The users of energy in the schools were the staff, students and members of the public who might visit it to take part in events or activities.

Energy Management Expertise

Levels of knowledge about energy management and awareness of how equipment functioned in the school varied among both decision makers such as business managers and implementers such as caretakers.

Energy targets

Targets may have been set internally as part of an Eco-schools action plan Other than this, no formal targets had been set by schools or local authorities for energy reductions

although at least one local authority had asked schools to reduce their energy costs some years ago..

Decision Makers and Key Influencers: External Actors

An external actor is anyone not employed within the organisation who may influence energy management.

Energy suppliers

Half the schools negotiated their energy contracts themselves, sometimes using energy brokers. Two others used the supplier contracted by the local authority; the last school was unsure if they were still tied into this. Schools using the local authority supplier had the option to look elsewhere and planned to look more widely and make a comparison at the next review.

One of the pathfinder schools had built up a very productive relationship with their electricity provider over the years to their mutual gain. The other pathfinder school had been involved in trialling an online tool from a different energy provider which was designed to engage children in energy saving behaviours.

> Energy brokers I get hassled by quite a bit. I'm always a bit nervous about energy brokers because whenever I've managed to get a look at anybody else's invoices who use energy brokers, they're always more expensive than mine. They don't get it any cheaper than I can get it direct. (C2; secondary (Academy); DM)

Energy consultants

Most of the schools had had some dealings with energy brokers, often because they were approached by them on a regular basis and might feel they had nothing to lose by getting a quotation.

Most of the schools also had had some contact with some of the providers of energy services that participants were asked about although there was little take-up of the services on offer. There was a marked reluctance to pay for such services either up-front or further down the line out of putative cost savings, and some uncertainty over subscription charges.

Local authorities

Various networking opportunities were available to business and site managers organised by local authorities or providers to which they had out-sourced services. These included bursars' and business managers' forums and a site agent working group. These were seen as opportunities to discuss issues such as energy management and the use of smart meter data.

Government

While participants made the point that they would comply with any regulation around energy affecting schools, they did not seem to be motivated to manage their energy as a

result of any government policy drivers. While they had Display Energy Certificates (DECs)[9] for their buildings, these did not seem to be central to improvements they were making. One school referred to the contribution it was making to its local authority's Carbon Reduction Commitment (CRC)[10] obligations.

Other influencers

Other potential influencers included those involved in refurbishment or new build work, the Carbon Trust and local Community Interest Companies and social enterprises.

Pathfinder schools as influencers

Both pathfinder schools were actively supporting other schools in their area with their energy efficiency initiatives using their expertise and experience. This took such forms as giving presentations at meetings, advising schools on reducing their energy bills and helping them practically by adjusting boiler settings or sensors or by monitoring solar PV. They were acting as a consultant to other schools and it seemed that once it became known that they were the go-to schools for energy advice, requests for help grew.

By coincidence, the business manager from the primary school had attended such a presentation which had inspired her to look further at when boilers and heaters were switched on. She felt this was the sort of 'consultant' in whom she would have more trust and confidence.

[9] Since 9 July 2015 public buildings in the UK over 250m2 must display a Display Energy Certificate (DEC). They are based upon actual energy usage of a building and are intended to promote the improvement of the energy performance of buildings.
[10] The Carbon Reduction Commitment (CRC) Energy Efficiency Scheme is a mandatory reporting and pricing scheme to improve energy efficiency in large public and private organisations.

Energy Management

‘Energy management’ is used in this report to cover the range of activities that organisations were found to be using to control energy costs, including energy procurement, installation of energy efficiency measures and equipment, control systems and the use of smart meter data to monitor performance. This chapter considers the energy efficiency culture found within schools (cluster 2) in the sample, along with the range of energy efficiency measures that had been adopted. The factors that were driving energy efficiency, the potential triggers and the barriers to (greater) efficiency are also set out.

These issues were addressed on both an unprompted and prompted basis using a list of items derived from the context map developed as part of the research framework (see Non-Domestic Smart Metering Early Learning Research reports: Main Report). The findings reflect what was reported during the interviews but should be approached with caution as they may not give a full picture of what was being done or why.

Culture of Energy Efficiency

There were clear differences between the pathfinder and other schools in the sample in that the former benefited from the interest and encouragement of members of the board and senior leadership team with respect to energy management while the latter felt that without signals from senior management that energy efficiency was a priority, there was little reason to seek improvements. The pathfinders also showed the difference made by expert energy managers who could make an effective case for change and influence the key decision makers.

The level of connectedness to the local authority varied in terms of decision-making about energy. Three of the schools had had the support of their local authority; for two of them, in the form of an individual who was responsible for energy management across the county. The two pathfinder schools welcomed this support, whereas the other school, an academy, was sceptical about the information provided from the smart meters by the local authority and had not asked for advice to make greater use of it.

Energy Efficiency Measures

During the case study and depth interviews, respondents were asked to outline the main energy efficiency actions that they had put in place. The responses are summarised below. These should be approached with caution as they may not give a full picture of what was being done – they were simply what was reported during the interviews.

Between them, the schools had implemented a wide range of measures to try and better manage their energy consumption although the pathfinders had engaged with markedly more and varied measures. It should be noted that in most instances, having access to smart meter data was not the reason why action had been taken; however, the data enabled the pathfinder schools at least, to identify possible cases of unusual consumption and to evaluate the impact of their actions (see Users of Smart Meter Data, p28).

The measures have been grouped into two broad categories: things that schools could change and things they could invest in, either as part of major refurbishment/new build programmes or as smaller projects.

Things that could be changed

- Most of the schools were reviewing their **tariff and/or supplier**[11] and some had used brokers to help them identify the most appropriate contract.
- At least one school had looked to **change the type of energy** they were using by switching from electric to gas heated radiators
- Some had **changed timers/settings** on heating systems; for example, by programming holiday dates and/or British Summer Time into control systems or in response to weather forecasts, or adjusting frost protection settings on boilers.
- There were also examples of **processes and procedures being changed** in order to try and improve energy efficiency. In some cases, this involved switching off equipment manually but as previously noted, this was problematic when it came to things like IT equipment due to the number of such items and the fact they were located across the school site. One of the pathfinder schools had attempted to address this by installing automatic cut-off on computers. All student computers were switched off at 3.30 pm and staff computers at 6.00 pm although it was possible for them to be turned on manually again if needed (they then turned off automatically after half an hour of non-use).
- The extent to which the schools were **encouraging staff and students to use energy efficiently** varied across the sample. Behaviour change programmes were characteristic of the pathfinder schools where energy efficiency had been incorporated into the culture of

> The fact that staff were clamouring to get a green sticker stuck against their classroom, it incentivised it. But that wasn't the intention of some of the schemes that we set up, it was purely about engaging everybody but it had a really, really positive effect. (C2; secondary (LA); DM)

[11] Strictly speaking, reviewing tariff and/or supplier is not an energy efficiency action but a cost saving action however it is included here as it was reported to be something many organisations were doing. Indeed, the primary motivation for any energy efficiency was to try and reduce energy costs (see Key Motivations).

the school and was a regular 'event'.

> We know that when we have things like 'Switch off fortnight' and we have a push, we see an actual appreciable drop in the use of the electricity and the kids can see that and so they appreciate that they can make a difference. (C2; lower & middle (LA); I)

At one of these, members of the sixth form were involved in helping run the Science, Technology, Engineering and Mathematics (STEM) group with the guidance of the energy manager. This group regularly checked that sensors were working properly (by comparing the temperature in rooms with that shown on the BMS), had access to consumption data online and ran twice-termly campaigns to monitor whether equipment was switched off. Stickers were left on equipment and light switches, notices on classroom doors and teachers and students apparently took non-compliance seriously. Energy management messages might be incorporated into staff and student bulletins and frequently appeared as part of the curriculum.

The other pathfinder school also had 'Switch Off Fortnights' to alert staff and students to the need to switch off equipment and the site manager reported that it had a marked effect on behaviour, even in January. They too reinforced the message regularly and especially with each year's new in-take. This school's 'eco council' also met every half term; the site manager briefed them on energy usage and they discussed energy saving initiatives. The students produced posters and spread the message among their peers and the head of the eco-council had spoken at assemblies.

Both schools were aware that efficiency drives needed to be regular but not constant so that fatigue did not set in, and that they needed to be fun rather than onerous. Introducing a competitive element was seen as helpful to engaging everyone.

Other schools in the sample were making occasional and low-level efforts, sometimes as part of a wider sustainability agenda, and seemed to take the view that students and staff could not be expected to be energy-conscious.

Things that could be invested in

- **Premises refurbishment** and the **construction of new buildings** provided an opportunity for energy efficiency measures to be introduced; there were examples of a roof being replaced and the installation of a new floor in a high-ceilinged building and, in another case, walls, ceilings, roofs, and corridors between buildings being insulated and pipes being lagged.
- The **replacement of equipment** was a further opportunity for improving energy efficiency
- **Improvements to heating and/or cooling systems** were being made, for example the introduction of timers and thermostats and the optimisation of boiler controls. The ability to use BMS effectively was instrumental in enabling schools to manage their buildings for energy efficiency. However, some schools had boilers that were very old and over which remote control was not possible.

> The other thing I haven't mentioned yet is knowing how the building controls work because in this school we have a lot of people making a lot of effort and we're making a few small gains, but it's been totally wiped out by technical mismanagement of the building management system and lack of awareness of what was going on at a strategic level. (C2; secondary (LA); DM)

The energy manager in a pathfinder school also expressed a note of caution about BMS – the system could be easily upset if operated by those without the knowledge of how the controls work in the school.

- There were also examples of **improvements to lighting systems**; this often involved the installation of LEDs but also low energy tubes. Other examples included the use of sensor-controlled lighting, removing excess lighting, and the systematic checking that lights were switched off when not needed.
- As previously noted (see Types of energy and meters, p9), when it came to **micro-generation**, all of the schools either already had solar PV or were in the process of installing it, sometimes for the first time but for two schools, as an addition to existing panels. There was little awareness of the contribution made by the solar PV (except at one of the pathfinder schools) and it was often thought to be small; several participants suggested its value was more educational.

The pathfinder schools were able to quantify savings they had made and how the sums they had invested had been paid back through savings. In one, the net cost of energy was reported to have been reduced from over £100k to around £20k and the school also reported buying 70 per cent less energy than it used to as a result of greater control of consumption using technology and through behaviour change, and the contribution (energy and income) from renewable energy sources. They estimated that 40 per cent of savings were as a result of behaviour change. The other pathfinder reported that, over three years, they had saved about £33,000 on their energy bills, about £10,000 of which they attributed to adjustments to the gas boilers.

Key Motivations

The term **key motivations** is used to refer to the key internal motivating factors behind an organisation's energy efficiency efforts. **Other drivers** is used to refer to any other influence on energy management activity. **Barriers** refers to anything that could make it difficult for an organisation to become (more) energy efficient. **External factors**[12] could also have an impact on approaches to energy management. The relationship between these various factors in cluster 2 are summarised in the pathway summary maps (see Figure 1, p33 and Figure 2, p34).

In analysing and reporting on key motivations, other drivers and barriers, we have looked to see if there were differences between those organisations that were using their smart meter data and those that were not. It is important to note that any such differences do not necessarily imply a cause and effect. Organisations that were using their smart meter data tended to be more engaged with energy management; smart meter data might be a tool that they use as part of this but the use of smart meter data was not necessarily driving these differences. For example, they may employ a dedicated energy manager but they

[12] A number of external factors, such as climate change, energy prices, company reputation, etc. were relevant to how an organisation manages its energy. In some cases, these factors motivated organisations to become more energy efficient (e.g. compliance with government policy initiatives where applicable) or were a driver/trigger (e.g. increases in energy prices) but they could also be a barrier (e.g. planning restrictions).

almost certainly had not made this decision because they were using the smart meter data.

> I mean we'd like to reduce costs, there's no doubt about that, because our budgets are really being squeezed now, so we have to make every effort to save every penny. So yeah, which is why I should be doing a full review of the energy, who we're buying from, very shortly. (C2; secondary (Academy); DM)

- **Cost reduction:** as with organisations from other clusters, the key driver for all the schools in the sample was one of cost reduction, although, in the case of schools, this was not in order to become more profitable but to enable them to free up budget for learning at a time of severe financial constraints.
- **Being seen to be a responsible organisation** and wanting **to do our bit for climate change** only characterised the pathfinder schools in the sample. One of the pathfinder schools had set itself ambitious targets for further reductions in emissions. The business manager in the other pathfinder school had taken courses in sustainability and energy management and this was a personal priority when she came to the school.

  Three of the six schools in the sample were Eco-schools (all Green Flag, the highest award) including the two pathfinders. However, this did not necessarily signal a strong commitment to energy management; for example, despite flying the scheme's flag outside its buildings, the third school was doing very little. It had an Eco club led by one of the science teachers which the site manager had talked to about encouraging fellow students to turn off lights and equipment, and the business manager had also proposed that students could be asked to perform a more active role in energy management but this had not been taken forward. In contrast, for one of the pathfinder schools, being an Eco-school was just one of the initiatives it had adopted; it had committed to reducing CO_2 emissions by 'at least another 100 tonnes per year' in its action plan and to helping other schools with their energy reduction. The transformation of this pathfinder school from an 'ordinary comprehensive' to a community-minded and environmentally committed school had had a significant impact on its reputation and students' confidence.

Other Drivers

While some schools were sceptical about whether energy efficiency measures would yield sufficient savings to make efforts and/or investment worthwhile, there was widespread take-up of opportunities for improving energy efficiency, typically as part of the renewal of energy contracts, refurbishment and new build projects, and renewing plant and equipment. Changes to the system of funding schools meant that all the schools in the sample were looking to take advantage of funding streams to finance such improvements (see, for example, Figure 2, p34). Having access to smart meter data had been a significant trigger for the pathfinder schools to upscale their efforts. In addition, the pathfinder schools were driven by the availability of expertise to guide their efforts as well as having the support of their Board of Governors and/or Local Authority, their success in securing funding and the prompt demonstration of how measures resulted in energy and cost savings (see Figure 1, p33).

Drivers that characterised schools (cluster 2)

There were two drivers that applied, in particular to the schools in cluster 2:

- **Reduction of capital budget** and **taking advantage of funding streams:** the availability of financial incentives and indeed, finance generally, was a significant factor in determining a school's ability to put in place energy efficiency measures involving the refurbishment of buildings, the purchase of new plant or equipment, or the installation of energy management systems or renewable energy technologies.

  All of the schools referred to the recent dramatic reduction in their capital budget and the need to apply for grants to fund energy efficiency improvements as the cost exceeded their capital budget or there were other improvements that took priority. The academies seemed particularly aware of funding limitations and concerned about funding opportunities where they were unsure of their future financial commitment. One cited the run down condition of some of its boilers that were coming to the end of their life but which would cost around £50k each to replace. If they were to fail, the school might need to shut but they needed to win funding from government to do the work.

  Some schools were aware of new sources of funding, with Salix loans[13] mentioned by two schools; one was preparing a bid for this while the other had opted not to.

  > The way it works is they'll give you a loan saying that you'll save x amount over a number of years, but really whether that's a realistic saving is another thing. So I'm not convinced that you do make the savings that the companies say that you are going to make. But you know, it is there to use. We will be trying to address our worst lights over the next two or three years. (C2; secondary (Academy); DM)

  The pathfinder schools, who had been committed to improving their energy efficiency for some years not only had been able to draw on healthier capital budgets in the past but sources of external funding that had been a springboard for their ambitions. For example, one of them had attracted funding from its energy provider who had contributed to their wind turbine.

  While most of the schools had solar PV and were aware of government incentives for renewables, the payments received were not always valued. There were examples of solar panels not being serviced or even registered to receive the payment and a wind turbine was seen by one school as producing little revenue.

Drivers which applied to schools, but also to other clusters

Three further drivers were found to operate across all or most of the clusters, including cluster 2.

- **Energy price increases/contract renewal:** when prompted, increases in energy prices were sometimes noted as something that could trigger a review but schools were sometimes tied into contracts for several years and it was more the case that contract renewal was seen as an opportunity to seek a more favourable deal. None of the participants talked about energy prices being very high and indeed, some felt that

[13] Salix is a finance company providing 100% interest-free capital to the public sector to improve their energy efficiency and reduce their carbon emissions.

either the local authority or themselves had been able to negotiate competitive (sometimes lower) rates. This did not stop them wondering if they could bring the prices down further and save some money. For one academy, negotiating a better deal with their energy suppliers was the principal way to save money on their energy rather than putting in place energy efficiency measures.

A couple of schools spoke of energy brokers that were used by the local authority to access beneficial rates based on economies of scale or were used by a number of schools in their county. While a number of schools considered that brokers had a role in obtaining competitive quotes, most seemed to prefer not to close a contract through one because they felt that they could possibly get a better deal by negotiating themselves. In addition, one of the pathfinder schools felt it was better to own the relationship with the energy provider and build on this for mutual benefit. While he might seek quotes from other providers, he preferred to use these to see if the existing provider could match the best.

- **Refurbishing premises:** the refurbishment of school buildings was an on-going challenge whether it was replacing roofs or windows, replacing buildings altogether or adding new buildings. Upgrading the fabric of a building or building anew presented opportunities both to improve the learning environment and energy efficiency. A number of the schools had installed or were installing solar PV as part of new build projects.

> Every time we refurbish our existing premises, we are thinking about making things more efficient. Not of the heating system, because we can't afford it, but only in terms of the windows, the insulation and the roofs. So we are doing it from that point of view. (C2; secondary (Academy); DM)

Once changes had been made, schools hoped for and expected improvements in energy consumption and spoke of reviewing this once the changes had had time to bed in. For those who were not looking at smart meter data, this would be on the basis of the size of their bills; however, there was no evidence of any intention to monitor consumption in a rigorous way.

- **Equipment refurbishment/renewal:** several schools in the sample identified the purchase of new items of equipment as an opportunity to upgrade their energy efficiency. Lighting was often mentioned in this context because changes in light fittings were not only associated with major refurbishment but might be achieved in a more piecemeal fashion.

> Whenever we upgrade premises, we have a policy to consider the most energy efficient equipment. So if we were putting in new lights, we'd say we don't want T8's or T12's, we want LED's now. So revamping a room would be a reason for reviewing the energy use within it. (C2; secondary (LA); DM)

Attitudes to the servicing and maintenance of items of equipment varied; some schools made a point of commenting that they attended to servicing diligently at some expense while others referred to items that were not serviced, usually because the cost was not deemed worthwhile.

Drivers that characterised users of smart meter data

Although the numbers are small and therefore great care is needed in interpreting the findings, there was an indication that those schools that were using their smart meter data

were also being prompted to think about their energy consumption by a wider range of other drivers. The smart meter data was not necessarily driving this; instead, these schools were more motivated to be energy efficient in the first place, and had access to, and were engaging with, internal and external expertise. One consequence of this was that they were using their smart meter data.

- **In-house or proactive Local Authority expertise**: being able to draw upon the knowledge and expertise of experts in the local authority or having that expertise within the school was an important enabler in both initiating and sustaining energy management efforts. Three of the six schools in the sample had put in place or had access to someone with greater knowledge of energy matters which had led to discussions about, and implementation of, specific initiatives. In one of the pathfinders this was their very well-informed energy manager; in the other two schools, this was somebody in the local authority.

  While both pathfinder schools had already been interested in, and were taking some steps towards, greater energy efficiency, their efforts stepped up a gear once they had access to somebody with the expertise to identify the measures that were needed as well as potential sources of funding to make them a reality. In one school this was the Energy Programme Manager from the local authority who conducted an energy audit, developed an energy efficiency action plan and introduced the school to the local authority's Invest to Save programme. He also presented the plans to the governing body and won them over, and provided training in the use of data from the smart meters. The importance of the 'expert' voice (and available funding) was demonstrated by the fact that the board had considered similar measures three years earlier but had not been convinced enough to proceed.

  The roles played by these energy managers were viewed favourably because they were seen as impartial and grounded in the school environment. Schools without access to such a person who were asked about their potential usefulness responded positively.

  Local authorities had also organised the odd meeting to 'inspire' business managers about energy efficiency.

  Where external expertise was only available if schools were prepared and able to pay for it in the form of consultancy, then this was unlikely to be successful because of the concerns about trust and uncertain financial commitment.

- **Supportive Local Authority/Board of Governors:** only in the pathfinder schools was there proactive and continuous investigation of ways to maintain and improve energy efficiency. In one, the energy manager would typically firstly present his ideas to the business manager who might encourage particular courses of investigation. When these had been worked up, they were presented to the governing body. The business manager in the other pathfinder would similarly (often encouraged by the energy programme manager in the local authority) present her ideas upwards. Both schools felt that having heads, members of the senior leadership team or governors who were at least interested in, and often passionate about environmental issues, was essential in supporting the staff members who were tasked with driving energy management.

Some schools stated their priorities lay in learning rather than energy efficiency; business managers sometimes commented that they had not been asked to look into making improvements in this area by the senior leadership team or governing body so given their heavy workload, they did not give it attention. Indeed, in one case, they were bemused by the idea of decision making around energy. Where business managers had been interested and looked into energy efficiency measures that might be taken, their efforts had not received senior level support and they were unable to take them forward.

> Because you can't just come to me and say, 'can we do this?' because I've got to ask somebody who asks somebody who, you know. I can think it's a fantastic idea and, 'yes please, let's go ahead and do it', but then the governor might say, 'well, if you do this, then you're either setting a precedent or it's going to cost you further on down the line or you need to ask this question'. So I do find often I'm a bit in the middle but at the end of the day they've got to be able to show me up-front that they're going to be able to save me money, and they often are unable to do this. (C2; secondary (Academy); DM)

> Because I think there's so many other challenges to meet first. So for the school, for the head teacher, the priority is teaching and learning, making sure that the results are good and that everything to do with the tuition and managing of students is tip top. So energy is secondary. (C2; secondary (Academy); DM)

- **Suggestions from external organisations:** most of the schools in the sample had received information, advice and suggestions from external organisations, however, those schools that were actively using their smart meter data were more likely to have acted upon this input.

One of the pathfinder schools had built up a very productive relationship with their **electricity provider** over the years to their mutual gain. It had provided advice and funding and had twinned the school with another European school doing similar things. It had also advised them on the installation of the biomass boiler and, as noted above, contributed some funding for their wind turbine. The school had a different supplier for gas. It had been motivated to switch from its previous gas supplier after it won a competition organised by their current provider. The prize enabled the school to buy new boilers and install more solar panels, LED lighting and thermostatic radiator valves. The school also had dealings with an energy distribution company regarding the connection of its wind turbine to the system and exporting electricity to the grid.

Two of the academies had had dealings with **energy consultants** who had either contacted them directly to offer their services or whom a third party had suggested bringing in. These organisations had conducted audits and prepared proposals for measures that might improve energy efficiency as well as financing options. The schools had not gone ahead due to lack of immediate funding and uncertainty over what their future financial commitment would be.

The **Carbon Trust** was mentioned by several schools in terms of its networking with local authorities and as a source of advice and possibly, grants. In the case of the secondary school pathfinder, the Trust had carried out an audit some years ago of how it was performing relative to other schools which they used to demonstrate to staff the need for cuts in energy consumption.

One of the academies had been introduced to the idea of having an energy audit by a local **Community Interest Company**, and a pathfinder school had first been introduced to the idea of installing solar PV by a local **social enterprise** advising on renewables and energy efficiency.

> We've been lucky that we've had so many works done here recently that we've been able to say during the planning and design process, 'no, we don't want to do that, we want to do it like this' and they've kind of gone 'okay'. (C2; lower & middle (LA); DM)

Other potential external influencers were those who were involved in major **refurbishment or new build work** and who were in a position to discuss and advise on energy efficient design features and the installation of renewables. In the case of a couple of schools with recent projects, they had used a surveyor with experience of working with schools or worked with the property services contractors maintained by the local authority. While there had been consultation with staff and students in some cases, some schools seemed largely to have left it to the contractors to make decisions about the design and assumed that the building would be more energy efficient. The pathfinder schools seemed to have been more proactive however during the planning and design stages.

- **Success in securing funding and early demonstration of savings:** both pathfinder schools had been able to access funds that enabled them to put in place measures resulting in energy and cost savings. It also seemed that once they had been able to demonstrate how effectively they could use funds, it was easier to secure further funding. Moreover, by showing early on the scale of savings that was possible, this gave an impetus to the programme of change, particularly in gaining the support of senior management and the governing body, and bringing about cultural change within the school.
- **Information from smart meters:** all the schools with access to smart meter data had used this to identify when and where they might be wasting energy/money and all had at least made adjustments to their boilers. For the pathfinder schools, the data had been instrumental in guiding their programme of energy efficiency improvements (see also Users of Smart Meter Data, p28).

Barriers

For pathfinder schools, the key barrier to greater energy efficiency was funding for additional improvements, combined with the on-going challenge of maintaining and improving effective energy management by staff and students in buildings that often posed challenges in terms of making them energy efficient (See Figure 1, p33). There were many more barriers operating for other schools (see Figure 2**Error! Reference source not ound.**, p34), the most fundamental of these being a lack of recognition that it was worth trying to reduce energy use and/or spend on energy and associated with this, a lack of prioritisation by senior management so that business managers did not see it as something meriting their attention. All the schools were resistant to paying third parties for advice or services where they perceived a profit motive and were unclear about the financial outcomes.

Barriers common to all schools in the sample

The following three barriers were found to be operating across the sample of schools. The first two were also found to be operating in other clusters.

- **Staff and student compliance:** as previously noted, while it was acknowledged that energy consumption could be reduced by changing staff and student behaviour, it was not something that most of the schools felt they could control. For even the pathfinder schools, it was an on-going challenge.
- **Condition of the buildings:** regardless of age, schools spoke of the poor repair of many of their buildings meaning that there were gaps in the fabric, insulation was often poor and they leaked heat, and ceilings were also often high in older classrooms. Some portacabins were in use which were also very energy inefficient; too cold in the winter and too hot in the summer so that air conditioning was required.
- **Lack of ready funding for energy efficiency measures:** while schools were often able to identify the buildings and plant that were contributing to excessive energy use, the lack of available funds to finance improvements was a major obstacle. It took time to apply for grants and some sources of funding were perceived to lack clarity in terms of potential future costs for which schools were liable. This applied to both loans from the Government and from third parties.

  > We can only really afford to do things that we can get funding or grants for, or things where we would see a quick return on our investment. We don't have the capital to invest in other projects. (C2; secondary (Academy); DM)

  Even though the pathfinder schools had achieved considerable success in securing funding, nevertheless, they also identified this as a barrier to them becoming even more energy efficient.

Barriers that characterised schools that were not using their smart meter data

The remaining barriers largely characterised the schools that were not using their smart meter data; many of these barriers were also found in other clusters.

- **Buildings leased, not owned:** In one academy, some of the buildings were owned by an educational trust from which potentially some permissions would need to be sought if energy efficiency measures were to have an impact on the building fabric.
- **Energy costs and Return on Investment (ROI):** while the majority of the schools were keen to reduce their energy bills because of ever tighter budgets, only the pathfinder schools were convinced that even small measures made a difference. Others often expressed scepticism about whether any savings would be outweighed by the cost of investment or the time and effort required to put them in place. This was particularly the case with the primary school where the energy bills were seen as both small in themselves (a total budget of £17k for all utilities) and a tiny proportion of the operating costs.

  > Which is why, I suppose, it's difficult to keep going, because if you were able to tell somebody, 'we saved 25 pounds yesterday because you all turned your lights off', then that would be fab. But no, we can't see that. (C2; secondary (Academy); DM)

  The business manager in one of academies thought that having proof that even small measures made a difference would be helpful.

- **Lack of interest, information, time and expertise:** were all potential barriers. As previously noted, few of the decision makers were experts in energy management and lacked the interest and drive to increase their knowledge. Bringing in expertise involved cost and issues of trust that meant this was not an appealing option.

> It's a bit of a barrier because you've got to have time and then somebody else has got to be willing to do it and they're either going to do it because you've paid them to do it, or if it's free of charge, then they're going to try and sell you something, so there's that to take into account. (C2; secondary (Academy); DM)

  However, the idea of having a new member of staff with expertise in the area was seen as desirable and one business manager expressed regret that in recently appointing a new facilities administrator, she had not included this in the specification. Business managers also claimed (reinforced by other parties) that they did not have the time to give to this area, especially as more senior managers were not prioritising energy efficiency. One of the site managers commented that he lacked information on energy efficiency as well as access to smart meter data although he would be interested to do more if he was given time to do this.

  It was also notable that several decision makers made the point that implementers such as site staff did not have the time to carry out the control changes on boilers or to check that equipment was switched off in order to reduce energy consumption.

- **Perceived lack of control:** as noted earlier some of the schools felt they had little control over the use of equipment by staff and students. This was linked to a **lack of reliable information about consumption** for example, the difficulty of identifying where energy was being consumed in terms of buildings or items of equipment, and the **lack of awareness of smart meter data, how it can be accessed and used.**

- **Scepticism about achievable savings/distrust of advisors and the reluctance to pay for advice:** most of the schools had had some contact with energy service providers although there was little take-up of the services on offer. There was a marked reluctance to pay for such services either up-front or further down the line out of predicted but not guaranteed cost savings, and some uncertainty over subscription charges. The energy manager, with his experience of helping a number of schools, was also of the opinion that schools were often unconvinced that they would make the savings suggested. He thought that, unless the school had someone who was really driving the changes, including an effective energy management programme, then in fact, this was likely to be the case.

> They don't think it's achievable, do they? I don't think they get it at all. I know schools that have put in these sorts of systems because we've done it here and they really haven't made much progress at all, because unless there is somebody in the school who's really passionate about it, it doesn't get followed up by actions anyway. So you do need that person in the school who's really going to make it work for you. (C2; secondary (LA); DM)

- the **lack of prioritisation by senior manager/the governing body of energy efficiency** and the fact that **site managers might have responsibility for energy consumption but lack any decision making power** also characterised the approach to energy management in these schools.

Smart Meters

Three of the six schools in the sample had accessed data from their smart meters but only the two pathfinder schools were using it regularly and proactively. Managers in other schools showed some interest in being able to access data and in being trained in its use, recognising that it could provide useful information to help manage consumption.

Motivation for Installing

The secondary school pathfinder had its first smart meter in 2008, with others added in later years. It was the only school to have requested and paid for smart meters itself and had done so to measure its consumption and the contribution of its new solar PV. It also had a single traditional meter that it was waiting to be replaced as part of the smart meter roll-out. Two other secondary schools had had smart meters installed a few years ago as part of a smart metering programme put in place by the local authority. In one of the academies a 'cello' device[14] had been attached to the gas meter to convey information. The primary school only had a smart meter installed for its electricity six weeks prior to the case study interview.

The other pathfinder in the sample had had smart meters for some time before the energy manager from the local authority enquired about use of the data and, when he found it was not being used, provided the necessary training. The visual representation of the data that was possible proved very persuasive and enabled the school and local authority to bring other senior leaders and governors on board with the energy efficiency programme.

The schools that were not using their smart meter data saw the principal advantage of smart meters as remote reading and more timely and accurate billing, avoiding the need for costly 'catch-up bills'. These advantages were also identified in the pathfinder schools.

Installation Experience

Several of the schools had experienced difficulties around installation of their smart meters and gaining readings and bills and in three cases, were still providing readings or someone was coming to take the readings. This seemed to have created some cynicism around the benefits of smart meters.

[14] A device that captures and communicates gas consumption.

Non-users of Smart Meter Data

> I did go onto that site, I did go on to these websites that I had here, but it wasn't giving me anywhere to log on or if it did, I need log-on details, so that's why I'm wondering if maybe they might be sending that out at a later date. (C2; primary (LA); DM)

Three of the six schools had not accessed their smart meter data although one was interested and had tried to do so. The lack of handover at installation and/or training in accessing and using data left schools unable to get started even if they wished to.

Users of Smart Meter Data

The other three schools made use of smart meter data to varying levels. Both pathfinder schools made regular and extensive use of data to guide energy management and engage staff/students. In one, the energy manager was looking at it on a daily basis (frequently in the evenings and during holidays) while the site manager looked at it two or three times per week. They received the data from three sources and were analysing it themselves rather than opting for suppliers to analyse, interpret and provide advice based on the data.

A third school had used data minimally (via a local authority mediated interface) and was sceptical about its value. The business manager thought she referred to the data about three times per year possibly in response to getting a bill or two years ago when planning for temporary classrooms. The supplies officer in the local authority who was responsible for liaising with this school, along with over 700 other schools in the county, explained that schools were invited to centrally-run training sessions on the use of the data. She was aware that the interface with the data presented some challenges and was considering re-tendering the service. She also suggested that greater simplification of the pathway between meter operator, data collector, data aggregator and data retriever could be helpful in providing the end user with what they need.

Examples of how the pathfinder schools used the data, as well as specific examples of when it had prompted action are provided in Box 1.

The academy that was looking at the data only occasionally and was sceptical about its value, described how it had enabled them to identify that energy use was not falling off as much as expected in the evenings and at weekends, probably as a result of equipment being left on standby, but this had not prompted purposeful action. More recently, it had also shown that there was a spike in usage at night; they had called in Property Services from the local authority and the optimisers and control panels on the boilers had been adjusted to make them work better together.

Smart meters had enabled all those using the data to do things which they previously were unable to do; the facility to measure consumption meant they were able to manage it.

Box 1: Smart meter data provision and use by pathfinder schools

Example 1: Secondary school

The energy manager can identify spikes in use and investigate the cause after taking into account factors like outside temperature, events going on at the school, anything that might reduce or stop the renewables operating. In the past he had found, for example, a gas leak, the malfunctioning of a temperature sensor (it defaulted to minus 55^{o}) that meant the boiler had come on, and computers that had been left on all night.

He has worked out for gas what a reasonable usage would be and looks for variance from this, trying to manage consumption to keep within what is expected unless there are unusual circumstances. Similarly for electricity, he examines half hourly usage and compares it against the average day profile.

The data is used to check the monitoring equipment is operating correctly (accurate to 5 per cent).

The data is accessed by students in relation to curriculum-based work or for the STEM Club as part of their monitoring activities.

If there are any problems he gets an automated text message e.g. if a boiler has not come on.

Specific examples were given of how smart meter data had enabled the school to make significant cuts in its energy consumption;

- **originally their heating was being controlled remotely by the local authority; data gave them the evidence to take control of it themselves**
- **they found that an adjacent leisure centre that used the school's electricity supply was consuming £5k worth p.a. Once they started billing them, their energy use plummeted**
- **it showed the building was being heated all the time including the Easter holidays. Over one Easter period the school used 100,000 kWh of gas; in the following Easter period after appropriate action was taken, consumption was reduced to 20,000 kWh.**

Example 2: Nursery, lower and middle school

The school can identify spikes in use, as well as troughs as a basis for questioning the reasons for this. The example was given of there suddenly being a spike in gas usage which on investigation, was found to be due to a lightning storm causing the heating controls on the lower school's site to be switched on all the time. The programme was reset.

The system can be set to send alerts if a usage threshold is exceeded; this was in the form of an email.

Can identify pressure points on energy use.

Can see the effects of changes made e.g. from changing time settings in a new building especially when viewed over at least a month.

Can interrogate usage year on year; because the pattern of a school year is fairly stable, any discrepancies should be investigated.

The data is also used in simple graphic form to show pupils how much energy is being used or saved - examples included the energy used to prepare and serve Christmas lunch to the whole school and savings that were made during 'Switch Off Fortnight'. In the latter case, they used degree day data to show that usage was lower even taking winter weather conditions into account.

Reactions to Products and Services

Methods of accessing data

Respondents were shown information on how smart meter data could be accessed (see Figure 3, p40). The general response to the options for accessing smart meter data was a preference for doing so via a PC at their desk. Although the energy manager in the pathfinder secondary school could access data using an app on his mobile phone, others were less keen on using such a small screen and there did not seem to be the same level of interest in accessing data off-site. One of the site managers could see its potential use when out and about but thought it would be easier to look at data and graphs on a computer screen.

The managers in the schools who had yet to access smart meter data could quickly see its potential usefulness to identify if energy was being used unnecessarily.

The business manager in the primary school compared the data to what she had seen when she used a portable energy meter to demonstrate how much electricity certain devices used. She was the only participant who related to the idea of a list of tips for organisations to help them save energy and gave an example herself.

> Sometimes with that heating system, it takes a couple of days to heat up [ ] so we would put it on, on the Saturday, ready for coming back on, on a Monday, in the winter. But on the same side, I would start turning it off on a Wednesday because it would take a couple of days to cool down. (C2; primary (LA); DM)

However, the other two business managers found it difficult to understand some of the more sophisticated features and in the one case, felt this was for somebody else to take on in her team.

Added value services

At the end of the case study visits, reactions were explored to four product or service ideas that are intended to help organisations make better use of the information from their smart meters. Due to constraints of time, it was only possible to briefly cover each of these. The ideas were not covered in the telephone depth interview. The ideas, as described to participants, are shown in Box 4, p41.

The **power of attorney** service whereby an organisation could be automatically switched to a cheaper tariff when it becomes available was understood but largely rejected; the other three ways of engaging with smart meter data (automated buildings performance evaluation; pattern recognition; and device disaggregation) were already known to those accessing such data already. Others seemed to struggle with understanding and this left them unsure of their usefulness and whether, with other demands on their time, they were the best people to get to grips with the data and convert it into action.

- ***Power of attorney:*** the main reasons for rejecting this idea included scepticism about whether better deals could be achieved with suppliers than from brokers or the local authority; a resistance to switching suppliers frequently (it was felt this was suggested by the description) because of problems in the past and the need to go through the process of getting approval from the governing body; the fact that the quality of service was important as well as cost; and there was reluctance to lose control of the relationship with the supplier. The service would need to result in considerable savings to overcome these negative perceptions.
- ***Automated buildings performance evaluation*** (a means of comparing a building's energy performance against itself to help identify the extent to which energy is being

used efficiently)***: t***he pathfinder schools thought they were already able to do this using smart meter data including degree day analysis, by comparing performance over different periods. The business manager who was sceptical about the value of the data could access this data if she wished, but she was not interested. Others who were not using smart meter data felt that this type of service could be of value but they would need to understand it better.

> So my point is if every building is being measured and just sort of the data going off to a database, you would soon spot the schools that were being extravagant with their use of energy. And again, you could have automatic messages going through, 'did you know that the school down the road, the same as you, spent £500 yesterday and you spent £1,000?' (C2; secondary (LA); DM)

Although the description of this service (see Box 4, p**Error! Bookmark not defined.**) suggested that comparing one organisation to another is often not helpful, a couple of participants felt that it could be interesting to compare their school with other schools with similar characteristics. It was also suggested that this was information that local authorities might already have access to. The energy manager suggested that schools could be alerted to potential problems if they were consuming markedly more than a comparable school.

- ***Pattern recognition*** (using smart meter information to identify unusual patterns of consumption)***: a***gain, the pathfinder schools were able to extract data to enable them to do this. The business manager in the academy making minimal use of smart meter data recognised this as something that the school had already used but she saw it as something to be done as a one-off rather than continuously. Her site manager was however interested and could see that it might have value.

  The local authority Energy Programme Manager felt that alarms and exception reporting were only useful once a school was working in a stable, efficient way; otherwise, reports could be sent too often. The supplies manager in another local authority who planned to retender the data provision service commented that the new specification would include the facility to send recommendations direct to the site.

  - ***Device disaggregation (a*** method of indicating the electricity consumption of individual devices)***: t***his was something that was being used in a pathfinder school centred on devices which had the greatest possible impact if they were to go wrong.

  The view of the local authority energy programme manager was that there were too many electrical devices in schools to make this realistic and would indeed need to be targeted. While plug-in devices had been tried in a couple of schools to test energy consumption as a one-off exercise, there was scepticism about how such information could be applied.

Willingness to pay for added value services

While one of the pathfinder schools was paying several subscriptions for its data from different providers, the other with access via the local authority was not (yet) doing so and an academy resented the amount it was paying. There was some reluctance to pay a charge for access where schools lacked the time and expertise to exploit the data.

Conclusions

Summary of Key Findings

Summary pathway maps

Two pathway maps were developed for cluster 2 to illustrate how different factors influenced energy management, one based on those schools that were using their smart meter data to manage their energy (see Figure 2), and the other for schools not using their smart meter data (see Figure 3).

The maps display a number of boxes that group together various factors that are involved in energy management. The four boxes shown within the central red box relate to those things that are internal to the organisation itself and include important organisational factors, the key motivations for trying to manage energy efficiently, the internal actors that have a role in energy management. The fourth box labelled Energy Management summarises how, if at all, the organisations were analysing their energy use, the energy saving actions that had been implemented and the extent to which the organisations had achieved energy savings and reductions in energy costs.

The boxes labelled Other Drivers and Barriers are shown at the top of the map inside a pink box. They include a mix of internal and external factors that influence energy management.

The yellow box at the bottom of the pathway map summarise things that are external to the organisation and is divided into External Actors that played some role in energy management, together with any particular Engagement Strategies that were being adopted. The External Context box outlines external factors that were relevant to how the organisations managed energy.

Factors that were common to all or most of the six clusters are shown in [square brackets] as they do not appear to differentiate between clusters. Factors highlighted in **red** indicate things that may discriminate between users and non-users of smart meter data from cluster 2. These maps need interpreting with care as they are based on small numbers of schools.

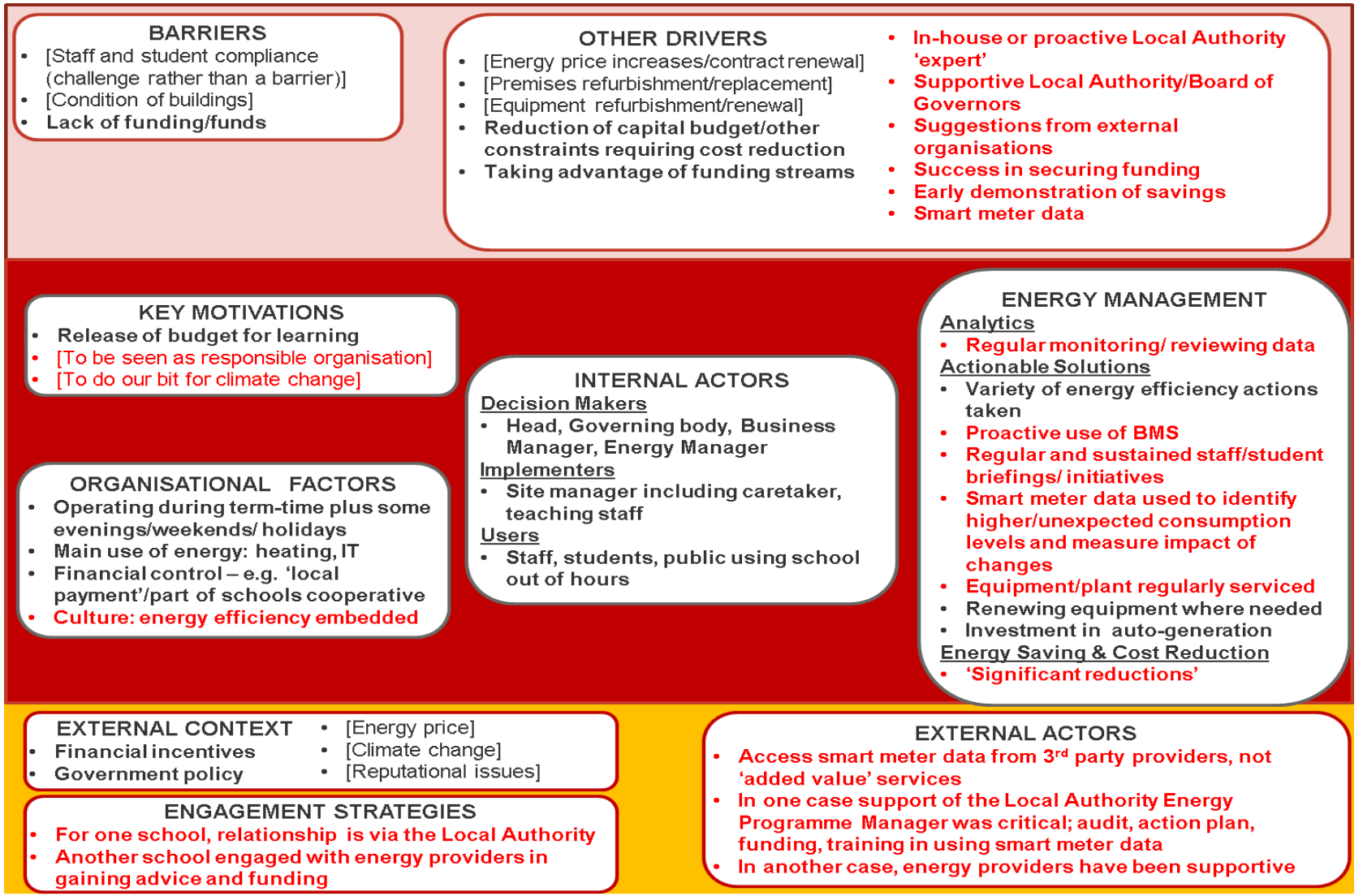


Figure 2: Users of smart meter data pathway map

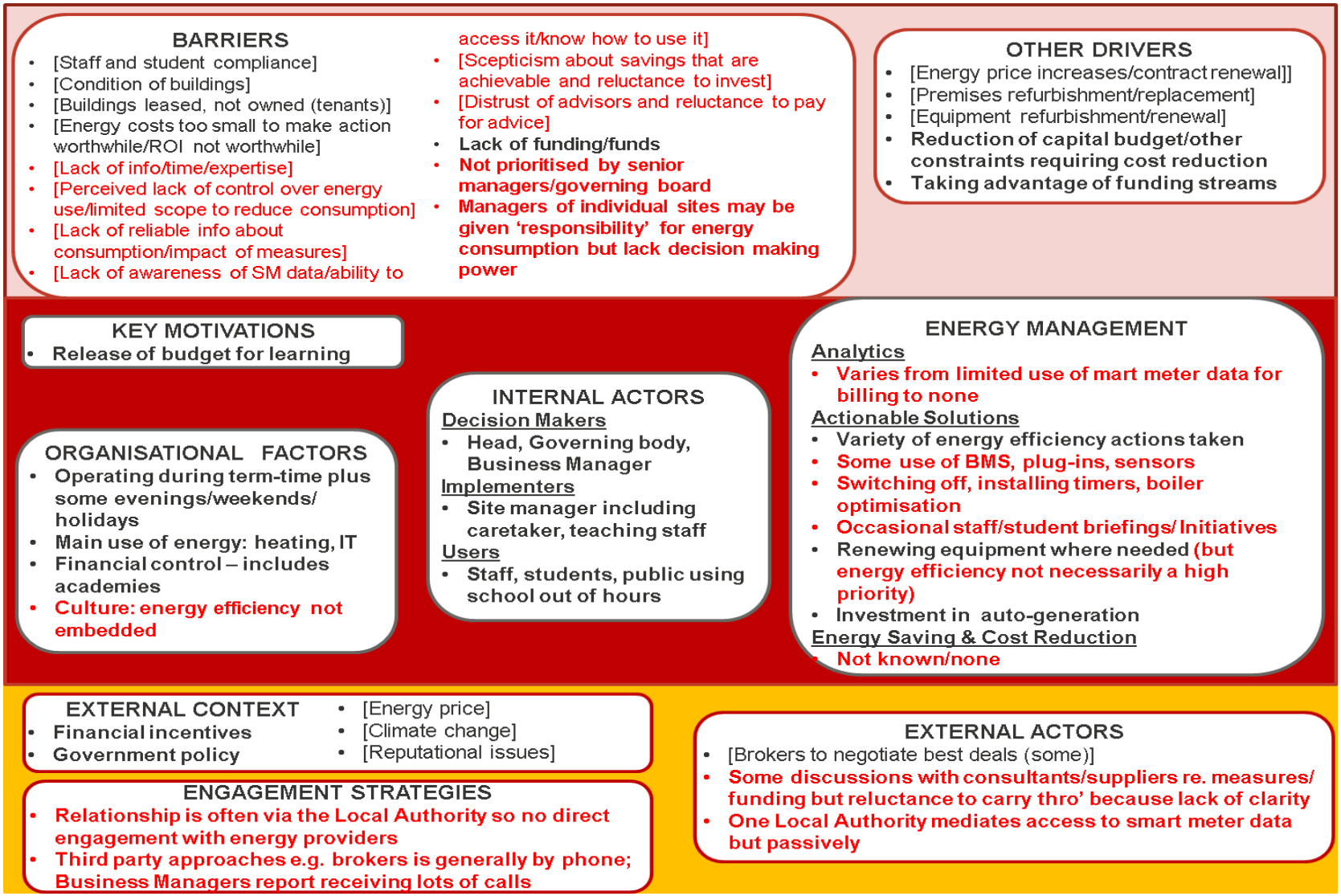


Figure 3: Non-users of smart meter data pathway map

Cluster specific findings on Energy Use, Management and Associated Influences

This cluster stands out from others, being both public sector and deriving its funding in different and various ways (local and central government). Its operations are focused on term-time but for various reasons, the expected reduction in energy consumption may not be seen over the shorter holidays, over weekends or overnight. As with all other organisations taking part in the research, cost reduction was a key motivation for effective energy management; however, in the case of schools, this was not to increase profitability but was to free up more of the budget for learning. Changes in capital funding arrangements and concerns about future funding make savings in the cost of energy more appealing but the uncertainty associated with loans and other schemes for financing significant energy efficiency measures sometimes weighs against investment.

For these reasons, there were a number of factors relating to energy management that seemed to apply, in particular, to this cluster. These are summarised below.

- The schools were operating during term-time but also there was some evening, weekend and holiday use, at least for parts of the premises.
- Heating was one of the main uses of energy and boilers represented significant investments.
- IT equipment, because of the large numbers of items, was also important and could represent a large potential waste of energy when the use was not controlled. The support of and prioritisation of energy efficiency by the senior leadership team was critical particularly where decisions involved a higher spend.
- Expertise in energy management was an important influencing factor, but was often lacking within a school; support from the local authority could be very helpful.
- Refurbishment and renewal of assets were critical points at which energy efficiency measures may be installed.
- Accreditation to the Eco-schools initiative may have created awareness of environmental issues but did not always reflect real and sustained commitment to energy management.
- The impact of energy management measures was amplified when energy efficiency was incorporated into the culture of a school.
- Funding of more substantial energy efficiency measures could be an issue especially where future savings and payments were uncertain; while there was engagement with third parties, what they had to offer was sometimes viewed with scepticism.

Differences between users and non-users of smart meter data

Two of the six schools in the sample were using their smart meter data to improve their energy efficiency on an on-going basis; a third school was doing so only sporadically. The principal reason for it not being used elsewhere was a lack of awareness that it was possible to access and use the data but there was also scepticism about whether it would merit the time and effort to do so, and indeed, whether this required someone who was more focused and competent. Key differences between users and non-users of smart

meter data are summarised in Box 3 however given the small sample sizes, great care is needed when interpreting the findings

Users of Smart Meter data	**Non-users of Smart Meter data**
Had greater control over buildings, plant and equipment through BMS	Less control, sometimes due to the lack/less use of/lack of understanding of BMS
Energy efficiency embedded throughout the school	Energy efficiency not embedded; low expectations of compliance by staff and students
Supportive senior leadership team and/or governing body	Senior leadership team and/or governing body who appear disinterested in energy management
Presence of a trusted 'expert' as a key part of the decision-making process/access to expertise	No easily accessible and trusted 'expert' Not accessing or making full use of expertise
Successfully taking advantage of funding opportunities	Cautious approach to applying for funding, scepticism about possible savings
Key barrier: funding for additional energy savings	Wide range of barriers
Reviewing smart meter data regularly to identify unusual patterns of consumption and to evaluate impact of any changes	Unable to use smart meter data to identify opportunities for energy reduction or to demonstrate impact of any changes
Substantial cost savings have been achieved	Inability to identify savings from specific actions
Greater value put on, and use made of, micro-generation	Less use of/value placed on micro-generation

Research Implications

Importance of Size and Other Factors Influencing Energy Management

Although for the purposes of this report, the schools have been divided into two groups, users and non-users of smart meter data, they can also be seen as representing a spectrum in terms of where they are on their energy efficiency journey. At one end was a large secondary school that had been working to reduce its energy consumption for several years, had put in place numerous measures and pieces of technology to help monitor its use at a very granular level, and had embedded a culture of energy efficiency among staff, students and beyond to other schools and the wider community. They had taken advantage of sources of funding, harnessed micro-generation and used smart meter data proactively to guide energy management. They had been very successful at making substantial savings and would like to be able to do more.

At the other end was a small primary school which had only recently received its first smart meter. The business manager had yet to find out how to access smart meter data and, while interested herself in doing so, suspected that energy efficiency will not be a key consideration in the near future and speculated whether, given the small size of their bills, it ever would be.

Between were four schools that either, to varying degrees were making use of smart meter data or, were unaware of its existence. Some were keen to have access while others were unsure whether and how they would make use of it.

From the schools in this research, the hypothesis that size is a determining factor in terms of interest in energy efficiency and the use of smart meter data as a tool to achieve this, holds true, however this is a limited due to sample size. Larger schools tend to have higher student numbers, larger sites and higher energy bills from which the greatest potential savings can be made. It could also be argued that it is likely to be the largest schools that can afford to have a staff member who is at least partly focused on the task of energy management. Certainly, where schools have a single administrator, it is unlikely that they will have time to give to it.

However, extrapolating from the process that the pathfinder schools had gone through and how their journey had been facilitated, as well as the barriers for other schools to do more, one can hypothesise that all schools could be helped to become more energy efficient by having:

- direction and support from the senior leadership team to signal that it considers energy efficiency and savings on energy bills to be a priority and something that business managers should concern themselves with
- access to expertise in energy management and the technology of energy systems that enables an energy efficiency programme to be designed, implemented and evaluated effectively
- a site manager or other staff who can work with the energy 'expert' (these may be the same people) to implement the energy efficiency programme
- access to interested teaching (and possibly site) staff who can help drive a programme of behaviour change in the school
- access to funding which is transparent and clear about the financial implications for schools so that they understand the impact on budgets going forward.

Engaging Non-users: key learnings

As noted, a number of schools in the sample that had smart meters in place were not using the data to help manage their energy. The key learnings from the research about how to engage these schools, as well as those that have not yet had smart meters installed, are summarised below.

Encouraging schools to engage with smart meter data depends on developing their interest in energy efficiency and demonstrating that this can produce savings that merit the time and effort. One can hypothesise that it is important that all of the conditions set out in the bullet points above need to be in place for an energy efficiency programme to be successful; if any are missing, some aspect of the process is likely to be undermined. For example, the research has shown scepticism about the extent of energy savings that are possible and reluctance to take up funding opportunities. Without access to a trusted 'expert' capable of devising effective energy efficiency measures, decision makers are likely to remain unconvinced. Moreover, without such a person (or other site staff) with an understanding of the school's systems, the programme will not be implemented effectively, and without culture change in the school, savings will not be maximised.

The research has shown the potential importance of the role played by local authorities in offering expertise, support, training and funding and it might be considered whether the model used in one of the pathfinder school's local authority could be usefully applied elsewhere. Certainly, there was evidence of local authorities having encouraged energy efficiency in the past. More generally, it seems there may be opportunities for sharing experiences and good practice in forums such as those for bursars and business managers.

A final consideration. **All of these schools have in place some elements that might contribute to an energy efficiency programme, be it smart meters and potentially, smart meter data, a BMS, a desire to be seen as an Eco- school, some form of micro-generation; that is, none of the schools are starting from scratch.** It seems that this potentially provides a positive platform to encourage schools to do more – for example, by making a case for developing an overarching strategy that will make the most of what they have and focus them on what else they might achieve.

Appendices

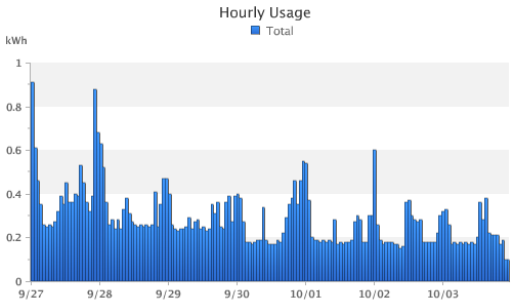
Research Questions

- **How does the population of smaller non-domestic sites covered by the smart metering mandate use energy and make energy efficiency related decisions? How do these uses and decision-making processes vary according to key characteristics?**
- **In what ways do different types (i.e. clusters) of smaller non-domestic sites covered by the smart metering mandate interact with;**
    - **other key influencing actors (e.g. energy suppliers, facilities managers, landlords)?**
    - **other influences on energy management (e.g. energy prices, reputational and/or corporate social responsibility)?**
- **How does data from smart meters contribute or have the potential to contribute to improved energy management, energy efficiency and reduced energy consumption in smaller non-domestic sites? What are the barriers to improvements? How does this differ for different types of smaller non-domestic sites?**
- **Based on an understanding of the support, products and services being (or planned to be) provided to help increase awareness, what is the level of understanding and use of smart meter data within small-non domestic sites? What has been or is likely to be the take-up or response from non-domestic sites?**
- **What are the implications for maximising the benefits of smart meters (in smaller non-domestic sites)?**

Stimulus Materials

Information from smart meters

- On a PC/laptop via the web
- Smart phone app
- Consumer Access Device – a visual display that links with the smart meter(s)
- More detailed bills



Creative Research 9

Figure 4: Information from smart meters

Power of Attorney Service

- **Cheap Energy Club is an existing 'power of attorney' service for domestic energy customers**
- **Subscribers enter data including their current supplier, previous consumption, etc.**
- **They are sent an email automatically once a cheaper deal becomes available**
- **Smart meters means that accurate consumption data could be used**

Automated building performance evaluation

- **Smart meter data can be used to compare the current energy use of your business premises with the energy use over time, taking into account weather related fluctuations. This can help identify the extent to which energy is being used efficiently**
- **Where this reveals that energy is being used less efficiently, the service could provide ideas and advice on what is causing this as well as suggestions for improvements**
- **By comparing a building's energy performance against itself overcomes the problems of comparing two different buildings**
- **For example, two hotels, one urban and one rural near to a lake, with a similar building fabric and number of rooms may have a large difference in heating requirements in winter and any benchmarking programme would struggle to account for this**

Pattern recognition

- **Pattern recognition technology can use smart meter information to identify, for example:**
- **Heating or cooling comes on too soon or switches off too late**
- **Boilers, or other heating components such as heat exchangers, are the wrong size for a building**
- **Building energy management systems have been manually overridden and not re-set**
- **Insights/recommendations can be sent to building managers and occupants; e.g.**
- **"high gas and electricity consumption indicates that heating and cooling systems are working simultaneously"**
- **"your building's lights are on all night"**
- **"changing your air conditioning filters will pay back in approximately eight months"**
- **"you should change your air-conditioning settings to X today due to the weather forecast"**

Device disaggregation

- **A range of technologies that allow you to understand the electricity consumption per device. For example, a smart plug that sits between the plug on the appliance**

and the socket

- **This could inform you about items of equipment that are using the most energy, as well as those using more energy than they should be, such as an air con unit that needs servicing**

List of Reports

Non-Domestic Smart Metering Early Learning Research reports:

- Main Report
- Annex 1: Cluster 1 - Higher energy, customer facing chains
- Annex 2: Cluster 2 - Small Public Sector Sites (Schools)
- Annex 3: Cluster 3 & 4 - Small, customer facing independents
- Annex 4: Cluster 5 - Lower energy, customer facing chains
- Annex 5: Cluster 7 - Higher energy, employee only sites
- Annex 6: Cluster 8 – Offices
- Annex 7: Landlords & Tenants

Technical Report

Department for Business, Energy & Industrial Strategy
1 Victoria Street, London, SW1H 0ET
www.gov.uk/beis