CARBON TRUST

Making business sense of climate change

Advanced metering for SMEs

Carbon and cost savings

Full Report

The Carbon Trust would like to thank everyone who has contributed to this report, either through direct involvement in the trial, general discussions or review of findings and implications.

Contents

Executive summary

Widespread use of advanced metering by SMEs can provide cost-effective carbon savings for the UK and significant energy savings for customers. The Carbon Trust's field trial has demonstrated the potential benefits, identified key barriers and clarified the action required by the SME community, Government and energy suppliers to accelerate the market.

Advanced metering can enable businesses to identify energy, cost and carbon savings by providing detailed information about the way in which they use their energy. Although this technology is fairly well established in companies with significant energy demands, it is not widely used by small to medium-sized enterprises (SMEs).

There are over 2.7 million manually-read energy meters in UK SMEs, all of which could be replaced by advanced meters. The energy consumption through these meters is estimated to cost £6.5 billion per year and lead to emissions of over 50 MtCO_2 per year.

From 2004 to 2006 the Carbon Trust carried out the first UK field trial of advanced metering for SME users. The trial aimed to demonstrate the potential benefits of the technology and to understand the case for encouraging widespread adoption of advanced metering by SMEs. A total of 582 advanced meters were installed in SMEs across the UK and metering services were provided to these sites by seven different consortia.

> SMEs using advanced metering can identify an average of 12% carbon savings and implement an average of 5% carbon savings.

The study has demonstrated that SMEs using advanced metering can identify an average of 12% carbon savings and implement an average of 5% carbon savings through reduced utility consumption, as shown in Figure 1. The SMEs involved in the trial achieved average annual savings of over £1,000 and 8.5 tCO_2 per site.

Figure 1 *Average % carbon savings in SMEs using advanced metering*

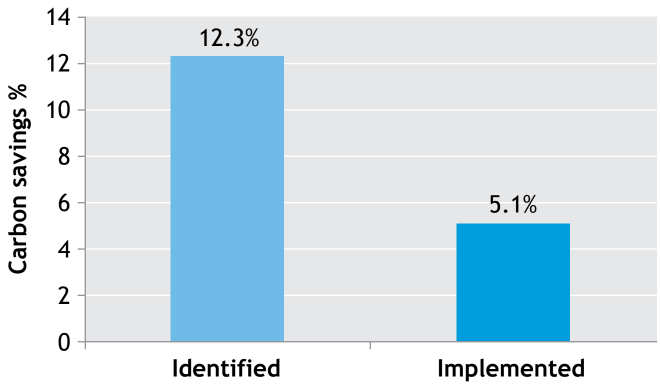
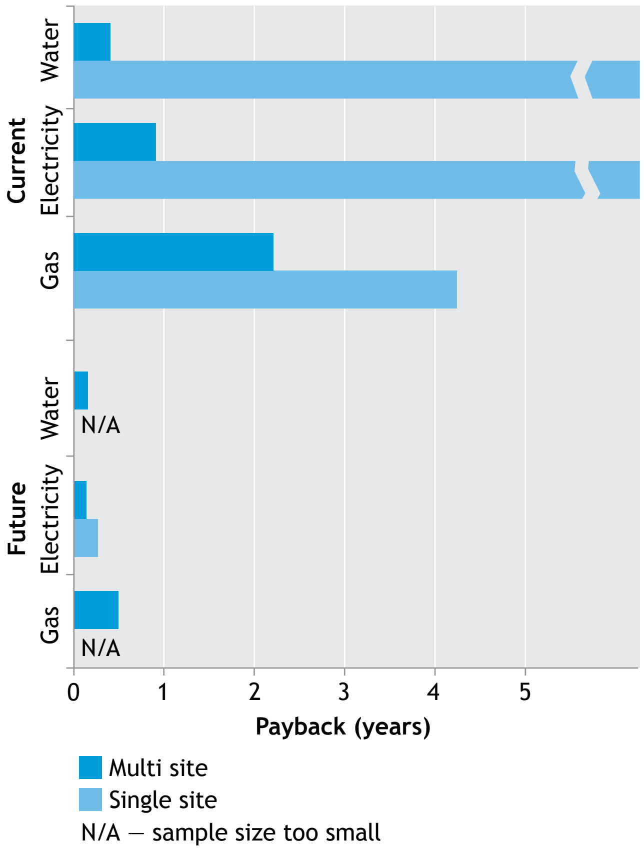


Figure 2 shows the paybacks modelled for single and multi-site companies. Based on current meter and service costs, there is already a very strong business case for using advanced metering at multi-site SMEs, such as retail and wholesale chains, and for energy-intensive SME sectors, such as manufacturing. For single-site SMEs with lower energy consumption, the business case is less attractive with paybacks over five years in most cases. However, modelling has also been carried out using predicted costs and this has indicated that in future a clear business case will also exist for single-site SMEs with lower consumption levels, as the costs of metering services will be driven down by increased innovation, automation and economies of scale.

***Figure 2** Advanced meter payback periods for SME sites based on current and future costs*

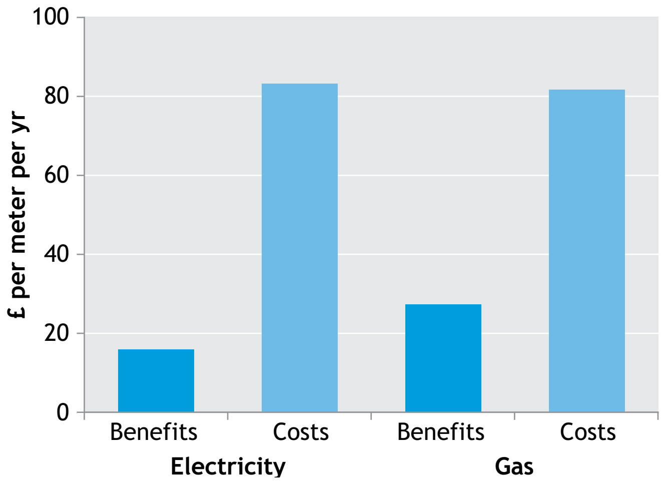


A variety of different metering services were included in the trial, ranging from basic data provision to detailed advice via phone calls and site visits. The highest energy savings were achieved by providing consumption profiles and energy saving recommendations via email. This is a significant finding which suggests that low-cost metering services could be provided using automated systems in future.

Although some SMEs were initially sceptical about the potential benefits of advanced metering, there was a widespread recognition of these once the services had been used. Of the many customers that were offered the chance to continue their metering service on a full commercial basis, over 80% opted to continue at the end of the trial.

From the perspective of energy suppliers, there is likely to be a good business case for providing metering services to certain sections of the SME community which have large consumption or concentrated sites. However, as Figure 3 illustrates, the current costs of providing advanced metering services to all SME users significantly outweigh the potential benefits. Furthermore, even as costs of technology continue to come down in future the business case for energy suppliers appears to remain marginal overall.

***Figure 3** Supplier costs and benefits for widespread roll-out of advanced gas and electricity metering to the SME community, using current costs*



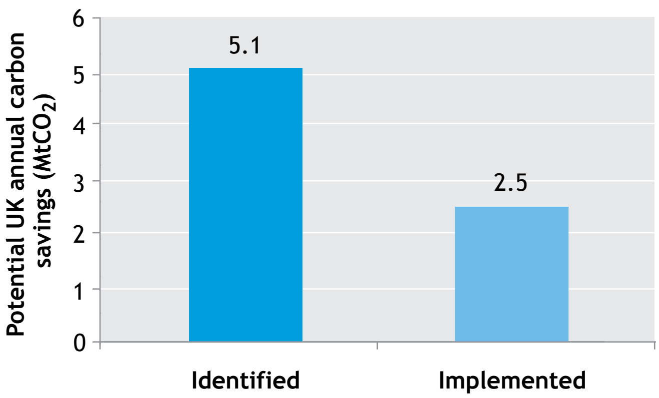
> There is already a very strong business case for using advanced metering at multi-site SMEs and for energy-intensive SME sectors.

> The trial findings highlight a significant barrier to the wider uptake of advanced metering due to the insufficient financial incentives for energy suppliers.

Energy suppliers can benefit by altering their business models to realise new opportunities, such as sales of higher-margin metering services. They may also benefit from enhanced customer acquisition and retention. However, the trial findings clearly highlight a significant barrier to the wider uptake of advanced metering due to the insufficient financial incentives for energy suppliers to provide these services on a widespread basis. Given this context, if the SME advanced metering market is left to grow organically it is likely to develop in a fragmented way, with slow growth and limited economies of scale being achieved.

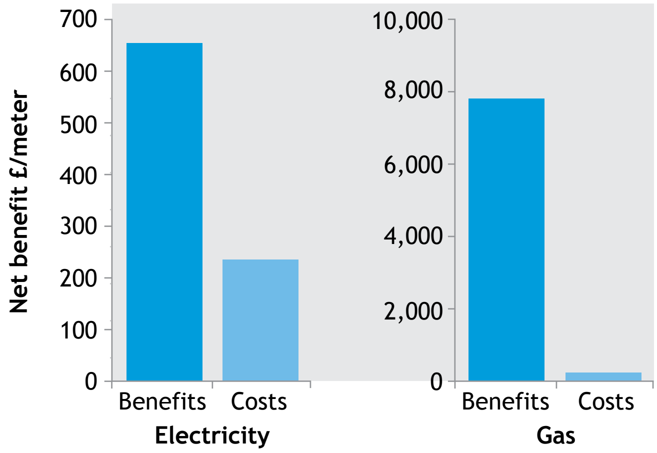
From the overall UK perspective, widespread adoption of advanced metering in the SME community represents a significant opportunity for achieving cost-effective carbon savings. Figure 4, which shows the results of the field trial scaled up to the UK level, illustrates that a total of 5.1 $MtCO_2$ savings could be identified and 2.5 $MtCO_2$ savings could be implemented per year. This level of identified savings is equivalent to over 2% of all carbon emissions from UK businesses. Scaling up the results in financial terms indicates that total cost savings of £650 million could be identified and £300 million implemented per year across the SME community.

Figure 4 *Field trial carbon savings scaled up to UK level*



Furthermore, a very significant proportion of these carbon savings can be achieved with a net financial benefit to the UK. Figure 5 shows that at current costs, there would be a net UK financial benefit from rolling out advanced metering to all but the lowest use groups of SME users[1]. Under expected future costs there would be a net UK benefit for rolling out advanced metering to all business users.

Figure 5 *Net UK costs and benefits for advanced metering roll-out to all but the lowest consuming SMEs[1]*



In the future annual savings of 5.1 $MtCO_2$ could be identified and 2.5 $MtCO_2$ implemented at no net cost to the UK.

[1] Lowest consuming groups refers to electricity customers in profile classes 3 and 4 and gas customers with annual demand of less than 732 MWh.

In light of the significant cost savings available to SMEs and carbon savings achievable at net financial benefit to the UK, it is essential that the market for advanced metering in SMEs grows as rapidly as possible. Given the lack of incentive for energy suppliers to provide advanced metering services across the entire commercial sector, there is a very strong case for a mandated roll-out of advanced meters for SMEs.

There are various policy options which could be used to achieve a mandated roll-out. The most basic policy measure would be to ensure that advanced meters are installed for all new and replacement meters.

Beyond this the Government could mandate an accelerated roll-out to increase the rate at which existing meter stock is replaced. An accelerated roll-out is likely to be most effective if targeted initially at all high-consumption SME users, where the business case is currently most attractive, and then extended to the wider SME community. Using a 20% accelerated roll-out rate, targeted initially at the highest consumption users, could lead to savings of 1.5 $MtCO_2$ per year by 2012 and 2.5 $MtCO_2$ per year by 2016.

Without a mandated roll-out, widespread uptake of advanced metering by SMEs is highly unlikely and a significant cost-effective carbon saving opportunity will be missed.

Further supporting measures will also be required to ensure that the market grows in a coordinated manner. For example, it is vital that industry-wide standards regarding meter functionality and interoperability are adopted. This work is underway, led by OFGEM, but must be prioritised to ensure that agreement is reached at the earliest possible opportunity. Further measures are also required to ensure that the data from advanced meters is made freely available to the relevant parties and that standards are agreed relating to the frequency and format of data transfer.

> Without a mandated roll-out, widespread uptake of advanced metering is highly unlikely and a significant cost-effective carbon saving opportunity will be missed.

For energy suppliers, roll-out will stimulate the market for innovative new metering services and generate increased customer awareness of the benefits of using such services. Widespread uptake of advanced metering would also help catalyse an associated energy services market, particularly for smaller service providers. It would also put in place an infrastructure of meters capable of supporting further policies to reduce carbon emissions in future.

The following is a summary of the key recommendations coming from the trial:

- Trade bodies, the Carbon Trust and others should continue to promote the benefits of proactive use of advanced meters to the SME community
- Based on the new evidence from this study the Government should take action to ensure a widespread roll-out of advanced metering technology to SME users
- Government should work to ensure that appropriate standards are put in place regarding advanced meter functionality, data availability and data transfer procedures
- Energy suppliers and metering service providers should investigate new business models to provide innovative metering services to their SME clients.

The benefits of advanced metering are clear in terms of cost savings for SMEs and carbon savings for the UK. Action is now required to stimulate the market and ensure a widespread roll-out of this important technology.

1 Introduction to advanced metering

1.1 The potential benefits

The Government has set a target to cut carbon emissions by 60% by 2050 and, in order to achieve this, significant reductions will be required from all areas of the UK economy. Energy use by business is the largest source of carbon emissions in the UK and reducing energy consumption in companies of all sizes is therefore vital in order to meet our targets for reducing emissions.

In order to make reductions in energy consumption, consumers must first understand their energy usage. For many business customers the only information they receive on their energy consumption is via utility bills. However, the frequency of billing does not provide sufficient detail for energy management. The situation is exacerbated by the use of estimated bills which prevent customers from gaining an accurate picture of when and how their energy is consumed.

Advanced metering provides accurate and regular consumption data to consumers, allowing closer management of utility use. The half-hourly data derived from advanced metering can also be aggregated for billing purposes, avoiding the requirement for estimated bills.

The overall carbon dioxide emissions from the UK business sector are around 220 $MtCO_2$ per annum[2] and around 50 $MtCO_2$ of these emissions come from SMEs which do not generally have any form of advanced metering of their utility use. There is therefore significant potential for carbon savings if advanced metering can help reduce energy demand in the SME sector.

1.2 Use of advanced metering in businesses

For large UK businesses advanced metering is often used across all three utilities (electricity, water and gas), but is most established for electricity. Consumption data is routinely captured by suppliers for high-volume consumers in the category referred to as 'Code 5'[3]. This half-hourly data is used to provide accurate bills and also to allow the electricity to be traded via the Balancing and Settlement Code (BSC) system. Larger consumers of gas and water also benefit from using advanced metering and have found that when used to manage consumption, the savings achieved can justify the capital investment required. At this high consumption end of the market, where there are significant potential savings on utility bills and energy managers are on hand to interpret the consumption data, advanced metering is used to good effect.

For small and medium-sized UK enterprises (SMEs), advanced metering is rarely used since half-hourly data is not required or collected by utility suppliers, and 'optional' systems are not commonly used. If the potential benefits of advanced metering could be realised in the SME sector, this could provide attractive cost savings for SME users as well as a significant contribution in terms of UK carbon savings. Some SMEs, for example chains of high-street retail stores, may also see Corporate Social Responsibility (CSR) and brand benefits from the reduced environmental impact associated with these carbon savings.

Recent developments in areas such as communications technology have helped bring costs down, making advanced metering a more realistic proposition for smaller sites such as those found in the SME community. With these cost barriers eased, the Carbon Trust set up a major field trial in 2004 to investigate if the SME market can realise the cost and carbon benefits seen in many of the larger UK companies already using advanced metering.

[2] Source: 'Climate Change: The UK Programme 2006', Defra report. End user emissions from business were 60.5MtC (222 $MtCO_2$) in 2004.

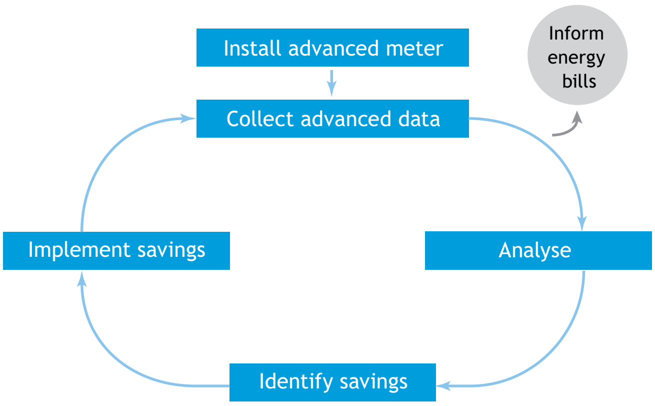
[3] 'Code 5' users are sites which already have electricity consumption monitored half-hourly.

1.3 Principles of advanced metering

In general terms an advanced meter is any form of metering system which provides a greater degree of energy consumption data beyond that used for basic billing. The increased granularity of data provided by an advanced meter can be used for energy management purposes and also has the potential to be aggregated for, or by the supplier for billing purposes if required. Using metering for effective energy management requires consumption to be detailed at regular periods throughout the day. Half-hourly periods have become the most commonly used time interval for advanced metering systems.

The metering solutions involved in the Carbon Trust field trial can be most accurately described as 'advanced metering, monitoring and targeting' (AMM&T), as illustrated in Figure 6.

Figure 6 *Use of advanced metering: Data is collected and analysed to identify and quantify possible savings, saving measures are implemented, and data is reviewed again*



1.4 Analysing advanced metering data

Advanced metering can help identify energy savings in several ways. Figure 7 represents a typical half-hourly energy profile shown for two different days.

Figure 7 *Example half-hourly profile data, showing the three key areas for energy reduction*

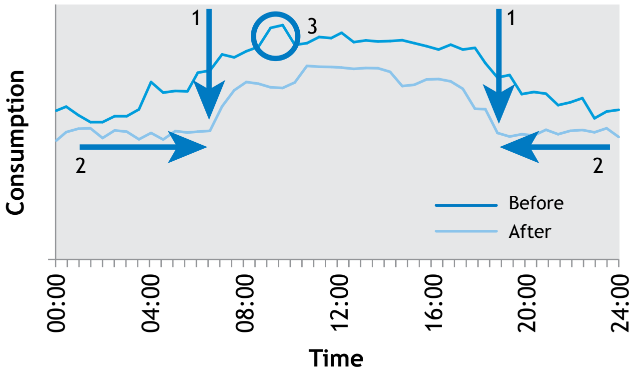


Figure 7 illustrates three key types of potential energy saving measures that can be derived from advanced meter data:

1. **Base load reductions** – the overall base load of the site can be studied and reduced, for example, by identifying unnecessary constant energy use.
2. **Process optimisation** – the profile can be used to identify what equipment is running and when. Altering the start-up and shutdown times of key processes and equipment can reduce consumption by limiting the duration of high-energy use at the start and end of working schedules.
3. **Peak usage reduction** – analysing timings and frequencies to establish the causes of peaks in energy usage, and understanding the causes in terms of specific activities or equipment.

1.5 Sources of energy savings

Energy saving opportunities identified from advanced meter data can be pursued in a number of ways. This section highlights the role of benchmarking and describes how savings can be derived from information, process and investment-based actions.

Benchmarking

Benchmarking can play an important role in the effective use of advanced metering data. Reference data is collected for a site or process over a typical period of operation and comparisons are then drawn between this data and a relevant benchmark. Having an understanding of the consumption profile relative to 'best practice' sites or processes similar to the one being observed can provide a valuable reference for what can be achieved.

Where groups of similar sites are monitored, those with lowest levels of energy consumption can be identified as best practice sites. The efficient processes and equipment used at those sites can then be rolled out to the other sites, with meter data being used to monitor performance against defined consumption targets.

Information-based (behavioural) energy savings

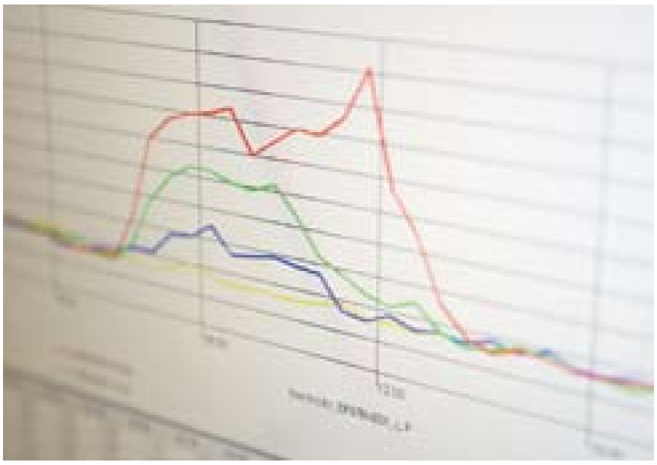
Some of the easiest energy savings to identify and implement come from changes in behaviour. Understanding the scope for such savings requires an awareness of a site's base load and energy usage profile, which can be obtained from advanced metering data. This information can be combined with an understanding of how employees use energy across the business to identify possible savings.

The relevant behavioural changes can then be targeted via a motivational programme to foster a best practice approach to energy consumption within the organisation. Measures could be as simple as encouraging employees to turn off lighting and equipment when not in use. Advanced metering data can identify and quantify the effect of implementing these measures and monitor their impact over time. These types of savings typically cost nothing to implement.

Process-based energy savings

Advanced metering data offers insights into the quantity of energy consumption used at specific times of day. By comparing this data with its operational patterns an organisation can build up a picture of how much energy is consumed by individual processes and specific equipment.

Data from advanced meters can identify where processes can be optimised and quantify their impact. Process-based energy savings can be achieved by changing the start-up and shutdown times of specific systems or by altering their power usage and temperature settings. Process-based savings generally cost little to implement and there is usually no capital expenditure.



Investment-based energy savings

Advanced metering data can identify inefficiencies in equipment and infrastructure. The energy consumption of specific systems can be rated against manufacturers' specifications and more efficient equivalents. This can inform the business case for an equipment upgrade or replacement. Investments might include more efficient heating or air conditioning systems, low-energy appliances or improved levels of insulation or glazing.

Investment-based energy savings may involve significant capital costs. However, the improvements have higher persistence levels than information-based or process-based savings, which can sometimes be undone by changes in behaviour, procedures or staff[4].

1.6 Advanced metering technology

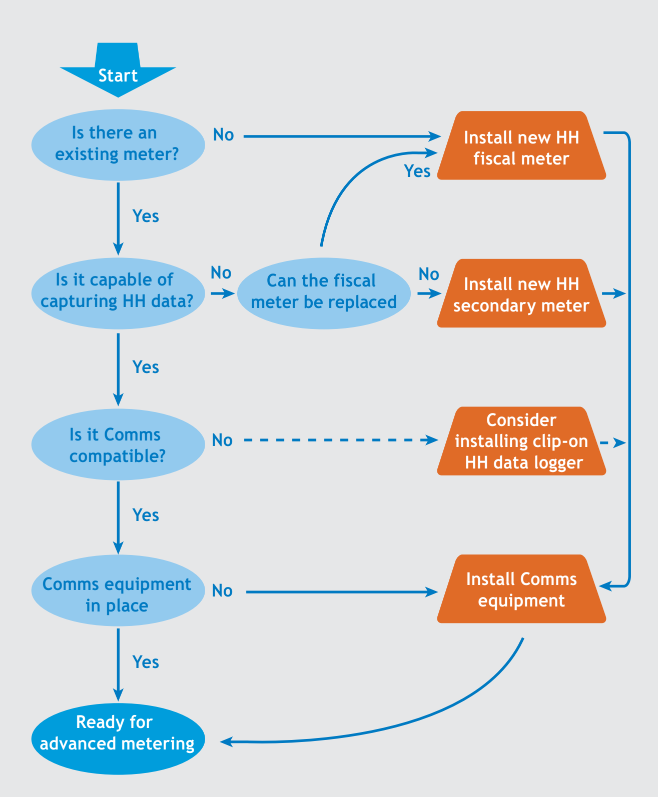
Metering solutions

There are a variety of advanced metering solutions on the market. In many cases more than one solution is viable and the selection of an appropriate system will be determined by the existing meter and the favoured technology of the meter service provider. The simplest solution is where a half-hourly meter already exists at the site. In this scenario no change is required to the hardware and the only additional requirement is an appropriate data provision service.

For the majority of SME sites that do not have an advanced meter, a direct replacement is the preferred option for moving from a standard meter to an advanced meter. However, some service providers have proprietary clip-on style meter readers, which when coupled with a fiscal meter can offer a lower cost solution. Figure 8 summarises the range of metering system options which are available.

[4] The persistence level of an energy saving action refers to the length of time that action has an impact on energy consumption. For example, a behaviour change may persist for a few months before employees revert to old behaviour.

Figure 8 Advanced metering technology options for SMEs



KEY:

Fiscal meter – main meter used for billing
Clip-on – retrofit meter reading device
Secondary meter – a second meter connected near the first to independently collect half-hourly data
Comms – communications
HH – half-hourly

Communications

Today's lower cost communications is one of the main reasons advanced metering has become a realistic proposition for smaller consumers. Mobile networks make it simple to upload data from many disparate locations at relatively low cost. Previously, this would have required a large number of more expensive land lines.

Advanced meters are often able to record and store data locally for a period of days or weeks. Wireless communications can then be used to transfer energy data to a central database.

Emerging communication systems, such as short-range local wireless networks, are expected to be used more widely in future, allowing metering communications costs to fall further.

The specific communications solutions chosen are typically dictated by the practicalities of the site. Wireless systems can be less effective in basements and in locations with limited network coverage. However, high-gain aerials can often overcome such problems. As a last resort standard landlines can still be used.

1.7 Advanced metering services

Existing commercial services

A small number of advanced metering service providers currently offer a range of different commercial services for business users. These vary from remote collection of data from existing half-hourly meters to installing new advanced meters or providing 'clip-on' meter reading devices for existing meters where compatible.

However, there is currently a lack of full end-to-end metering services for the SME market. The smaller service providers tend to specialise in either data collection or meter installation and sometimes form strategic alliances with companies providing complementary services. A few larger players operate across all areas, but these tend to target the larger half-hourly 'Code 5' electricity market.

Types of service offering

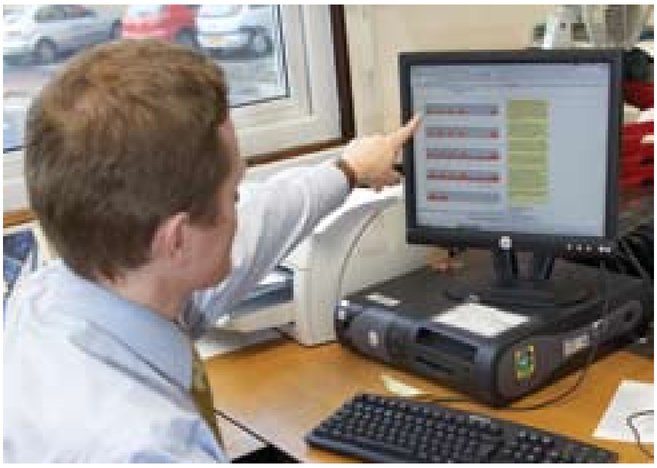
There are three generic levels of service which can be provided to accompany advanced metering technology for business customers to enable energy savings:

Data only – provision of the meter and access to the meter data, typically via a website with simple diagnostic tools.

Data and advice – provision of the meter and meter data plus some level of energy saving analysis and advice. This is typically sent via email.

Personal contact – provision of the meter and meter data plus some form of personal contact to provide customised energy saving advice, typically via telephone calls or site visits.

There are also some lower cost solutions aimed at the domestic market, including user-friendly displays showing consumption information but without remote access to meter data. However, the solutions used in the Carbon Trust field trial are focused on SME users and all involve remote collection of data and provision of access to this data.



2 Metering and billing in the UK

2.1 Industry structure

The UK electricity and gas markets were opened up to competition in the 1990s. Since then, new players have entered the market, leading to greater choice and a more competitive market.

Utility regulators are responsible for protecting consumers and promoting effective competition. The Office of Gas and Electricity Markets (OFGEM) regulates electricity and gas markets. OFWAT, the Water Services Regulation Authority is responsible for the water industry. Both regulators wish to see improvements in metering and billing services as customers will benefit by being able to monitor and control energy and water use more effectively.

The UK energy industry comprises two main groups: suppliers and distributors. Customers have contracts with the suppliers who ensure that the customer receives energy and that it is appropriately metered and billed for. Distributors are responsible for the energy transportation infrastructure and suppliers contract them to physically deliver energy to their customers.

Suppliers use meter reading and data collection services to keep track of their customers' energy use. In theory, customers can choose which company provides them with their metering service. In practice, most SMEs leave this decision in the hands of their energy supplier.

2.2 Consumption and billing

Utility bills in the UK are based either on actual consumption data or on estimated readings. Suppliers generally require more accurate consumption information from their largest consumers. Customers with lower consumption levels can be handled through estimates, since from the suppliers' perspective, the balance of any inaccuracies is fairly small relative to overall consumption levels.

Around 2.3 million electricity[5] and 420,000 gas meters[6] are in use at SME premises in the UK. Water meters in the SME sector are estimated at around 1.6 million[7]. The gas, electricity and water markets are all segmented according to levels of consumption.

2.3 Electricity metering

Market segmentation

In the electricity market, customer sites with peak consumption exceeding 100 kWh for three consecutive months are classified as 'Code 5' and suppliers collect actual consumption data into the Balancing and Settlement Code (BSC) system (see Figure 9 for more details). This process provides accurate bills for the customer as well as accurate predictions for electricity demand. Additionally, all companies are entitled to opt into the Code 5 system if they are prepared to pay additional charges and upgrade their meter. This typically appeals to larger organisations with multiple sites which separately do not exceed 100 kWh peak consumption, but collectively are significant. There are currently 107,000 Code 5 meters in the UK, of which as many as half are believed to have 'opted in' to the BSC system.

Sites on Code 5 meters have access to their half-hourly consumption data. However, their ability to access this in a timely fashion is dependent on the energy supplier. In a 2005 survey, the Carbon Trust found that the time it took for energy suppliers to make data available varied from 24 hours to as long as a month. Clearly, long delays between consumption and availability of data compromise the usefulness of that data for energy management purposes.

[5] ELEXON 2007.
[6] Nera/Datamonitor 2005.
[7] Derived from OFWAT 2005 and SBS 2006.

Sites below the Code 5 threshold are sub-divided into a number of 'profile classes', based on type of customer and typical energy consumption levels. These range from domestic users (profile classes 1 & 2) to significant energy users (profile classes 7 & 8). The vast majority of business customers in profile classes 3-8 have standard, manually-read meters and estimated utility bills. Table 1 provides a breakdown of the different groupings of business customers in the electricity metering market.

Table 1 *Customer groups and consumption levels for electricity metering*

Group	Description	General billing type	Number of meters	Average annual consumption
Profile class 3	Unrestricted	Estimated	1,662,800	14,900 kWh
Profile class 4	Economy 7	Estimated	506,700	24,800 kWh
Profile class 5	0-20% Load factor	Estimated	38,000	81,600 kWh
Profile class 6	20-30% Load factor	Estimated	53,700	109,800 kWh
Profile class 7	30-40% Load factor	Estimated	27,600	128,900 kWh
Profile class 8	>40% Load factor	Estimated	48,100	142,300 kWh
		Sub-total	2,336,900	
Code 5	High consumption	Accurate	107,000	
		Total	2,443,900	

Source: ELEXON, January 2007

Figure 9 *The Balancing and Settlement Code*

The Balancing and Settlement Code (BSC)

Like other commodities, electricity is produced, sold into a wholesale market and then resold to consumers. The Balancing and Settlement Code (BSC) contains the governance arrangements for electricity balancing and settlement in Great Britain and covers all electricity users and the companies that generate and supply the electricity.

Under the terms of the BSC, generators who produce electricity contract with suppliers who sell it on to commercial and domestic consumers. These contracts are notified into a central settlement system, which is managed by **ELEXON Ltd**. Any difference between the amount of electricity contracted for and the amount delivered by generators or sold on by suppliers, is bought or sold through ELEXON's systems. ELEXON debits and credits members' accounts at the end of each day.

Roles and relationships

Figure 10 shows the roles and relationships between the key players in the electricity metering market.

The following descriptions explain the role of each player:

Customer
The Customer enters into a contract with a Supplier for provision of electricity.

Supplier
The Supplier is licensed to supply electricity to the Customer and to charge them for their consumption. The Supplier also coordinates the associated contracts with the Meter Operator, Meter Asset Provider, Data Collector and Data Aggregator. The Customer may nominate these parties, but in most circumstances the Supplier appoints them.

Generator
The Generator owns the plant which generates the electricity and is licensed to sell electricity directly to the Supplier. Some Generators are owned by Suppliers.

Distributor
The Distributor owns the local distribution network through which the electricity reaches the Customer. This includes cables, transformers, meters and other infrastructure assets.

Meter Operator/Meter Asset Provider
The Meter Operator (MOP) has overall responsibility for operating and maintaining metering equipment. In most cases the MOP is also the Meter Asset Provider (MAP), but the consumer can opt to rent a meter from a MAP or purchase the meter directly. The MOP is contracted to the Supplier and normally has a separate contract with the Meter Asset Manager to manage the meter.

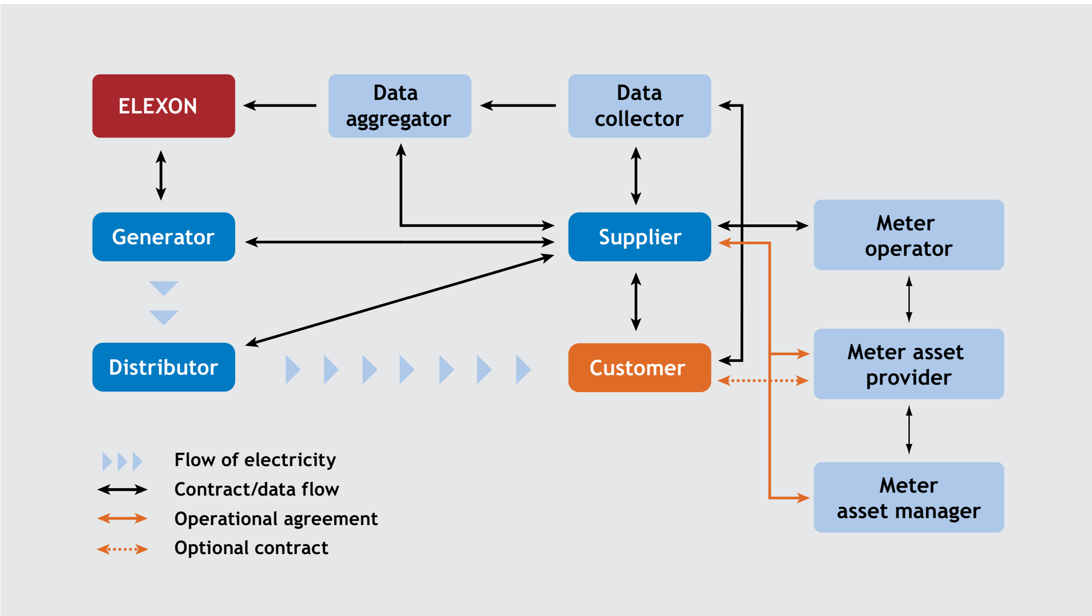
Meter Asset Manager
The Meter Asset Manager (MAM) is contracted by the MOP or MAP to install, commission, maintain, remove and dispose of the meter and to ensure that it complies with regulatory requirements. The MAM also contracts with other third parties to carry out on-site inspections etc.

Data Collector
The Data Collector (DC) is responsible for the collection and processing of consumption data from actual meter readings, or the determination of an estimate. This consumption information is then passed to the Data Aggregator.

Data Aggregator
The Data Aggregator (DA) is responsible for the aggregation of data regarding the electricity supplied to customers. The Supplier and ELEXON use this aggregated information for balancing and settlement purposes and to ensure that customers are billed correctly.

ELEXON
ELEXON runs the Balancing and Settlement Code system (see Figure 9 for more details).

Figure 10 *Schematic of key players and relationships in the electricity market*



2.4 Gas metering

Market segmentation

In the gas market, customers are divided into high and low volume users. High-volume users, with annual consumption levels of 58,600 MWh or more are classified as 'daily read'. They are billed based on their exact consumption generally using advanced metering systems which provide daily (rather than half-hourly) readings. There are currently around 2,000 daily-read gas meters in the UK[8].

Lower volume gas users in general do not have advanced metering systems and frequently receive estimated bills. There are over 400,000 such users, divided into four consumption bands (see Table 2 below).

Roles and Relationships

Figure 11 (overleaf) shows the roles and relationships between the key players in the gas metering market.

The following descriptions explain briefly the role of each player:

Customer
The Customer enters into contract with a Supplier for provision of gas.

Supplier
The Supplier is licensed to supply gas to the Customer and to charge them for their consumption. The Supplier also coordinates the associated contracts with the Meter Operator.

Shipper
The Shipper buys gas directly from the producers and sells this to the Supplier. In order to keep the level of gas in the UK network at a constant level, the Shippers need to balance the amount of gas going into the system with that which is being consumed. This process is carried out according to a legal and contractual framework set out in the Network Code.

Transporter
The Transporter (or Network Operator) owns the gas pipeline system. The Supplier needs consumption information for billing and the Transporter needs the same information to ensure balance in the network. As a result, most meters on the customer's side of the network are owned and maintained by the major gas network owner – National Grid.

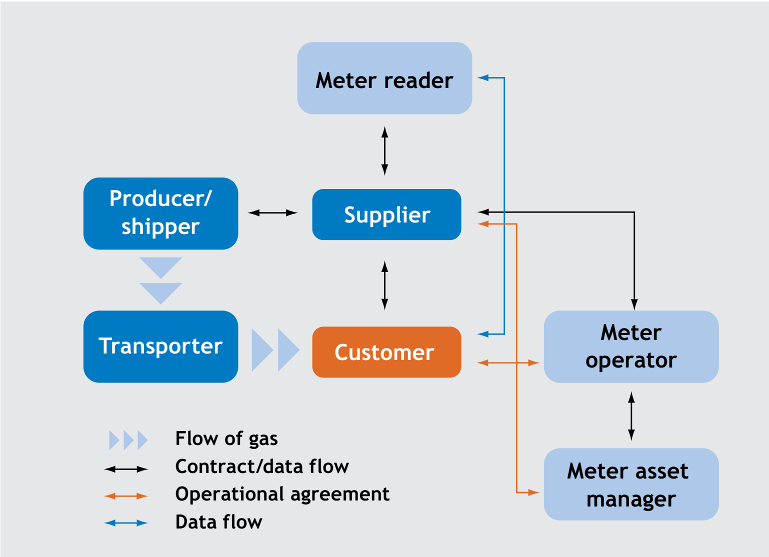
***Table 2** Customer groupings and consumption levels for gas metering*

Group	Consumption	General billing type	Number of meters	Average annual consumption
Non-daily 1	73-732 MWh	Estimated	381,000	170 MWh
Non-daily 2	732-2196 MWh	Estimated	26,600	1,160 MWh
Non-daily 3	2196-5860 MWh	Estimated	7,700	3,320 MWh
Non-daily 4	>5860 MWh	Estimated or Monthly	3,100	14,240 MWh
		Sub-total	418,400	
Daily-read	>58,600 MWh	Accurate	2,000	
		Total	420,400	

Source: NERA, British Gas/Transco/Carbon Trust

[8] Source: Nera/Enviros report for Defra on Energy Efficiency and Trading, April 2006.

Figure 11 Schematic of key players and relationships in the gas market



Meter Operator/Meter Asset Manager
The Meter Operator is responsible for keeping the meter in order. The Meter operator contracts with a Meter Asset Manager (MAM) to install, commission, maintain, remove and dispose of the meter and to ensure that it complies with regulatory requirements. The MAM also contracts with meter workers to carry out on-site inspections.

Meter Reader
The Meter Reader gathers gas consumption data. These readings are fed back to the Supplier for the purpose of billing and also for the Shipper to ensure the gas on the network is balanced.

2.5 Water metering

Market segmentation

In the water market, customers are generally classified as 'large' and 'non-large' users. Sites with a consumption above 50,000 m^3/year are classified as large and are equipped with interval meters. These sites receive accurate bills based on this meter data. There are currently around 1.6 million water meters located in SMEs in the UK. These consume a total of 915 million m^3/year[9].

Most commercial sites can choose to fit water meters and receive more accurate billing. Half-hourly data is not routinely captured so most half-hourly water meters are used for process control systems. Table 3 provides a breakdown of the major groupings of business customers.

Roles and relationships

Services concerning the supply and removal of water are generally restricted to a particular geographic area. Standard customers usually have little choice other than to enter into a contract with the local provider. However, large consumers using more than 50,000 m^3 of water a year may be able to contract with someone other than the local supplier.

Water companies are responsible for the provision of water to all of the customers within their geographic supply area. They own the distribution network within that area, along with all of the metering and pipes. Water companies contract with meter readers to collect data so that they can bill customers according to their consumption.

Table 3 Customer groupings and consumption levels for water metering

Group	Description	General billing type	Approx number of commercial sites	Average annual consumption (m^3)
Non-large	Up to 50,000 m^3/year	Estimated	1,600,000	570
Large	>50,000 m^3/year	Accurate	2,500	261,000

Source: OFWAT

[9] OFWAT 2005.

2.6 Barriers to advanced metering for SMEs

Given the potential benefits of advanced metering it is important to understand why this technology is not currently widely used by the SME community.

Customer-side barriers

Awareness of advanced metering – there is a low level of awareness among SMEs of advanced metering and its potential benefits.

Linking energy use to costs – in general, SMEs believe their choice of supplier and underlying energy price rises are the main drivers of energy costs. They do not always recognise that changes in their own behaviour, processes or equipment can reduce costs significantly.

Limited time and resources – SMEs are resource and time constrained, and most do not have dedicated energy managers. Installing or using advanced metering may not be seen as a priority, even where there is awareness of the potential benefits.

Transparency of costs – there is a lack of transparency as a result of the complex market structure. For instance, since some metering service providers are not accredited data collectors the SME may have to bear the cost of managing two meters if they opt for advanced metering.

Understanding of service options – there is little understanding surrounding the levels of service, or resource investment required to best obtain savings using advanced metering technology. Many SMEs are not familiar with the concept of paying for metering services which can ultimately lead to energy and cost savings.

Availability of metering services – currently there is no widespread, competitive market providing advanced metering services for SMEs.

Supply-side barriers

Capacity of metering service providers – most suppliers of meter reading and data analysis services are small-scale players who are unlikely to have the capacity to drive large-scale market uptake.

Insufficient incentives for suppliers – the major energy suppliers are ideally positioned to drive a rapid take-up of advanced metering technology. However, most suppliers do not currently offer services targeted at SMEs. Although there are potential new revenue and customer acquisition opportunities these are not yet seen as sufficiently attractive to offset the costs associated with metering service provision or potential loss of revenue from reduced consumption. There are currently no regulatory requirements placed on suppliers to drive advanced metering forward.

Stranded asset concerns – the energy supply companies, associated meter operators and meter asset providers are concerned that investment in advanced meters will leave them with stranded assets if customers decide to switch suppliers. This is due to a lack of common standards for advanced meters to ensure that meters can be taken on and used by new suppliers as currently happens for conventional meters when customers change suppliers. There is also a concern about having to write off sunk costs associated with the current stock of meters which are still serviceable.

These customer-side and supply-side barriers must be addressed in order to accelerate the market for advanced metering. The aim of the Carbon Trust's field trial has been to gain a better understanding of these barriers and to quantify the potential benefits of advanced metering in terms of cost savings for SMEs and carbon savings for the UK.

3 The advanced metering field trial

3.1 Scope and objectives

In light of the potential carbon saving benefits of using advanced metering but also the existing barriers to adoption, the Carbon Trust decided to run the first UK field trial of advanced metering for the SME community.

The advanced metering field trial was devised with the following high-level objectives:

- Understand the potential benefits of advanced metering for SMEs
- Stimulate market demand by demonstrating that advanced metering can reduce energy consumption and costs
- Help understand the barriers to broader uptake and how they might be overcome
- Identify the nature of advanced metering services which yield the best savings
- Develop case studies, highlighting the advantages of advanced metering
- Quantify the potential UK-wide carbon savings attributable to advanced metering in the SME community
- Identify potential policy measures to stimulate uptake.

This project was managed as one of the Carbon Trust's portfolio of Technology Acceleration projects[10]. This project began in 2004, most sites were recruited by the start of 2005 and metering data was captured and analysed until late spring 2006.

3.2 Methodology and approach

To deliver the field trial, the Carbon Trust contracted with seven consortia all of which were already operating commercially in the metering market. The lead organisations are shown in Figure 12.

***Figure 12** List of lead organisations involved in the trial*

- **BEAMA** www.beamaenergy.org.uk
- **Bglobal** www.bglobalmetering.com
- **EMT** www.eccl.co.uk
- **Pilot Systems** www.pilotsystems.com
- **TAC Satchwell** www.tac.com
- **TEAM** www.teamenergy.com
- **UPL** www.up-ltd.co.uk

The delivery consortia each recruited portfolios of SMEs or SME-like sites and installed advanced metering for electricity, gas and water at these sites as appropriate (not all utilities were metered at every site). A total of 582 sites were involved in the trial.

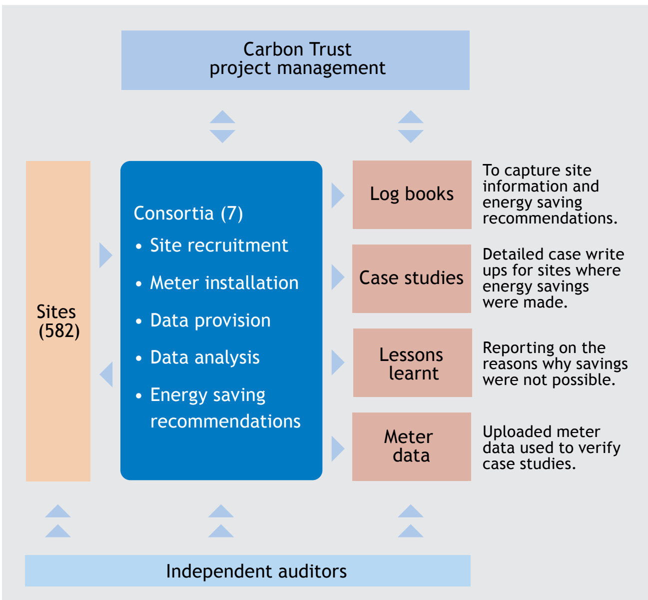
Figure 13 illustrates the structure of the project. In addition to installing meters, the consortia provided varying degrees of support to the SME sites in relation to data provision, analysis and recommendations to reduce energy use.

The consortia completed log books for each site, tracking the estimated energy savings for each recommendation and the extent to which each recommendation was successfully implemented.

For each site a case study was also produced to describe the overall actions taken and associated savings made. These captured the situation at the site prior to advanced metering, including details about the organisation and annual energy and water consumption levels. Case studies included graphical data showing consumption and areas where potential savings had been identified. They also included the financial case for implementing energy saving actions and the levels of potential savings in terms of consumption, carbon emissions and costs.

As part of this process the consortia reviewed the half-hourly meter data to identify and validate actual savings made for each of the utilities measured. Where it was not possible to implement energy saving recommendations, the reasons for this were discussed with the site and captured for reference.

***Figure 13** Key players and relationships for the field trial*



[10] For more on Technology Acceleration visit: www.carbontrust.co.uk/technology/technologyaccelerator

The Carbon Trust appointed a team of independent auditors to review the energy savings reported. The auditors verified the nature of the recommendations and savings claimed at each site through a programme of site visits and analytical research using recorded meter data. The Carbon Trust collaborated with four external consultancies in the delivery of this project as detailed in Figure 14.

***Figure 14** Project collaborators for the field trial*

- **AEA Energy and Environment** coordinated the collation and analysis of log books and case studies and carried out the audit process
- **TEAM** managed a central database of all half-hourly meter data
- **Paul Arwas Associates** carried out the UK scale-up and cost/benefit analysis and supported policy development
- **Hama** provided project management services

3.3 Site activities

Figure 15 illustrates the key steps for the sites in the trial.

Site recruitment

Each of the delivery consortia managed their own recruitment of sites. The process adopted was intended to replicate typical recruitment techniques which might be used commercially for the roll-out of advanced metering services. This included direct marketing to new and existing customers and mass mailing of flyers to existing contacts.

Participating sites benefited from meter installation and service provision free of charge for the lifetime of the project. The amount of time, resource and capital investment dedicated to energy saving identification and implementation was left up to individual sites.

Meter installation

The delivery consortia installed the necessary metering and communications equipment for selected sites. A total of 64 trial participants were already on Code 5 electricity meters. For these sites no meter installation was necessary. All that was required was access to the existing half-hourly data.

The Code 5 sites were treated as a control group to investigate differences in use of advanced metering services between sites with and without existing interval metering. The findings from these sites were excluded from the bulk of the analysis in this report in order to understand the potential for advanced metering in the SME sector where sites do not currently have interval metering in place.

Of the remaining sites, 73 made use of 'pulsed-output' meters with the capability to capture half-hourly data through the use of clip-on readers. These readers allow half-hourly data to be obtained without the need for upgrading the primary meter. The remainder replaced existing manually read meters with new advanced meters. The majority of gas meters in the trial were replaced with half-hourly meters, but a number had the capability to store half-hourly data which could be collected by the consortia.

Billing approach

The 64 sites already on Code 5 electricity meters were billed on their half-hourly consumption data under the Balancing and Settlement Code system. However, all other electricity meter sites (and all sites with gas and water meters) continued to be billed on the basis of estimated reads.

Some sites were able to use the advanced meter data to provide accurate customer readings to their suppliers and therefore receive more accurate bills. In some cases the delivery consortia provided such customer readings on behalf of the sites using the meter data. Therefore, while all sites gained more accurate energy consumption data, only a limited number saw these benefits directly via more accurate bills during the trial.

***Figure 15** Key steps for the sites in the trial*

Site recruitment	Meter installation	Billing approach	Type of service	Energy saving actions
New customers	Existing HH	Based on HH data	Data only	Recommendations
Existing contacts	Clip-on	Informed by HH	Data and advice	Implementation
Nominated sites	New HH	Estimated	Personal contact	Verification

HH = Half-hourly

Type of service

Sites received different levels of interaction in the services provided by the consortia. These were classified as follows:

Data only (134 sites, incl. 39 Code 5 sites) – the most basic offering was the provision of meter data only, normally via a website. Basic online tools were provided to allow sites to conduct basic analysis of their energy profiles.

Data and advice (112 sites, incl. 1 Code 5 site) – this intermediate level of service typically consisted of data provision together with a review of the site energy consumption and some basic energy saving recommendations relating to the profile. This information was normally communicated via email.

Personal contact (336 sites, incl. 4 Code 5 sites) – this level of service involved two-way communications with the site including detailed discussion around the consumption profiles, either via telephone or site visits. The delivery consortia produced site-specific recommendations and advice.

Energy saving actions

For each site the project team tracked the energy saving recommendations made by either the site or the consortia. Of the 538 sites which didn't already have advanced metering installed[11], a total of 504 sites (94%) identified (or were provided with) energy saving recommendations. From these, 304 (56%) implemented at least one recommendation. It is notable that only just over half of the sites in the trial

Recruitment and meter installation at **538** sites (100%)

Energy saving recommendations identified at **504** sites (94%)

Energy saving recommendations implemented at **304** sites (56%)

had the inclination, resources or relevant experience to make use of advanced metering data. This is perhaps to be expected given the pressure on time and resources within SME companies. The project team recorded the estimated energy savings of each recommendation and the extent to which it was implemented. If the site was intending to implement a recommendation in a subsequent year this was also recorded. This was an important consideration for some sites as capital investment cycles may preclude energy saving recommendations from being implemented immediately. The data on expected future implementation is not included in the core set of field trial results in this report. However, it is used in the cost/benefit analysis (see Section 7) for modelling expected payback periods in future years.

3.4 Characteristics of participating sites

The trial aimed to be representative of a broad range of SMEs covering different market sectors and geographical areas. It included a representative distribution of employees, utility bills and consumption levels. Sites also had different levels of prior experience in energy management.

Consumption levels

Table 4 summarises the overall and average consumption and emissions statistics[12] for the sites in the trial, broken down by utility.

Although the sites in the trial came from a diverse range of industry sectors, their involvement was to some extent self-selecting. Consequently the set of trial sites was skewed towards the larger end of the overall UK SME population.

Figure 16 shows that the average gas and electricity consumption for the sites in the trial (excluding the Code 5 control sites) was greater than the average across the UK SME community as a whole. The sites in the trial typically had a gas consumption twice the average of UK SMEs and electricity consumption of over ten times the UK average (300,000 kWh/year as opposed to 22,500 kWh/year).

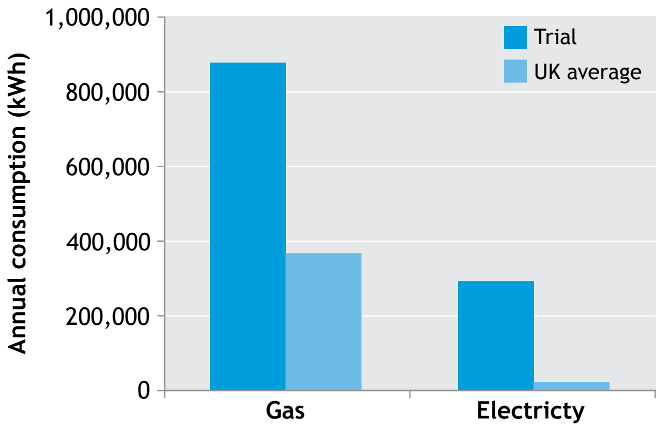
When the trial savings were studied in relation to company size, there was found to be no discernible difference in average percentage savings. This suggests that the difference in consumption levels between the trial sites and the UK average is not significant in terms of key trial findings.

[11] Sixty-four of the 582 trial sites already had Code 5 electricity meters installed and have been excluded from the electricity analysis. However, 20 of these 64 sites also had gas and water meters so only 44 of the 582 sites are excluded. Consequently a total of 538 sites are included in the main analysis.

***Table 4** Annual consumption and emissions levels for trial sites*

	Electricity (Code 5 sites)	Electricity (core SME sites)	Gas	Water
Sites	44	518	108	101
Total consumption	70 GWh	160 GWh	97 GWh	355,000 m^3
Average consumption	1,600 MWh	310 MWh	900 MWh	3,500 m^3
Total emissions	30,100 tCO_2	68,800 tCO_2	18,430 tCO_2	138 tCO_2
Average emissions	684 tCO_2	133 tCO_2	171 tCO_2	1.4 tCO_2

***Figure 16** Comparison between UK average SME consumption and the trial average*



Industry sectors and utility bills

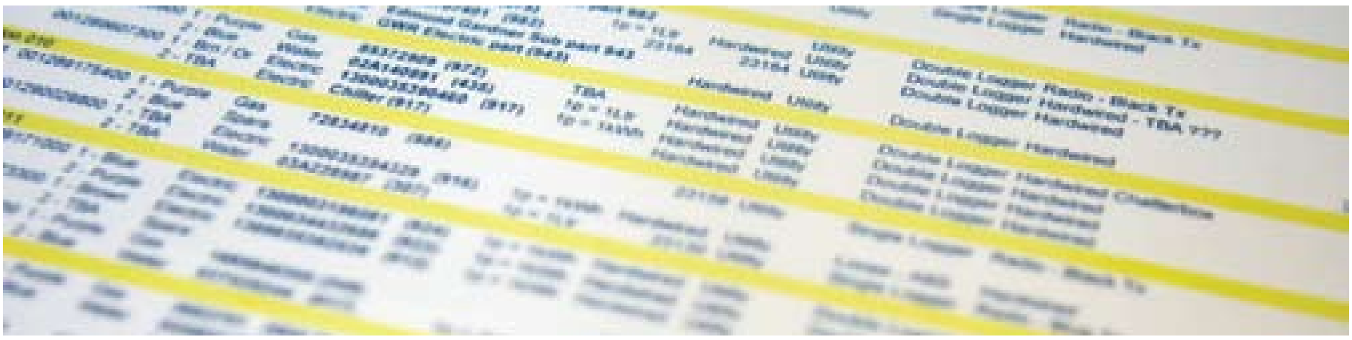
Table 5 breaks down sites by sector and presents sectoral averages for utility bills and carbon emission levels.

The average combined utility bill for the electricity, gas and water consumption (where measured) for the 538 core sites came to £23,400 per year and the average carbon emissions per site were 160 tCO_2 per year.

Sector coverage is fairly representative of the SME community. The 'Other' category includes Utility providers, Transport, Agriculture and Horticulture. These have been grouped together due to low sample sizes.

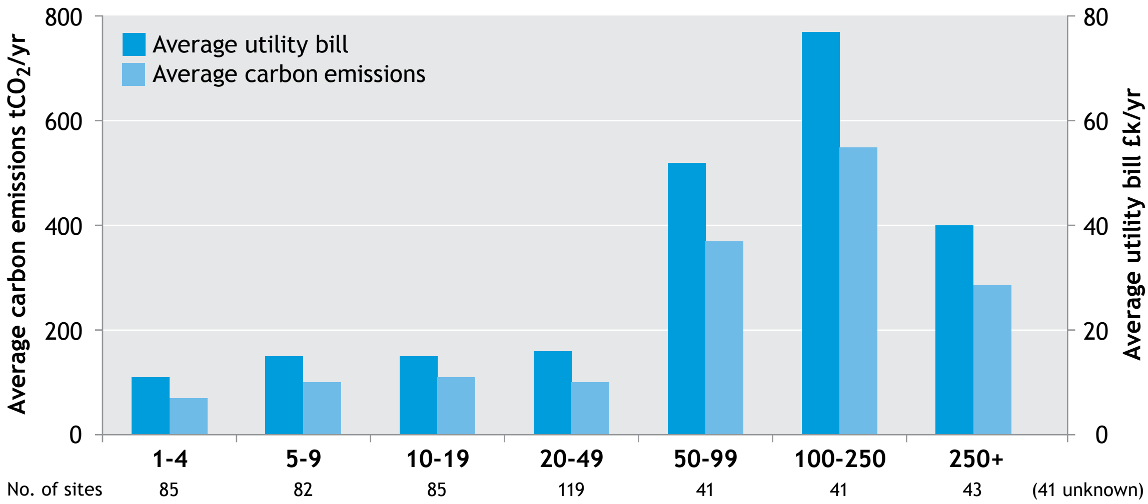
***Table 5** Breakdown of sites by sector*

Sector	Number sites	Average utility bill (£/yr)	Average carbon emissions (tCO_2/yr)
Community, social and personal	77	41,400	290
Education	107	20,000	140
Financial and business services	53	32,200	210
Government	96	23,800	160
Health and social work	24	18,700	130
Manufacturing	16	50,100	440
Wholesale and retail trade	21	25,600	170
Other sectors	144	10,300	70
All sectors	**538**	**23,400**	**160**



[12] All carbon emission calculations in this report are based on the following carbon emission factors: Electricity: 0.43 $kgCO_2$/kWh; Gas: 0.19 $kgCO_2$/kWh (Source: www.defra.gov.uk/environment/business/envrp/gas/envrpgas-annexes.pdf) Water: 0.389 $kgCO_2$/m3 (Carbon Trust derived from www.bre.co.uk/pdf/WaterNews4.pdf)

Figure 17 Site characteristics by number of employees



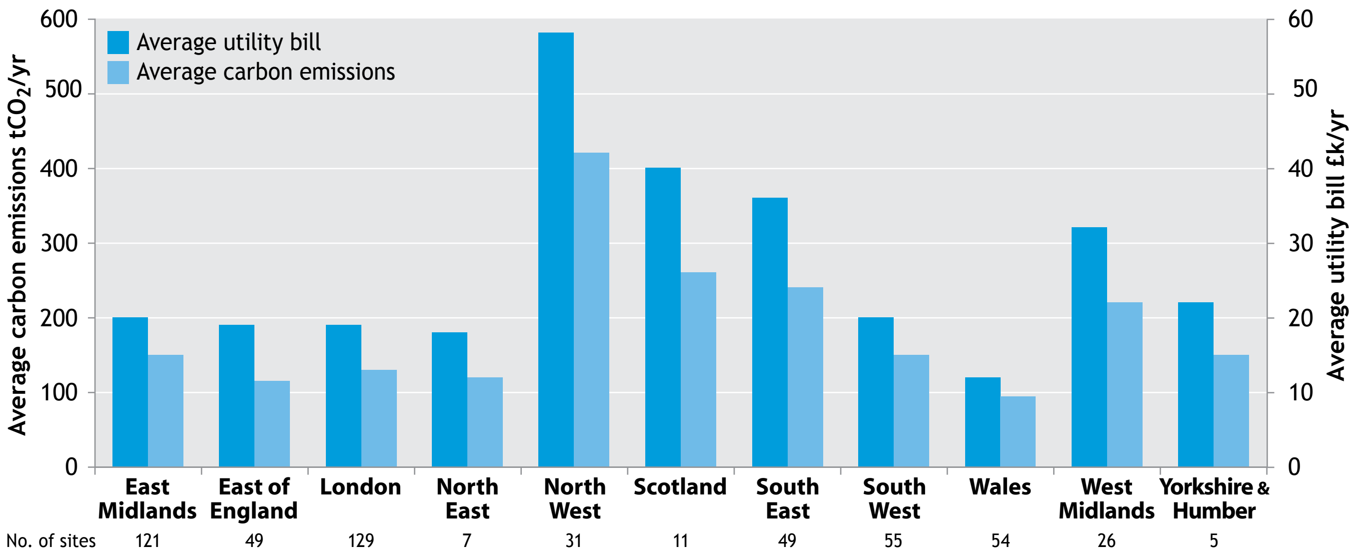
Number of employees

Figure 17 shows the relationship between the number of employees, the average carbon emissions and utility bills per site. Carbon emissions are generally seen to increase with the number of employees, as might be expected. The distribution is also influenced by the nature of the industry found in each employee band. Many of the small engineering and industrial sites with higher energy consumption are in the 100-250 employee band, while some of the large offices, which are less energy intensive per person, are in the 250+ bands.

Geographical spread

Figure 18 shows the distribution of sites, utility bills and carbon emissions by geographical region. Across the trial sites the highest average utility bills were seen in the North West and the lowest in Wales. The spread of sites was influenced to a large extent by the location of the consortia involved in the trial and consequently London and East Midlands had the largest number of participating sites. The East of England, Wales, the South East and South West were also well represented. However, there were far fewer sites in Scotland, the North East, Yorkshire and Humber, the North West and the West Midlands. There were no sites in Northern Ireland in the trial.

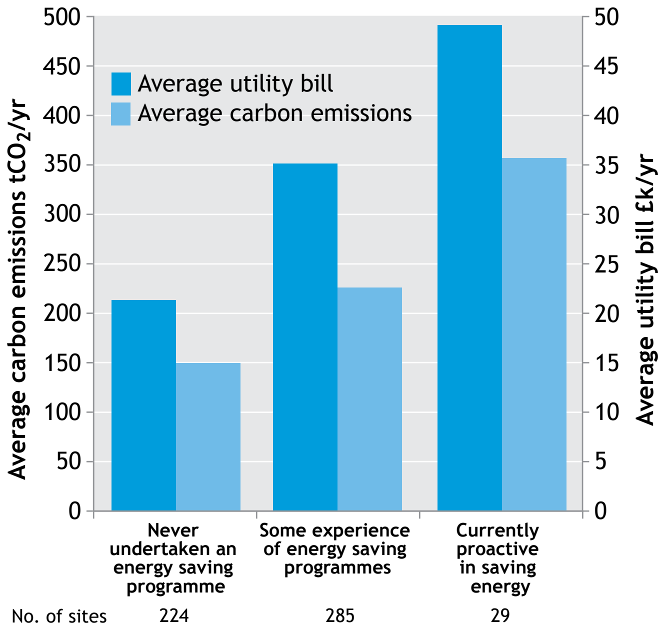
Figure 18 Site characteristics by geographical region



Energy saving experience

Trial participants had varying degrees of prior experience. 37% of sites had never undertaken any energy saving activity; 54% had some history of energy saving activities, but had no active programmes; And only 9% reported that they were actively undertaking energy saving measures at the time of the trial. Figure 19 shows that sites which were already undertaking energy saving activities tended to have higher than average utility bills and carbon emissions.

***Figure 19** Site characteristics by prior experience of energy saving activities*



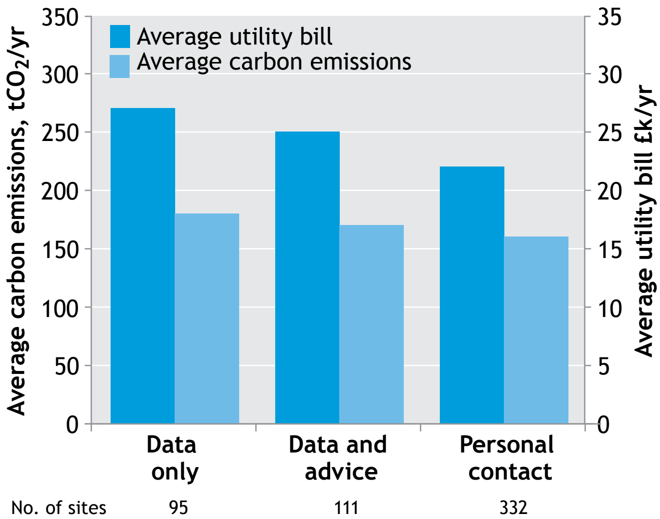
Single sites vs. multi sites

The field trial involved a mixture of single-site SMEs and sites which were part of larger multi-site groups (6 or more sites) but behaved independently, such as sites from retail chains. Generally SMEs which are part of a multi-site organisation benefit from economies of scale relative to single-site SMEs. They can aggregate consumption to negotiate more favourable contracts, coordinate metering roll-out across multiple sites and replicate energy saving initiatives. Of the trial sites, 132 were classified as single-site SMEs and 450 were multi-site SMEs.

Type of metering service

Sites received different types of metering service, depending on the requirements of the site and the capabilities of the consortium. As shown in Figure 20 over half of the sites received Personal Contact services. The average utility bill and carbon emissions are broadly similar regardless of service type, allowing a valid comparison to be made between these different types of interaction.

***Figure 20** Site characteristics by metering service type*

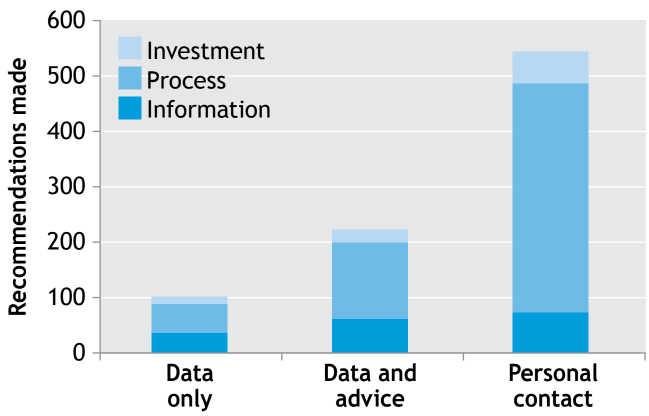


Types of energy saving recommendations

Figure 21 shows the types of energy savings identified for each site, broken down by the type of service provided. As might be expected, the overall number of recommendations tended to increase with the level of service provided. Around 15% came from the Data Only service, 25% from Data and Advice and around 60% from Personal Contact interactions with consortia.

Across all service types process-based energy saving recommendations were by far the most prevalent, accounting for around 70% of all recommendations. Around 20% of the recommendations were information-based (behavioural) and the remaining 10% were investment-based. Most investment-based recommendations came from the Personal Contact service, where the metering consortia were able to identify specific equipment upgrade and plant investment options based on a closer and more detailed understanding of the site.

***Figure 21** Breakdown of recommendation type for each level of service provided*



4 Results and findings

This section summarises the key results from the field trial for consumption, cost and carbon savings. It analyses these savings by utility, sector, previous experience and level of service provided.

Throughout this section, where averages are quoted, the figures have been calculated using the arithmetic mean. This approach is used to prevent the results at sites with higher energy consumption and saving levels from skewing the overall results.

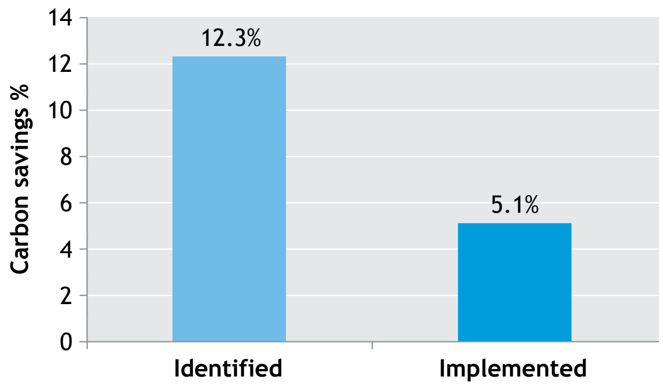
4.1 Headline results

Overall carbon savings

Figure 22 shows that across all sites in the advanced metering trial an average of over 12% carbon savings were identified and over 5% carbon savings successfully implemented within the time frame of the trial. These overall figures include the carbon savings across electricity, gas and water utilities. They also take into account all of the sites in the trial, including those where no energy saving actions were identified or implemented.

These findings are important in that they highlight the significant carbon savings which can potentially be unlocked in the SME community. By way of comparison, OFGEM has assumed that the potential level of energy savings from advanced metering in the domestic market is 1%[13], while Sustainability First assumes savings in the range of 1-3%[14].

Figure 22 *Average annual % carbon savings identified and implemented across all sites*



Carbon savings by utility

Figure 23 shows the breakdown of savings by utility. The proportion of carbon savings achieved for gas and electricity are similar at just under 5%. Carbon savings from water are more significant in percentage terms, with an average of over 12% savings achieved.

The proportion of identified savings which were implemented successfully is higher for gas than electricity. Although a significantly higher level of carbon savings were identified for electricity, sites found it more difficult to implement these. This is likely to be due to the variety of recommendations. For example, electricity savings tend to be achieved via behavioural or process changes across a wide range of different equipment and systems, and through a number of control points. By contrast gas saving measures tend to be implemented via simpler centralised behaviour or process changes, such as to temperature and timing settings.

Figure 23 *Average annual % carbon savings by utility for all sites in the trial*

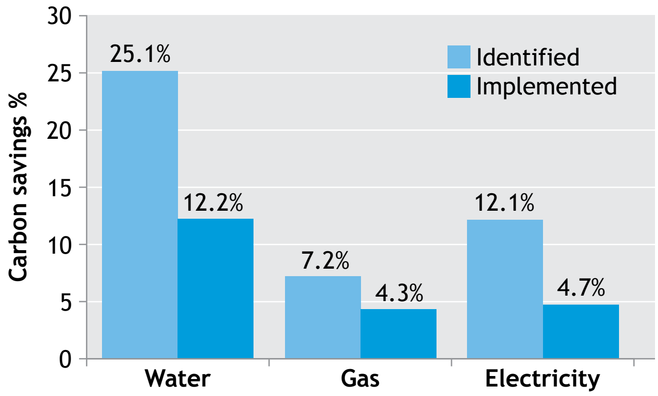
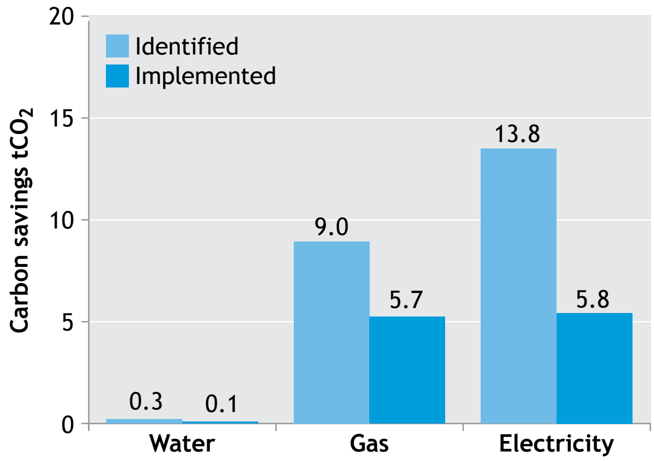


Figure 24 shows the average absolute carbon savings by site. The absolute carbon savings associated with water are very low relative to those for gas and electricity. This is due to the relatively low levels of energy used for pumping and treatment of water.

Figure 24 *Average annual absolute carbon (tCO_2) savings by utility*



13 'Domestic Metering Innovation', OFGEM consultation document, 1 February 2006.
14 'Smart Meters: Commercial, Policy and Regulatory Drivers', Sustainability First, March 2006.

Consumption and cost savings

Figure 25 shows that on average sites in the trial saved around 375 m^3 of water, 13,500 kWh of electricity and 30,000 kWh of gas per year from advanced metering. This equates to average annual savings of £1,070 and 8.5 tCO_2 per site.

Despite the fact that Figure 23 indicated that carbon savings from electricity (calculated at 0.43$kgCO_2$/kWh) were slightly higher in percentage terms than savings from gas (calculated at 0.19$kgCO_2$/kWh), it can be seen that the absolute levels of savings from gas are higher than for electricity due to the large volume consumed.

Figure 25 *Average consumption savings by utility*

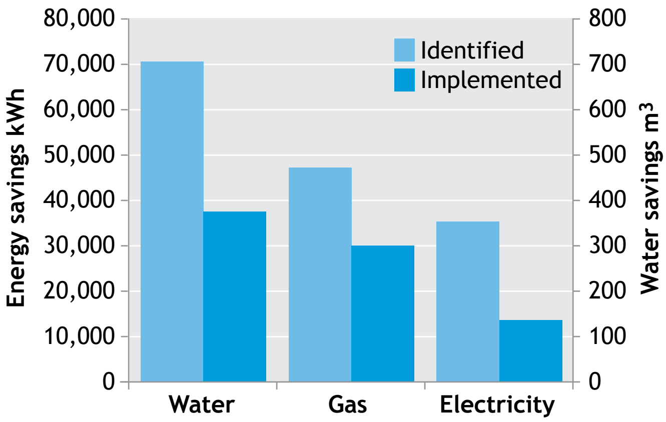
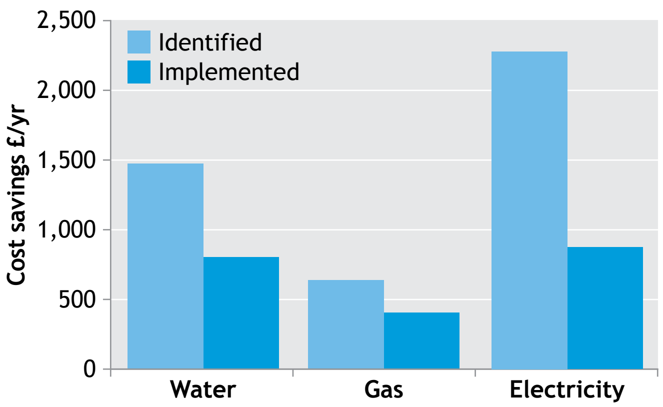


Figure 26 shows the average cost savings identified and implemented per year for each utility. On average, sites in the trial saved around £800 on their water bills, £870 on their electricity bills and £405 on their gas bills per year[15]. The financial savings achieved were directly related to levels of energy consumption, with high consuming sectors seeing the greatest financial savings.

Figure 26 *Average annual cost savings by utility*



These charts also highlight that although average kWh consumption savings are higher for gas than electricity, the average cost savings are higher for electricity due to relative utility prices.

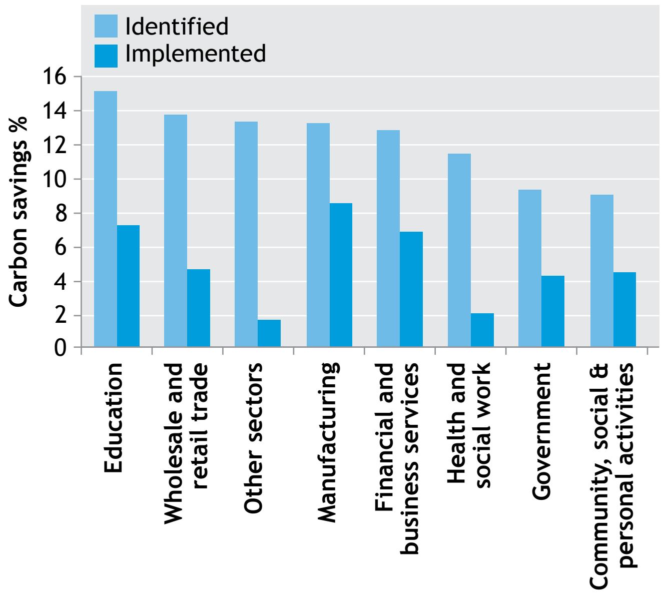
4.2 Breakdown of savings

Savings by sector

Figure 27 shows the variation in percentage carbon savings identified and implemented for each sector. The variation in energy savings between different sectors is very significant in some cases.

The Manufacturing sector implemented the largest average carbon savings (8.5%), followed by Education (7.2%) and Financial and business services (6.8%). Most sectors identified at least 10% in potential carbon savings, suggesting that there is scope for SMEs to make significant progress on energy management given the right incentives. The healthcare sector only managed to implement savings of 2%, less than a fifth of the savings identified. This result merits further research but there may be higher resistance to change in this sector, or longer approval cycles for process-based or investment-based actions.

Figure 27 *Average annual carbon savings by sector*



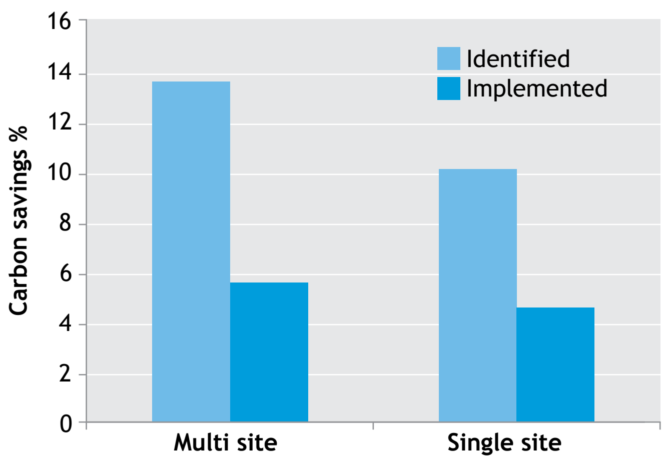
[15] The underlying utility prices for this analysis were based on baseline 2005 prices of 6.5p/kWh (electricity), 1.8p/kWh (gas) and £2.7/m^3 (water). However, where sites have special tariffs these were used.

Savings by type of site

The field trial consisted of a mixture of single-site SMEs and SME-like sites which were part of larger multi-site groups, but behaved independently. Figure 28 shows the differences in levels of carbon savings identified and implemented for single sites and multi sites. On average the savings identified were around 4% higher and the savings implemented about 1% higher for multi sites than for single sites.

Discussions with the sites, the delivery consortia and energy suppliers have also concluded that a collection of similar sites can undertake an energy saving programme more effectively. The collective effort expended on identifying and implementing energy savings yields greater success than at individual sites since they are able to share best practice and transfer energy saving recommendations between sites.

Figure 28 *Comparing average % carbon savings for single-site and multi-site SMEs*



Savings by level of experience

Figure 29 highlights that sites with no prior energy saving experience made greater savings than sites with some prior experience of energy saving programmes. This probably reflects the fact that many of the 'quick win' savings had already been realised for sites with previous experience and that the measures now identified generally required more effort to implement. This is confirmed by Figure 30 which shows that more information-based savings were identified at sites with no prior experience of energy saving programmes. More process-based and investment-based measures were identified at the more experienced sites.

Figure 29 *Average % carbon savings by level of experience*

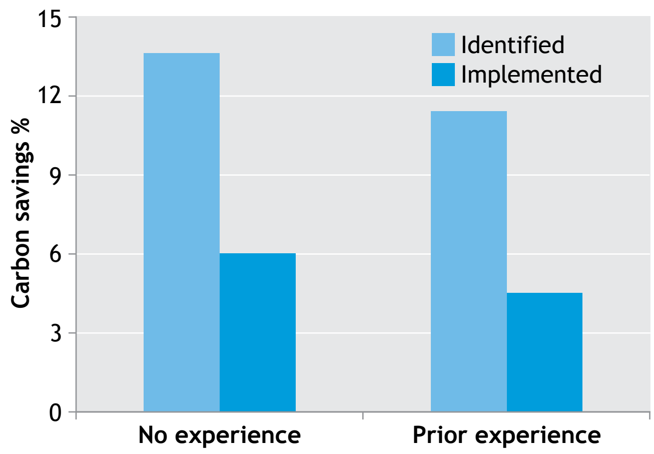
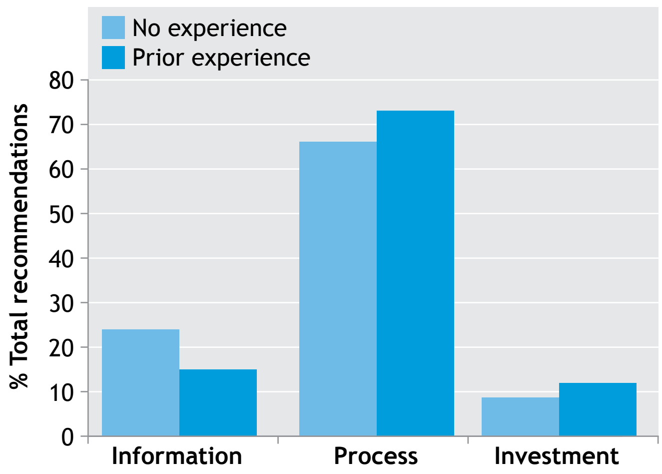


Figure 30 *Breakdown of energy saving recommendation types by level of experience*

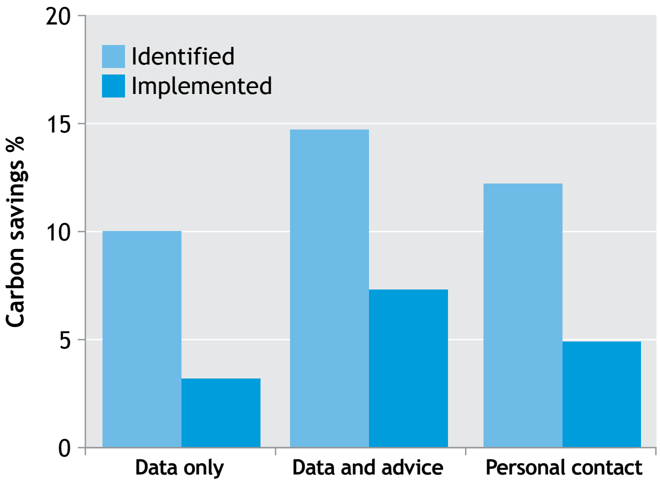


Savings by service type

Figure 31 considers savings by service type. The way in which energy saving advice was delivered to SMEs resulted in marked differences in the savings achieved. The Data Only service, where customers are simply provided with remote online access to their energy usage data, led to the lowest levels of savings. However, even here 10% energy savings were identified and 3% implemented on average. These are significant savings, especially as this service is considerably less resource-intensive for the service provider to deliver.

Most notably, the Data and Advice service, where energy saving advice is provided remotely via email, lead to the highest levels of energy savings, with an average of 15% savings identified and 7.5% successfully implemented. These savings are higher than those achieved for the Personal Contact service, with advice provided directly via site visits and telephone calls, where an average of 12.5% savings were identified and 5% implemented successfully.

***Figure 31** Average % carbon savings by service type*



This is a significant finding and there appears to be two key potential reasons behind this. Firstly, when service companies provide advice via site visits and telephone calls, it is generally highly customised and there is a tendency to focus on high added value recommendations. These are likely to lead to more complex process-based changes or more expensive investment-based actions. There is also less focus on providing generic energy saving recommendations, such as simple information-based or process-based changes. However, it seems that many SMEs, and especially those with limited prior experience of energy saving, can benefit from these quick win actions.

Secondly, energy saving advice which arrives via email is readily available and more likely to be looked at and acted upon directly than more conventional energy audit reports. This is especially true when the email contains simple, intuitive graphical information, such as daily consumption profiles. Also, the email format allows the information to be easily forwarded on to staff within the organisation to take the relevant actions, for example operations or facilities management personnel.

Another key implication of this finding is the possibility of providing advanced metering services at significantly lower costs in the future. The email service model is highly scalable and it would appear feasible that automated systems could be used to analyse SME energy usage profiles, identify appropriate recommendations and automatically email these to the customer, with supporting graphical evidence. Such an automated service, backed up with call-centre support, would allow for a significantly lower-cost service model than one involving on-site or telephone-based analysis and discussion as standard.

In summary, simply providing half-hourly data to an SME allows the site to identify and implement significant energy savings. However, to maximise the energy savings some form of additional advice service is required. This implies that the site either does not have sufficient expertise to use the data on its own or lacks sufficient time to analyse and act on it appropriately. The trial results suggest that using email as a mechanism for providing this additional service leads to the best results and this opens up the potential for highly cost-effective metering services to be provided on a widespread basis in the future.

Level of site buy-in

Where sites had energy saving recommendations made but failed to implement these, the reasons for 'failure' were captured as lessons learnt case studies. These are discussed further in Section 10. One of the most common reasons was a lack of buy-in from the site. Typically such sites reported resource constraints or considered reviewing energy consumption to be a low priority activity.

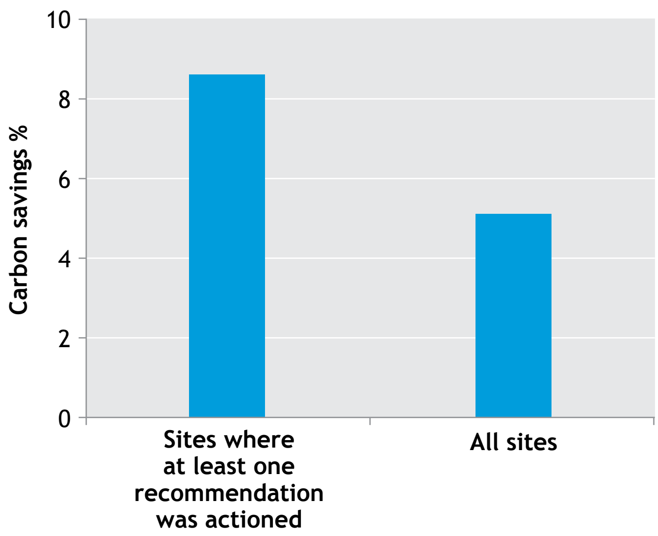
The average savings discussed previously in this report focused on averages across all non-Code 5 sites in the trial, including those which made no use of their advanced meter data. This information is useful in that it gives the most accurate representation of what might happen if there was to be a widespread roll-out of advanced metering across the SME community.

However, it is also of interest to understand the potential energy savings where a site is willing to commit at least a minimum amount of effort to using advanced metering information. The chart below shows the level of average savings achieved by sites which actively made use of the advanced metering data.

Figure 32 shows that for sites where at least one energy saving recommendation was implemented the previously quoted average carbon saving of 5.1% rises to 8.6%.

These findings indicate that a significant increase in savings can be achieved where sites have a level of buy-in to using the advanced meter.

***Figure 32** Impact of site 'buy-in' on average carbon savings*



5 Scale-up of results to UK level

5.1 Introduction

This section analyses the findings from the field trial in the context of the UK SME community. The trial results are scaled up to estimate the potential national impact of advanced metering across the UK and to identify the potential UK carbon savings available.

As highlighted in the previous section, the carbon savings associated with water are low. Consequently this section focuses on electricity and gas consumption when considering the carbon saving potential at the UK level.

5.2 Basis for scale-up analysis

The scale-up analysis aims to identify potential carbon savings for the group of UK SMEs which don't currently use advanced metering. Site savings have been scaled up to estimate UK savings for gas and electricity. The appropriate total size of current UK utility use and carbon emissions has been identified based on recent consumption data for sites using non-half-hourly meters in the UK.

The carbon savings have been scaled up on a per sector basis to estimate the UK carbon savings by sector. This assumes that the results in trial sample were broadly representative of sector-based trends at the UK level.

The split of carbon savings between single sites and multi sites in the field trial has been found to be well aligned with the equivalent breakdown in emissions from UK SMEs as a whole. Nationally, an estimated 59% of non-domestic non-Code 5 metered carbon emissions are from multi-site organisations. In the trial, 65% of identified carbon savings were from the equivalent population.

Breakdown of UK SME meters by utility

For gas meters the field trial findings have been scaled to those that would be seen across the user base of SMEs that don't currently have interval metering. This equates to around 418,000 meter points. According to National Grid, the total gas consumption across these users is around 153 TWh per year, which equates to carbon emissions of 29.1 $MtCO_2$.

Similarly, for electricity meters the trial findings have been scaled to those that would be seen across the user base of SMEs that are currently below the Code 5 mandatory threshold for half-hourly metering, equating to around 2.3 million meter points. According to ELEXON, the total electricity consumption across these users is around 57 TWh per year or annual carbon emissions of 24.5 $MtCO_2$.

The total energy consumption through SME gas and electricity meters is estimated to be worth £6.5 billion per year.

Water savings

Since the carbon savings associated with water usage are low, the bulk of this report focuses on the potential benefits of advanced metering in terms of reducing emissions from electricity and gas consumption. However, it is worth noting that the identified annual water savings are very significant and consequently these have been scaled up as follows. For water meters the trial findings are assumed to be scalable to those that would be seen for the user base of SMEs currently classified as 'non-large' users (ie those customers consuming less than 50,000 m^3). The data for water consumption in 2004/05 suggests that non-large users consume 915 m^3 per year[16].

In fact, the volume of potential UK savings identified is 60% greater than the size of the proposed new Thames Water reservoir (whose cost, at 2006, is estimated at £1 billion) and nearly five times the output of the proposed Thames Water desalination plant. The financial savings associated with water are also considerable, and help build the business case for the customer.

UK SME consumption and cost data

Total consumption	915 m^3
Assumed unit cost	£2.7/m^3
Total UK SME market	£2.5 billion

Source: OFWAT, Carbon Trust

Field trial findings and potential UK savings

Savings identified	25.1%
Savings implemented	12.2%
Cost savings identified	£620 million
Cost savings implemented	£300 million

5.3 UK-wide implications

Overall carbon savings

Based on the assumptions set out above the total carbon emissions from UK SMEs which don't currently have any form of advanced metering are estimated to be 53.6 $MtCO_2$ a year.

The trial results indicate that a roll-out of advanced electricity and gas meters across the entire UK SME population could identify annual savings of 5.1 $MtCO_2$ and make annual savings of 2.5 $MtCO_2$.

[16] In England and Wales non-large users are about 59% of non-domestic water consumption. While segregated data for commercial and domestic is not readily available for Scotland, the same proportions have been used to estimate the consumption of water in Scotland by non-large user from the total non-domestic consumption.

These are very material carbon and consumption savings with a significant associated financial benefit. In financial terms, this is equivalent to savings of £650 million per year identified and £300 million per year implemented.

Table 6 summarises the consumption and cost data for UK SMEs and the field trial findings in terms of savings identified and implemented. Table 7 summarises the potential UK-wide SME carbon and cost savings based on scaling up the results of the field trial. In terms of value to the UK, the carbon savings that can potentially be identified are equivalent to over 2% of all emissions from UK businesses.

Table 6 *Summary of UK SME data and field trial findings by utility*

Utility	UK SME consumption and cost data				Field trial findings	
	Total consumption	Carbon emissions ($MtCO_2$)	Assumed unit cost	Total UK SME costs (£bn)	Savings identified (%)	Savings implemented (%)
Electricity	57 TWh	24.5	6.5p/kWh	3.7	12.1%	4.7%
Gas	153 TWh	29.1	1.8p/kWh	2.8	7.2%	4.3%

Source: DTI, ONS and Carbon Trust

Table 7 *Summary of the potential UK-wide SME carbon and cost savings based on scaling up the results of the field trial*

Utility	Potential UK SME carbon savings ($MtCO_2$)		Potential UK SME cost savings (£bn)	
	Identified	Implemented	Identified	Implemented
Electricity	3.00	1.20	0.45	0.17
Gas	2.10	1.30	0.20	0.12
Totals:	**5.10**	**2.50**	**0.65**	**0.29**

Source: DTI, ONS and Carbon Trust

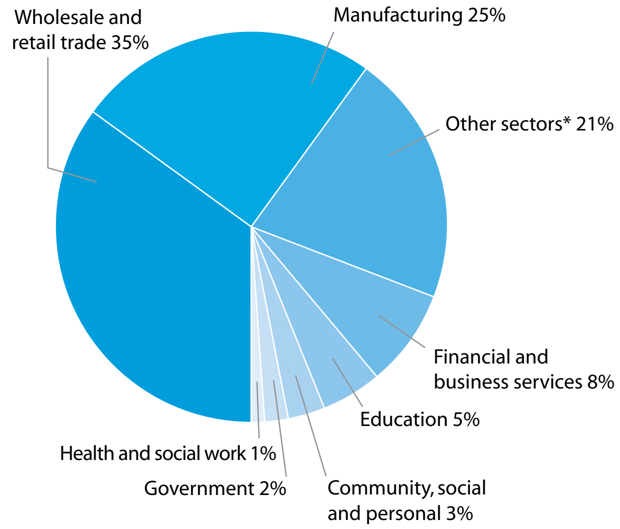
Carbon savings by sector

In order to calculate the breakdown of potential carbon savings by sector an approach has been used which draws together data from DTI[17] (for total fuel usage by sector), the Office of National Statistics (ONS)[18], the Small Business Service (SBS)[19] (using headcount data to estimate the usage amongst large users and SMEs), NERA[20] (estimates of half-hourly electricity usage by sector) and the Carbon Trust (which sectors are likely to have interval vs. non-interval meters).

Given the difficulty in drawing together several different data sets these results are included to provide an illustrative breakdown of where the savings can be achieved, rather than to estimate total potential carbon savings. It therefore serves to highlight the relative magnitude of carbon savings available in individual SME sectors.

Figure 33 combines the sector-based breakdown in national emissions and the carbon savings from the trial to give an indication of the identified carbon savings by sector. This shows that the largest carbon savings are mainly concentrated in two sectors, Wholesale and retail trade, and Manufacturing, which together account for 60% of identified savings.

Figure 33 *Breakdown of potential UK carbon savings by SME sector*



* *Other sectors consists of various sectors which had small sample sizes, including transport and agriculture.*

17 DTI http://www.dtistats.net/energystats/dukes5_2.xls
18 ONS http://www.statistics.gov.uk/downloads/theme_commerce/PA1003_2006/UK_Business_2006_Optimized.pdf
19 http://www.sbs.gov.uk/sbsgov/action/layer?topicId=7000011759 20 NERA, restricted circulation.

6 Advanced metering costs

6.1 Overview

This section provides details regarding both the current and future costs of advanced metering technology and service provision, plus an associated set of underlying assumptions. This cost information is used in subsequent sections as the basis for performing separate cost/benefit analyses from the perspectives of the site owners, energy suppliers and the UK as a whole.

An assessment has been made of the average costs incurred by the participating sites, including the installation and use of the meters, and the technical and advisory support offered by the metering service providers. These estimates have been combined with the average savings in the trial in order to estimate the likely payback periods for the advanced metering services provided.

6.2 Cost components

The cost of providing advanced metering solutions to a site depends not only on the nature of the services supplied but also on the current metering installations present at the site.

For sites without interval metering systems in place, the initial set-up costs will include the cost of the meter or logger and the costs for associated ancillary items including loggers, communication systems and appropriate software. There will also be a charge associated with the actual installation of the meter(s), although this may be included within the cost of the 'service offering' provided by the metering company.

Costs for meters and telemetry equipment are generally spread over a number of years. Software licence costs will typically be paid on an annual subscription basis.

Following installation of one or more meters, the costs to the customer vary depending on the level of service provided to the site by the metering service company. These costs are largely made up of data provision and the time for offering utility efficiency advice.

There are also operational costs, including staff time spent implementing the savings identified from the meter data. However, a significant proportion of savings can probably be carried out by staff as part of their normal activities without incurring additional costs. Investment-based savings measures will require further capital expenditure as well as management time.

It should be noted that the cost/benefit analysis presented in this report does not take into account any potential increases in Balancing and Settlement Code charges due to handling actual data (as opposed to estimated data) for billing purposes. This is consistent with the fact that the savings in the field trial were achieved without the half-hourly data being used to generate accurate bills.

6.3 Current costs

To build an accurate picture of the current costs for equipment and services, the delivery consortia involved in the field trial were asked to provide 'current market value' quotes for the services they provided. These quotes were then market tested with other key players in the industry and adjusted where applicable, to create a set of 'average' costs to use as the basis for analysis.

The cost/benefit analysis presented in this report has not taken into account the costs of any capital investments made in response to specific recommendations from the half-hourly data. This was due to a lack of availability of reliable data for the costs associated with the capital-intensive measures implemented. For consistency, the analysis also therefore excludes the benefits associated with investment-based savings. The costs also exclude any indirect costs potentially incurred by sites such as staff and management time.

Meter and installation costs

The current costs for meters and associated equipment vary considerably. The key factors that influence this are the level of pre-existing equipment on the site and the local environment where the meter is to be installed. The unit price also depends on whether a single meter is installed, or whether multiple meters are installed at one site or multiple sites within the same parent company.

Based on a variety of quotes from the meter and service providers in the trial, the current average total installed cost of an advanced meter is estimated to be £561. This includes provision for an initial site survey to establish technical requirements, estimated at £218, plus the cost of the meter itself and associated communications equipment, estimated at £343. The costs of data logging and telemetry links are affected by factors such as the proximity of pre-existing telephone lines or the availability of a mobile telephone network signal.

The figures quoted above include typical communication costs experienced by the sites in the trial. Metering and telemetry costs can both be annualised and are spread over a period of three years which is a typical contract term for these services.

Service and support costs

The cost of metering consultancy services provided to SMEs depends on how much external support a site or group of sites is willing to fund. This, in turn, will depend on what the company perceives as its needs and on how much internal resource effort can be dedicated to this work. From the evidence of the field trial it is generally advisable for SMEs with no prior experience of advanced metering to have external expert support in the selection and installation of meters and initial interpretation of half-hourly data.

As described previously, the sites in the trial were exposed to three different levels of service, which are referred to as 'Data Only', 'Data and Advice' and 'Personal Contact'. Based on a variety of quotes from the service providers involved in the trial three separate average current costs have been calculated for these different levels of service. These costs currently range from £242 per year for 'Data Only' through to £936 per year for 'Personal Contact'.

It has also been necessary to differentiate service cost levels between single sites and multi-site organisations, based on separate quotes received from service providers. Multi-site organisations are those with six or more discrete sites. Organisations with more than six sites typically benefit from economies of scale both from purchasing volume and, in the case of the 'Data and Advice' and 'Personal Contact' service types, benefit from the use of benchmarks and recommendations mirrored across a number of similar sites.

6.4 Future costs

The current costs reflect the current embryonic state of the market with low penetration in the SME community and a limited number of market propositions tailored for this segment.

However, experience from growth of other early stage technology and service markets suggests that there is significant potential for reductions in both capital and service costs as the market develops. This will be because of economies of scale as well as service innovations due to increasing levels of competition and larger players entering the market. A future cost scenario has therefore been based on a more developed market for advanced metering for SMEs in the UK.

It is predicted that by 2012 this situation could be realistically achieved. Giving the market a clear signal and time frame will greatly help development and market innovation in this field.

Meter and installation costs

Meter and installation costs are expected to drop significantly with volume. Using estimates from Sustainability First[21] as guidance, and including some provision for site surveys at scale, it is projected that advanced meter costs could fall to £164 installed (at 2006 prices).

Service and support costs

In a similar manner, service costs have the potential to fall rapidly as the market matures and levels of competition and innovation increase. In particular, costs for the information-driven services such as the 'Data Only' and 'Data and Advice' are expected to drop dramatically at greater scale through increased use of IT systems automation and advances in analytical software packages for metering.

In future it is expected that service providers will be able to use automated systems to analyse SME energy usage profiles, identify appropriate generic and semi-customised recommendations and automatically email these to the customer, with supporting graphical evidence. Discussions with IT consultancies have indicated that costs of such services could fall as low as £70/year for a fully automated advice service and £20/year for supplying data only. This is in line with the current cost of similar services deployed at scale in other industries, such as personal credit rating services.

[21] 'Smart Meters: Commercial, Policy and Regulatory Drivers', Sustainability First, March 2006.

6.5 Summary of costs

The overall costs to a site for metering services used in this analysis are summarised in Table 8 below.

In summary, the current costs represent typical costs to a site in the current market, based upon the service offerings provided during the trial. The future costs represent estimates of costs once the market for SME orientated advanced metering services has matured as part of a widespread roll-out.

The future cost of the 'Personal Contact' service is not estimated as it is expected that such a service model will never be cost-effective for widespread use in a future advanced metering market for SMEs, due to the high commitment of man-hours required. It is therefore assumed that service providers will in future use 'Data Only' or automated 'Data and Advice' service propositions to provide cost-effective services.

Table 8 *Summary of current and future meter and service costs used as the basis for cost/benefit analysis*

Component	Costing scenario	
Meter costs	**Current (£)**	**Future scenario (£)**
Site survey	218	44
Meter (inc. installation)	343	120
Total	561	164
Service costs	**Current single/ multi sites (£/year)**	**Future scenario (£/year)**
Data Only	242/120	20
Data and Advice	522/176	70
Personal Contact	936/507	N/A

Source: Meter service providers, Sustainability First, Edengene, Carbon Trust, PAA

6.6 Utility prices

The other key set of assumptions underlying the cost benefit analysis in this report relates to utility prices. In order to assess the likely benefits of advanced metering, utility prices have been selected that reflect reasonable expectations of future prices.

The DTI publishes long-term energy price scenarios. Historical end user prices have been used which reflect likely conservative longer-term prices expectations. The period from 2003 to 2006 has seen steadily rising energy prices from relatively low to relatively high prices. 2005 is representative of typical conditions in the DTI central high scenario, and therefore these prices have been selected as a base case for the analysis and are thought to provide a realistic long-term energy price expectation.

For electricity prices it is also necessary to distinguish between single sites, whose prices were close to domestic electricity tariffs, and multi sites, whose prices were closest to higher consuming industrial tariffs.

Water prices are subject to variation by region as well as to overall price control, although suppliers control individual price tariffs. The 2003 prices recorded in the trial data were generally around £2.7/m^3, which is consistent with the business water rates for 2006 published by Wessex Water. Table 9 summarises the utility prices.

Table 9 *Summary of utility prices used for analysis*

Utility	Users	Price (2005)
Gas	All users	1.8p/kWh
Electricity	Multi sites	5.6p/kWh
Electricity	Single sites	6.5p/kWh
Water	All users	£2.70 m^3

Source: DTI, Wessex Water

7 Site-based cost/benefit analysis

7.1 Introduction

This section performs a cost/benefit analysis from the perspective of the SME customer, balancing the costs of metering equipment and service provision against the benefits in terms of consumption and cost savings. The aim of this is to determine to what extent an attractive business case exists for SMEs to adopt advanced metering under both current and future cost scenarios.

7.2 Methodology

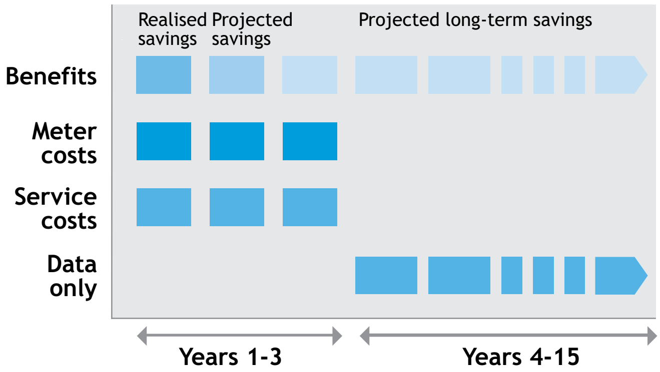
Advanced metering is an energy efficiency investment. Experience from the Carbon Trust and elsewhere indicates that the main financial investment criterion for energy efficiency investments for SMEs is the payback time, although many factors other than financial return play a part in investment decisions. Consequently, the site-level cost/benefit analysis involves studying the payback periods for the three different utilities and the range of sectors involved in the trial.

In addition to capturing the total carbon savings which were identified (average 12.3%) and implemented (average 5.1%) at each site, the project also recorded the anticipated savings (average 6.6%) based on predictions of which recommendations will be implemented in the following year, and those in the longer term (6.9%).

The method used to calculate paybacks for the site-based cost/benefit analysis is illustrated in Figure 34 and used the following assumptions:

- At year 0, a site invests in an advanced meter incurring both the capital cost and the installation cost
- In years 1, 2 and 3 the site pays for the service that was provided during the trial (either Data Only, Data and Advice or Personal Contact)
- In year 1 the site gains the actual utility savings implemented in the trial
- In year 2 the site gains the predicted savings for the year as reported in the trial
- In year 3 the site gains the predicted long-term savings as reported in the trial
- In year 4 onwards, the site pays for the Data Only service and maintains the savings at the level of year 3.

Figure 34 *Approach used to model payback periods*



In practice ongoing savings will be a trade-off between the level of new savings identified and implemented each year and the level of persistence of previously implemented savings, which in general will decline over time. The approach outlined above assumes that these factors balance out and that paying for an ongoing service simply serves to maintain the previously implemented savings. This assumption is intuitive rather than supported by any firm data. In fact a key area for potential further study is a longitudinal analysis of the effect of advanced metering on savings persistence factors.

However, to a certain extent this assumption is not material to the business case as, based on Carbon Trust experience, it is unlikely that a payback time of greater than four years will act as a sufficient incentive for investment.

The calculated payback time is the point at which the cumulative benefits are greater than the cumulative costs.

This method is also somewhat conservative in that the capital cost of the meter is applied in total in year 0. In reality, the meter cost is likely to be spread over the life of the meter plus a service contract of, say, three years, thus bringing forward the payback time. As illustrated above the lifetime of the meter asset is assumed to be 15 years in line with assumptions generally used by meter providers.

In calculating the benefits from the perspective of the site, no value was placed on reduced carbon emissions as, at present, there is no mechanism by which SME sites can realise carbon value. In line with the core analysis in this report, the sites with existing half-hourly electricity meters (Code 5 sites) have been excluded from the cost/benefit analysis. For the future cost scenarios it has also been assumed that supplier benefits (such as savings through remote meter readings, and distributed network operator fee savings) will be passed through to sites through lower energy prices. This is a relatively minor effect from the point of view of the sites, averaging about £10 per meter per year.

7.3 Results

The site-level cost/benefit analysis presents the implications for single-site and multi-site SMEs separately.

Current cost scenario

Figure 35 shows the payback periods for each of the utilities based on the current cost assumptions and using 2005 energy prices.

It shows that under these assumptions the investment case appears attractive for multi sites, with paybacks of about two years for gas, about one year for electricity and under six months for water. These paybacks are expected to meet most SMEs investment criteria, especially given the ongoing cost savings likely once the payback period has been reached.

The picture for single-site SMEs under the current cost scenario is less attractive, with significantly longer payback periods of about four years for gas and greater than five years for electricity and water.

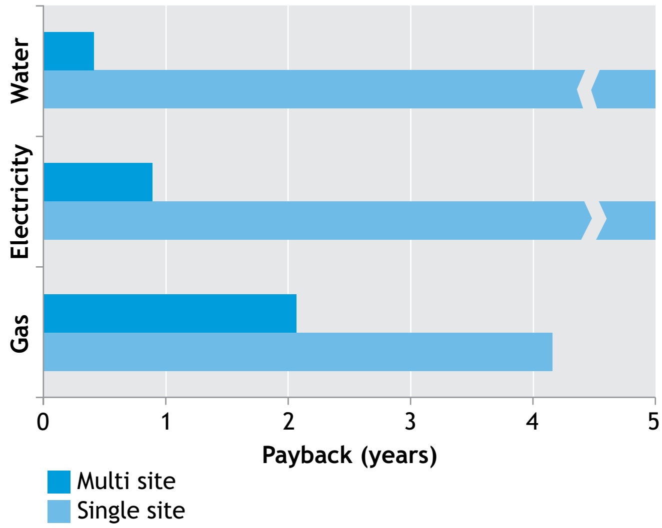
Future cost scenario

Figure 36 shows the payback periods for each of the utilities using the same energy prices but now based on the future cost assumptions.

This shows that the investment case for advanced metering is likely to be attractive for both multi and single sites in the future. In order to model this scenario, it has been assumed that the 'Data and Advice' service has been adopted by all sites since this service has the potential to be automated and delivered as a low-cost proposition in a mature SME metering market. Consequently only sites which received this level of service in the field trial are included in the analysis.

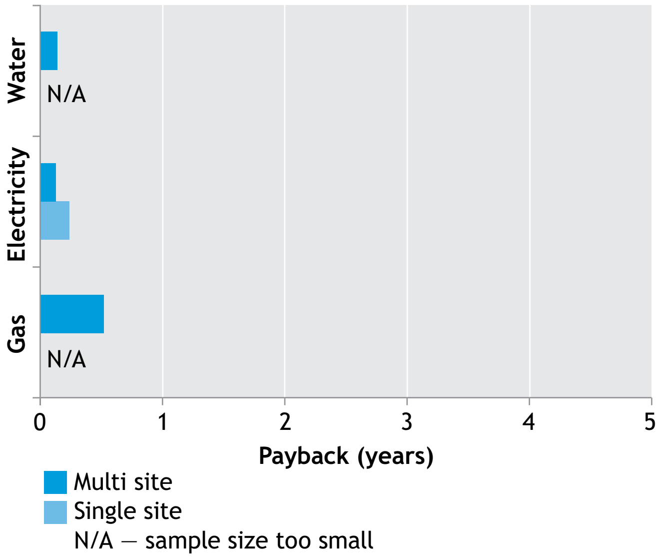
For multi sites paybacks are extremely attractive, at around six months for gas and less than two months for electricity and water. Unlike for the current cost scenario the paybacks for single sites also appear attractive at around three months for electricity. However, the sample sizes for the water and gas sites are low and potentially unreliable, so the results are not shown[22].

Figure 35 *Payback periods for SME sites based on current costs*



Source: Carbon Trust, PAA

Figure 36 *Payback periods for SME sites based on future costs*



Source: Carbon Trust, PAA

[22] The 'future costs' scenario assumes use of the 'Data and Advice' service by all sites. The analysis is therefore limited to sites in the trial which used this service.

Paybacks by sector

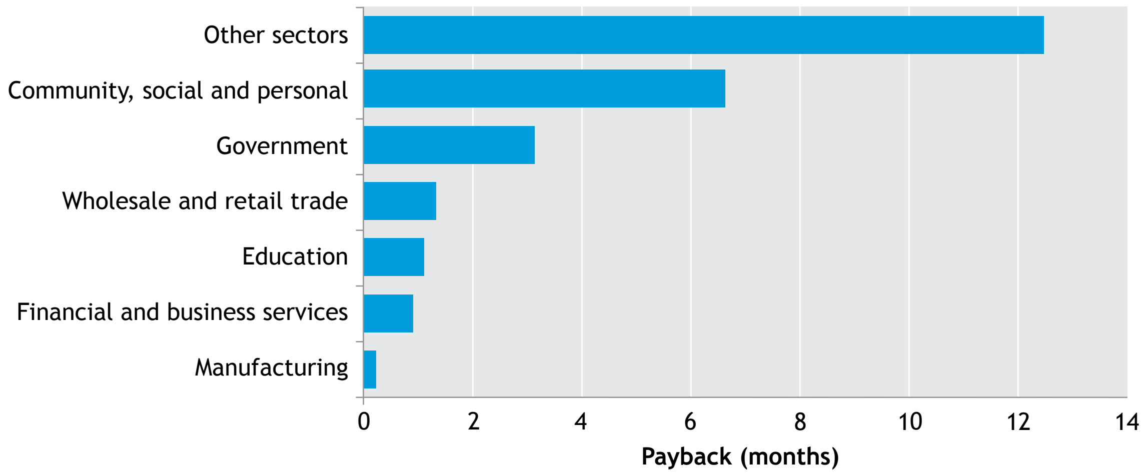
The cost/benefit analysis has been extended to estimate paybacks by sector for the future cost scenario. Here the focus is on electricity meters, because there is insufficient data from gas and water meters in the trial once spread over all sectors. Again it is assumed that all sites adopt the 'Data and Advice' service, and results from single and multi sites have been combined to achieve reasonable sample sizes.

Figure 37 shows that all the sectors have payback times below 13 months. The best returns are generated in the high-consuming sectors such as manufacturing.

Summary

Based on current meter and service costs, there is already a strong business case for using advanced metering at multi-site SMEs, such as retail and wholesale chains, and for energy-intensive SME sectors, such as manufacturing. However, for single-site SMEs and SMEs with lower energy consumption the case is less attractive; although they will save money over the lifetime of the meter, the costs are currently prohibitive when considered in terms of acceptable payback periods. Modelling expected future meter and service costs indicates that in the future, a clear business case will also exist for single-site SMEs and users with lower consumption levels. This scenario requires the costs of metering services to be driven down by increased innovation and automation.

Figure 37 *Payback by sector for future costs (electricity only)*



NOTE: Health and social work omitted due to low sample size.

8 Supplier cost/benefit analysis

8.1 Introduction

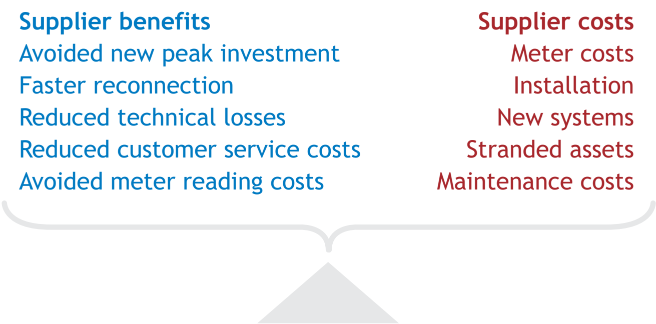
This section performs a cost/benefit analysis from the perspective of an energy supplier considering roll-out of advanced metering to its SME customers. This analysis balances the costs of providing metering equipment and dealing with stranded assets against the benefits in terms of reduced meter reading costs, reduced customer service costs and other avoided investment. The aim of this is to determine to what extent an attractive business case exists for energy suppliers to roll-out widespread advanced metering services to their SME customers under both current and expected future cost scenarios.

8.2 Methodology

The cost model used was originally developed by OFGEM to support recent work on domestic metering innovations[23]. OFGEM used the model to analyse the financial incentives for a supplier to install advanced metering in domestic non-interval metered sites, and is considered to be the most robust model available in the public domain. Some adjustments have been made to reflect differences between the SME and domestic markets. Figure 38 illustrates the balance between the key supplier benefits and costs associated with roll-out of advanced metering.

The model used for the cost/benefit analysis compares the annualised costs and benefits of advanced metering from the perspective of the supplier, using a 10% discount rate over the lifetime (15 years) of the meters. The analysis assumes instantaneous roll-out of meters.

***Figure 38** Supplier benefits and costs from roll-out of advanced metering*



Supplier benefits

Avoided new peak investment – by reducing consumption at peak periods the demands on the system at peak times are reduced. Consequently, the need for investment in generation, transmission and distribution assets is reduced. It has been assumed that 2.5% of peak consumption can be avoided if advanced meters are adopted. (Note: this is significantly lower than the savings achieved in the trial since savings will be spread throughout the day; consequently a conservative figure is presented.)

Faster reconnection – advanced metering can allow remote reconnection or disconnection. An estimated 25,000 connections or disconnections occur in the SME market per year, priced at £150 per event. Faster remote reconnections means less call centre time and fewer site visits. Given the small number of such events in the SME sector, this benefit is relatively low.

Reduced technical losses – advanced metering leads to lower consumption and therefore reduces the losses in the energy supply networks, especially if reductions occur at peak times. A better understanding of gas and electricity networks allows better design and system optimisation. Network operators are under various incentive schemes to reduce losses through transmission and some benefits are seen by the energy suppliers. Advanced metering is thought to provide a 1% reduction in technical losses, and the current network operator incentive is placed at £48/MWh.

Reduced customer service costs – advanced meters provide more accurate bills, and will result in fewer inaccurate estimates and contested bills. Consequently demands on energy suppliers' call centres will reduce significantly. 15% of sites contest their bills and require an average of 20 minutes call centre intervention time. Call centre time costs are estimated at £10/hour.

Avoided meter reading costs – advanced meters can be read remotely, removing the need for site visits. Frequency of billing depends on site energy consumption, but suppliers report that on average each meter is read manually (or an attempt is made) twice a year. These costs could be saved if advanced meters were installed. The 'cost to serve' figure quoted by Datamonitor, and subsequently adopted by OFGEM, indicates that the average cost of manual meter readings is around £2.60 per meter. Further additional cost savings may come from a more structured approach to the two-year annual inspection, and in practice this could also be combined with any scheduled meter maintenance.

[23] www.ofgem.gov.uk/Markets/RetMkts/Metrng/Smart/Documents1/12813-2006.pdf

Supplier costs

Meter costs – capital costs of new advanced meters based on market rates. It is assumed that costs are spread over a three year contract, not the life of the meter.

Installation – cost of having meters installed on-site (as detailed in Section 6.5).

New systems – new infrastructure and data processing systems are required to handle data from advanced meters. These have been calculated at £20 per meter for the suppliers' systems over 15 years. These figures are based on work previously carried out by OFGEM[24].

Stranded assets – the cost of replacing meters ahead of the end of their useful life has been taken into account. Prices for stranding have been derived from the price control review from the 2001 network operators. This places electricity meters at £15 and gas at £17.

Maintenance costs – advanced meters will potentially require more maintenance than standard meters. For the purposes of this analysis maintenance costs have been taken as 3.5% of meter costs. This includes one battery replacement for gas meters over their 15-year lifetime.

8.3 Results

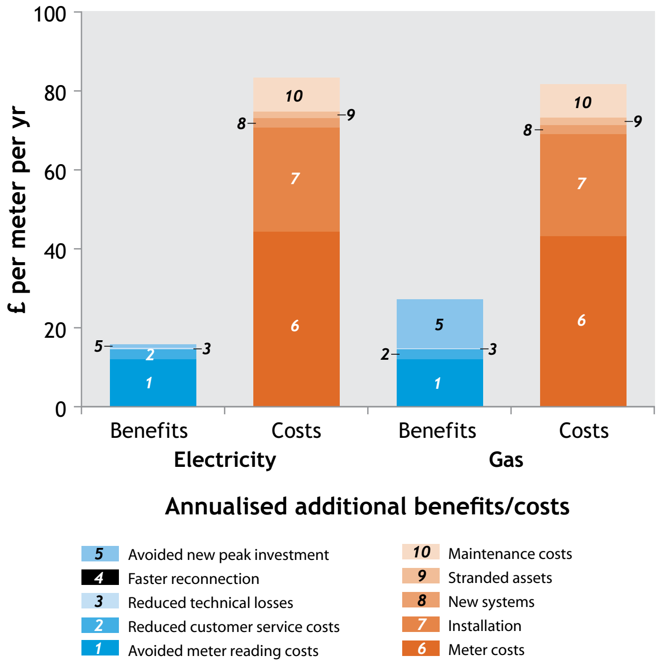
As for the site-level analysis the supplier cost/benefit analysis looks separately at the costs and benefits under both current cost and future cost scenarios.

Current cost scenario

Figure 39 shows the magnitude of the various costs and benefits for suppliers based on the current cost assumptions and assumes that suppliers provide advanced metering to the entire SME market.

For both electricity and gas the costs substantially outweigh the benefits indicating that there is no financial incentive for suppliers to initiate a widespread roll-out of advanced metering to the SME community. The crucial cost elements are the meter and installation costs, which clearly outweigh the benefits, the largest of which are the avoided meter readings and, for gas, the avoided peak investment.

***Figure 39** Supplier benefits and costs for widespread roll-out of advanced gas and electricity metering to the SME community, using current costs*



[24] OFGEM Domestic Metering Innovation 2006.

Future cost scenario

Figure 40 shows the magnitude of the various costs and benefits for suppliers based on the future cost assumptions. Again, it assumes that suppliers provide advanced metering to the entire SME market.

Using the future costs scenario improves the business case from the point of view of suppliers, but the financial incentives for a widespread roll-out of advanced metering to SMEs are still limited. For electricity, the costs still outweigh the benefits and for gas the case is marginal.

Supplier business model innovation

In addition to the benefits included in the model, it is recognised that energy suppliers may also have strategic reasons for moving to the provision of advanced metering services for SMEs. These might include:

- Enhanced customer retention
- The ability to attract new customers from other suppliers
- The ability to sell higher margin energy consultancy services.

These benefits have not been considered in the analysis since they are variable and difficult to quantify across all suppliers.

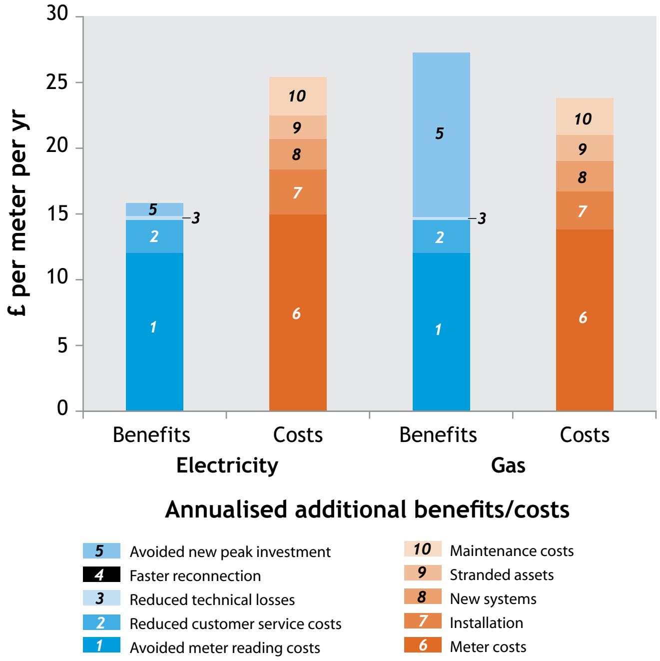
The analysis in this section suggests that a widespread roll-out of advanced metering to SMEs is unlikely to be initiated by suppliers for all customers, given the potential costs and risks in terms of stranded assets and uncertainty regarding the regulatory environment. The medium-term outlook indicates that suppliers are only likely to target metering services at those SME customers at the high consumption end of the market, since smaller consumers represent a poor return on investment.

The site level cost/benefit analysis presented earlier provides a good indication of those SME sectors and types of sites which would be the best potential customers for advanced metering services from the suppliers' point of view.

Summary

From the perspective of energy suppliers, the current costs of providing advanced metering services to all SME users significantly outweigh the potential benefits. Furthermore, even as costs come down, in future the business case appears to remain marginal. There is likely to be a good business case for providing metering services to certain limited sections of the SME community, such as SME-like multi-site companies (eg retail chains). However, the overall case is hampered by the large number of single-site SMEs, mainly due to the high cost to serve associated with these sites due to their disparate nature.

Figure 40 *Supplier benefits and costs for widespread roll-out of advanced gas and electricity metering to the SME community, using future meter costs*



There is some potential for suppliers to benefit further through altering their business models to realise new opportunities. However, the trial findings highlight a significant barrier to the wider uptake of advanced metering due to the insufficient financial incentives for energy suppliers to provide these services on a widespread basis. Furthermore, it is unlikely that simply targeting the sectors which are currently cost-effective will yield a large enough market to make the business case sufficiently attractive from the suppliers' perspective. If the SME advanced metering market is left to grow organically it is likely to develop in a fragmented way, with slow growth and limited economies of scale being achieved.

9 UK net cost/benefit analysis

9.1 Introduction

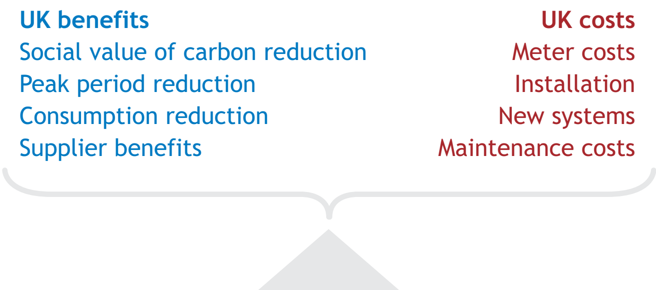
This section provides a cost/benefit analysis for a roll-out of advanced metering across the whole of the UK. The analysis balances the entire set of costs, principally for the provision of metering equipment, against the entire set of benefits, including the social value of carbon emissions reductions, reduced consumption and other system and supplier benefits. It demonstrates the extent to which, under both current and future cost scenarios, the UK can achieve cost beneficial carbon savings and a positive economic outcome by rolling out widespread advanced metering to the SME community.

9.2 Methodology

To assess the impact of advanced metering on a net UK level a new model has been developed. The basis for this model is the core methodology used in the OFGEM supplier model discussed in the previous section. However, a number of modifications and assumptions have been made to reflect the picture at a net UK level and to allow carbon savings benefits to be compared effectively with other UK policy work relating to reduction of carbon emissions.

Figure 41 illustrates the balance between the key UK benefits and costs associated with roll-out of advanced metering.

Figure 41 *UK benefits and costs from roll-out of advanced metering*



UK benefits

Social value of carbon reduction – the societal benefit of reduced carbon emissions is well accepted, and are valued here at £26/tCO_2 in line with current DEFRA guidelines[25].

Peak period reduction – reducing the peak energy consumption has a number of UK benefits mainly from avoided operation costs and network infrastructure costs relating to storage, transmission and distribution.

Consumption reduction – advanced metering has been demonstrated to yield financial savings from reduced energy consumption. The savings from the trial sites have been used as the basis for cost-saving calculations at retail prices previously outlined.

Supplier benefits – avoided meter reads, reduced technical losses, reduced customer service costs and faster reconnection are all benefits of advanced metering which fall to the supplier (refer to supplier analysis).

UK costs

Meter and service costs – market rates for advanced meters are spread over 15-year service life for the national analysis. Service costs of 'Data and Advice' are included in this figure (see costs in Section 6.5).

Installation costs – costs of installing individual meters at individual sites (see costs in Section 6.5).

New systems costs – new infrastructure and data processing systems are required to handle data from advanced meters. These have been calculated at £20 per meter for the suppliers' system over 15 years.

Maintenance costs – advanced meters will potentially require more maintenance than standard meters. For the purposes of this analysis maintenance costs have been taken as 3.5% of meter costs. This includes one battery replacement for gas meters.

In line with the IAG Guidelines[26] a standard treasury discount rate of 3.5% has been used on customer costs. On capital expenditure, a 10% cost of capital has been adopted to reflect a typical commercial return. It should be noted that stranded asset costs have been excluded from the UK-wide analysis, in line with Government guidelines, since these are effectively sunk costs and are not net costs to the UK. However, sensitivity analysis has also been carried out with these costs included; the effect is minimal and does not change the key outcomes of the analysis.

[25] DEFRA GHG policy evaluation tool October 2006 (restricted).
[26] www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/greengas-policyevaluation.pdf

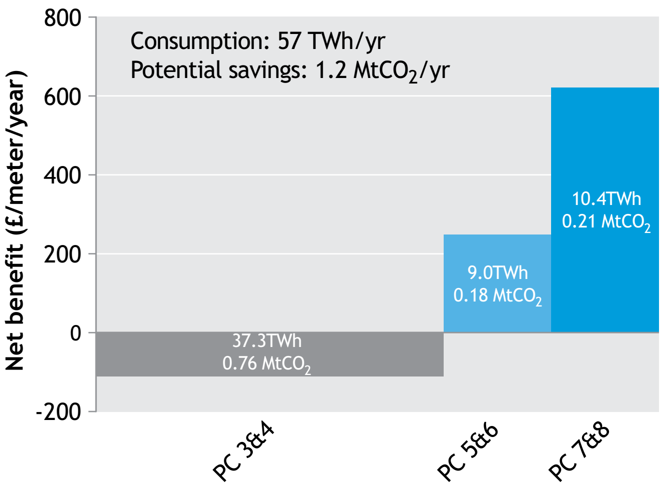
9.3 Results

The UK cost/benefit looks separately at the costs and benefits under both current cost and future cost scenarios. As previously, it is assumed that 'Data and Advice' is used as the service model for all customers. The major cost is the provision of services to make best use of the meter data while the major benefits are reduced consumption and the social value of emission reductions.

Current cost scenario

Figure 42 shows the net UK benefits or costs of rolling out advanced electricity metering to the SME community, broken down by 'profile class' groups and based on current costs. At current meter and service costs there is a net UK benefit of around £600 per meter from providing advanced metering to customers in profile classes 7 and 8, the highest volume consumers, and a benefit of around £240 per meter for SMEs in profile classes 5 and 6. Usage through these meters is about 20 TWh/year, almost one third of all the electricity usage in the group of SMEs that don't currently have interval-based meters for electricity. This represents an annual reduction of carbon emissions of about 0.40 $MtCO_2$ based on savings levels implemented in the trial. However, for the other SME customers in profile classes 3 and 4 implementing advanced metering would represent a net cost to the UK of £110 per meter.

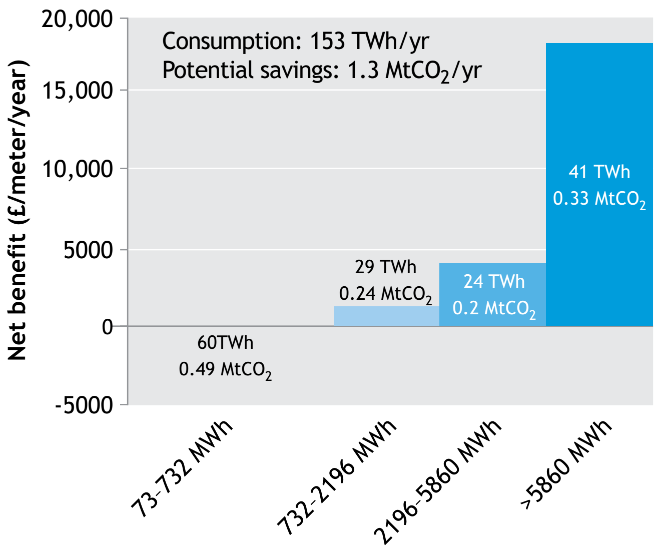
***Figure 42** UK cost/benefit by electricity profile class using current costs*



Summary			
Profile class:	3 & 4	5 & 6	7 & 8
Total annual consumption (TWh)	37.3	9.0	10.4
Total annual emissions ($MtCO_2$)	0.76	0.18	0.21
Net UK benefit or cost (£/meter/year)	-£110	£240	£620
Cost of carbon (£/tCO_2)	£318	No cost	No cost

Figure 43 below shows the net UK benefits or cost of rolling out advanced gas metering to the SME community, broken down by consumption level and based on current costs.

***Figure 43** UK cost/benefit by gas consumption band using current costs*



Summary				
Profile class:	73-732 MWh	732-2196 MWh	2196-5860 MWh	>5860 MWh
Total annual consumption (TWh)	60	29	24	41
Total annual emissions ($MtCO_2$)	0.49	0.24	0.20	0.33
Net UK benefit or cost (£/meter/year)	-£7	£1,225	£3,944	£17,870
Cost of carbon (£/tCO_2)	£5	No cost	No cost	No cost

At current meter and service costs there is a significant net UK benefit from providing advanced metering to gas customers in all but the lowest consumption band (up to 732 MWh per year). Usage through these meters is 94 TWh/year, or about 60% of all the gas usage in the group of SMEs that don't currently have interval-based meters for gas. This represents a reduction of carbon emissions of about 0.8 $MtCO_2$ based on savings levels implemented in the trial. For the lower consumption SME customers implementing advanced metering would represent a net cost to the UK of around £7 per meter.

Future cost scenario

Figure 44 shows future cost benefit analysis for electricity and indicates that advanced metering will be cost-effective for all profile classes. The potential carbon savings from electricity are 1.2 $MtCO_2$.

Figure 44 *UK cost/benefit by electricity profile class using future costs*

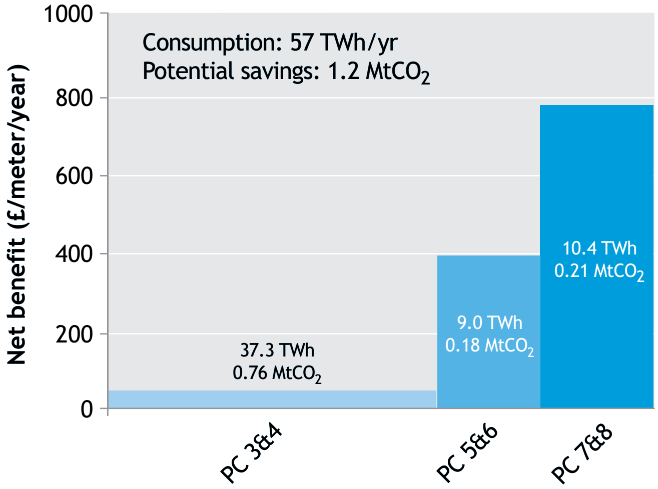
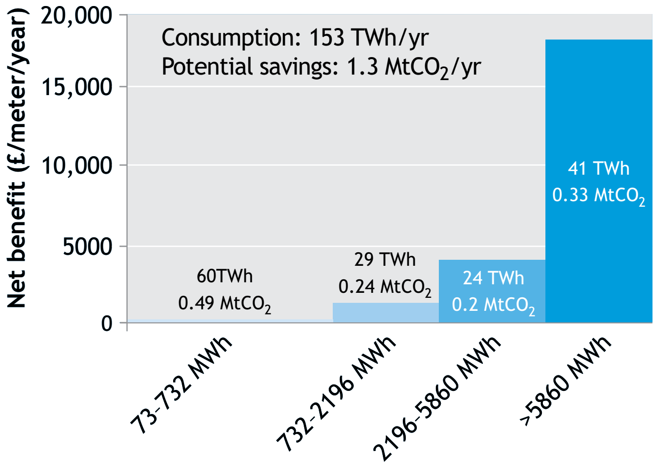


Figure 45 shows the effect of applying the future cost scenario to gas advanced metering. It can be seen that advanced metering is cost-effective for customers in all consumption bands. Potential carbon savings come to 1.3 $MtCO_2$.

Figure 45 *UK cost/benefit by gas consumption band using future costs*



Summary

From the overall UK perspective, widespread adoption of advanced metering in the SME community represents a significant opportunity for achieving cost-effective carbon savings as well as economic benefit for the UK. We have already seen that scaling up the results of the field trial to the UK level for gas and electricity indicates that a total of 5.1 $MtCO_2$ savings could be identified and 2.5 $MtCO_2$ savings could be implemented per annum. The analysis in this section indicates that a significant proportion of these carbon savings can be achieved at no net overall cost to the UK.

Based on current costs annual carbon savings of nearly 1.2 $MtCO_2$ can be implemented at a net benefit to the UK, by targeting electricity users in profile classes 5–8 and gas users with annual consumption above 732 MWh. Using future cost assumptions the full potential annual carbon savings of 2.5 $MtCO_2$ can be implemented at a net benefit to the UK, by targeting all SME electricity and gas users.

In light of the significant potential cost-effective carbon savings and the economic benefit to the UK, but also the limited incentive for suppliers to provide advanced metering services to the market as a whole, there is a clear case to take action to ensure the widespread roll-out of advanced meters for SMEs. A widespread roll-out of advanced metering would also catalyse an energy consultancy market and put in place an infrastructure of meters capable of supporting further policies to reduce carbon emissions in future.

Section 11 looks in more detail at the potential policy implications from these findings.

10 Barriers to adoption

10.1 Introduction

The Carbon Trust has worked with advanced metering suppliers to install a large number of advanced metering systems at SME sites throughout the UK. This has enabled the Carbon Trust to gain valuable insights into the key issues which currently impede uptake of this technology. This section reviews the reasons why sites were unable to implement one or more of energy saving recommendations identified. It also looks at various other practical barriers highlighted by the trial, and discusses some of the well recognised market barriers which exist.

10.2 Reasons for lack of implementation

Energy savings actions were identified at 504 of the 538 SME core sites in the trial. Sites typically had 2-3 recommendations and a total of 384 recommendations were made and not implemented.

Figure 46 shows a breakdown of the reasons why savings weren't actioned. These were captured through lessons learnt case studies, where sites provided feedback on why identified energy savings could not be implemented. The reasons for not implementing energy saving actions are broken down into the following categories:

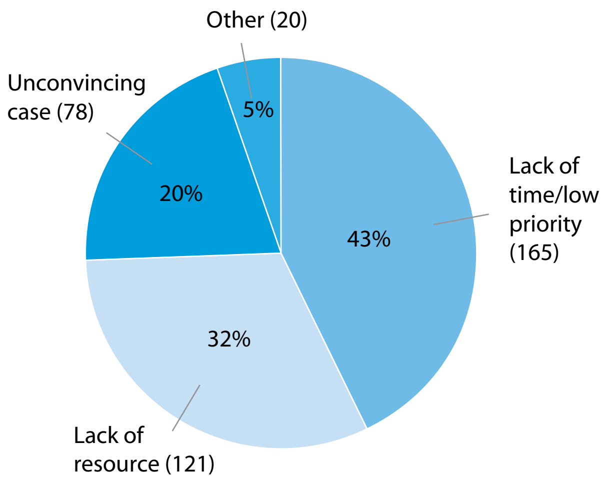
Unconvincing case – the recommendation was rejected or needed more research to demonstrate the feasibility or potential benefits.

Lack of time/low priority – the recommendation couldn't be implemented within the timescales of the trial, generally due to other business activities taking priority. Typically sites did not 'run out' of recommendations.

Lack of resource – the recommendation was accepted as worth doing, but there was insufficient personnel or funding at the site.

Other – typically the meter or communications equipment failed or it was found that no saving was possible after further investigation.

Figure 46 *Reasons for not implementing identified energy savings*



This analysis shows that the main reason for failure was due to a lack of time or low priority to implement the changes required: this accounts for 43% of recommendations which were not implemented. However, many sites claimed that such recommendations would have been implemented in future but were not possible within the timescales of the trial. Nevertheless, the inevitable competing pressures on SMEs suggest that a certain degree of buy-in is important in order to realise the full potential of advanced metering.

The delivery consortia reported that in some cases sites also failed to identify or implement energy saving recommendations due to a lack of willingness to engage with using the meter effectively. In such cases site owners or managers were often preoccupied or unconvinced of the benefits of using advanced metering.

Changes of personnel also resulted in loss of site engagement. This was only evident in sectors where a high turnover of staff is common such as wholesale and retail. Increased awareness of the potential benefits were found to help motivate personnel at sites to make better use of advanced metering services.

20% of recommendations were considered to be unconvincing, meaning that either the recommendation was unsuitable (because it was provided remotely without direct knowledge of the business), or because it was thought that it would not yield the anticipated level of savings. For a further 32% of recommendations the sites would have been willing to implement but they had insufficient resources to carry this out, either in terms of manpower or financial resources.

10.3 Technical and practical barriers identified

In addition to the reasons identified for potential energy savings not being implemented, the trial also identified a number of technical and practical barriers to the use of advanced metering.

Installation issues

There were various difficulties reported in coordinating meter replacement activities. At sites where the most appropriate course of action was to replace the existing meter, significant delays were often experienced in getting the energy supplier and meter asset owner to cooperate with the installation of the replacement meter. Furthermore, the often necessary interruption to the power supply was often inconvenient for the site.

Clip-on style meter reading devices did not face these issues. However, some energy suppliers and data collectors were reportedly apprehensive about these devices being fitted to existing fiscal meters and a small number of sites reported operational problems. In practice, suppliers are often not notified that clip-on meters have been installed since they have no impact on normal operation. There is a need to clarify standard procedures and codes of practice in relation to clip-on devices.

Commercial interoperability

For the purposes of the trial all sites continued with their existing data collection services and received energy and bills from their energy supplier in the same way as before the trial. In theory, it would have been possible for those sites with metering services being provided by accredited data collectors to send data to the suppliers for accurate billing. However, in practice this was found to be hard to achieve owing to the fact that energy suppliers often have preferred data collectors and can be reluctant to accept data from other collectors.

Use of preferred data collectors is common practice since suppliers require data to be provided in a standardised format which can be readily aggregated for billing purposes. In the absence of industry-wide standards on the format and timing of such data in the non-half-hourly market, suppliers prefer to work with specific collectors rather than have to deal with a variety of different data formats. Furthermore, where suppliers do accept data from independent metering service providers, via an accredited data collector, they are still often reluctant to reimburse the customer for the fact that data is no longer being provided by their standard data collector.

The lack of transparent charging for metering services is another key barrier. Customers incur charges for various metering services, including meter asset provision, meter operation, data collection, aggregation, safety inspections and settlement charges. However, most customers have consolidated supply contracts and relative costs can be hard to identify. Equally, it is unclear exactly which charges will change or disappear if the customer chooses to upgrade to an advanced meter. This lack of transparency prevents customers from making informed cost-benefit decisions and can lead to actual or perceived double charging for some meter services. This situation would be greatly improved if definitions of charge types and details of charge levels were published within utility bills.

Furthermore, experience from the Code 5 sites in the trial (where advanced meters were already in place) has highlighted that even when half-hourly data exists, there is a sometimes reluctance by suppliers to make this freely available in a timely fashion to customers.

Communications

Most technology-related issues in the trial concerned communication equipment as opposed to the meters themselves. The most common problem was when communications equipment went out of service, resulting in missing periods of data. Sometimes communications technology was chosen without knowledge of the site and was then found to be unsuitable. The industry now recognises that no single communications protocol is appropriate for all sites. GPRS, SMS and landline communication systems are all used to good effect. While communications issues were experienced in the initial stages of the trial, this is not now a major issue as practices and technology have further developed.

In light of the above it is not necessary to define specific communications protocols in terms of the different technologies being used. Rather there is a requirement for data protocols which define the nature and frequency of data to be transferred, to allow integration between metering systems, data collectors and data aggregators.

10.4 Established market problems

Stranded assets

The risk of stranded assets is a significant barrier to suppliers rolling out advanced metering in the UK. It applies to both the existing meter stock and any new meters which are installed. By replacing an existing meter with an advanced meter before the end of its useful life the value inherent in the old meter is lost since it is unlikely to be re-used at a different site. Asset owners are also hesitant to offer advanced meters into the non-half-hourly market due to the risk of installing high value, high functionality meters which will be redundant, or not be exploited fully, should a customer change supplier. If the new supplier will not use the full functionality of the meter, it is unlikely that a full market value for the meter can be derived by the asset owner from the supplier.

This risk means that the cost of using more advanced meters is currently high to those suppliers who are interested in rolling out advanced metering services. In the electricity market this problem can be alleviated to some extent through longer supply contracts. However, in the gas market suitable contract lengths are less feasible since terms of supply are currently very variable and typically short term.

In order to reduce the risk to the meter owners, and thus the cost to the suppliers, it is essential that all advanced meters adhere to basic minimum functionality standards. This would ensure that any advanced meter could support the associated advanced metering services of another energy supplier, therefore allowing the asset owner to transfer the use of an existing advanced meter to a new energy supplier.

A small risk still remains from a site potentially downgrading back to a standard meter, but this risk will diminish as the market realises the benefits of advanced metering and more utility suppliers offer these services.

OFGEM acknowledges that a lack of standards exacerbates the stranded asset issue. In 2006 OFGEM set up a working group to address the issues of meter interoperability for both domestic and commercial gas and electricity metering. This activity is widely supported by the metering industry and, once complete, will improve market confidence for the key industry players. However, it is vital that standards are agreed as soon as practicable in order to facilitate the growth of advanced metering.

Balancing and settlement issues

Balancing and settlement code (BSC) rules in the non-half-hourly electricity market can present a further problem. Settlement between generator and supplier under BSC rules within the non-half-hourly market is based on estimated profile data. Therefore there is potential for discrepancy between the supplier's liability to generators and income due from the customer. It is likely that the BSC rules and systems will need updating to handle half-hourly data in the large volume advanced metering that the SME community would generate, so the supplier and customer can both benefit. However, if the half-hourly settlement process is extended, balancing and settlement charges will need to be reduced, or an alternative process be created, to take account for the lower energy bills which exist in the SME sector.

11 Policy implications

11.1 Introduction

This report has highlighted the significant energy and cost-saving benefits of advanced metering for SMEs and the associated cost-effective UK carbon savings which could be achieved from roll-out to the SME sector. The trial has also highlighted a number of barriers to the uptake of advanced metering, some of which are already recognised within the industry.

Most notably, there are significant barriers to suppliers providing advanced metering services. This is in part due to stranded asset concerns and lack of agreed meter standards. However, the trial findings suggest that even if these barriers were to be addressed, it is still likely there would be insufficient financial incentives for suppliers to roll-out the technology on a widespread basis.

In light of the above, some level of compulsion must be considered to assist the move towards a mass market adoption of this technology and addresses the barriers which exist on a UK level. This section therefore identifies a range of measures which the Government should consider adopting to further promote the uptake of advanced metering.

11.2 Actions to assist uptake

Mandation of new and replacement meters

The simplest regulatory change regarding adoption of advanced metering would be for the Government to mandate the installation of advanced metering for all new meters, and whenever an existing meter comes to the end of its useful life.

Such a requirement, applied to all gas and electricity consumption bands, would result in an estimated 584,000 electricity meters and 105,000 gas meters being rolled out by 2012, assuming a 5% churn rate. This could lead to annual carbon savings of around 0.60 $MtCO_2$ being achieved per year by 2012.

It is questionable whether this volume of meters would be sufficient to make significant impact on one-off meter costs, but it would certainly contribute significantly towards lowering service costs provided by energy consultancies, which currently form the major element of the previous cost/benefit analysis.

In relation to this measure Government should safeguard against suppliers passing on the full cost of new and replacement advanced meters to smaller consumers. There are reduced costs to serve benefits to suppliers, particularly with the higher consuming sites and the strong market signal this measure would bring will allow new higher value services to be developed from the supply side. Asset owners benefit from reduced stranded asset liabilities though greater clarity around the future of their meter investments. Both these factors will offset costs associated with new and replacement meter roll-out. Any outstanding costs which may originate from smaller consuming sites could be apportioned in the same way as many other infrastructure upgrade programmes in the utility industry. This would mean spreading the costs over the lifetime of the asset and the entire targeted population. The Carbon Trust believe that these measures should avoid any unfair cost burden for smaller SME customers.

Accelerated roll-out of meters

The compulsory installation of advanced metering for new and replacement meters is an obvious first step, but using this approach alone would clearly take many years to replace all of the meter stock. This approach could therefore be extended to set accelerated replacement targets for suppliers to provide advanced meters for those groups of higher consumption customers where there is a clear net benefit to the UK under current costs.

Such an accelerated roll-out would apply to all gas sites with an annual consumption greater than 732 MWh, and all electricity sites in profile classes 5, 6, 7 and 8. Combined with the previous measure and assuming an accelerated roll-out rate of 20% per year this would replace an estimated 843,000 meters by 2012, giving carbon savings of around 1.5 $MtCO_2$ per year.

Potential policy measure	Impact	Benefit
1. Mandate that all new and 'end of life' replacement meters are advanced meters	Meters by 2012:	
▸ Electricity: All SME customer groups	▸ 584,000 electricity	▸ Addresses all groups with potential to be cost-effective for UK
▸ Gas: All SME customer groups	▸ 105,000 gas (Assumes 5% churn)	▸ 0.60 $MtCO_2$ savings per year by 2012

Potential policy measure	Impact	Benefit
2. Mandate accelerated roll-out in addition to standard replacement	Meters by 2012:	
▸ Electricity: Profile classes 5, 6, 7 & 8	▸ 710,000 electricity	▸ Targets groups where meters are currently cost-effective at UK level
▸ Gas: Users above 732 MWh/year	▸ 133,000 gas (20% annual roll-out)	▸ 1.5 $MtCO_2$ savings per year by 2012 (for measures 1 and 2)

Collectively, the estimated 843,000 gas and electricity meters are covered by these recommendations, and the proposed rate of deployment are thought to be sufficient to drive a market for competitive data services for advanced metering which has been seen as a major cost component.

Furthermore, these roll-out suggestions would necessitate action from the major energy suppliers. If a clear timeline for the adoption of advanced metering in the UK can be defined in this way, suppliers would be able to shape product and service offerings appropriately from the outset, targeting these initially at the early adopters with higher consumption levels. In such cases the business case will look attractive both for the site in terms of payback and also for the supplier in terms of the ability to sell associated metering services to the site. As the volume of advanced meters increases through this accelerated roll-out, it will be possible to design optimum products and services. The accelerated roll-out rates will drive economies of scale throughout the advanced metering supply chain, leading to costs reducing towards those presented in the 'future cost' scenario.

Full market roll-out

If the above suggestions were to be adopted it is expected that by 2012 the necessary market conditions would be present to allow advanced metering to be rolled out cost-effectively to the remainder of lower consuming electricity and gas customers, as demonstrated in the future cost scenario. This could be achieved by setting a final date by which suppliers must ensure that all remaining customers in these groups have been migrated to advanced metering technology.

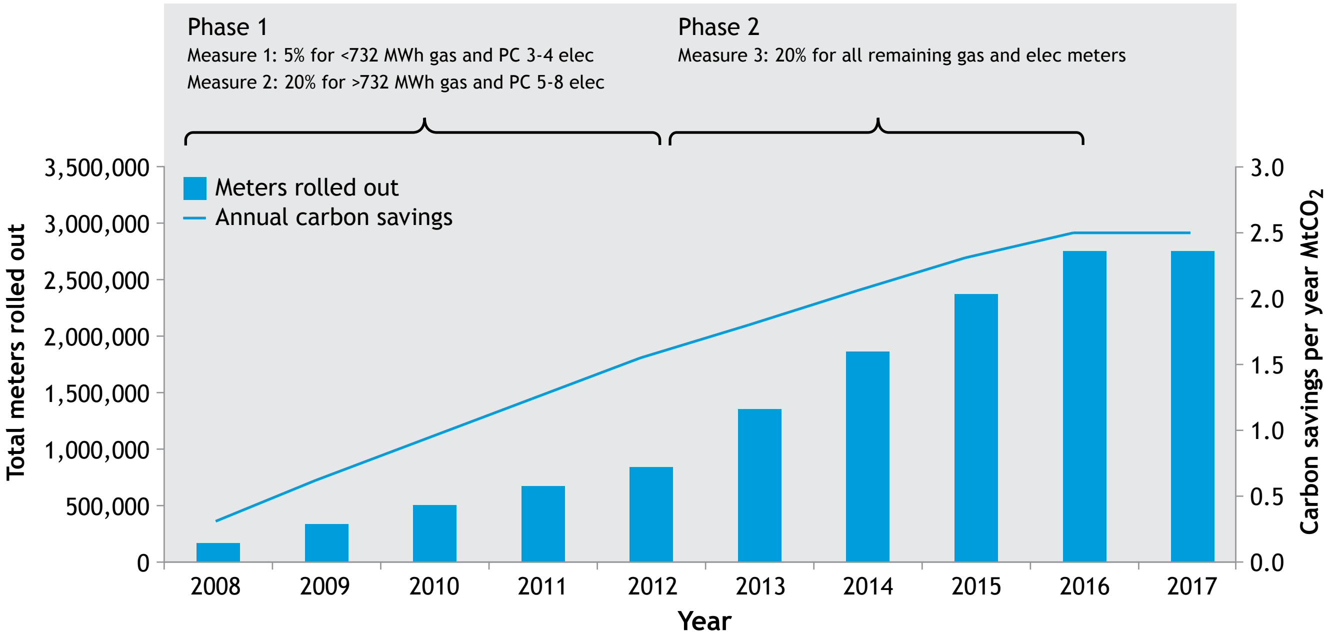
A date for full roll-out gives the industry a clear signal and time-frame to optimise meter technology and drive costs down.

Assuming an annual replacement rate of 20% for these lowest consumption bands suggests that full roll-out can be achieved by 2016. However, a more aggressive date would be preferable in terms of unlocking potential carbon savings as early as possible. In combination with the previously identified measures this could lead to the full savings potential of 2.5 $MtCO_2$ per year being realised by 2016.

Potential policy measure	Impact	Benefit
3. At 2012 Mandate accelerated roll-out to all remaining users in lowest consumption groups	Meters by 2016:	
▸ Electricity: Profile classes 3 & 4	▸ 2.3m electricity	▸ Meter roll-out completed to all cost effective groups
▸ Gas: 73-732 MWh consumption	▸ 418,000 gas (20% annual roll-out)	▸ 2.5 $MtCO_2$ savings per year by 2016 (for measures 1, 2 and 3)

Figure 47 illustrates the net effect of these three potential policy actions. It shows the impact of the predicted total number of advanced meters rolled out across the UK SME sector and associated annual carbon savings in two phases.

Figure 47 *Summary of advanced meter roll-out and carbon saving potential*



For the gas consumers using less than 732 MWh per year, it has been seen that a fairly modest reduction in meter and service costs would make a mass roll-out of advanced metering cost-effective at the UK level. Consequently, it is likely that the potential annual carbon savings of 0.49 MtCO_2 from this group may be possible earlier than 2016 due to organic market growth following the proposed accelerated roll-out for higher consumers.

However, for electricity customers in profile classes 3 and 4 a step-change cost reduction would be required to access the annual savings of 0.75 MtCO_2 from these sites earlier than 2016 at no net cost to the UK.

More work is required to understand the nature of services which can engage cost-effectively with this group of electricity users in the short term. At this stage it seems unlikely that a detailed service offering would be cost-effective for this group and that to address this segment a 'meter only' approach may be the most viable option in the near future.

Since many of these smaller SMEs hold similar attitudes to energy consumption to domestic customers it is recommended that DTI and OFGEM include SME sites with profile class 3 and 4 electricity meters in the forthcoming trial of domestic meters to test the effectiveness of low-cost advanced metering solutions.

Potential policy measure	Impact	Benefit
4. Domestic metering trials ▸ Include lower electricity usage SME customers (profile classes 3 & 4) in scope of DTI/OFGEM metering trials	▸ Identify potential savings using 'meter only' type solutions	▸ Potential to take total savings to 2.5 MtCO_2 per year before 2016

Summary of potential measures

Table 10 shows a breakdown of the various consumption groups for gas and electricity SME customers and highlights which are cost-effective from the overall UK perspective under both current and future cost scenarios. For each group it then summarises the potential initial policy measures identified in the previous sections.

These potential policy measures are indicative only and the detailed regulatory mechanisms for mandating the roll-out of advanced metering have not been examined as part of this analysis. However, it is hoped that Government will use these findings to shape appropriate policy responses to capture the benefits from the roll-out of advanced metering to SMEs.

Alternative delivery options

The measures identified in the previous sections are indicative and represent one possible set of actions to encourage the roll-out of advanced metering in the UK. In terms of dates, an alternative option would include a 'big bang' approach with roll-out of advanced meters to all SME sites by a given date. In terms of policy mechanisms, an alternative to setting targets for meter replacement would be to mandate an increased number of accurate meter readings per year.

Table 10 *Summary of UK cost/benefit analysis and potential policy measures for each consumption group*

UK cost/benefit Y = Net UK benefit N = Net UK cost		Current costs	Future costs	Potential initial policy measures
Gas	**73-732 MWh/year** 381,000 meters	N	Y	▸ Mandate all new/'end of life' replacement meters to be advanced meters
	732-2196 MWh/year 26,000 meters	Y	Y	▸ Mandate all new/'end of life' replacement meters to be advanced meters ▸ Mandated accelerated roll-out
	2196-5860 MWh/year 7,700 meters	Y	Y	
	>5860 MWh/year 3,100 meters	Y	Y	
Electricity	**Profile class 3 & 4** 2,169,500 meters	N	Y	▸ Mandate all new/'end of life' replacement meters to be advanced meters ▸ Investigate further in domestic metering trials
	Profile class 5 & 6 91,700 meters	Y	Y	▸ Mandate all new/'end of life' replacement meters to be advanced meters ▸ Mandated accelerated roll-out
	Profile class 7 & 8 75,700 meters	Y	Y	

11.3 Supporting and enabling measures

Meter standards

In order to ensure the recommendations in section 11.2 can be implemented effectively there are a number of additional measures which must be progressed. The first of these relates to the need for advanced metering standards to address stranded asset issues and allow meter asset owners to make reliable estimates of the future worth of advanced meters. This is being addressed by the current Interoperability Working Group coordinated by OFGEM. It is essential that appropriate standards are agreed as quickly as possible.

Data availability

This study has also highlighted that the level of service provided around the advanced meter data plays a crucial role in the level of energy savings achieved. It is therefore important that competition and innovation exists in this area to continually improve the level of service and drive down costs.

To facilitate this it is vital that half-hourly data is freely available to appointed third parties independently of the energy supply companies. This will allow customers to select the data and consultancy service which is most suitable to their needs. There is therefore a need for industry-wide standards relating to the format and possibly the frequency of data transfer between data collectors and suppliers. This will mean that suppliers can accept data from any accredited data provider without needing to change internal systems and processes.

Potential policy measure	Impact	Benefit
5. Meter standards		
▸ Put in place standards for basic minimum functionality ensuring interoperability between half-hourly meters	▸ Essential to support policies mandating roll-out	▸ Avoids concerns over stranded assets

Potential policy measure	Impact	Benefit
6. Data availability		
▸ Mandate that where half-hourly meters are installed data is made available to customers and nominated 3rd parties ▸ Put in place standards relating to the format and frequency of data transfer between data collectors and suppliers	▸ Ensures usage data is provided in addition to meters ▸ Ensures ease of switching between data providers	▸ Enables market competition and innovation for energy consultancy services

12 Next steps

12.1 UK SMEs

Advanced metering can currently provide energy and cost savings for many SMEs and in future will be highly cost-effective as service costs come down. Effective solutions are already available to install advanced metering in parallel to the non-half-hourly services currently offered by energy supply companies. Consequently large numbers of SMEs can realise worthwhile financial benefits from moving to advanced metering solutions immediately and will not need to wait for market roll-out. This is particularly true for multi-site SMEs such as wholesale and retail chains, and single-site SMEs with large energy consumption, such as manufacturing companies.

However, it is important that SMEs acknowledge the fact that installing advanced metering will not save energy in its own right. Appropriate time and resources must be allocated to review advanced metering data to identify energy saving opportunities.

The trial has demonstrated that a moderate level of consultancy services (such as data and advice and recommendations provided via email) can yield significant improvements in savings over a 'Data Only' service. Since many of the savings identified are low-cost behavioural savings, the cost of implementing them is correspondingly low. However, due to the nature of these savings it is crucial that there is a high level of buy-in across the site, and that employees are motivated to identify, implement and maintain energy saving actions.

The Carbon Trust's field trial has demonstrated that once an SME has had an advanced meter installed they begin to fully appreciate the potential cost-saving benefits of the technology. 300 of the SMEs involved in the trial were offered the chance to continue the service on a fully commercial basis and 83% of sites have opted to continue under full commercial arrangements.

Trade bodies, the Carbon Trust and others should continue to promote the benefits of advanced meters to the SME community.

12.2 Suppliers and metering service providers

From a supplier perspective, there is currently a business case for providing advanced metering to certain limited sections of the SME community but providing such services to single-site SMEs is generally not cost-effective. However, the analysis conducted in this study is based on suppliers' current business models and there is considerable potential for suppliers to benefit further through adopting new business models and capturing new business opportunities associated with advanced metering.

Suppliers will need to shape new products and services relating to energy consultancy and these have the potential to be higher margin products, thus offsetting potential losses from reduced utility consumption. Providing advanced metering services can also play a valuable role in customer acquisition and retention for supply companies in the future, as customers seek out the most attractive services.

Rather than placing an additional burden on suppliers, a mandated roll-out of meters would provide a framework within which suppliers can innovate and compete to provide advanced metering services. When meeting any future obligations to provide advanced metering, suppliers will naturally target the sites which are most cost-effective now. However, suppliers should also give due consideration to business models which will ultimately allow them to most cost-effectively serve a much larger market in future, including smaller single-site SMEs.

Smaller advanced metering companies, which offer services alongside energy suppliers are currently in a strong position as the energy suppliers have yet to enter the market for SME metering services. The ability to tailor metering and consultancy packages to the areas of the SME market where the business case is positive is a key advantage over a 'one size fits all' service. Additionally, innovative technologies such as 'clip on' meter reading devices can offer cost-effective alternatives to meter replacement for single-site SMEs.

In the longer term, energy suppliers may opt to form strategic alliances with smaller meter service providers to deliver their advanced metering obligations.

There is a need for innovation in both the level and nature of advanced metering services provided to SMEs, and also in the way companies providing metering solutions, software for data provision and energy consultancy collaborate. Additionally, advanced metering companies who work closely with accredited data collectors will be able to build a strong business case for SME sites.

Energy suppliers and metering service providers should investigate new business models to provide innovative metering services to their SME clients.

12.3 Government

This report has demonstrated that there are significant carbon savings and economic benefits available for the UK through widespread roll-out of advanced electricity and gas metering to the SME community, starting with the highest consuming users.

However, modelling the supplier benefit case has illustrated that there is no benefit to suppliers from widespread roll-out of advanced metering to SMEs at current meter and services cost levels, and the case will remain marginal even for predicted future costs in an established market.

The Carbon Trust recognises that there are some sectors where providing advanced metering services will be seen as attractive to suppliers and predicts that, with time, larger multi-site SMEs will be offered competitive advanced metering services. However, relying on organic market growth in these areas will not bring advanced metering into play in a timely enough fashion to either have a material effect on UK carbon emissions, or realise the necessary economies of scale to provide more cost-effective metering solutions to all sites. Furthermore, leaving the market to grow organically also carries a significant risk of creating a fragmented and unmanageable advanced metering stock in the UK, making any future initiatives difficult to implement.

In light of the above evidence there is a clear case for Government action to stimulate the appropriate market adoption of this technology via some form of mandation. A potential roll-out plan has been proposed which could deliver savings of 1.5 $MtCO_2$ per year by 2012 and 2.5 $MtCO_2$ by 2016. The specific regulatory actions required to implement such a plan remain to be defined in detail, but the evidence collected by the Carbon Trust suggests that such a compulsory roll-out could be both feasible and cost-effective.

Furthermore, in light of the significant barriers to investment on the supply side, such a mandated roll-out is essential to achieving the carbon savings potentially available. In addition a number of necessary supporting actions have been identified, including the need for agreement of standards for advanced meters and also for the frequency and format of data transfer between collectors and suppliers.

Creating an advanced metering infrastructure for all UK SMEs will create a framework capable of supporting further policies to reduce carbon emissions in future. For example, the proposed Energy Performance Commitment, which is likely to be aimed at businesses which already have Code 5 electricity meters, could in future be extended to cover SMEs.

This report has focused largely on the carbon saving potential of advanced metering, but SMEs can also derive significant cost savings from using advanced water meters. There is an associated potential UK benefit from widespread roll-out of such water meters in terms of the potential reduction in infrastructure upgrade costs.

The benefits of advanced metering are clear in terms of cost savings for SMEs and carbon savings for the UK. Action is now required to stimulate the market and ensure a widespread roll-out of this important technology.

Government should take action to ensure a widespread roll-out of advanced metering technology to SME users.

Government should work to ensure that appropriate standards are put in place regarding advanced meter functionality, data availability and data transfer procedures.

CASE STUDY

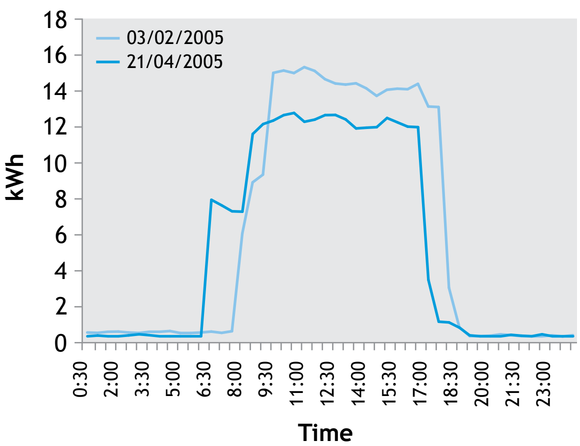
Half-hourly metering for multi-site businesses

For businesses with a number of sites, installing half-hourly meters across their portfolio is a significant undertaking. But as organisations such as those below have shown, half-hourly metering at key sites can be used to assess best practice and develop a business case for wider roll-out. Multi-site companies can also benefit from some economies of scale since certain service or consultancy costs can often be spread over a number of similar sites.

Peacock Group

The Peacock Group plc is a leading UK value-for-money fashion retailer. The Group has 450 Peacock stores and 360 Bonmarché stores with over 9,000 employees nationwide. The average electricity bill at each site is around £7,000/year. Electricity bills based on supplier's actual or estimated readings lack the accuracy needed to identify potential seasonal and out of hours energy wastage. To learn more about the energy consumption in its stores, the Peacock Group selected ten of its sites to install remotely-read half-hourly electricity metering. Analysing the accurate data from the advanced metering system against opening times, revealed out of hours energy use which could be costed and targeted as energy savings. Equipment was categorised as essential and non essential. Business cases were put forward for the investment in changing the main electricity distribution boards, to enable non essential equipment to be automatically switched off when the stores are unoccupied. The initial pilot of advanced metering systems has revealed the benefits of installing advanced metering and establishing consumption profiles for comparison between stores (an example consumption data is shown in Figure 48). The Peacock Group is now developing a benchmarking system as part of an ongoing energy reduction plan for identifying and fostering best practice. On average, each of the 10 stores in the trial saved £500 in controlling out-of-hours energy waste, around 8% of their energy bills. As well as saving money, the individual sites have also reduced their average carbon footprints by 5.5 tCO_2 per year.

Figure 48 *Peacocks half-hourly profile*



Cardiff City Council

The council manages approximately 500 buildings, more than 90% of which are not large enough to warrant half-hourly electricity metering as standard. By installing advanced metering at five trial sites, the council were able to identify simple, zero-cost ways to reduce their energy consumption.

For instance, energy audits based on meter data initially focused on lighting across all sites. It was found that there were a number of areas that were unnecessarily lit during operational hours and overnight. Analysis of the data also showed that the two participating schools left their heating in demountable classrooms running overnight. Figure 49 shows the resulting energy savings once this and other measures had been implemented.

Cardiff County Council has seen merit in the use of half-hourly data for energy management and is intending to continue monitoring the trial sites, as well as extending the use of half-hourly meters. On average the council has reduced their energy consumption by 5% resulting in average savings of £500 at each site.

Figure 49 *Cardiff half-hourly profile*

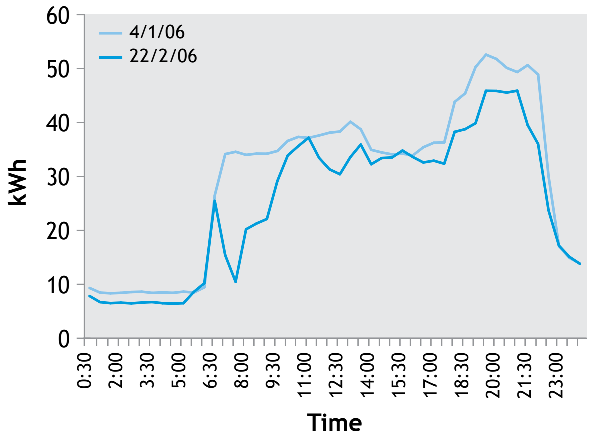
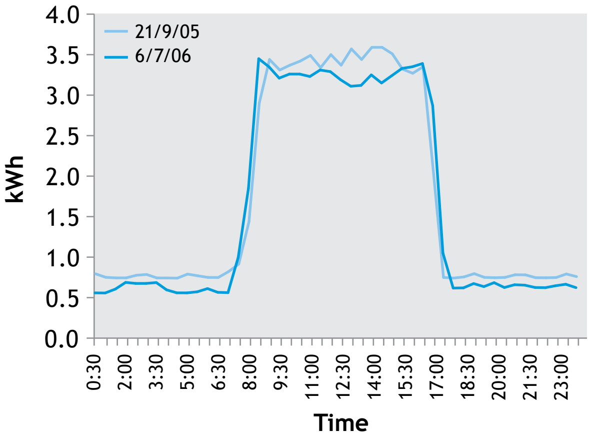


Figure 50 *Orange half-hourly profile*



Orange Retail

Orange, the UK mobile phone retailer, has 250 retail stores with a combined annual utility bill of £780,000. Half-hourly metering was seen as an opportunity to help the company understand its energy consumption at the level of detail needed to identify where changes could be made.

Half-hourly metering has helped Orange Retail gain a much better appreciation of the energy consumption in its stores and identify areas for savings. Energy audits revealed that prior to the trial there was little focus on energy conservation, with analysis of the half-hourly data showing that unoccupied areas were frequently lit, heated or cooled unnecessarily, and that overnight energy use was consistently excessive.

Looking at results from the Bath store, Figure 50 shows how energy consumption changed from the two weeks before implementation to the two weeks after. This clearly shows that energy use has been reduced, in this case by ensuring that heaters, plasma screens and lighting were turned off overnight and in unoccupied areas during the day.

As a result of the trial, the company has saved an average of £230 at each store (8% of annual energy costs). They have also reduced their emissions by around 2.5 tCO_2. Some of the best practice identified has been translated directly to new stores. Advanced metering can then be used to both ensure persistence of translated energy saving measures, and identify new site-specific energy savings.

BUPA Care Homes

BUPA Care Homes is the largest provider of care homes for older people in the UK. The company has experienced a significant increase in both electricity and gas costs with annual energy bills in excess of £9 million. To install half-hourly meters for all 290 sites would take a considerable amount of planning and capital investment and requires a well-developed business case. BUPA's energy manager has used the half-hourly data and consultant recommendations from ten trial sites as a model for the whole of their property portfolio. He has gathered as much information as possible on energy saving opportunities from the trial sites before presenting his business case to the BUPA board.

One of the sites in the trial, Forest Court Nursing Home, was seen as having a high standard of energy efficiency by the consultants. It was suggested that BUPA look at this site, to identify best practice and use its data as a benchmark for their portfolio.

At other sites, benefits are already being seen as a result of the recommendations made from analysing half-hourly metering data. When the company is in a position to roll out the recommendations to remaining sites across the whole of their portfolio, similar reductions are anticipated.

CASE STUDY

World Museum Liverpool

"National Museums Liverpool are firmly committed to their social responsibility policy, part of which recognises the importance of reducing their impact on the environment."

Carole Youds – Energy and Facilities Manager, National Museums Liverpool.

Cost of metering system (multiple meters)	£7,000
Consultancy and implementation	£15,000
Annual energy saving	935,000 kWh
Annual carbon saving	214 tCO_2
Annual cost saving	£35,100
Payback period	7.5 months

Half-hourly metering at World Museum Liverpool revealed high levels of overnight electricity and gas consumption. The metering system and the cost of the resulting energy efficiency solutions have paid for themselves in less than eight months.

Background

World Museum Liverpool is a large multi-disciplinary museum which combines a global collection of historic treasures with the latest interactive technology. Originally opened in 1853, it recently completed a major development that doubled its size to 16,000m^2. Its electricity and gas consumption both exceed 5 GWh a year. The rapid rise of wholesale gas and electricity prices and an important environmental policy has highlighted the need to save energy.

Site profile and metering

Before the trial the site contained one main electricity meter, two main gas meters and one main water meter. In August 2005, a tailored meter replacement and data logging system were installed to provide half-hourly metering for electricity, gas and water.

The system reports through a software package that can be dialled up remotely, both by National Museums Liverpool's Energy Manager and by external consultants. The analysis of information gathered every 30 minutes from advanced metering equipment swiftly became a critical tool for people working to reduce electricity and gas consumption.

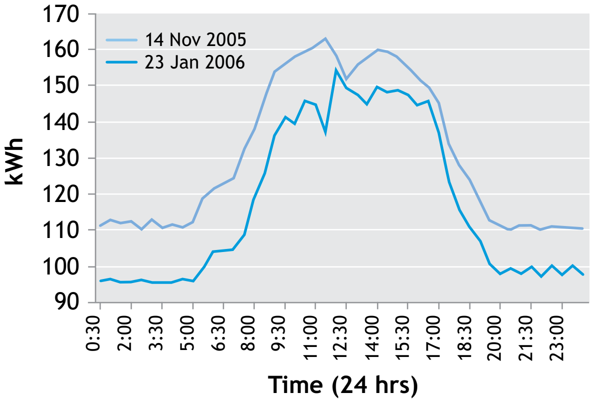
Findings and energy saving measures

Consultants' analysis of the half-hourly meter data showed that, although energy consumption was lower overnight than during the day, it remained relatively high given that the building was unoccupied (500 kW at night against 840 kW during the day). Further investigation attributed this to the fact that artefacts were stored at 50% humidity levels with high tolerances. Boilers and chillers were running 24/7 to maintain the prescribed temperature and humidity conditions. Some climate control is needed for the preservation of artefacts, but it was found that tolerances could be relaxed. The humidifying system's controls were reset to operate between 40 and 60%. This has had a significant impact on electricity consumption (Figure 51 illustrates these savings) but no adverse effect on the museum's treasures. These measures have resulted in reductions of around 20% in energy consumption and cost nothing to implement.

Meter data also revealed that the air conditioning system was competing with the heating system. Gas usage has also been considerably reduced by optimising the sequence of all three museum boilers and reducing the temperature of the building from 21°C to 19°C overnight.

Electricity base load has been further reduced by updating the lights in the museum's atrium with LED units. The metering systems have enabled this upgrade to be quantified; it saved 1.2 tonnes of CO_2 a year. The atrium lights were a major investment at £15,000, but have resulted in savings of more than £800 a month.

Figure 51 *Electricity consumption before and after changing humidifier controls*



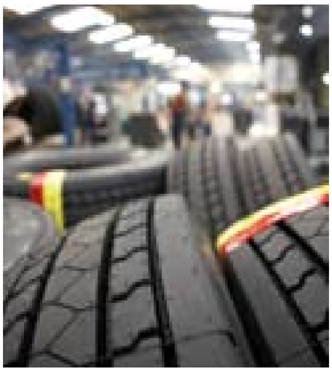
A key outcome has been the recognition of the need for improved employee engagement in energy efficiency. National Museums Liverpool has introduced Energy Awareness Training and the advanced meter data has provided a strong motivational feedback loop. Employees at World Museum Liverpool have become more energy aware and now adopt behavioural best practice.

CASE STUDY

Bandvulc Tyres

"This metering system is all part of our approach to our environmental principles and part of our belief that we should practise what we preach."

Patrick O'Connell, Managing Director, Bandvulc Tyres.



Cost of metering system	£5,600 (multiple meters)
Cost of implementing saving	£20,000 lagging + £35,000 lighting
Annual energy saving	800,000 kWh gas + 574,000 kWh elec
Annual carbon saving	152 tCO_2 gas + 247 tCO_2 elec
Annual cost saving	£10,800 gas + £20,000 elec
Payback period	24 months

Analysing data provided by half-hourly meters allowed Bandvulc Tyres to identify quick and simple ways to reduce energy consumption. It has implemented a series of measures, which have generated cuts in energy bills and carbon emissions.

Background

Bandvulc Tyres produces remoulded tyres for heavy goods vehicles at a factory on the outskirts of Plymouth. It is one of the leading companies in European truck tyre retreading, with operations throughout Europe. The company has an annual turnover of £22 million and employs some 240 people.

Energy is a significant business overhead. In 2005, the company consumed approximately 10.3 GWh, resulting in energy bills of more than £300,000. Managing energy use efficiently is therefore a key objective for the company.

Site profile and metering

Before its involvement in the Carbon Trust metering trial, Bandvulc had half-hourly data just for its main electricity meter and there was a one-month time lag before it had access to the information. It had no detailed data for gas or water and no way of monitoring related factors such as outside air temperature.

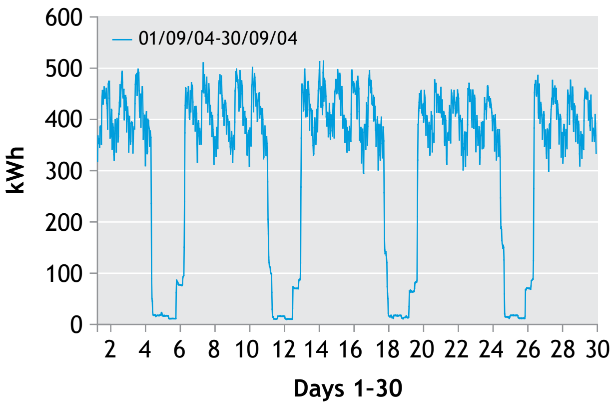
Bandvulc operates on a 24-hour production cycle Monday to Friday, but with planning, engineers were able to install the metering equipment during working hours without disruption. The system was designed to be accessible either remotely or on-site. In addition to the main electricity meter, eight electrical sub-meters monitor specific processes within the factory. The total cost of the meter system was £5,600.

Findings and energy saving measures

Initial analysis of advanced meter data allowed general energy usage trends to be studied. Energy consumption was found to be steady during the night shift and higher during the day, when the administrative team was on-site and more processes were running. As expected, energy usage was low at the weekends when the site is unoccupied.

The tyre presses were an early focus for reducing gas consumption. Analysis of the meter data had indicated a large standing loss in the tyre presses and steam distribution system. Once the presses had been insulated with lagging the meter data was re-checked to measure the effectiveness of the process. Figure 52 shows the half-hourly gas profile used to identify these measures.

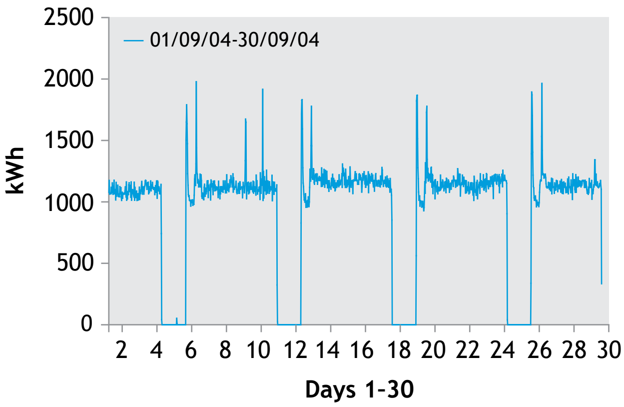
***Figure 52** Mains meters: Gas*



Further gas consumption savings came from installing a new heat recovery unit, which raised the boiler feedwater temperature by 40°C, and insulating its boiler feedwater tank and associated pipework.

To reduce base loads the high-pressure sodium lighting in the factory was replaced with more responsive T5 fluorescent fittings connected to a control system, which monitors both occupancy and daylight. In addition to these, dirty skylights were cleaned to maximise the use of daylight. Bandvulc was able to use advanced meter data to quantify the impact of this change. Figure 53 shows the electricity profile.

***Figure 53** Mains meters: Electricity*



Further base load reductions came from installing a control unit for its cooling systems and an inverter-driven compressor to manage air compression more efficiently. The compressors themselves were ducted to the outside of the building to improve operating efficiency. Advanced metering allowed Bandvulc to quantify the effect of these measures.

Bandvulc were also keen to target behavioural change and set up an Energy Team with 'local champions' to promote good practice and champion culture change. Since then there has been a tangible shift in attitudes across the business. This has made the workforce considerably more receptive to adopting process and behavioural energy saving recommendations.

Results so far

The ability to use advanced metering to isolate and identify different trends in consumption in the factory has been critical to the energy efficiency program. Bandvulc covered its gas and electricity implementation costs within 14 months and significant savings have now been made.

The lagging measures delivered quick results – saving around 800,000 kWh in the first 12 months, worth £10,800, and 152 tonnes of CO_2 for an initial cost of £20,000. The change of lighting system cost £35,000, but generated £18,000 in annual electricity savings – payback in less than two years.

The company has registered weekend energy savings of £2,000 per year due to best practice shutdown measures alone, and generally it is also noticeable that machinery is now almost always switched off when not in use during the working week.

Further planned projects include fitting variable speed drives to extraction motors and fans and installing a fully automated system to control the boiler.

Notes

www.carbontrust.co.uk
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The Carbon Trust is a UK-wide company, with headquarters in London, and bases in Northern Ireland, Scotland, Wales, and the English regions.

The Carbon Trust is a private company set up by government in response to the threat of climate change, to accelerate the move to a low carbon economy.

The Carbon Trust works with UK business and the public sector to create practical business-focused solutions through its external work in five complementary areas: Insights, Solutions, Innovations, Enterprises and Investments. Together these help to explain, deliver, develop, create and finance low carbon enterprise.

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