Metering

Introducing the techniques and technology for energy data management

Preface

For many organisations, energy use is the second highest cost after staff salaries. For some energy-intensive industries it is the highest cost. Energy wastage does not just cost money, it also results in increased carbon emissions. While dependence on energy is unavoidable, effective energy management can result in savings on both counts.

Once an organisation has been sufficiently mobilised to address energy management and individuals have been identified for the tasks involved, the next stage is to accurately gather and collate consumption data. Metering energy use is a fundamental action for all organisations, regardless of size or expertise.

This overview introduces metering technology and shows how organisations can adopt an appropriate level of metering in a way which will help them to save energy and cut costs.

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Contents

Introduction

Good metering practice is a powerful tool which forms the basis of an effective energy management campaign.

Traditionally, metering has been used by utility companies to measure and bill for the quantity or volume of that utility being delivered to a site. More resourceful sites gather their own consumption information from their bills or directly from their meters to monitor their consumption. Knowing and understanding consumption enables organisations to predict and account for their expenditure more accurately. The benefits are clear:

Accurate readings mean accurate billing
At its most basic, good metering will provide the information needed to check the accuracy of invoices.

Many organisations are paying too much for their utilities through estimated bills and basic errors.

Timely and detailed information leads to better decisions
Recording and analysing the data will have the added advantages of allowing organisations to monitor energy use patterns, discern how the site should be operating, identify anomalies and highlight areas that can be improved. Changes that are made as a result will show up in improved energy usage data. The analysis of consumption data for these purposes is called monitoring and targeting (M&T).

A field trial by the Carbon Trust showed that, on average, organisations that switch to using advanced metering identified 12% carbon savings and achieve 5% through reduced utility consumption.[1]

You cannot manage what you do not measure.

[1] For more information see Advanced metering for SMEs (CTC713), available from the Carbon Trust.

Who is this publication for?

This publication gives information to enable organisations to develop an appropriate metering system. It is suitable for both beginners who wish to understand metering better as well as energy managers wishing to develop a sound approach to metering on a complex site.

It does not detail M&T processes, dealing primarily with metering the main utilities on site: electricity, gas and water. It provides information on the industry, types of meters and sub-meters, as well as data collection techniques.

Although water is not energy, it is a metered resource and is discussed in this publication. Water conservation can lead to energy savings indirectly through pumping, treatment and heating reduction, additionally water metering could highlight substantial cost savings so it makes sense to include it in a metering and energy management strategy.

Further information on M&T and energy management is available from the Carbon Trust through publications and advice. As well as the helpline and website, the following free publications may be of interest:

Energy Management – a comprehensive guide to controlling energy use (CTG054).

A strategy for measuring consumption

The steps to a good metering strategy for an organisation are as follows:

1. **Understand the priorities of the organisation**. The reasons behind undertaking metering will affect how much – and which – data are actually required. It is important to strike a balance between having too much information and too little information.
2. **Determine energy management roles and responsibilities.** Identifying management roles will ensure there are resources for an appropriate level of analysing. Advanced metering will not itself result in savings, this can only come from analysis of the data and action taken as a result. Therefore it is imperative that resources are made available for this.
3. **Understand and check invoices.** These can be a rich source of information about current systems and consumption, but they are frequently estimated or incorrect.
4. **Find out what information is currently available and what systems are in place**. Collate the information that is available and understand how it is being collected. Gather information about meter reads – how often, when, the collection methods and what is done with the information.
5. **Decide what further information is needed.** Initial investigations may clarify where important data are missing, and may suggest where further metering options need to be considered. Examine different types of meters and data collection techniques that will deliver the data needed for effective management.

Industry breakdown and roles

In order to make sense of metering for an individual site, it is important to understand the industry and how it is regulated. These markets are still in a state of flux, and the responsibility for roles within the market may shift. However, the main roles are likely to persist.

The UK electricity and gas markets (excluding Northern Ireland) were gradually opened up to competition over an eight year period beginning in April 1990, starting with the first section of the electricity market. Since then, further players entering the market have increased choice in the supply of energy and energy services and have ultimately reduced the cost to the customer.

The Office of Gas and Electricity Markets (OFGEM) is the electricity and gas regulator. One of OFGEM's primary functions is to protect and advance the interests of consumers through promoting effective competition and putting regulation in place, helping to drive competition where necessary. In the water industry, this is mirrored by the Water Services Regulation Authority (OFWAT). These two bodies exist to protect customers' interests, through increasing their ability to control their energy and water use, including regulating billing and metering.

For metering and billing of energy, that is for electricity and gas, the UK energy industry can be broken down into two main groups: **suppliers and distributors**.

Suppliers hold the contracts with customers for the provision of energy. It is their responsibility to ensure that the customer receives their energy and that it is sufficiently metered and invoiced.

Distributors are generally contracted by suppliers to get the energy to the customers. To do this, the distributor is responsible for the energy transportation infrastructure. In some cases the Distributor is also responsible for the provision of metering.

Electricity

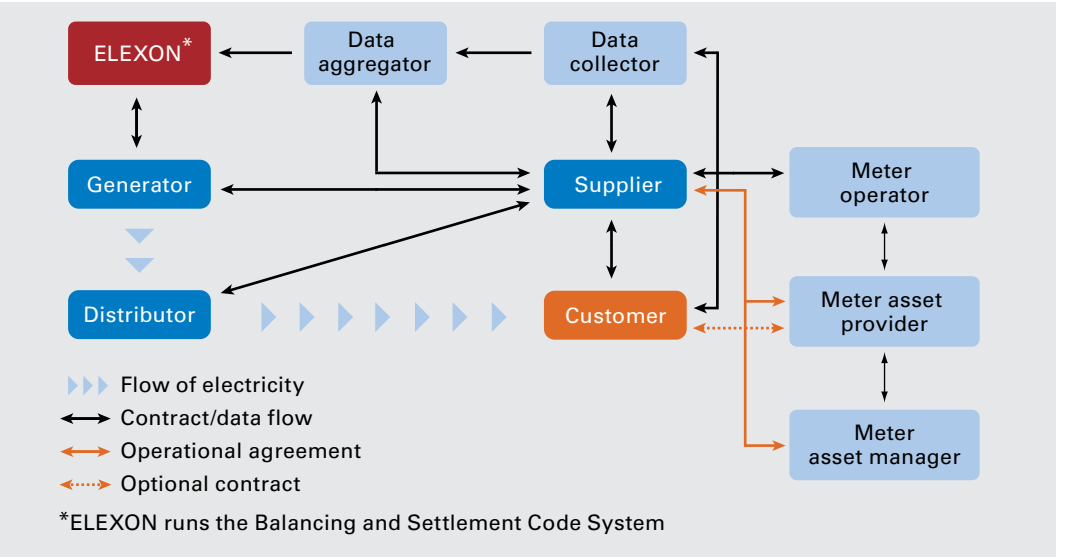
The schematic opposite shows the primary roles in the electricity markets. See Figure 1, right.

Electricity suppliers are licensed by OFGEM to supply electricity to domestic and commercial customers and to charge the customers against their consumption. The supply of electricity is governed by the Network's Balancing and Settlement Code, which is run by a company called Elexon.

Suppliers purchase electricity directly from **licensed electricity generators**, in some cases, the generators will be owned by the electricity supply company, whilst in other cases, the supply company is a trading intermediary. The electricity reaches the customer through the distribution network which is owned by the **distributors**. This network can include the cables, transformers, meters and other assets of distribution which can be owned by numerous distributor entities.

In order for to keep track of the amount of energy their customers are using, and to provide the customer with accurate and timely bills, suppliers contract services for meter reading and data collection. However, the supplier is not obliged to provide metering services to the customer under the standard supplier licence which only enforces the supplier to read and inspect the meter once every two years. More regular metering is therefore subject to commercial arrangements between the supplier and the customer. This means that the customer can choose who provides them with their metering service, if they do not express a preference, the supplier will elect a known service provider. Historically, separate contracts for metering services have only been undertaken by larger electricity customers (Code 5, discussed further later in the guide).

Figure 1 Schematic of key players and relationships in the electricity market [3]



[3] Based on OFGEM diagram of the electricity market.

The **meter operator** (MOP), who is also the **meter asset provider** (MAP) in most cases, is responsible for maintaining and installing metering equipment. In cases where the consumer is leasing the meter directly from the MAP, or where the consumer has purchased the meter, the MOP will still be contracted for maintenance and installation of metering equipment. The MOP (and MAP) may be a branch of the supplier.

A **data collector** (DC) is responsible for the collection and processing of consumption data through actual meter reading, or the determination of an estimate. The consumption information is then passed to the **data aggregator** (DA) who is responsible for the aggregation of electricity supplied to the consumer. These aggregates are then used by the supplier for balancing and settlement.

Suppliers are responsible for ensuring that a meter operator, data collector and data aggregator are appointed to a meter point, however, the consumer can nominate who these are. If a consumer does not nominate these parties, the supplier will automatically appoint someone. For more information on customer entitlements regarding electricity data, see page 18.

Metering is at the centre of some key changes to electricity and gas markets which will occur over the period 2012 - 2019. The regulatory roll-out of smart metering will entail the replacement of around 53 million gas and electricity meters. These new conditions are an essential building block in the government's carbon reduction programme for the UK.

The Energy Act 2008 (extended by the Energy Act 2011) provided new powers to the Secretary of State to make changes to legislation, licences and codes, and to introduce a new licensable activity for the purposes of supporting the roll-out of smart meters. The proposed changes include:

- Amendments to existing energy licences and industry codes, for example to require suppliers to roll-out smart meters by a date in 2019, and consequential changes to legislation, licences and codes. The implementation proposal is for 05 – 08 profile electricity meters, and for gas meters where consumption is in excess of 732MWh per year. The new metering standards for all Profile Class 05-08 meters will be CoP10 for whole current and CoP5 for current transformer operated (CT) meters. Customers have until 2014 to change their meters, but any smart meter installed from 1st January 2009 must comply with this new metering code of practice.
- The introduction of a new licensable activity relating to communications between suppliers and other parties and smart meters in consumer premises, and the appointment of a Data and Communications Company to carry out this licensed activity.
- The introduction of a new Smart Energy Code; this will set out the rules, right and obligations for all parties for the new enduring metering arrangements in Great Britain.

According to DECC, the new meters must 'store measured consumption data for multiple time periods; and at least half hourly', and must 'provide remote access to such data by the licensee'. DECC also states that 'timely' access to the data from the meter must be given to the customer.

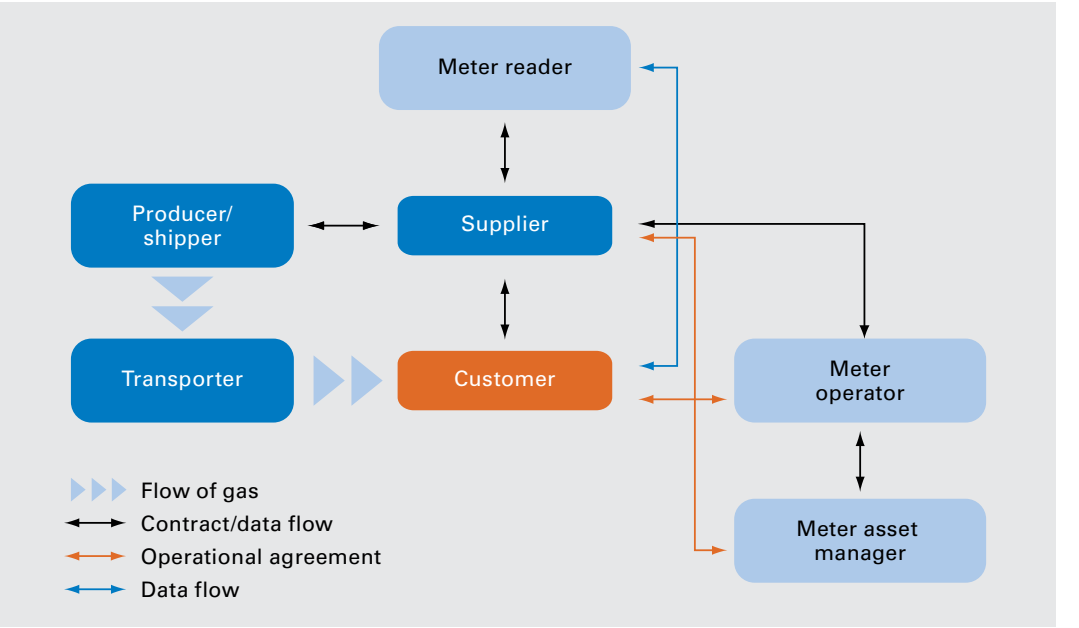
Gas

As with electricity suppliers, **gas suppliers** are licensed by OFGEM to supply gas to domestic and commercial customers and to charge the customers against their consumption. See Figure 2, right.

The **gas shippers** buy gas directly from the producers, wholesalers and traders. Suppliers then buy from the shippers who use the pipeline system owned by the **gas transporters** (or Network Operators) to deliver it to the suppliers' **consumers**. In order to keep the level of gas in the UK network at a constant level, the shippers must balance the amount of gas going into the system with that which is being consumed. This process is carried out under the Network Code which is a framework of legal and contractual arrangements.

Measurement of volume of gas being transported has to take place at both sides of the network: suppliers need consumption information for customer billing, and the network operators need to have this information to ensure the balance is maintained in the network. As a result, the large majority of meters on the consumer's side of the network are owned and maintained by the major gas network owner – National Grid (formerly TRANSCO).

Figure 2 ***Schematic of key players and relationships in the gas market*** [4]



Under the Gas Act the supplier, transporter or consumer is responsible for keeping the meter in order. Therefore, to maintain the meters, the **meter owner** (that is, the National Grid) makes use of a **meter asset manager** (MAM) who will usually contract the services of **meter workers**.

Suppliers use the services of a meter reader to take readings manually or automatically. These readings of consumption are fed back to the supplier for the purpose of billing and for the gas on the network to be balanced between the supplier and the shipper. Alternatively, the consumer can provide an actual meter reading themselves. The customers' entitlement to gas meter data is discussed further on page 20.

[4] Based on OFGEM diagram of the gas market.

Water

The supply and removal of water is generally restricted to a particular geographic area, therefore, customers often have no choice but to enter into a contract with the local provider. As mentioned, OFWAT are responsible for ensuring that customers are treated fairly in the provision of clean water and the removal of wastewater.

It is possible for consumers who use more than 50,000m^3 of water a year to enter into a 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 therefore own the distribution network within that area, along with all of the metering and pipes. The water company will contract a meter reader for sites that have them. This will enable them to bill accurately for the site's consumption.

However, the threshold for competitive supply is to be dropped. Non-household customers in England who use more than 5Ml (5,000m^3) of water may be eligible to switch suppliers to one of the water supply licensees – although, as yet, there is no timescale defined.

Understanding energy bills

Energy bills are the primary source of information about energy consumption and will be the first point of reference when trying to understand what is being used, as well as how the organisation is being measured and charged.

Electricity

Sites have historically been classified as code 5, or non code 5 based on their consumption profiles. This classification determines the type of metering and subsequent billing the site receives.

Electricity bills for sites with consumption **below the code 5** threshold are less detailed and based on either physical monthly meter readings or an estimated level of consumption.

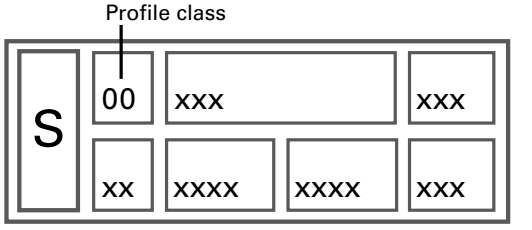
Sites classified as code 5 should receive an electricity bill itemised with consumption figures at half-hourly intervals. The meter readings themselves will not be included in most cases. These show how much electricity is being used at specific times as well as the cost of the electricity supplied within those periods.

The bill itself gives information about the sort of meter and billing methods that are in place. Simply look at the MPAN (Meter Point Administration Number) on the bill, also known as the 'supply number'. The MPAN looks like the diagram in Figure 3, and is the unique supply number the core of which (bottom line) will not change, unlike the meter number which will change whenever a meter is replaced. This should be the reference number used for your electricity supply – not a meter number or account number, which may change over time.

Figure 3 MPAN as it would appear on a bill

Broad breakdown of profile classes:

00:	Half-hourly metered
01 – 02:	Domestic non-half-hourly
03 – 08:	Non-domestic non-half-hourly



As indicated in the diagram, the first two digits of this number (the upper left numbers) describe the profile class of the meter. If these digits are '00', this is a half-hourly meter and half-hourly data can be made available from the meter either directly, or through the electricity supplier. Call the supplier for further clarification on the metering and billing methods used.

As previously described, all profile classes 05 – 08 will have SMART meters in place for electricity by April 2014. This will mean that they will also have access to half-hourly interval consumption data.

Half-hourly interval data allows you to understand your daily energy consumption in detail, and analysis of this data can be key to identifying wastage. For further information refer to CTG077 Monitoring and Targeting.

Fact

You are not obliged to pay a bill based on an estimated meter reading and can provide a 'customer read' for the supplier to reissue an accurate bill.

On the electricity bill, check:

What tariff the site is on – understand exactly what is being charged per unit of energy, and whether this changes at different times of the day. If you have meters with a profile class other than 01 or 03 you should have multiple tariffs, with a higher cost per unit during peak times (such as the middle of the day) and a lower cost per unit at off-peak times (such as midnight).

Available capacity – this is the amount of electricity that the distribution company makes available for a business. This authorised supply capacity is measured in kilovolt amperes (kVA) and charged on a monthly basis. If a business consumes more electricity than its authorised supply capacity there will be an excess capacity charge. This is charged at least three times the normal kVA rate.

Maximum demand (kW and kVA) (or 'peak load') – a site's usage of its authorised supply capacity is determined every month by means of a highest maximum demand (HMD). This is based on the type of metering available at the site. For sites where single-channel metering is in use, the kW value will be used instead of the kVA.

If you are paying additional charges – some businesses are liable to pay the Climate Change Levy (CCL) and this will appear on the bill. Check also for charges for meter data collection. See below for further explanation.

Whether your bill is estimated or actual – sometimes bills are estimated by the supplier, rather than an actual read. The disadvantages of estimated readings are discussed on the next page.

Gas

Very large consumers of gas, that is those consuming over 58,600 MWh/year, generally receive bills based on daily meter readings. These bills include details of consumption and price according to time of use.

Other sites will receive bills on a monthly or quarterly basis depending on the billing arrangements and consumption levels. As with electricity, these bills could be based on actual or estimated readings.

As previously described, gas customers using in excess of 732 MWh per year will have SMART meters implemented by 2014. This will provide interval consumption data similar to that for electricity.

Gas meters measure consumption in either cubic feet or cubic meters. It is important to know which unit your meter is reading in, so that you can convert your readings correctly to kWh. The conversion information is usually detailed on your bill, but includes the application of two independent correction factors – one for calorific value and one for pressure. It is worth noting that calorific value will change constantly, so be aware of this when obtaining any revised bills/ refunds for overestimated consumption.

Similar to electricity supplies, gas supplies also have a unique identification number, the Meter Point Registration Number (MPRN). This should be the reference number used for your gas supply – and not a meter number or account number, which may change over time.

On the gas bill, check:

Is the reading accurate? – like electricity bills, gas bills may be estimated, particularly for smaller customers. Check to see if the meter reading is correct, and how many units have been used

The charge per unit – know what the supplier is charging for each unit, measured in kWh.

If you are paying additional charges – gas usage, like electricity consumption, is subject to the Climate Change Levy (CCL) for some businesses. This will appear on the bill. Some sites, particularly larger consumers, may also be paying meter data collection charges.

Emergency contact details – keep the bill handy in case the site experiences a loss of supply or has any other emergency.

Estimated meter readings

When actual meter data are not collected, that is by a remote reading device, a meter reader, or by the customer, the invoice will be based on an estimated reading. If this is the case, a bold '**E**' will usually be present next to the meter reading. This estimate will be based on past use, or more often on typical average figures for the profile class. This can result in large errors in invoicing.

Clearly, estimated readings do not take into account any savings efforts, or changes in routine that have been made – these would need an actual meter reading to prove. To ensure that the bill is based on an actual reading, at the very least, take a 'customer read' on site and communicate this to the supplier for billing.

Customer reads can also help spot billing errors, which occur from time to time. The practice of providing customer readings to the supplier can ensure that the business is paying the correct amount for utilities.

Accurate bills based on actual readings will also aid monitoring of consumption and comparison of historical performance.

Additional charges on energy bills

Climate Change Levy
Besides the cost of energy consumed, the final amount on the electricity and gas bill may include additional charges such as standing charges, meter reading and data collection charges as well as a Climate Change Levy (CCL) on the units the site consumes.

From 1st April 2012, the CCL will be charged as an additional 0.509 pence per kWh for electricity and 0.177 pence per kWh for gas in Great Britain.

Meter reading charges
Additional charges on bills can include: standing charges, meter reading and data charges. However, in cases where charges are not made, it is likely that the supplier will be charging a slightly higher unit price for the gas or electricity used. In order to understand energy expenses more fully, request a fully itemised bill from the supplier, with details of applicable tariffs for each period of the day.

What do the letters on the meter reading mean?

There are a number of letters that appear before or after the meter reading on gas and electricity bills. These letters give specifics about the meter reading:

E – supplier has estimated the reading.

A – supplier has used an actual meter reading obtained by a meter reader.

C – supplier has used the reading provided by the customer.

R – the reading is the final one from a meter that has now been removed.

N – the first reading from a new meter.

F – final meter reading when leaving a property, discontinuing a supply or switching supplier.

Water

Water bills consist of charges for both supply of clean water and removal of waste-water and surface drainage as well as standing charges.

Organisations which pay for water on a **metered basis** will receive a bill on a monthly or quarterly basis which will vary between an actual reading of their water meter and an estimate of their actual use – depending on whether their water meter has been read or not. The bill will also include a standing charge.

For those non-domestic sites which **do not have a water meter**, an annual amount will be charged for their water use. This charge will be calculated according to the 'rateable value' of the property (see box above, right).

A **rateable value** (RV) is a measure of the deemed value of a property. RVs were originally a way of assessing the value of local property rates before Council tax was introduced. Today RVs are only used for calculating unmeasured water bills, as the setting of RVs was discontinued in 1990 with the introduction of the Community Charge. This means that properties built since this date will not have an RV. This practice is still common for domestic properties, however it is less common for commercial sites which tend to have water meters fitted.

Billing for wastewater removal

Properties have a wastewater removal charge as part of their bill, whether they are connected directly or indirectly to the public wastewater system, or where they have the benefit of these services, including foul water, surface water and highway drainage. If the property only benefits from surface water drainage, the customer pays a fixed fee determined by the water company.

If the site returns less than 90% of the water supplied to the public wastewater system, the customer may also be entitled to a reduced wastewater charge.

On the water bill, check:

The metering and charging arrangements – is the site being charged for water supply and wastewater charges, or is it un-metered, meaning that charges are based on the rateable value of the property? Is the meter size correct for the site needs? Standing charges are based upon meter size and rise dramatically with increased size.

The surface water drainage fee – this covers the disposal of rainwater run-off from the roof of the property and other paved areas. If there is no connection to the public sewerage system this charge can be rescinded.

If the water is supplied by a water company other than the one which provides drainage services, the other company should appear on the bill. In such a case, the Water Supply charges on the bill will appear as nil and the drainage services company will send a separate bill.

Meters and data collection techniques

Meters vary greatly, but in essence they are all designed to measure volume flow or power.

The majority of customers are required to have fiscal meters for gas and electricity to measure the amount of energy provided. Put simply, the term 'fiscal' means that the meters relate to public finance, so fiscal meters are termed as such because they measure commodities which impact on government revenue. From the suppliers' point of view, however, fiscal meters' primary function is to collect information for billing.

Electricity is measured by the number of kilowatt hours passing through the meter, while gas is measured by volume delivered to a site. Periodic readings from these meters are then fed into the billing process.

Metering and communications technology has developed to the extent that some meters can provide a much wider range of energy management and related functions. These are discussed in this section. Remember that the type of meter used and the data collection and billing arrangements remain the responsibility of the supplier, however there is scope to negotiate these elements at the time of tendering for a supply contract.

Electricity

The electricity metering market is the most sophisticated of the utilities. As a consequence, perhaps, the range of meters and collection techniques available to consumers are wider, providing opportunities to not only have accurate billing, but also to readily access their consumption information to identify waste.

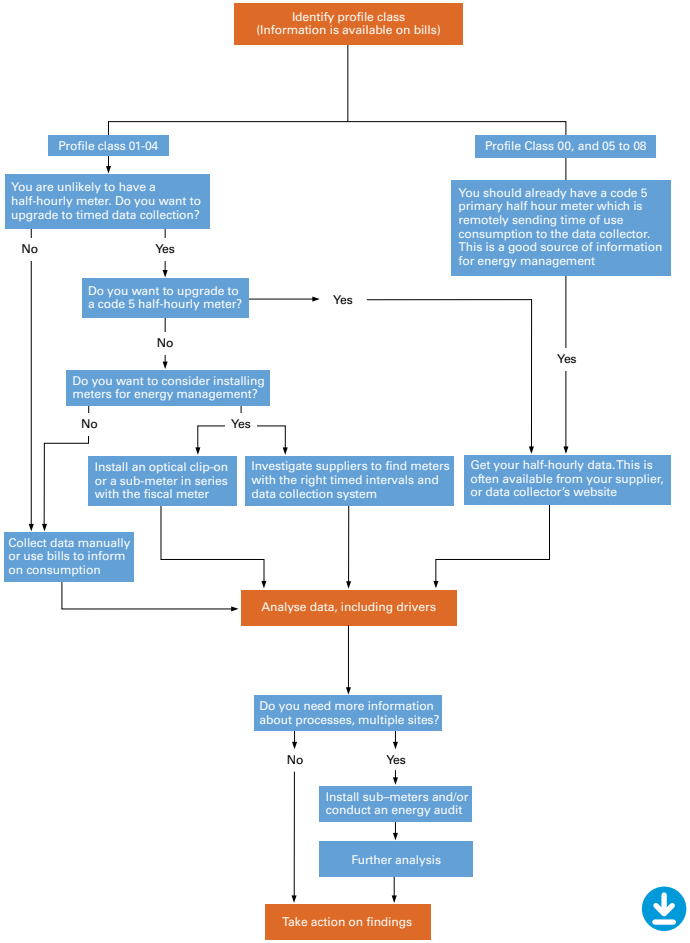
On the next page, Figure 4 diagrams a process for assessing the electricity metering options available to collect consumption data.

Check the current systems

In order to make use of electricity data, first identify the current systems and assess whether they provide enough detail for analysis.

If the site is not classified as code 5, it is unlikely that it will have a half-hourly meter. However, customers may ask the supplier to re-classify the site and install one. This can be an expensive option, as there will usually be extra charges for additional data collection and settlement. This route is most suitable for big companies with a large number of sites who can take advantage of bulk electricity purchase tariffs. If your supply is profile class 05 – 08, by 2014 you will have a SMART meter in place which will provide you with half-hourly data.

Figure 4 *Electricity metering system flow*



Access electricity data

For code 5 sites, detailed energy consumption data are typically available online from the supplier's website. It is well worth accessing the data, as they can be invaluable in identifying potential energy savings. Many suppliers now also offer a free software viewing platform to help with analysis of data and provide reports.

Conversely, sites that are not metered half-hourly get little information about electricity consumption with the bills only presenting the total consumption to date. More detailed consumption information could still be useful for these sites. If this is the case, consider purchasing or leasing a half-hourly meter as a replacement for the existing fiscal meter. These metering services employ various techniques to gather and display consumption data from the fiscal meter, or a sub-meter. Ask suppliers and specialist energy management companies to find out more about their equipment and services.

If half-hourly metering is not available or viable for the site, ensure that the organisation still makes the most of its existing meters. This can be done through reading the meter regularly, even daily, and recording consumption.

Display options

Although databases and spreadsheets are the most common tools used to analyse half-hourly energy usage data, the various metering solutions often incorporate a visual display device which shows real-time consumption. These devices vary in how they present information, but the underlying principle is that by displaying consumption in real time, problems are spotted earlier and changes can be made instantly.

Proactive organisations are linking their metering data to prominent viewing platforms, such as TV screens, located in reception areas or working spaces as a means of encouraging positive behaviour to reduce energy consumption.

Customers' entitlements – electricity data

Non half-hourly customers

A consumer has the right to contract directly with their preferred Meter Operator for the provision and maintenance of an approved meter. To begin this process, write to the supplier requesting to initiate the change of agent process to the customer's contracted Meter Operator. In parallel, the consumer may contract with a data collector to provide a service for the provision of half-hourly data. This must be an accredited DA/DC for suppliers to use the meter readings as 'actual' reads within their billing.

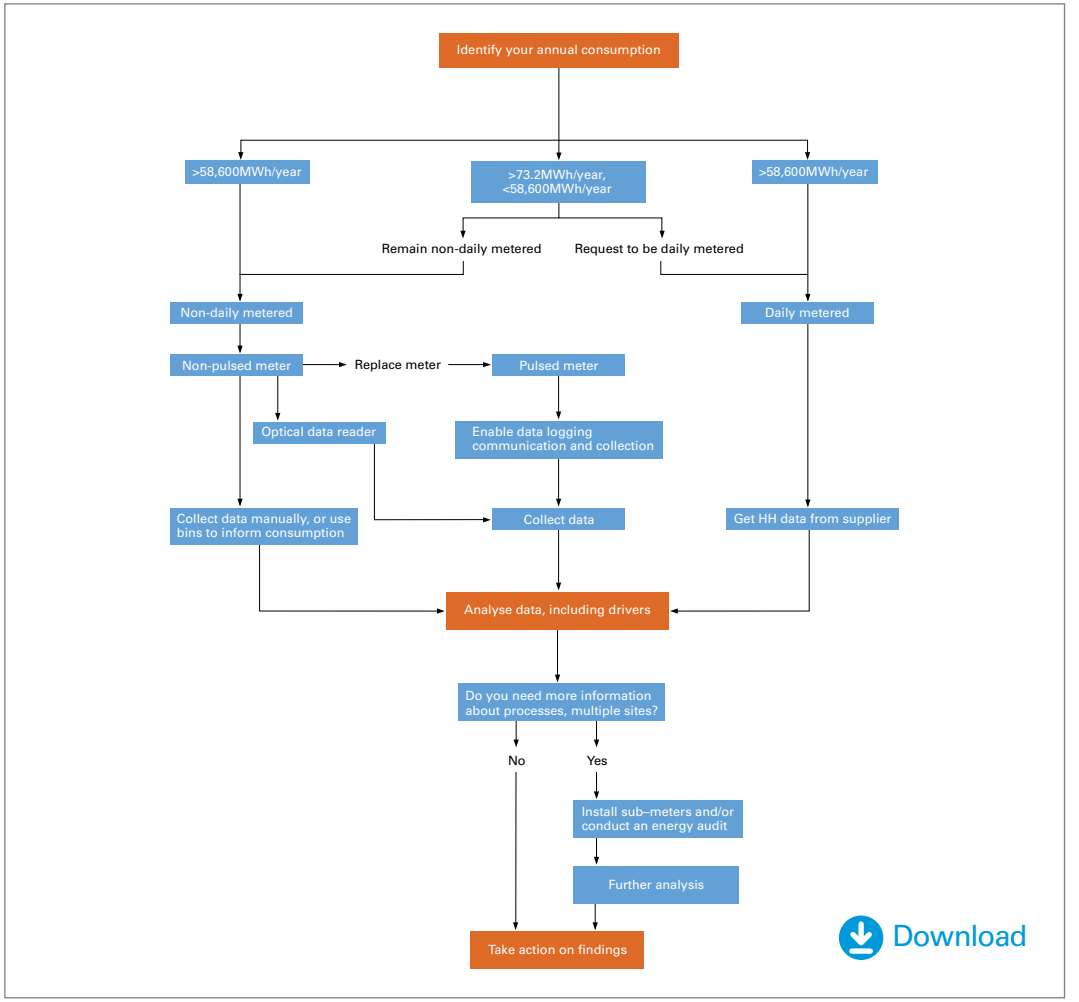
Note that in the non half-hourly market, because it is not covered by the Balancing and Settlements Code, the supplier has no prior claim nor interest in the half-hourly data. However, the supplier does require the end of month meter readings. This meter reading service is offered by registered data retrievers and non half-hourly data collectors (NHHDCs) and the cost of providing this service to the supplier can be bundled in with the meter operator/data collection service agreement.

Electricity half-hourly data customers

Customers with sites with a peak load over 100kW can nominate their preferred half-hourly data collector (HHDC). The request is made to the supplier, who will initiate the change of agent process. Arrangements for the provision of half-hourly data are on whatever commercial terms are agreed between the consumer and the HHDC.

Note, however, that the supplier owns the data. Therefore, it is important that when requesting a change of HHDC the consumer also requests that the supplier agrees to authorise the HHDC to make available the half-hourly data to the consumer.

Figure 5 *Gas metering system flow*



Gas

As with electricity, there are a variety of metering systems that could be in place on a site, offering the customer different level of detail. Figure 5 and the following text shows how to identify the available gas metering options and how to access the data.

Daily metered (DM)

If a site's gas consumption exceeds 58,600MWh/year, it will be classified as a daily metered (DM) site and will have a communication enabled gas meter enabling the supplier to track the time-of-use consumption. If the site is not classified as DM, it is possible to request to become DM if the gas consumption is in excess of 73.2MWh/year. By requesting that the site becomes DM, the business must also sign up to an interruptible gas supply tariff. This means that the supplier can potentially turn the gas off 30 days a year. This enables suppliers to maintain the supply of gas to other customers during periods of shortage; it also enables the site to negotiate cheaper tariffs with their primary supplier and with additional suppliers during periods of interruption from their primary supplier.

Note that the majority of the fiscal gas metering infrastructure in the UK is owned by National Grid Metering. The supplier will therefore have to request permission from them before any changes can be made to a fiscal gas meter.

Non-DM

Some sites which do not qualify for DM may be able to arrange the meter so that it measures consumption on a half-hourly basis. Similarly, this could be a good route for sites with consumption between 58,600 and 73.2MWh but for whom an interruptible supply is not appropriate. In many cases, the fiscal meter which has been installed is capable of collecting half-hourly data and can be enabled with a data logger and communication kit.

Some meters are not capable of recording pulses, which is an essential feature for collecting half-hourly gas data.

In this case the meter must be replaced, but remember, changes to meters can only be made with the permission of the supplier. Once the meter has been changed, the data can be collected and made available to the organisation or a company specialising in metering data analysis.

As with electricity, it is possible to bypass the option of replacing the fiscal meter by installing a primary sub-meter at the site. Alternatively, an optical reader can be placed over the analogue dial and programmed to take a reading every half-hour. Remember that, by 2014, all customers with gas consumption in excess of 732MWh will have to have a SMART meter installed, which will have the capability to provide interval consumption data.

Customers' entitlements – gas data

Half-hourly data are not as readily available as that for electricity, but it is still possible to arrange to get the data.

If the site's gas meter was installed in the last 15 years then there is a very good chance that it will have a pulsed output capability. (Rule of thumb: a meter reference beginning with the letter A indicates auto read capability). The favoured method for counting the pulses is to use a battery powered data logger with integrated GSM communications. National Grid UK specifies that these units must be suitable for 'zone zero' conditions, that is, they must offer protection against the highest chance of ignition. In addition, the National Grid also specifies that they must be approved by accreditation agency SIRA and can only be fitted by an accredited installer. Typically, the logger will be scheduled to send a daily SMS text message that contains the 48 half-hourly data values.

Safety first

If you plan to install a primary sub-meter, you should ensure that your technician is CORGI registered.

Water

As discussed in the billing section, unlike gas and electricity, not every customer is expected to have a fiscal water meter installed. Whilst fiscal water meters are only insisted upon in cases where usage is high, most water companies will provide a meter on customer request.

Usually, meters supplied by water companies are pulse enabled, meaning that it is possible to gain half-hourly interval consumption data. Permission from the water company is required to install a half-hourly bolt-on, capable of collecting and transmitting the flow volume through the meter.

Water meters older than 15 years are unlikely to be pulse-enabled. In such instances, the most straightforward way of getting half-hourly consumption readings is to request that the water company replaces the meter on site.

Top Tip

Having a water meter fitted will give you the option to request to be billed for actual consumption. In most cases, the water bill will not be linked to time of use, rather, it will be monthly, quarterly, half-yearly or yearly. Most water utilities will guarantee an accurate bill at least once a year.

Metering options

Consider devices that supplement the data from the site's fiscal meter. Extra data could highlight areas where savings can be made.

In addition to the fiscal meters on site, it is possible to install a new meter, or data logging device which can enhance energy management data. Sites could choose to upgrade to a smart meter through the supplier, or an energy metering company. Alternatively, or concurrently, make use of sub-metering or other portable data collection options available.

Smart meters

Smart meters can provide reliable and timely consumption data readily usable in an energy management programme. Such meters can also eliminate problems associated with estimated bills and the potential consequences of not being able to correctly forecast and manage energy budgets. They also can be used to show the energy consumption profile of the site, which can help an energy manager identify wastage quickly.

There is no universal definition for smart metering, although a smart metering system generally includes some of the following features:

- Recording of half-hourly consumption.
- Real-time information on energy consumption that is available immediately or via some form of download to either or both energy suppliers and consumers.
- Two-way communication between energy suppliers and the meter to facilitate services such as tariff switching.
- An internal memory to store consumption information and patterns.
- An easy to understand, prominent display unit which includes:
  - Costs in £/p.
  - Indicator of low/medium/high use.
  - Comparison with historic/average consumption patterns.
  - Compatibility with PCs/mobile phones.
- Export metering for micro-generators.

- Illustration of demand-side management options. For example, tariffs which charge high prices for peak demand, but lower than average prices for off-peak are used to encourage consumers not to use excessive energy during peak periods.

The essential features of smart metering are those which relate to consumption data storage, retrieval and display. Smart metering can be achieved by installing a fiscal meter which is capable of these essential tasks; it is these types of meters which are being rolled out between now and 2019 for all gas and electricity supplies.

Alternative metering solutions are available to bypass replacement of the fiscal meter with a smart meter. These include the use of sub-metering, for instance, a bolt-on data reader which is capable of storing and transmitting half-hourly consumption data. See page 25 for further information on this option.

Other automated solutions, which are sometimes conflated with the term 'smart meters' are AMR and AMM, which are described to the right.

Automated meter reading (AMR)

Automated meter reading (AMR) is a term that refers to systems with a one-way communication from the meter to the data collector/supplier. It can be applied to monitoring of anything with a pulsed output, allowing the full range of utilities and energy consuming process to be monitored.

AMR readings can only be used for fiscal purposes, however, if the AMR system is managed by an accredited DA/DC who then pass on the consumption data to your supplier. There are a number of AMR service providers who operate to a voluntary Code of Practice (ASPCoP) that defines the operations, standards and methods by which metered consumption data is read and supplied to customers, energy suppliers or others. By providing a regularised system it ensures that customers have assurance about the data accuracy, integrity and completeness to be achieved as well as the service levels they will receive from the providers.

Automated meter management (AMM)

Automated meter management (AMM) systems are similar to AMR arrangements, except that they allow a two-way communication between the meter and the data collector/supplier. As well as having all the benefits listed above, AMM allows for remote manipulation by the supplier. The advantage to the customer is that there is potential to display real-time tariff data, energy use, and efficiency at the meter; and the potential to negotiate collective tariffs with suppliers.

AMM is mostly available for electricity with some safety issues affecting AMM for gas.

Commercial data services

Some organisations are well equipped to present and analyse their meter data, while others require specialist help. Companies that provide data services can be divided into three types:

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.

Bureau Services – this includes a combination of the above, plus the validation and management of utility invoicing, and often includes utility contract procurement services.

Personal contact – provision of the meter and meter data plus some form of personal contact to provide customised energy saving advice, typically via phone 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.

Consider the requirements of the site and the in-house expertise when deciding whether to seek the assistance of a professional data service.

Building Energy Management Systems (BEMS or BMS)

Large commercial buildings and businesses that spend more than £10,000 a year on energy will often make use of a Building Energy Management System (BEMS). This is a computer-based system through which building services are monitored and controlled to maintain the environment within the building.

In connecting half-hourly meters with the BEMS system by cabled or wireless communications, it is possible to monitor consumption alongside the site's information on building control and management. The system therefore enables users to concurrently identify areas of exceptional consumption and discern what has caused them.

Sub-metering

Metering the total energy used at a site is important, but it does not show how energy consumption is distributed across areas or for different applications. Therefore it can be hard to understand why and where energy performance is poor and how to improve it. Installing sub-metering to measure selected areas of energy use could give a considerably better understanding of where energy is used and where there may be scope to make savings.

Sub-metering is a viable option for primary metering where it is not possible or advisable to interfere with the existing fiscal meter. For this purpose, a sub-meter can be fitted on the customer side of the fiscal meter so as to record the total energy entering the site.

For new non-domestic buildings, sub-metering is covered under part L2 of the Building Regulations and requires at least 90% of each incoming energy source to be accounted for through sub-metering, so that it can be assigned to the various end-use categories (heating, lighting etc.)

It also states that the output of any renewable energy system should be separately monitored and that in buildings with a total useful floor area greater than 1000 m^2, automatic meter reading and data collection facilities should be provided.

In addition, a good level of sub-metering can help with the production of accurate Display Energy Certificates, a current annual requirement for public sector buildings >1,000m^2; and for the annual CRC reporting and levy requirements.[6] This regulation has been designed with the view that having sub-metering to such an extent will enable effective energy management. Common areas that require sub-metering are set out in Table 1, below.

When considering a sub-metering strategy, break down the site into end uses of energy. This might be by area (for example, floor, zone, building, tenancy or department), by system (heating, cooling, lighting or industrial process) or both. Sub-metering of specific areas also provides more accurate energy billing to tenants, if it is required. The sub-metering strategy should also identify individuals responsible for the energy consumption in specific areas and ensure that they have the ability to monitor the consumption which falls under their management responsibilities.

Additionally, it may be worth separately metering large industrial machines or plant. The following table lists the sizes of typical plant which commonly justify separate metering.

Table 1 ***Common plant requiring sub-metering*** [5]

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

[5] Source: Part L2 of the Building Regulations

[6] CRC reporting and subsequent levy charges are a requirement for any organisation with one or more meters consuming over 6,000kWh per year.

Sub-metering methods

There are five methods of sub-metering energy use and these are discussed below, in order of most accurate, reliable and expensive to least.

Direct metering is always the preferred option, giving the most accurate data. However, it may not be cost-effective or practical to directly meter every energy end-use on a site. Weigh the cost of the meter plus the resource to run and monitor it against the impact the equipment has on energy use, and the value of the data that direct sub-metering will yield.

'Hours-run' (also known as 'constant load') metering can be used on items of equipment that operate at a constant, known load (for example, a fan or motor). This type of meter records the time that the equipment operates which can then be multiplied by the known load (in kW) and the load factor to estimate the actual consumption (in kWh). Where possible, measure the true power of the equipment, rather than relying on the value displayed on the rating plate.

Indirect metering is where information from a direct meter is combined with other physical measurements to estimate energy consumption. Its most common application is in measuring hot water energy consumption. Heat meters work on this principle. A direct water meter is used to measure the amount of cold water going into a hot water heater. This measurement, combined with details of the cold water temperature, the hot water temperature, the heater efficiency and the specific heat of water, enable the hot water energy consumption to be calculated.

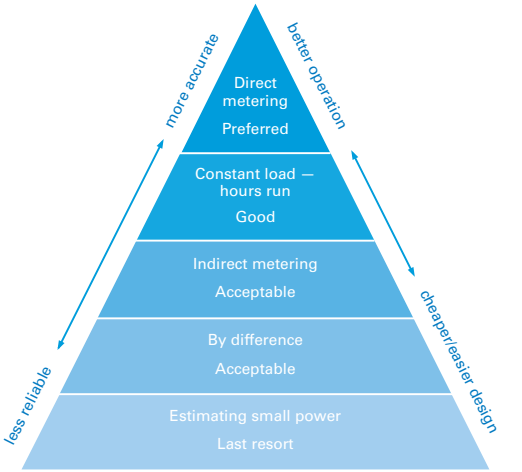
'By difference' metering is where two direct meters are used to estimate the energy consumption of a third end-use. For example, if direct meters are used to measure the total gas consumption and the catering gas consumption in an office building, the difference between the two measurements would be an estimate of the energy consumption associated with space heating and hot water. This form of metering should not be used where either of the original meter readings is estimated, since this could lead to large errors. Also, this form of metering should not be used where a very small consumption is subtracted from a large consumption, because the accuracy margin of the large meter may exceed the consumption of the smaller meter.

Fact

Even if the organisation is made up of many small sites, the combined savings identified by good metering can be significant.

Where none of the above methods can be used, it may be possible to use **estimates of small power** to predict the energy consumption associated with items such as office equipment (by assessing the power rating of equipment and its usage). This method is very inaccurate and should be supplemented by spot checks of actual consumption wherever possible. Industry published benchmarks for energy end use can be used to provide typical energy consumption per output e.g. kWh/m^2; kWh/barrel figures for a particular process, such as lighting.

Figure 6 Sub-metering options and hierarchy in terms of accuracy, reliability and cost.



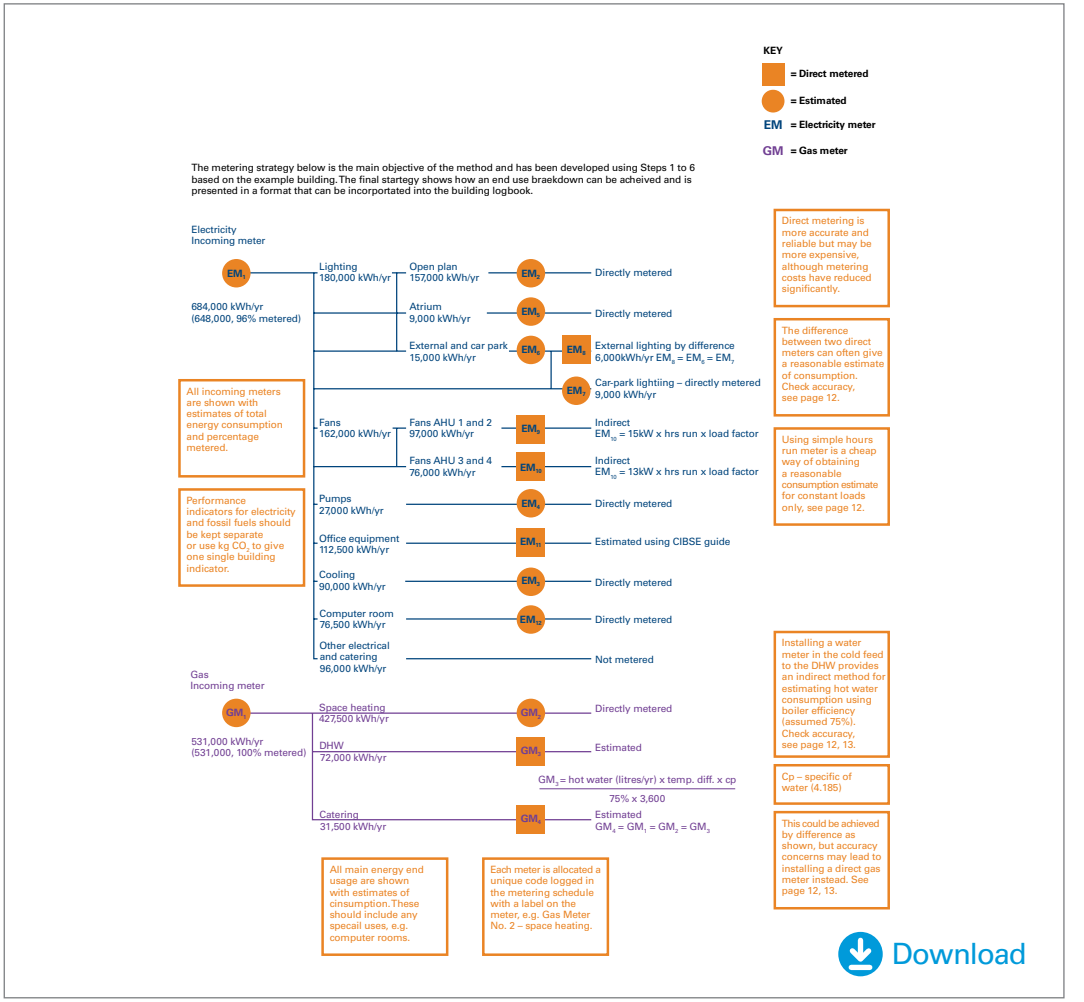
Metering schedules and strategy

If the site has multiple end uses of energy that would benefit from monitoring, preparing a metering schedule and strategy can help manage data collection and analysis, as well as helping to identify the most suitable type of metering level required for each process. It is worth setting out the location and function of each meter on the site, in tabular and diagrammatic form respectively.

Besides considerations of the location and function of meters, it is important that individual monitoring areas and responsibilities are identified and taken into account.

The management of these will be dependent on the functionality and/or location of the equipment so that responsibility for any savings (or otherwise) can be correctly attributed. Figure 7 shows a typical schematic of a metering plan indicating an appropriate level of sub-metering as well as a proposed delegation of sub-metering systems according to each energy manager's responsibilities.

Figure 7 ***(Right) Example schematic of metering plan***



An example of how this system can be presented for the purpose of energy management and accountability is shown in Table 2, opposite.

Table 2 shows how data from sub-meters could be presented for energy management purposes. Depending on the level of metering available from the sub-meters, further interrogations can be made to each of the sub-meters to reveal the consumption profiles leading to monitoring and targeting of energy use.

Top Tip

Tenants' bills

Sub-metering provides an ideal means to collect data on tenanted sites, enabling the landlord to send tenants regular and accurate bills, and can help with reporting and payment requirements under the CRC Energy Efficiency Scheme.

Table 2 ***Schedule from metering plan for Manager A***

Energy supply from: 0000 on 01/09/06 Energy Supply to: 2400 on 31/09/06				**Manager A: A. USER**
Meter	Utility	Consumption (kWh)	Cost per unit (£)	Total Cost (£)
Plant room	Electricity	666.67	0.0902	43.33
Pumps	Electricity	1000.00	0.0902	65.00
Cooling	Electricity	1250.00	0.0902	81.25
Catering	Electricity	500.00	0.0902	32.50
Other electrical	Electricity	333.33	0.0902	21.67
Total	Electricity	3750.00	0.0902	243.75
				0.00
Space heating	Gas	3583.33	0.0298	48.38
DHW	Gas	6000.00	0.0298	81.00
Catering	Gas	2666.67	0.0298	36.00
Total	Gas	12250.00	0.0298	165.38

Portable solutions

Temporary and portable metering solutions are available in the form of clip on devices and other non-invasive options. These measure the flow of the gas, electricity or water without interrupting it. Portable devices are beneficial for sites that require quick access to data, perhaps for initial analysis, or perhaps to inform the design of a more permanent metering and sub-metering solution. Remember, though, portable solutions are generally regarded as temporary, and are not likely to be able to replace the primary fiscal meter.

Clip-on ultrasonic flow meters can be used to determine the in situ flow rate of gas or water from outside the pipework. This flow rate can then be used to calculate the volume of gas or water being used. Electricity clip on meters use sensors to detect the electromagnetic field to measure flow and subsequent usage.

Portable meters are also available to measure other energy components, such as oil, steam and compressed air.

When purchasing metering equipment for energy management, consider cost, ease of use and flexibility.

The choice is wide and the cost in real terms is lower than it has ever been.

These instruments should allow surveys to be carried out at any desired (or convenient) point on the utility system to define the characteristics of the load at that point. These points may be anywhere between the incoming supply to a building or department down to an individual machine or appliance.

How the equipment works

Although portable meters come in a variety of forms, their basic operation is roughly the same. For example, to measure electrical energy, there are a number of different parameters that must be measured before kWh (energy) readings can be obtained. These perameters are volts, amps and power factor. The most basic instruments get round this by only measuring amps, and using assumed values for the remainder. This has some impact on accuracy (although not necessarily on repeatability) but this impact is often small because both voltage and power factor are likely to be relatively stable during any survey period.

These compromises are only acceptable, however, where low cost and ease of use are paramount. Where greater accuracy is required, all three variables must be measured. The simplest (and cheapest) equipment may not offer the greatest accuracy but generally will be very easy to use. More capable instruments will offer very high levels of accuracy but may require a skilled operator to get the best out of them. In many cases, mid-range instruments offer the most appropriate solution for the site.

Metering communication options

The technology available for the transfer of consumption data from metering ranges from GPRS or GSM modems sending data bundles to a receiver, through low power radio technology to ethernet/internet interfaces.

When installing a metering system which makes use of remote meter reading, consider which communication option is the most appropriate for each particular application. The appropriateness of the system will depend on practical factors such as:

- The number of meters (including sub-meters).
- Size of site(s).
- Location of meters.
- Power supply.
- Proximity to phone line or mobile/radio network coverage.

In addition to these factors, the communications options employed will depend on the site-specific needs as well as the expertise of the metering company being employed. Therefore, it is advisable to ask the meter provider to offer the most reliable and lowest-cost solution, taking into account all of these factors.

Glossary

Actual reading	A measurement of consumption based on a physical read of the fiscal meter for the purpose of billing.
AMM	Automated Meter Management – meter management system which allows two-way communication between the meter and the data collector or supplier, thus allowing for billing and energy management (as in AMR) as well as allowing the remote manipulation of the meter.
AMR	Automated Meter Reading – automatic collection of data from meters which is transferred to a central database for billing and/or analysis.
Available capacity	The amount of electricity that the distribution company makes available for a business during an agreed period (usually monthly). If the business uses more than this amount, they will be charged an excess capacity charge.
Building Energy Management System (BEMS)	A computer-based system through which building services can be monitored and controlled to maintain the environment within the building.
Climate Change Levy (CCL)	Government levy applied to the energy use of organisations in the industrial, commerce and public sectors, as part of the climate change programme.
Code 5	In electricity, metering profile which allows the collection of half-hourly data.
Customer reading	A meter reading made by the customer, or an agent of the customer, which is passed to the supplier in order for a bill to be produced.
DA	Data Aggregator – Responsible for the aggregation of electricity supplied to the customer.
DC	Data Collector – Responsible for the collection and processing of consumption data.

DM (daily metering)	In gas, metering that enables the supplier to track the time-of-use consumption.
Drivers	Parameters that impact on consumption of a utility. These can be classed as activity drivers (factors which are influenced by the activities of the organisation, such as production output), or condition drivers (factors over which the organisation has no control, such as external temperature).
Fiscal meter	A meter which provides the supplier with a means to collect accurate consumption data for the purpose of billing. All sites are required to have a fiscal meter to measure the consumption of gas and electricity.
Kilo-watt (kW)	1000 joules per second, or the amount of energy required to move 1000 Newtons through 1 meter in 1 second.
Kilowatt hour (kWh)	The standard unit of consumption used for energy billing. 1 kWh = 1000W of power over the period of 1 hour.
Kilo-volt amperes (kVa)	The amount of apparent power in an alternating current circuit equal to a current of one ampere at an electromotive force of one volt.
MPAN	Meter Point Administration Number – a 21 digit reference, used to uniquely identify the electricity supply point. Although the name suggests that an MPAN refers to a particular meter, an MPAN can have several meters associated with it.
MPRN	Meter Point Registration Number – The unique identification number for gas supplies.
Peak load	The maximum electrical demand for a site at any point in time measured in kW. This is determined by the maximum amount of electrical equipment that a site will have on at the same time.
Power factor	Term describing how efficiently electrical power is consumed. It refers to power in an alternating current (ac) electrical circuit.
Smart meters	Any meter which allows for the identification of consumption in more detail than a conventional meter. Smart meters will generally also include a means of communicating information to a central data collection site for energy management and/or billing purposes.
Zone zero	In gas, is the zone with the highest probability of having a flammable atmosphere.

Next Steps

Effective metering provides the basis for all energy management. Follow the steps below to understand the energy consumption on the site and identify where more information is needed.

Step 1 Understand the industry

Making sense of the complex industries of energy (electricity and gas) and water helps in understanding how energy is delivered to the site, how it is billed, and who has responsibility for supply and the hardware of utilities.

Step 2 Analyse energy bills

Invoices give a lot of information about supply, tariff and usage. Understanding the information given on them can lead to large cost savings as well as provide details for your energy management strategy. Also, bills may be estimated or wrong, so checking them is crucial.

Step 3 See what systems are in place

Analyse what meters are currently on site, and the data collection and recording techniques. Is enough data available from the current systems to properly assess the site? You may want more information than your current meters are giving you.

Step 4 Investigate other techniques

The meter industry is constantly changing, with new products and possibilities on the market frequently. New metering systems offer advanced collection and recording techniques and various display options.

Step 5 Install sub-meters

Large users or multi-site organisations could benefit from installing sub-meters. Look at the strategies for sub-metering, and install based on the data needed.

Step 6 Monitor energy use and improve

Having a good metering system is just the beginning. Investigate monitoring and targeting (M&T) techniques and make energy savings.

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The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

We help to cut carbon emissions now by:

- providing specialist advice and finance to help organisations cut carbon
- setting standards for carbon reduction.

We reduce potential future carbon emissions by:

- opening markets for low carbon technologies
- leading industry collaborations to commercialise technologies
- investing in early-stage low carbon companies.

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