

Energy essentials

A guide to energy management



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Introduction



Meeting the world's growing energy needs while mitigating the effects of climate change is one of the most demanding challenges of our time.

Global energy demand is expected to increase substantially in the next few decades. This is mainly due to the projected growth in world population, and the economic and industrial growth of developing countries such as China and India. Figure 1 shows the projected increase in world energy consumption up to 2040. At the same time, reducing the amount of greenhouse gas emissions, in particular carbon dioxide emissions from fossil fuel energy use, is necessary to tackle climate change

and achieve global sustainability. The transition to a low carbon economy raises infrastructure, affordability, and other challenges for all nations that rely on burning carbon-based fuels for energy.

Key to solving these issues will be managing energy use more effectively. **Energy management** is an essential strategy for all energy users who seek to minimise exposure to energy price volatility and reduce their carbon footprint and resource use. It can have further benefits for an organisation's overall effectiveness and social responsibility.

People are at the centre of energy management; **energy performance**

does not improve without active intervention. Energy management varies between organisations, but it starts with an individual taking initiative and asking questions about energy use. This guide places that 'energy manager' at its centre and describes the questions that should be asked as energy management is introduced in the organisation.

This introductory guide shows why energy management is important for all organisations and gives an overview and explanation of the process involved. It describes the main steps for introducing, implementing and maintaining an energy management system (EnMS). Lastly, it investigates the opportunities for those interested in the energy management profession and describes how to successfully develop their career.

It is not meant to provide detailed engineering or financial advice; rather it illustrates the broad concepts required to manage energy in a systematic manner. This guide is designed for individuals who need a high level introduction to managing energy, the informed layperson, and anyone who is at the early stages of their career as an energy management professional.

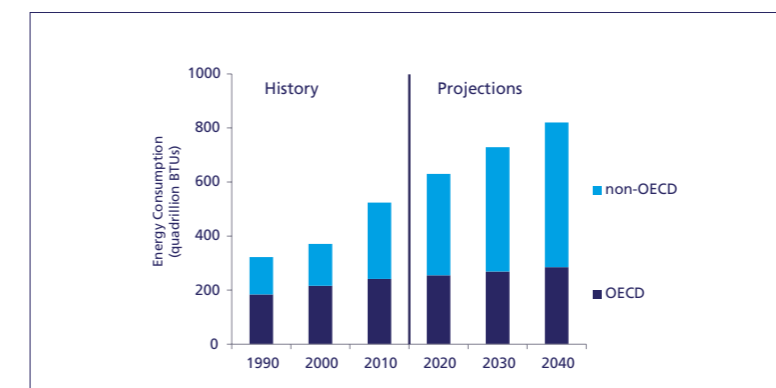


Figure 1: Historical and projected world energy consumption of OECD and non-OECD countries between 1990 and 2040 (OECD: Organisation for Economic Cooperation and Development) Sources: BP Statistical Review of World Energy June 2014 and Energy Information Administration (EIA) International Energy Outlook 2013

1 What is energy management?

Managing energy is directly related to other types of management within an organisation such as resource management, asset management and risk management.



Energy management and energy efficiency

The terms 'energy management' and 'energy efficiency' are often used interchangeably. However, there are differences between them.

Energy efficiency is the use of the minimum amount of energy while maintaining a desired level of economic activity or service. In other words, energy efficiency is the amount of useful output achieved per unit of energy input. Improving energy efficiency means either achieving more from the same input or achieving the same output with less energy.

Energy management is a systematic and continuous effort to improve energy efficiency within an organisation. It can take many forms and involve all types of interactions with energy, from procurement and purchasing strategies to technological improvements and behavioural changes.

Energy Management Systems (EnMS)

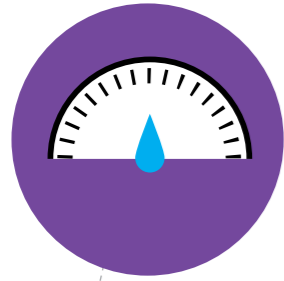
Energy management can be tailored to the size and the needs of any organisation. In order to be effective, it requires the implementation of a plan or system which is flexible, value-driven and in alignment with the strategic aims of the organisation.

Energy management systems are designed to help organisations by providing a systematic and well-structured framework. An EnMS supports energy management, but is not a substitute for it. Although the basic elements of an EnMS should be similar across organisations, there are differences in the implementation of the system depending on the size and the complexity of an organisation's operations. This guide uses the Plan-Do-Check-Act management process as an example of such a framework for improving energy performance. Whilst an EnMS is not a requirement for managing energy, it provides a useful and practical context for understanding and a structure for continuous improvement. Organisations should choose any or all of the components of the EnMS based on their specific circumstances and requirements.

What makes a successful EnMS?:

- Assessment of the EnMS at regular intervals and whenever there is a significant change in energy consumption
- Adjusting and improving the EnMS based on lessons taken from regular assessment





Treating energy as a tangible resource

Energy use is the consumption of an energy source or fuel such as electricity, natural gas, diesel, petrol or coal. Energy is used to provide a service such as lighting, heating, transport, or running industrial equipment or household devices. As a consumable resource, energy should be managed in a similar way to other resources, such as office supplies or raw materials for manufacturing. However, there are two unique challenges when it comes to treating energy as a consumable resource.

1. Identifying and managing risk:

The influence of geopolitical and market risk on the energy system is significant, and as a result prices are volatile. Organisations must have a sound understanding of their current and future energy needs in order for their purchasing to be cost-effective. Various factors add to the complexity such as politics, regulations, and weather conditions.

2. Measuring consumption:

Energy differs from other commodities and consumable resources in that, in many cases, it is intangible and invisible. For that reason, and because it is continuously delivered, the level of consumption of an energy source such as electricity or gas is difficult to gauge. The only way to quantify the use of electricity and natural gas is by monitoring consumption data.

Effective procurement strategy

Managing energy is inextricably linked with managing an organisation's assets, facilities, processes and transport activities. Procuring new energy efficient products and services that operate as well as or better than existing ones can reduce energy use and maintenance and replacement costs.



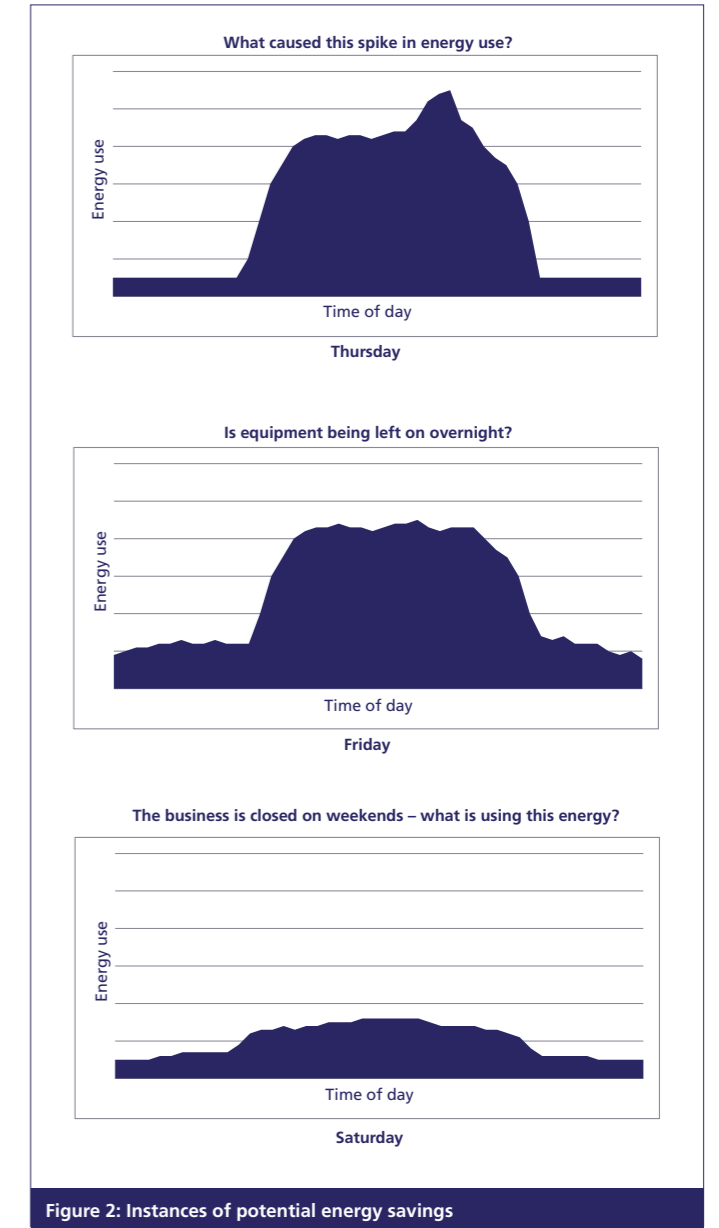
Understanding by measuring

Managing energy, as with any other resource, requires the development of an understanding of its use within an organisation. At the core of energy management is the process of **monitoring and targeting (M&T)**.

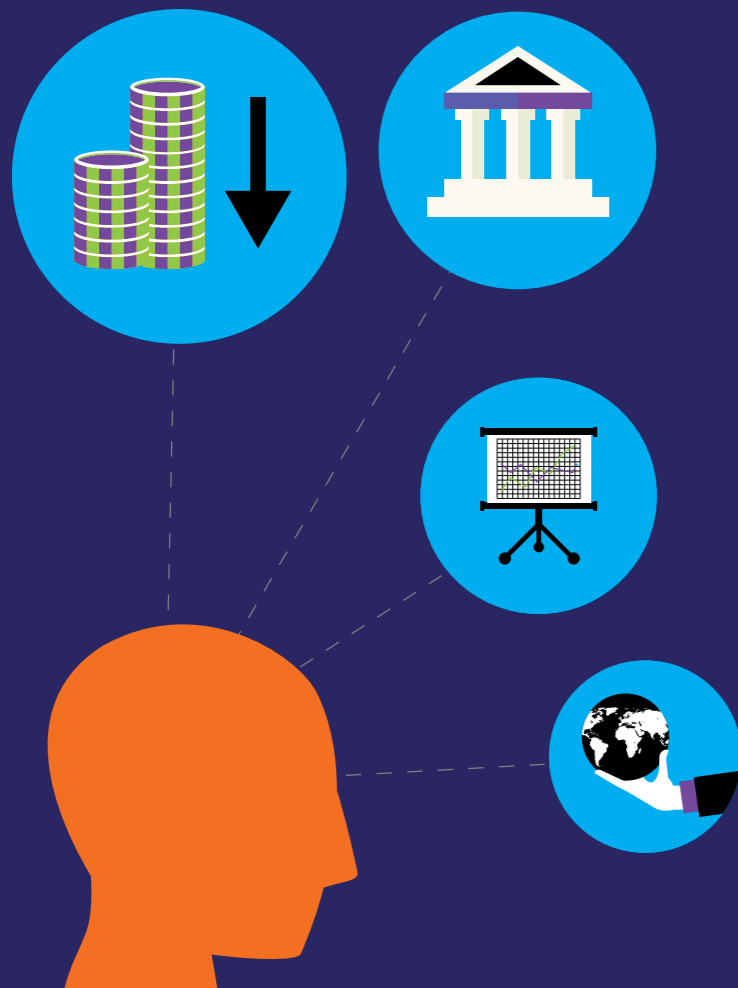
M&T is based on the fundamental principle that 'you cannot manage what you do not measure'. It is the first crucial step towards improving an organisation's energy performance.

M&T aims to identify opportunities to save energy. Monitoring is the process of establishing existing patterns of energy use and identifying drivers and variables of those patterns. Targeting refers to the identification of the desirable level of energy use.

Successful monitoring allows energy use to be correlated with driving factors such as weather, units of production and behaviour. As a result, areas of excessive and avoidable energy consumption can be identified. Figure 2 shows instances of potential waste identified through monitoring of detailed energy consumption data.

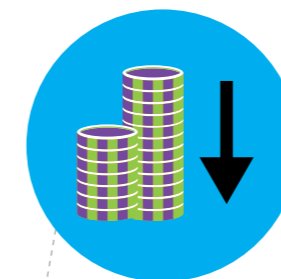


2 Why manage energy?



There are a range of drivers that motivate organisations to manage their energy use. Efficient use of energy helps to maintain competitive advantage and opens up many other opportunities. The majority fall into one of the following categories:

- reducing energy costs and minimising risks
- complying with policies and regulatory frameworks
- improving organisational effectiveness, and
- improving corporate social responsibility.



Reducing energy costs and minimising risks

One of the main reasons for businesses to manage their energy consumption is the financial benefit, including reduced exposure to price-related risks. According to the US Energy Information Administration (EIA), real end-use prices of electricity and fossil fuels (natural gas, oil products, coal) in the United States have become increasingly volatile in the past 20 years (see Figure 3 below). Similar trends have been experienced in other regions over this time period, including Europe.

Security of energy supply has risen to the top of the political agenda in many countries. In order to mitigate energy price risks and increase security of supply, many countries have prioritised minimising demand through increased energy efficiency as well as diversifying their energy supply mix.

At the business level, energy management provides many opportunities for organisations to minimise their exposure to these risks.

Increased energy efficiency can reduce the amount of energy an organisation uses as well as the associated energy costs. This can have a major impact on competitive pricing of products and services, and thereby the

financial position of the organisation. Energy management can also help organisations be more adaptable and resilient to change.

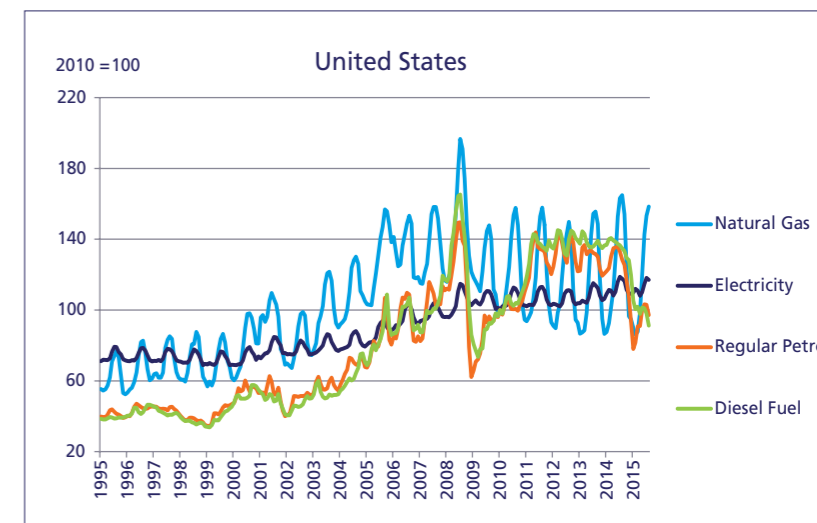
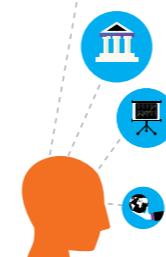


Figure 3: Indices of energy end-use prices since 1995 (Source: EIA November 2015 Monthly Energy Review)





Complying with policies and regulatory frameworks

The need for a worldwide transition to a low carbon and more energy efficient economy has led to the introduction of a wide range of energy policies and regulatory frameworks. These apply at all scales, from city-wide initiatives to regional frameworks and international agreements.

An example of an international-level policy is the European Union's Energy Efficiency Directive (EU EED). Under the Directive, all 28 Member States are required to use energy more efficiently at every stage of the energy chain, from generation to distribution to final consumption. This directive applies not only at the Member State scale, but also indirectly to individual organisations. Under Article 8 of the Directive, there is a mandatory requirement for large private sector organisations of each EU Member State to conduct **energy audits** at regular intervals. In the UK, this has been implemented through the Energy Savings Opportunity

Scheme (ESOS), an energy efficiency assessment and energy savings identification scheme.

At the national level, many countries have introduced their own energy management-related legislation:

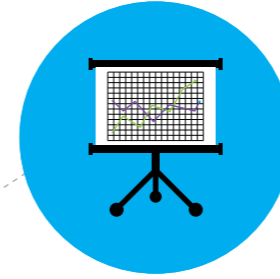
- China's Top-10,000 Programme affected approximately 17,000 of the country's organisations; from large industrial and transportation organisations to public buildings. The programme has set mandatory national targets for energy use and carbon dioxide emissions. To meet these targets, participants were required to implement various measures, including setting up energy management systems, reporting energy consumption data and carrying out audits.
- The UK's Climate Change Act 2008 established the world's first legally binding target for reducing greenhouse gas emissions (80% reduction by 2050 compared to 1990 levels). To reach this target, the UK will pursue many decarbonisation routes, including encouraging organisations to invest in low carbon technologies and reduce their energy demand.

International energy standards

International energy standards have been developed to help organisations improve their energy performance, comply with legislative requirements and take advantage of financial incentives. Examples include ISO 50001 'Energy Management Systems – Requirements with guidance for use', an internationally recognised standard for good energy management practice, and ISO 50002 'Energy Audits – Requirements with guidance for use', which sets good practice methods for carrying out energy audits.

Implementing these standards helps organisations follow industry good practice and presents an opportunity for organisations to lead on the future development of new standards. Implementation also sends a proactive corporate message to customers and the supply chain.

For more on standards, see p14



Improving organisational effectiveness

Efficient use of energy can be a commercially valuable objective in itself, helping an organisation reduce energy costs and exposure to price volatility. It can also have positive implications for other non-energy aspects of business operations, such as productivity levels, health and safety, and equipment performance. By identifying energy-inefficient practices and equipment, and making adjustments accordingly, a business can improve its operational effectiveness, process productivity, and overall competitiveness.

Improvements in energy efficiency can result in a more productive working environment and improved staff morale and comfort. For instance, a review of office building lighting can reduce energy consumption whilst also improving light quality. This leads to better working conditions, which can increase employee productivity.

Reducing unnecessary use of equipment or machinery can save energy. It can also improve overall safety in an industrial unit or office building, through reducing time spent in hazardous environments or reducing the risk of equipment damage.

Continual assessments of energy intensive processes and equipment can also reduce the frequency of maintenance and help to extend the operational lifetime of equipment and machinery. For example, ensuring that building heating, ventilation and cooling (HVAC) systems are commissioned and controlled appropriately, so they work in concert instead of struggle against one another, may extend the lifetime of HVAC machinery by reducing unnecessary use.



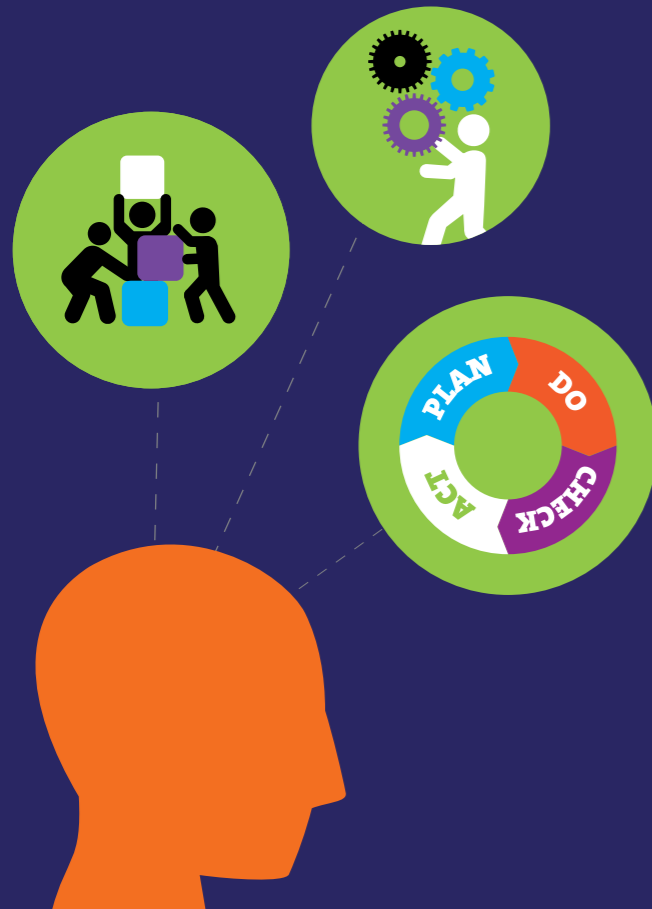
Improving corporate social responsibility

Putting in place a system to manage energy use can be an aspect of an organisation's corporate social responsibility initiative. It is an opportunity for an organisation to demonstrate good practice to both customers and shareholders. Successful energy management can benefit the wider reputation of an organisation, raise its profile and help the organisation gain a competitive advantage in the market.



3 How to manage energy

Energy managers serve as focal points for energy related activities and strategies within an organisation. They may operate alone or as part of a team. This section highlights important considerations for an energy manager.



The business case

The introduction of effective energy management within an organisation is an important step towards improving overall performance. For many organisations, formalising this process can represent a significant cultural change.

The size of an energy management team varies depending on the size of an organisation and the activities it undertakes. It can range from a single part-time role to a team of dedicated staff, or contracted service companies and consultants. For energy management to be successfully implemented, collaboration between departments and collective responsibility across the whole organisation should be encouraged.

The mandate to manage energy can originate from senior management, but in cases where it is driven by other employees, senior management support and buy-in should be sought. Initially, this might take the form of a commitment to improve energy practice and begin the process of examining organisational energy use. However, to enable a detailed examination of energy use as described in this chapter, some organisations may also need to approve initial expenses such as hiring



Implementing energy management

Managing energy in a systematic, structured manner is an on-going process; once the commitment has been made, an organisation can follow a step-by-step process that forms a continual cycle of assessment and improvement.

This process may be informal, following logical steps for continuous improvement without necessarily adhering to a particular standard. Conversely, an energy management system (EnMS) based on a formal standard can be adopted.

Whichever route is chosen, a common recommended structure for this process is Plan-Do-Check-Act. This structure is the backbone of many energy and other management practices, and repeating this cycle should drive continuous improvement.





Energy management standards

Since 2000, several national and international standards have been developed for use by energy managers to provide support and guidance for implementing an EnMS. This standardisation process culminated in the development of ISO 50001:2011 – Energy Management Systems standard. ISO 50001 supersedes many of the earlier national and European standards and, having been developed by professionals from more than 60 countries, is considered to be the benchmark standard for energy management worldwide. It is highly compatible with other well-known international management system standards such as those for Environmental Management Systems (ISO 14001:2015) and Quality Management Systems (ISO 9001:2015).

ISO 50001 was developed to ensure consistency and validity of energy performance worldwide, and as a result, has raised the professional status of energy management. It has been implemented by a wide range of organisations around the world and establishes a holistic and structured approach to improving energy performance. This standard uses the process of continuous assessment and

improvement to ensure that energy savings are achieved and maintained. In addition to this, the main benefits of the standard are that it:

- sets out the process of measuring and verifying (M&V) the energy performance of an organisation.
- can be used from large organisations to small and medium sized enterprises (SMEs) across a broad range of commercial, industrial and public sectors.
- enables energy management best practices to be introduced into business operations.
- increases transparency and effective communication on the management of energy resources.
- encourages the adoption of energy efficiency measures across an organisation's supply chain.
- ensures that everyone in an the organisation will be involved in the process.
- takes into account any external financial incentives (tax benefits, enhanced capital allowances, etc).

Whilst not a requirement, the implementation of ISO 50001 can be certified through a 3rd party certification body.

Various standards on how to conduct energy audits have also been developed. Examples of these standards are ISO 50002 – Energy Audits and BS EN 16247 – covering the general requirements and process of undertaking energy audits in buildings, industrial processes and the transport sector. These standards define the attributes, common features and methodologies, as well as the deliverables of good quality audits.

ISO standards are reviewed and updated at regular intervals to ensure that they adequately reflect industry's latest developments and requirements. To stay up to date with good practice, organisations should always use the latest available versions.

The following sections give an interpretation of the Plan-Do-Check-Act structure and process as applied to energy management.

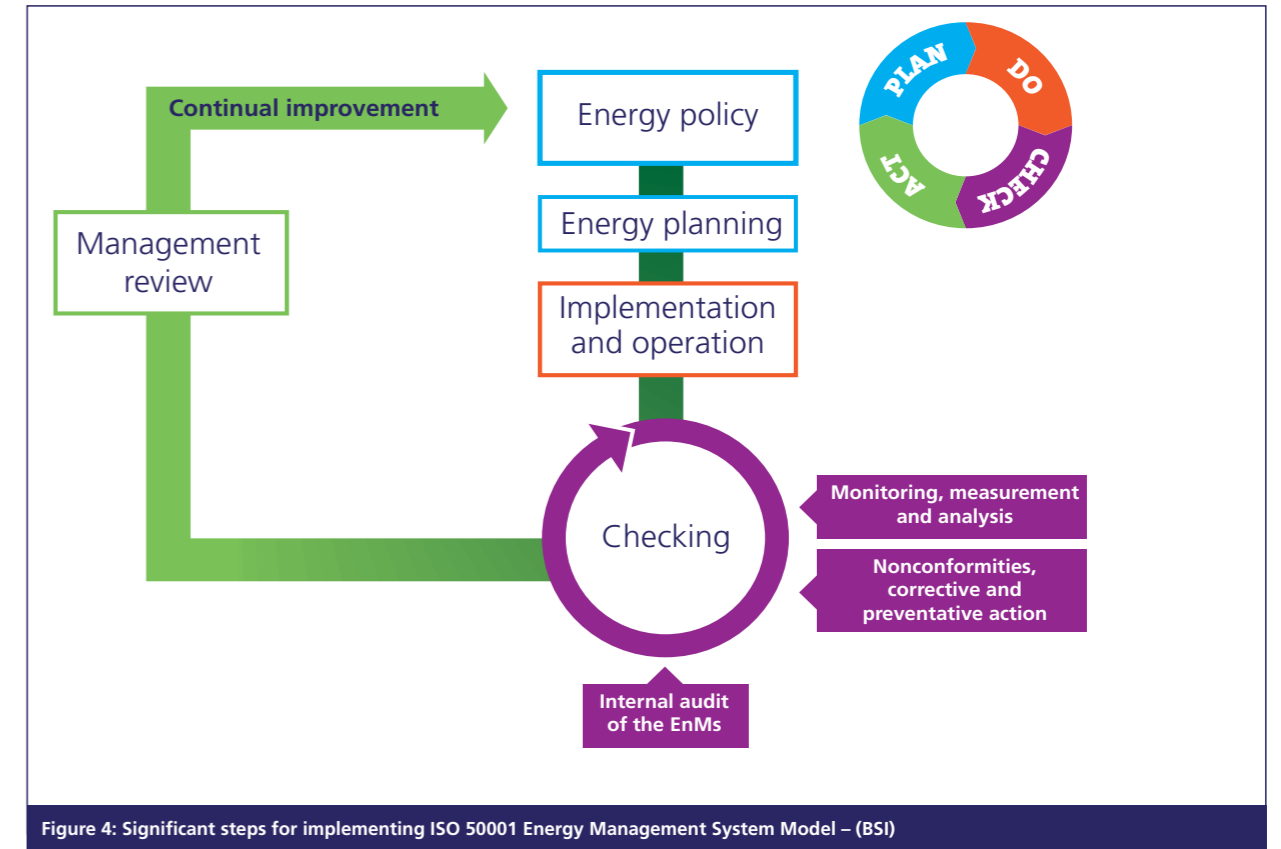
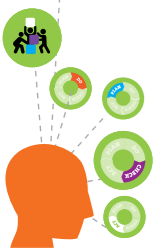
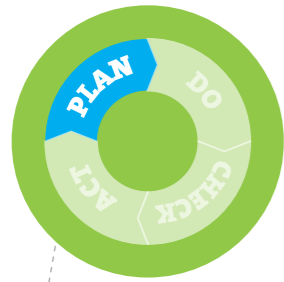


Figure 4: Significant steps for implementing ISO 50001 Energy Management System Model – (BSI)





Plan

The planning stage of the energy management process has two main aims. The first is to better understand an organisation's energy use. The second is to form a plan that uses this knowledge to improve energy performance. The basic steps included in the planning stage are illustrated in Figure 5.

The first time through this process, an energy manager may choose to simplify the planning stage. It is important to remember that the energy management process is cyclical, and more in-depth planning can be carried out in subsequent iterations of the process.

To begin to improve an organisation's energy performance, certain parameters need to be measured or estimated. These parameters feed into an energy review, the outputs of which should include energy management targets and objectives. These can influence the organisation's energy performance objectives as well as its strategic business planning.

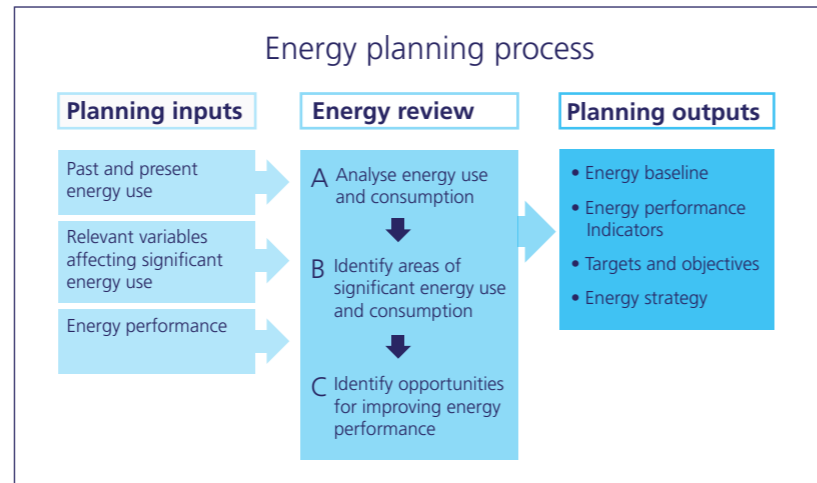


Figure 5: ISO 50001 – Energy planning process – (BSI)



Energy policy

An organisation's energy policy serves as a reference document for the implementation of an EnMS, and contains the organisation's high-level mission statements regarding energy. It should be a concise document tailored to an organisation's size and the nature of its business. The energy policy acts as the guiding document for managing energy.

The energy policy should use the information gathered in other phases of the planning stage to outline the organisation's current energy performance, future targets and the processes required to achieve these targets. The policy should be regularly adjusted to reflect any progress made in an organisation's energy performance.



Monitoring and targeting

The process of M&T is a fundamental part of energy management. It enables organisations to develop an in-depth understanding of their energy use, identify their areas of significant energy consumption, and establish targets for efficiency improvement.

By monitoring the normal pattern of energy consumption, effective M&T can also alert an organisation to any irregularities in energy consumption that may occur.

Monitoring can be broken down into several steps, including performing an energy review, establishing an energy baseline, and calculating Energy Performance Indicators (EnPIs).

The basics of these steps are described here. More detailed explanation is given in the Data analysis section, below.

Energy review

The energy review should give a breakdown of energy use within an organisation through the analysis of past and present energy consumption data. A successful energy review should lead to the:

- identification of energy consumption patterns, including peak consumption periods
- correlation of energy consumption to its driving factors
- identification of the most energy intensive areas and/or processes
- forecasting of future energy consumption
- identification and prioritisation of cost-effective energy savings opportunities.

Also, it can be used to establish an organisation's energy baseline.

Energy baseline

The energy baseline is the initial reference point to which future energy consumption data can be compared. It uses the data collected during the energy review to establish

the current level of an organisation's energy consumption.

Energy baselines can be established at various levels:

- whole organisation
- a building or industrial site
- a process or piece of equipment (in order to determine energy savings)
- an individual energy efficiency opportunity.

An energy baseline can be used to:

- identify and help understand the reasons for fluctuations in energy consumption
- identify energy performance indicators (EnPIs – described below)
- estimate energy savings achieved through the implementation of an EnMS.

An effective baseline should cover energy use over a representative period of time (e.g. over a year) and take into account all major variables that might affect a process or piece of equipment such as its age and maintenance status.

Similarly, a benchmark enables energy managers to compare energy

“It is largely recognised that **whilst 20% of office staff tend to feel too hot, 10% will always feel too cold with 70% generally being ‘about right’**. Without a corporately agreed Energy Policy setting out formally what the band for the company heating and cooling should sit within, Facilities Managers will inevitably be left with no option but to respond to the whims of those at the extremes of the group rather than, more sensibly, fixing temperatures for the largely silent majority... and **recommend short sleeved shirts for the former and fleeces for the latter.**”

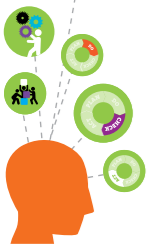
Chartered Energy Manager

performance between internal operations or with other organisations (for example those with buildings of similar size or carrying out similar processes). Benchmarks can also help to set appropriate future targets.

Energy Performance Indicators

Energy Performance Indicators (EnPIs) are essential for monitoring and measuring energy performance. They are metrics by which an organisation can relate its energy requirements to the various driving factors that have an impact on that consumption.

The use of an EnPI will provide a straightforward quantitative relationship between energy consumption and one of its driving factors.





They are defined as the energy consumption per unit of an activity metric.

EnPI = energy consumption / activity metric (driving factor)

Examples of factors that influence energy consumption include a process output, outside air temperature, time, staffing and occupancy levels, and building characteristics.

Targets and objectives

Organisational energy objectives and targets are determined by the data collected through monitoring. The objectives should be detailed, qualitative, and describe the goals for organisational energy use. These should be included in the energy policy document. Energy targets should be specific, quantifiable representations of the organisation's energy objectives. Timetables for the achievement of these targets and objectives must also be determined.



Energy strategy

A formalised **energy strategy** is based on the information collected through the monitoring and targeting process, and is recorded as an action

plan. It describes the various actions required to meet the objectives and targets set out in the energy policy.

A range of stakeholders (such as energy managers, senior management team members, various line managers and financial managers) will need to collaborate on the document, explaining the procedures, resources and tools required.

The key components of the energy strategy include:

- setting clear roles and responsibilities for those involved in the energy management process
- prioritising action items and measures
- setting specific timetables
- specifying the processes for procuring energy and equipment
- specifying the processes for releasing funds and resources for energy efficiency projects
- promoting behavioural change activities and encouraging staff members to participate in energy management training courses, and
- taking into account any mandatory policies and financial incentives.

It is vital that the organisation's senior management team stays informed of current and proposed energy-related policy developments, and that the most up-to-date legislation and developments are incorporated into the EnMS. Adherence to regulation should be factored into both the energy policy and the EnMS as a whole.



Getting senior management support

Senior management support is crucial for successful energy management. It demonstrates that energy management is considered to be a key priority within an organisation. Support is one of the major drivers for making energy performance change last. Strong leadership from board-level directors and senior managers can motivate all employees to be actively involved in the process and understand the role they play within it. Additionally, senior management support allows for substantial, company-wide changes to be implemented through the approval of resource use (for example: funding, employees, facilities).

Most UK companies have energy bills that are around 5% of total organisation costs. However, many companies are primarily concerned with maintaining output, turnover and profit, even though energy is one of the most controllable costs.

Making a business case

To convince senior managers of the merits of energy management, a robust business case must be made. This can be based on the energy strategy, and should include elements such as the potential energy saving measures and investments identified through monitoring and targeting, as well as the possible routes to implementation. Additional emphasis should be given to the opportunities for continual cost savings as operating costs are reduced, which could benefit the business' bottom line. A good understanding of the organisation's objectives is useful to demonstrate the positive contribution energy management can make in meeting those objectives.

The proposal needs to be clear, comprehensive and written in a way that is suited to the target audience. For non-energy management experts, the business case should be presented in concise and simple terms. Headline proposals should also be backed up by a more comprehensive document describing the technical and financial details of the project or initiative.

A convincing business case should give a satisfactory answer to each of the following fundamental questions:

- Why is energy management useful and important?

- Which energy saving measures should be prioritised?
- What will the benefits be?
- What are the projected energy savings (preferably expressed in monetary terms)?
- How much will it cost to implement?
- What is the payback period?
- What are the associated risks?
- What is the timetable?
- What other resources, such as people or equipment, may need to be allocated by the senior management team?

Successful case studies of other similar organisations can be a good source for potential energy saving opportunity ideas, including associated benefits and costs. Contacting independent consultants or Energy Services Companies (ESCOs) may provide initial valuable information on potential energy saving measures and ways to finance them.

Potential low (or even no) cost energy saving opportunities identified by the initial energy review and strategy can make the business case more appealing to senior managers.

The identification of all the pertinent risks is an essential element of a credible business case. Senior managers will want to understand the factors that may have a negative impact on the implementation of a project and that could also affect other aspects of the business. Three of the most significant risks while

Financial appraisal tools

Depending on the size of the organisation and the scale of the required investments, the financial appraisal of any of the identified projects could vary from simple payback period (SPP) calculations to the use of more advanced and complex financial tools such as **discounted cash flow (DCF)** techniques, which include **net present value (NPV)** and **internal rate of return (IRR)**. Life Cycle Cost Analysis (LCCA) is especially recommended for capital intensive projects. LCCA takes into account the costs and, in particular, the benefits that may occur over the whole lifetime of a project. It is a more reliable and complete method than SPP to evaluate whether an investment will be financially profitable over the long term.



implementing an energy management project can often be:

- exceeding the proposed budget
- reduced production output or services capacity due to pausing operations for a longer period than initially planned
- expected benefits not being realised due to the underlying energy use not being properly understood from the outset.

The biggest hurdle to justifying energy efficiency within an organisation is that in most cases, energy projects do not increase revenues or generate direct income, but instead reduce energy bills and lengthen asset life. Many organisations do not record the amount of money that has been saved due to investing in energy efficiency, and board members and financial directors may be more accustomed to evaluating projects that have direct financial benefits. It is therefore important to be able to estimate (in financial terms) the difference between energy consumption costs before and after the implementation of energy management projects.

For many organisations, energy savings represent direct bottom line profits, whereas the same amount of investment in other areas is likely

to incur taxation and other financial reductions before the net profit is realised.

It can be useful to establish appropriate comparisons to illustrate potential energy savings. For instance, if an organisation has a £1m annual energy bill and saved 20%, that represents £200,000 per year. One question to consider is the extra turnover the company would need to generate a profit of £200,000. For a company making a 5% margin, £4m of extra turnover would be needed.

The main outcome of a successful business case should be the allocation of all necessary resources: funds, staff, facilities etc. Ideally, a ring-fenced investment budget will be created for the implementation of energy management projects.



Do

Each component of the planning stage is used to develop an in-depth understanding of an organisation's energy consumption. These components set the groundwork for implementing measures designed to reduce energy consumption. The 'Do' stage of the EnMS process includes:

- making changes to processes and behaviours
- the procurement of energy services and products, and
- the installation of new equipment specified in the planning stage.

This stage involves a collective effort from all individuals in the organisation to achieve the targets and objectives laid out in the planning stage and stated in the energy policy and strategy documents. Awareness and competence are important, so this stage may involve setting up training courses for staff members, organising awareness campaigns and encouraging discussions within the workplace. It also requires developing or using existing effective internal communication channels in order to keep everyone informed of the actions taken along with the current status and progress of the project.

Each of the objectives set will naturally be reached at a different time. Having a combination of short- and long-term goals will help staff stay motivated and committed. Putting some 'quick wins' in place can help the EnMS gain momentum and encourage more people to get involved.

Actions can be divided into three categories:

- **Low- or no-cost** – these quick wins include switching off lights when not in use, or identifying poor performance of plant and equipment. These could be identified by an initial energy survey carried out across an organisation.
- **Medium-cost** – these require minimal cost and little design input, for instance replacing incandescent or old fluorescent lamps with newer higher-efficiency lamps.
- **High-cost** – these require a large amount of investment and design input, for instance a new boiler.

Aspects such as operational costs and the procurement of energy supply, services and assets should be clearly monitored and reported so they can inform decisions. When devising a

procurement strategy, an energy manager should adopt a method for estimating the future cost-savings needed to justify investments. Calculating **Simple Payback Periods (SPP)** and **Life Cycle Cost Analysis (LCCA)** are two of the most common methods.

Preventative maintenance of existing energy intensive equipment, such as air handling units or boilers can improve equipment lifespan, reliability, and energy efficiency. By understanding the energy use of energy-intensive assets, an energy manager can identify opportunities to increase efficiency or upgrade those assets.

For example, LED lighting has considerably lower maintenance costs than conventional lighting, due in part to a longer useful lifetime. However, a lighting upgrade must be evaluated based on the current system costs compared to the costs of installation, operation and maintenance of the proposed new system.

When it comes to purchasing or procuring energy, various risk management techniques are available, such as direct agreements between a utility provider and end-user (known as Power Purchase Agreements or PPAs), or buying energy in advance,

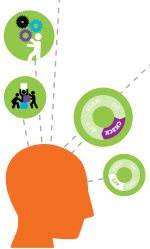
when market prices are relatively low or expected to substantially increase in the near future (known as forwards or futures).

Demand response programmes can also reduce energy costs and mitigate risks. The term 'demand response' refers to various mechanisms for energy users to reduce their electricity consumption during periods of high, or peak, energy demand or transfer some consumption to off-peak times. These programmes and related financial incentives, for example lower electricity prices during non-peak demand hours, help to ensure the electricity network can cope with high demand.



Ensuring staff engagement

Although technology plays an important role in managing energy and reducing consumption, fundamentally it is people and their behaviours that drive energy demand. As such, effective energy management requires the continuous support of an organisation's employees.



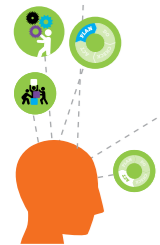


Getting staff members on board has two main benefits:

- It creates a common sense of purpose and encourages them to take responsibility for solutions; this can lead to more consistent and longer-lasting results.
- The staff members working directly with specific operational areas are more likely to identify potential issues and opportunities in those areas.

In some cases, processes can be automated. Where this is not possible, engaging people to change entrenched energy habits and behaviours can be challenging. Resistance to change has a variety of causes, some of which include:

- lack of understanding of the need for change
- fear of not having the necessary skills/competencies
- reluctance to change the status quo
- absence of the right motivations or incentives
- a lack communication or consultation, and
- not feeling involved in making change happen.



Effective communication is a primary method for ensuring staff member engagement, and can help minimise the barriers mentioned above. Having communication channels in place between departments can make energy management initiatives more interesting and easier to understand. Staff members are more likely to be engaged when the recommended energy saving actions are communicated at a more personal level, for instance equating energy savings to items with which they identify. An open forum for ideas and suggestions can also be useful for determining where and how energy savings could be focused.

Staff engagement should follow a similar process to technical energy management, prioritising those people with a significant impact on energy use. In this way, approaches can be tailored to individual or group requirements, rather than being a one-size-fits-all approach.

Appointing employees that are considered reliable, knowledgeable and influential as energy management 'champions' is one method of successfully engaging staff. To win 'hearts and minds' to the energy management cause, training can also help. Many associations offer online energy management training courses specifically designed for employees

and many large enterprises have their own in-house courses (see Chapter 4).

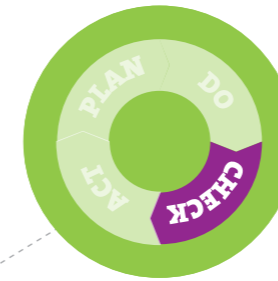


Buy-in from suppliers and partners

Making energy management a core value in business-to-business contracts can help reinforce key objectives and achieve better energy efficiency levels through the entire lifecycle of a product or service.

Those organisations that already effectively manage their energy should feel encouraged and empowered to extend their knowledge to companies in their supply chain, business partners and customers, and also to make energy efficiency a factor in tenders for new business.

Establishing energy efficiency as a key component of business relationships can have an impact far beyond good practice. Procurement is often a major element of an organisation's capital budgeting, and tendered contracts can become a vehicle for specifying energy efficiency in the products and services purchased. Contractors may also recognise the benefits for their own organisation of increased energy efficiency.



Check

In the 'Check' stage, actual performance should be compared with the energy policy targets and objectives. This will determine whether or not the organisation is on track with its energy management goals and should also highlight any processes and operations that need improvement.

This stage requires the assessment of the whole management process to confirm the system is effective, leading to continual improvement and delivering planned results. It involves regular monitoring, analysis and assessment of the areas that have the biggest impact on energy performance. These could include EnPIs, deviations between actual and expected consumption and the levels of effectiveness of the action items implemented.

The key component of the 'Check' stage is Measurement and Verification (M&V). This refers to methods and tools designed to estimate the achieved energy savings in an accurate, reliable and transparent way. Over time, the amount of energy saved and the value returned from each investment can be calculated. To increase confidence in the ability of energy efficiency projects to deliver

results, the need to verify and prove potential savings is a critical step in the process. A successful M&V process will increase the credibility of energy management within the organisation, and subsequently it may allow for future allocation of resources for implementing energy efficiency projects.

The International Performance Measurement and Verification Protocol (IPMVP) is a widely adopted framework used to promote good practice in recording, estimating, and documenting energy savings. It specifies various methods and techniques for determining savings of a wide range of projects, from industrial processes to new and existing buildings. It also describes the fundamental principles that underpin the design of an M&V plan to produce verifiable savings reports, and ensures the results of these reports will be real, accurate and complete.

The 'Check' stage also includes undertaking and communicating an objective, impartial internal assessment of the EnMS that confirms the system is operating properly and delivering the planned results.

Any errors and non-conformities, both actual and potential, should be identified and addressed through corrective and preventative actions.

Finally, the 'Check' stage includes testing for compliance with legal requirements applicable to an organisation's energy use, and reporting the results to senior management at regular intervals.



Act

The final stage of the Plan-Do-Check-Act cycle involves reviewing the overall performance and the results of the EnMS, and taking all the necessary actions to ensure the system's effectiveness and adequacy.

This is the stage where the energy management loop closes. All lessons learned through the previous steps should be fed back into the process and proactively incorporated into new projects and initiatives.

There will be cases where significant input into the system will be required (for instance, from senior management) and particular actions will be needed to drive a step change in the EnMS. The outcome of the 'Act' step should include any top-line changes to the energy policy document, the key characteristics of measuring an organisation's energy performance (such as EnPIs) and the targets and objectives of the energy management process.

Importantly, the energy management process does not end at the Act stage. After the lessons learned have been fed back into the energy policy and other documents, the cycle begins again with Planning. The cyclical nature of this process is important not only for making further improvements



to energy performance, but also for maintaining the improvements already achieved.

In depth: Data analysis

This section contains a more detailed explanation of concepts and techniques for analysing energy data.

Monitoring and targeting

Energy review

The first step in monitoring energy consumption is to perform an energy review.

The energy review should be evaluated at regular intervals and especially when significant changes take place in an organisation's systems, processes and activities (e.g. procuring new equipment). A formal energy audit can be a major supporting component of the energy review. It can provide a detailed assessment of how energy is used and what the saving opportunities are.

Initially, energy consumption data can be collected from utility bills and manual meter readings. To develop a more detailed understanding of energy use, more frequently collected, or granular, data is needed. Current smart metering technologies allow for real-time monitoring and collection of energy consumption data; half-hourly or more frequent data is particularly useful.

Sub-meters are a good option for organisations that wish to gain a more in-depth understanding of the most energy intensive areas they have identified. Once installed, these allow isolated monitoring of a specific area of energy use such as a staff room, kitchen, or even individual equipment or appliances.

Analysis of the collected data should aim to correlate energy use with its driving factors. For instance, when examining energy use within an industrial process, the process output is often the main driver for energy consumption; increased

output usually requires greater energy consumption. In the case of energy used for heating or cooling buildings, weather is usually considered the main driving factor.

Example: Degree days

Building heating and cooling are often significant drivers of energy use. 'Heating degree days' are used as a measure of cold weather over a specific period of time. Equivalent indicators for hot weather are known as 'cooling degree days'.

Degree days measure the difference between the outside temperature and a theoretical or desired static indoor temperature (often referred to as the base temperature) that is comfortable for carrying out everyday activities without the need for heating or cooling. Thus in the context of heating, if the outside temperature is higher than the base temperature, the heating system should not need to be turned on, and the heating degree days equal zero.

In the UK, the base temperature for most buildings is 15.5°C, whereas in the United States, it is 65°F (approximately 18°C).

Figure 6 depicts an example of the relationship between the levels of gas consumption in a building and the number of heating degree days.

Typically, the relationship between fuel consumption for space heating and heating degree days can be represented by a straight line on an x-y diagram. This line is referred to as the performance characteristic line or trendline.

The trendline allows the energy manager to calculate expected consumption and compare it to actual energy consumption. For instance, given the consumption data plotted in Figure 6, for 100 heating degree days expected gas consumption is about 520,000 kWh. In this example when space heating is not needed (0 degree days), there is still an expected

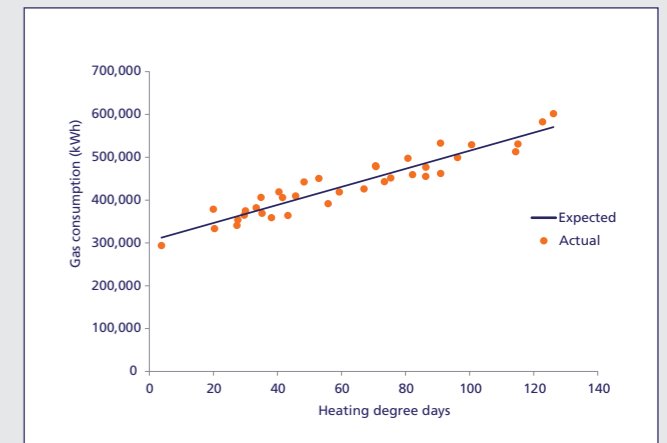


Figure 6: Example of the relationship between gas consumption and heating degree days, with trendline

gas consumption of approximately 300,000 kWh; this would be driven by demand unrelated to the outside temperature, such as water heating.

Building heating and cooling represent just one example of energy consumption that should be examined during an energy review. All forms of energy use should be monitored; this can be accomplished using simple spreadsheets or more automated and fully-featured energy management software.

Degree day correlations

Heating is usually provided by gas, therefore heating degree days are usually correlated with an organisation's gas consumption. Cooling is normally provided by electrical chillers, therefore cooling degree days tend to be correlated with electricity consumption.

Many resources for calculating heating and cooling degree days are available online.

Energy Performance Indicators

As discussed in the example, heating degree days are used as a metric for measuring energy consumed for space heating. This relationship between the number of degree days and energy used for space heating is an Energy Performance Indicators (EnPI), and would be expressed in units of energy per degree day. A deviation from this relationship may indicate that something has changed within the heating system, such as equipment maintenance, replacement, or malfunction, or human-driven change in use. Another example EnPI is the amount of energy used per person in a building or other context.

CUSUM Analysis

A particularly effective M&T technique for setting targets and detecting irregularities in energy performance is cumulative sum, or CUSUM analysis. For the implementation of CUSUM analysis, the differences between the actual and expected energy consumption must be estimated. CUSUM analysis consists of three steps:

Firstly, the actual and the expected energy consumption are plotted on the same chart. The expected energy consumption is calculated based on the EnPIs of the process or area being examined.

Automatic monitoring and targeting (aM&T)

Larger organisations or those with more experience managing energy can opt for automatic monitoring and targeting (aM&T) systems. These systems are widely used and benefit from modern integrated communication systems. An aM&T system consists of meters, data logger devices for capturing and storing energy metering data, and software for analysis.

A typical aM&T system is able to:

- automatically collect meter readings at regular intervals (half hourly, daily, weekly) depending on the energy manager's requirements
- transmit the collected data to the aM&T software for further analysis

Figure 7 shows an example of how the actual energy consumption (red points) of a process correlates with expected consumption (blue line).

Secondly, the differences between actual and expected consumption over the applicable time interval are calculated, as illustrated in Figure 8.

Thirdly, the cumulative sum of differences (commonly referred to as CUSUM chart) is calculated and plotted as shown in Figure 9.

The trendline of a CUSUM chart indicates whether the monitored procedure consumes more or less energy than expected.

- automatically identify malfunctions in data collection
- automatically identify missing data.

M&T software products have a wide variety of useful features:

- bill validation allows the user to examine whether supplier invoices are in line with the collected metering data
- system alerts highlight irregularities in energy consumption
- benchmarking functions enable automatic comparisons of current energy performance against established benchmarks .

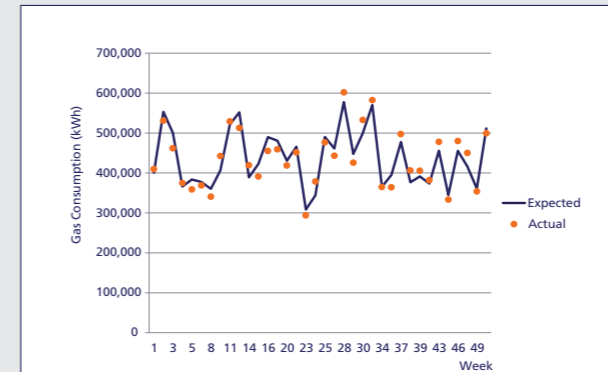


Figure 7: Relationship between actual and expected energy consumption

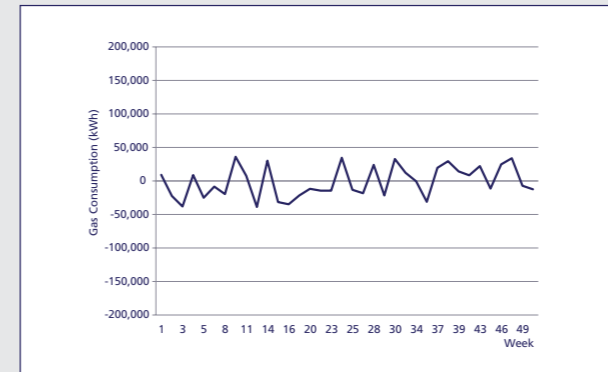


Figure 8: Differences from expected consumption

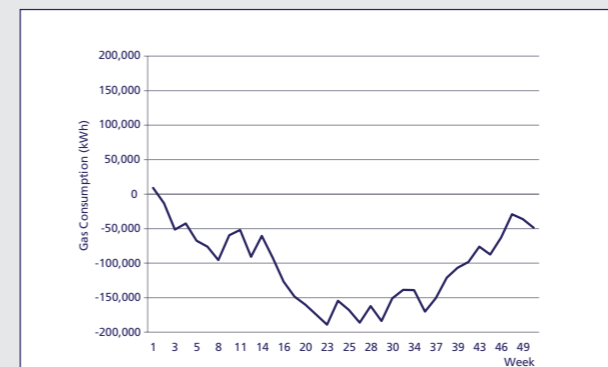


Figure 9: Cumulative sum of differences

An upward trend in the CUSUM chart indicates consistent use of more energy than expected, whereas a downward trend indicates less energy use than expected. A horizontal trend implies that there are no substantial differences between the actual and the expected consumption. An alteration in the slope of the trendline implies that a change has taken place in the performance of the monitored procedure.

CUSUM charts are particularly useful for achieving continuous improvement in energy efficiency. As explained above, if a downward-sloping trendline is consistently observed, less energy is being used than expected for the monitored activity. To ensure continuous improvement in efficiency, this expected amount should be ratcheted down via new targets, resetting the expected energy consumption (or EnPIs) to the current level of use. This adjustment should level the slope of the CUSUM line, until the efficiency of the monitored process is altered again.

M&T reporting

In order for the M&T process to be fully effective, an energy manager should create energy consumption reports based on analysis of the collected data. These reports can vary from simple visual representation of consumption to more analytical reports that include the correlation between consumption and driving factors. Reports should be tailored to the needs of the target audience. For instance, reports addressed to senior management could contain a synopsis of the most important findings, whereas reports addressed to key end users are likely to be more detailed or focused. If over-consumption is detected, **exception reports** can be created. Action can then be taken based on the findings presented in these reports.

4 Energy management as a career

Energy managers come from a variety of backgrounds and require both technical and managerial skills. There are resources available to help get started as an energy manager and to continue professional development throughout a career in energy management.



Who can be an energy manager?

Energy management is a diverse field suitable for people from a range of backgrounds. It is multidisciplinary, involving elements of engineering, management, accountancy, marketing, psychology and other disciplines.

An energy manager may have direct responsibility for energy use, modifying activities to improve energy performance. In larger organisations, the energy manager has a more indirect, advisory capacity: identifying the actions or investments that could improve energy efficiency or reduce demand, and informing the relevant operational manager about them.

The scope of the role is commensurate with the scale and structure of an organisation. For large, complex or energy intensive organisations, energy management is a full time technical position with an engineering focus. In smaller organisations, energy management may be an additional or part-time responsibility given to someone in another role, such as environmental management, logistics, facilities management, operations management, or health, safety and quality management.



Skills and competencies

Energy managers' skills vary widely depending on their organisation and responsibilities, but these can be grouped broadly as technical and managerial. Technical abilities are essential for those in roles with direct responsibility for energy management, as opposed to those who are coordinating consultants or in-house teams who deal with the more technical aspects. Managerial skills are indispensable for any energy manager.

Technical skills

A sound knowledge of both physics and engineering principles is useful for interpreting energy data as well as for putting energy efficiency measures into practice. Ideally this skillset would be supplemented by knowledge of mathematics and statistics to allow for a more in-depth understanding of energy data.

In practice, energy managers may need to consult specialists to resolve questions regarding fields outside their experience. These specialists could include internal employees who work directly with the process in question, or may be external consultants.

Working knowledge of systems and processes are often vital to understanding a large and complex organisation's energy use. For example, understanding technical issues would be necessary to carry out energy performance measurement and verification and assess the effectiveness of energy conservation measures.

Managerial competencies and skills

Energy managers should be seen as leaders and collaborators within their organisations, setting the energy agenda, getting buy-in at all levels, and identifying and managing those who can influence energy use. An energy manager's people skills and ability to influence decisions are as important as specialist technical knowledge.

Energy managers inform, engage, and motivate others to share their interest and plans for energy efficiency improvement. They must also engage customers, colleagues, senior management and external service providers, and involve them in the process of energy management.

Energy management requires an understanding of financial processes. Energy managers must be able to



assemble and manage budgets for energy efficiency schemes as well as assess relative scheme benefits. Procurement of energy efficiency technologies as well as supply contracts is a key area of energy management that directly impacts financial outcomes. Procurement considerations include return on investment for new equipment, market rates for electricity or gas, and the energy credentials of outsourced products and services in the supply chain.

In organisations with more sophisticated procurement strategies, energy managers may also need to understand market volatility and manage risks when purchasing energy. They will need to clearly set out the potential impacts of such price volatility, providing a basis for strategic energy procurement.

A detailed understanding of an organisation's operations is fundamental to controlling energy consumption. It will enable the energy manager to prioritise available time and resource on the areas that have the most potential for efficiency improvements within buildings, industrial processes, or staff activities and behaviours such as transport and business travel. Time management is essential to scope the multitude

of tasks and activities and provide a structure for implementation, reporting, and complying with regulation and legislation.



Career path

Basic training and information resources are available for those just starting out in energy management or those handling it alongside another job role. Good places to start are the numerous exhibitions and conferences in the energy demand sector, along with self-directed study such as reading articles or attending webinars. To transition into energy management from a non-technical field, there are a number of formal training avenues at certificate and degree level. Some of these are listed in the Additional information section.

Professional recognition

Full time energy managers, or those in energy-intensive organisations, often have a Bachelor's or Master's degree in an energy engineering discipline. They may demonstrate their professional status and qualifications through membership of a professional engineering institution, or institutions that deal with surveying, management and other disciplines. Additionally, they may achieve Chartered Energy Manager or Chartered Energy Engineer status; for those building a career in energy management, chartership can be a rewarding way of demonstrating and maintaining professionalism.

Continued professional development

As with any other profession, energy managers should reflect upon their learning needs and plan their professional development each year. This should not merely consist of counting hours of accredited CPD courses or other points-based approaches, but should focus on the desired learning outcomes and areas for improvement. CPD can involve, but is not limited to, the following activities:

- Attending events such as courses, conferences, seminars or lectures
- In-house training
- Self-directed private study – reading articles
- Informal 'on the job' training
- Distance and E-learning
- Secondment and special projects
- Disseminating your own knowledge, for example through written articles, presentations, blogs or social media.

Career support from the EI

The EI's three-level energy management training framework supports professionals in developing their knowledge and skills at every stage of their career. Professionals can start at any level depending on their experience.

Level 1: A 5-day introductory course providing a comprehensive, practical overview of the fundamentals of energy management. This course provides the essential knowledge and skills needed to save energy, reduce operational costs and carbon emissions, comply with legislation and meet an organisation's environmental goals. Offered as a 5-day classroom course or a 60-hour online course.

Level 2: A 15-module (200-hour) online course that provides a comprehensive overview of the essential technical theory of energy use, as well as in-depth understanding of the managerial and commercial aspects of an energy management role. This course can be started at any time and completed at your own pace. Expert tutors are available to answer any questions and provide guidance as you work through the course.

Level 3: A 12-day course designed as a comprehensive technical overview of energy management. Participants

will learn how to effectively develop energy saving projects, illustrate their return on investment to management, evaluate and monitor financial savings, and understand and use a comprehensive set of energy management technologies and principles.

The EI, along with other engineering and professional institutions, offers seminars at exhibitions, conferences, bespoke training events and branch meetings along with assessed CPD journal articles, many of which cover energy management or related themes.

Additional information

Further reading*

Capturing the multiple benefits of energy efficiency, International Energy Agency (IEA), 2014

Climate Change Act, Committee on Climate Change, 2008

Complying with the Energy Savings Opportunity Scheme, Environment Agency, 2015

Energy audits, ISO 50002:2014 ED1, British Standards Institution, 2014

Energy audits, BS EN 16247, Parts 1–4, British Standards Institution, 2014

Energy efficiency: a recipe for success, World Energy Council, 2010

Energy efficiency plan, European Commission, 2011

Energy efficiency, the definitive guide to the cheapest, cleanest, fastest source of energy, Steven Fawkes, 2013

Energy-efficient product procurement – A guide to developing and implementing greenhouse gas reduction programs, US Environmental Protection Agency, 2011

Energy management, a comprehensive guide to controlling energy use, Carbon Trust, 2013

Energy management handbook, Wayne Turner and Steve Doty, 6th ed, 2007

Energy management in business, the manager's guide to maximising and sustaining energy reduction, Kit Oung, 2013

Energy management in the built environment, Energy Services and Technology Association, 2012

Energy management matrix, Carbon Trust <https://www.carbontrust.com/resources/tools/energy-management-self-assessment-tool/>

Energy management systems, BS EN ISO 50001:2011, British Standards Institution, 2011

Energy Savings Opportunity Scheme, Environment Agency, 2014

EU Energy Efficiency Directive, European Commission, 2012

From shop floor to top floor: best business practices in energy efficiency, William R Prindle ICF International for Pew Centre on Global Climate Change, 2010

How to implement energy management in small and medium-sized enterprises, Dansk Standard, 2013

International energy outlook, US Energy Information Administration, 2013

International Performance Measurement and Verification Protocol, Concepts and options for determining energy and water savings, Vol. 1, Efficiency Valuation Organization, 2012

Making the business case for a carbon reduction project, Carbon Trust, 2013

Monitoring and targeting, techniques to help organisations control and manage their energy use, Carbon Trust, 2012

Information and support for energy savers, Vesma.com, 2015

Win the energy challenge with ISO 50001, International Organization for Standardization, 2011

World energy investment outlook, International Energy Agency, 2014

*All of these documents can be accessed via the EI's Energy Matrix at knowledge.energyinst.org

Glossary

Automatic monitoring and targeting (aM&T): products specifically designed to measure, record and distribute energy data, and analyse and report on energy consumption.

CUSUM analysis: the difference between the baseline (expected consumption) and the actual consumption of energy over a period of time; provides a trendline and shows variations in performance.

Degree days (heating or cooling): the difference between the outside temperature and a static theoretical indoor temperature (often referred to as the base temperature) that is comfortable for carrying out everyday activities without the need for heating or cooling. E.g., if the outside temperature is higher than the base temperature, the heating system should not need to be turned on, and the heating degree days equal zero.

Demand side response: a variety of schemes where customers are financially incentivised to lower or shift their electricity use at peak times. This aims to manage load and voltage profiles on the electricity network.

Discounted cash flow (DCF): uses future cash flow projections and discounts to arrive at a present value estimate of an investment opportunity.

Energy audit: an inspection, survey and analysis of energy use within a building, process, or other energy system undertaken to identify areas of wasted energy and the corresponding

opportunities to improve energy efficiency.

Energy efficiency: the use of the minimum amount of energy while maintaining a desired level of economic activity or service; the amount of useful output achieved per unit of energy input.

Energy management: the systematic approach to continuous improvement of energy efficiency within an organisation.

Energy performance: a measure of the energy efficiency or energy use of an organisation, process, building, or other asset. Can include aspects such as shifting energy demand or using waste energy.

Energy performance indicators (EnPIs): metrics by which an organisation can relate its energy demand to the various driving factors that have an impact on that consumption.

Energy policy (of an organisation): a written statement of senior management's commitment to managing energy. Often it forms part of a wider corporate social responsibility (CSR) policy. For large organisations an energy policy should be no more than two pages long; a few paragraphs may be sufficient for smaller organisations.

Energy strategy: a working document setting out how energy will be managed in an organisation. It should contain an action plan of tasks, which will initially involve understanding the organisation's

current position and establishing the management framework.

Exception report: a document which identifies that which is abnormal or not as forecast and requires attention or explanation

Internal rate of return (IRR): the discount rate at which the net present value of costs equals the net present value of profits for a particular project or investment. A valuation method used to estimate the profitability of an investment opportunity.

Life cycle cost analysis (LCCA): a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process.

Measurement and verification (M&V): the process of quantifying savings delivered through an energy saving action or measure; enables savings to be properly evaluated.

Monitoring and targeting (M&T): the process of establishing the existing pattern of energy use and its key drivers and variables, and the identification of the desirable level of energy use.

Net present value (NPV): the sum of the values of incoming and outgoing cash flows, as valued at specified times. This takes into account the time value of money, where a cash flow today is worth a different amount from the same

cash flow in the future. This difference in values is due to the interest-earning potential of money, and can also take into account inflation and other variables.

Simple payback period (SPP): the period of time, measured in years or operating hours, required to recover the funds expended in an investment.

Career resources

EI Energy Management training: www.energyinst.org/training/energy-management-courses

Register of Professional Energy Consultants, ESOS lead assessors: efficiency.energyinst.org

Chartered Energy Manager: www.energyinst.org/membership/individual-membership/charteredenergymanager

EI Careers website: careers.energyinst.org

EI accredited courses

The EI accredits a range of university courses for those wishing to further their knowledge of energy management and efficiency. For the most up-to date list of EI accredited courses, please visit: careers.energyinst.org/courses

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About Energy Essentials

Produced and published by the Energy Institute (EI), the Energy Essentials series provides an accurate, concise, accessible explanation for a variety of topical energy sectors. The guides are intended to promote understanding of energy topics among the general public, and are suitable for students, professionals whose work crosses over into the energy sector, or anyone with an interest in energy.

Energy Essentials are designed to provide foundation-level understanding with a scientific basis. Great care has been taken to ensure that these works are understandable by the lay person, and above all unbiased and factually accurate.

Because of the constantly evolving nature of energy technologies and markets, all data and information is current as of the date of publishing. For latest figures and supplemental resources, please access the online version at knowledge.energyinst.org/energy-management or contact the EI Knowledge Service at info@energyinst.org.

The development of this guide has involved an extensive review and analysis of relevant literature. The document has been through a robust peer review process, with contributions from over 60 subject specialists, including our Energy Management Panel, consisting of professionally qualified Fellows and Members of the EI with a broad range of backgrounds and expertise. The information, suitable for non-specialists, is presented in a format intended to be accessible, neutral and based on sound science.

Finally, the document has been approved by the EI's Energy Advisory Panel (EAP). We intend the result to be a high quality document that allows the reader to understand the subject with scientific and technical accuracy, in order to use that knowledge as a basis for informed discussion.

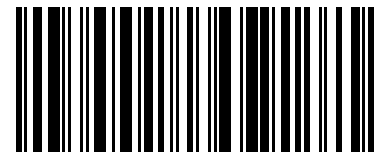
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