INDUSTRIAL ENERGY EFFICIENCY **Getting into Action**

Practical Guide for **Implementing an Energy Management System**

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Practical Guide for Implementing an Energy Management System

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 2013

Foreword

The Rio+20 United Nations Conference on Sustainable Development has strongly reaffirmed the principle that while energy is a fundamental prerequisite for development, economic growth and prosperity creation, current energy supply and consumption patterns are environmentally unsustainable. There is a need for a new energy paradigm reconciling the need for economic and prosperity growth with the sustainability of future generations.

Industry is and must be part of such a paradigm change. Today industry accounts for more than a third of global energy consumption and greenhouse gas emissions and it is bound to drive the growth of global energy demand over the next decades.

In order to achieve sustainable development and meet the climate change mitigation goals set by the international community, industry will need to significantly increase its energy efficiency and progressively switch from carbon-intensive to low-carbon and carbon-free fuels and energy sources. While the challenge remains daunting, there are policies, technologies, best practices and other instruments available to industry, policy-makers and the international community to support and enact such goals. The real immediate need and challenge is to disseminate and implement globally existing best available technologies and practices for industrial energy efficiency through knowledge sharing, capacity building, investments and partnerships.

The present *Guide* seeks to make a tangible contribution towards such efforts aimed at global dissemination of existing best available technologies and practices for industrial energy efficiency.

Energy management systems (EnMS) have emerged over the last two decades as proven best practice methodology to ensure sustainable energy efficiency and continually improving performance in industry. Most industrial enterprises that have implemented EnMS achieved on average double or triple annual energy savings compared to enterprises without an EnMS.

This *Guide* seeks to build enterprises' understanding of energy management systems in order to enable them to take actions for implementing energy management and in so doing improving their energy performance, productivity and environmental sustainability.

I am glad to welcome this *Guide* as one of the new UNIDO instruments to support and pursue the objectives of the Sustainable Energy for All initiative.

Kandeh K. Yumkella
Director-General
United Nations Industrial Development Organization (UNIDO)

ABOUT UNIDO

The United Nations Industrial Development Organization (UNIDO) is a specialized agency of the United Nations. Its mandate is to promote and accelerate sustainable industrial development in developing countries and economies in transition, and work towards improving living conditions in the world's poorest countries by drawing on its combined global resources and expertise.

In recent years, UNIDO has assumed an enhanced role in the global development agenda by focusing its activities on poverty reduction, inclusive globalisation and environmental sustainability. UNIDO services are based on two core functions: as a global forum, it generates and disseminates industry-related knowledge; as a technical co-operation agency, it provides technical support and implements projects.

UNIDO focuses on three main thematic areas in which it seeks to achieve long-term impact:

- Poverty reduction through productive activities
- Trade capacity-building
- Energy and environment

ABOUT UNIDO INDUSTRIAL ENERGY EFFICIENCY PROGRAMME

The UNIDO Industrial Energy Efficiency (IEE) Programme builds on more than three decades of experience and unique expertise in the field of industrial development and technology transfer. It represents a pillar of the Green Industry model that UNIDO promotes. Combining the provision of policy and normative development support services and capacity building for all market players, UNIDO aims at removing the key barriers to energy efficiency improvement in industries and ultimately transforming the market for industrial energy efficiency.

The UNIDO IEE Programme is structured around the following thematic areas:

- Energy management systems and standards
- Energy system optimization
- Low-carbon and advanced process technologies
- Benchmarking
- Carbon Capture and Storage for industrial applications

Contents

Figures

Acknowledgements

This publication was prepared by the UNIDO Industrial Energy Efficiency Unit with the financial contribution of the State Secretariat for Economic Affair of the Swiss Confederation, the Department for International Development of the Government of the United Kingdom, the Department of Energy and the Department of Trade and Industry of the Republic of South Africa.

Marco Matteini was the project lead and had the overall responsibility for the design and development of this publication. Pradeep Monga, Director of the Energy and Climate Change branch, provided essential leadership and inspiration during the whole project.

The *Practical Guide* has been authored by Liam McLaughlin, Apple Energy Group. William Meffert from Georgia Tech University, Aimee McKane from Lawrence Berkeley National Laboratory and Ronald Vermeeren from NL Agency provided significant inputs and support to its development. Richard Morrison, EPO Ltd, and Rainer Stifter, Energon, provided the technical peer review feedback.

Special thanks go to UNIDO Industrial Energy Efficiency Unit colleagues: Khac Tiep Nguyen, James New, Bettina Schreck, Sanjaya Shrestha and Rana Ghoneim for their valuable inputs and feedback, as well as encouragements, support and suggestions during the entire development process. The author and project lead would also like to thank Oksana Pavliska, Minitha Kanniakonil and Egbert Mentzingen for editing the manuscript and providing constant support to its preparation.

1. Introduction

Energy is a controllable resource—Using it efficiently helps to increase profits by reducing costs

Access to energy is becoming more costly and environmentally damaging. The era of cheap energy is coming to an end in many countries.

The effective use of the energy management system outlined in this *Guide* will help organizations of all sizes to manage their energy use in a sustainable way. This will result in:

- Reduced costs
- Reduced environmental impact
- Increased competitiveness

1.1 The punch line

It is a very rare organization that cannot make significant reductions in its energy costs by implementing small changes in how energy is used. This simple fact is rarely accepted by top management in organizations.

Energy cost can be reduced significantly—It may not require financial investment

A systematic approach as proposed in this *Guide* will lay the foundations for significant and sustainable cost reduction in energy use for organizations of all sizes.

This is not a difficult technical challenge; it is a challenge to how organizational resources including energy and people are managed.

Even in organizations with world class energy performance there is always room for improvement. In Denmark, one of the world's most energy efficient economies, it is estimated that a further 40 per cent improvement is possible using currently available technology and best operating practices.

It requires focus, drive, a systematic approach and above all, a willingness to change to improve.

There is a lot of discussion on the specific definitions of terms such as energy efficiency, energy use, energy consumption, energy intensity, etc. It is not overly important which definitions you use. What is important is that you reduce the energy used in your organization to the minimum required to perform its operations in a productive, safe and sustainable way while meeting the quality requirements of your customers, both internal and external.

1.2 Purpose of this *Guide*

The purpose of this *Guide* is to help organizations of all sizes, and in particular SMEs, to improve their energy performance in a logical, controlled and systematic way, thereby saving energy and reducing costs. This can be achieved by adopting a systematic approach to energy management which is based on the Plan – Do – Check – Act Deming's cycle for continual improvement.

This *Guide* tries to make the process of implementing an Energy Management System (EnMS) as simple as possible.

Figure I. Overview of an Energy Management System

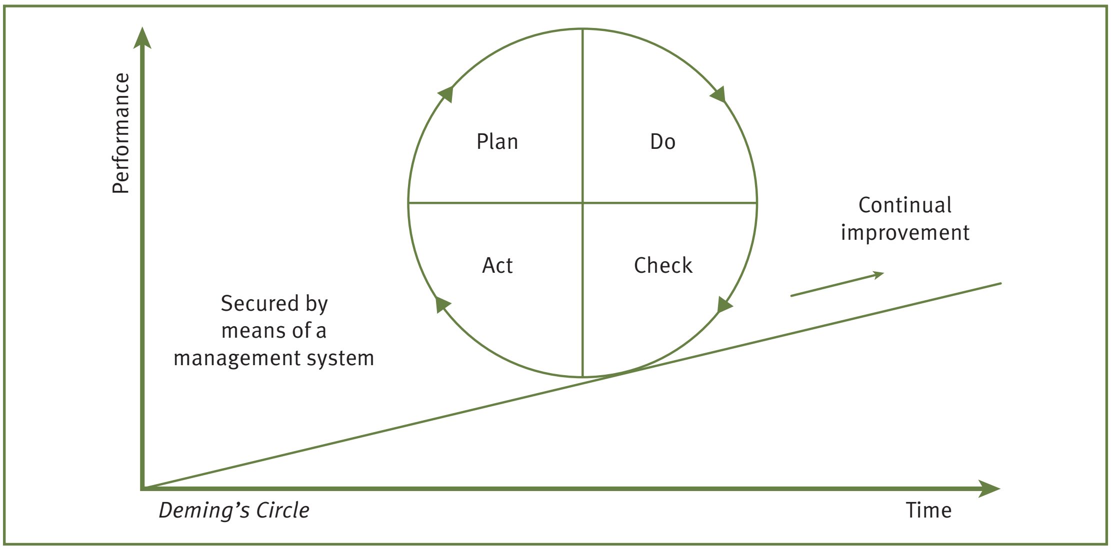


Figure I shows the principle of continuous performance improvement through the Plan, Do, Check, Act cycle.

The *Guide* is based on the approach and structures of a number of energy management system standards, including ISO 50001:2011 Energy Management Systems. The energy management system approach has a long and proven success record across all industry sizes and sectors. The information presented here has been structured to align with other popular industry management system standards such as those for quality (ISO 9001), occupational health and safety (OHSAS 18001) food safety (ISO 22000) and environmental management (ISO 14001). Organizations can thus, if appropriate, integrate an energy management system with their existing management system(s). Note that while this *Guide* is structured so that can be used with an energy management system standard, it is not necessary for all organizations to aspire to certification to a standard in order to use the principles set out in this *Guide* and to successfully improve their energy performances.

1.3 Structure of this Guide

This *Guide* is structured as closely as possible with how an organization would go about designing, implementing and operating an energy management system (EnMS) in practice.

It goes through each section of how you would plan and implement an effective EnMS.

The Guide includes a number of tools (spreadsheets, samples and templates) provided to help with the implementation of an EnMS. Such supporting material is found in the CD that accompanies the Guide. Tools that are not self-explanatory contain instructions on how to use them. Tools are mentioned all through the Guide and direct reference is highlighted through the following icon:

The Guide provides also sources for more detailed information, further studying and/or guidance on results, technical topics and issues that while related or instrumental to the implementation of an EnMS are beyond the scope of this Guide. Reference to such additional resources is highlighted through the following icon:

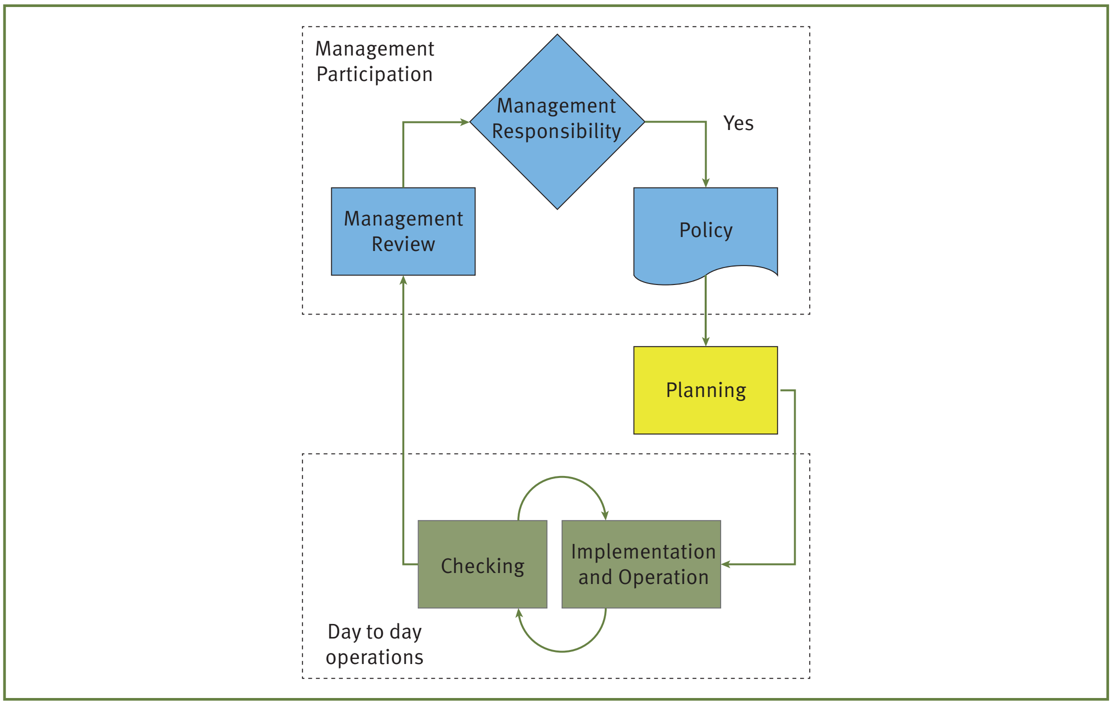
1.4 What is energy management?

Energy management is effecting organizational, technical and behavioural actions in an economically-sound manner with the objective to improve the energy performance of your organization.

Energy management means systematic attention to energy with the objective of continually improving the energy performance of your organization and maintaining these achieved improvements. It ensures that your organization continually passes through the cycle of making policy (including evaluation of objectives), planning actions, implementing actions and checking results, reviewing progress and updating policy and objectives, as required.

The Plan – Do – Check – Act (PDCA) approach is reflected in existing standards as depicted below in figure II. This figure includes all the main elements of the energy management system. Each of these elements is described in this *Guide*.

Figure II. PDCA approach



The implementation of an energy management system is not an objective in itself. What matters are the results of the system: energy performance improvement by anchoring attention to energy in daily practice. Whether an energy management system works depends on the willingness of the organization to manage energy use and energy costs and to make the necessary changes to their day to day operations to facilitate these improvements and cost reductions.

Figure II gives a simplified overview of an EnMS. It shows an overall cycle beginning with management responsibility and commitment. This is shown as a decision point and without it the system will have difficulty in being effective.

The cycle continues through development of a policy, planning, implementation and operation, checking and management review.

The three activities of management responsibility, policy and management review are grouped to indicate that these are the activities that involve the top management and where support for the EnMS is built.

The task of getting real management commitment is critical to the success of an effective energy management system.

The development of energy information and plans is a core activity that examines your organization's status in terms of energy performance and identifies actions that you can take to improve it.

Day to day operations and monitoring of performance are grouped as these are the day-to-day operational activities that are carried out to continuously improving your energy performance and ensure that it is sustained.

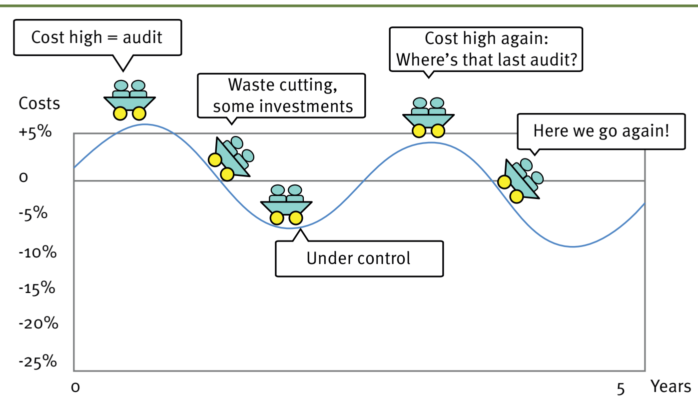
2. Why manage energy?

Reducing energy use makes perfect business sense; it reduces costs, reduces greenhouse gas emissions and improves company image. It also reduces exposure to volatile energy prices and helps with security of energy supply by reducing dependence on imported energy sources. So why is it often difficult to implement energy saving measures? Why do we not make simple changes to our organizational behaviour that would reduce the amount of energy we use?

It is well known that many companies are reluctant to focus on energy management or to invest in energy efficiency measures. Nevertheless, there are many good examples that prove that a systematic approach to managing energy performance can be successfully combined with the priorities of companies. This applies to all sizes of organization in both the public and private sectors. Figures III and IV below show how energy costs are affected by different approaches to energy management.

Figure III shows how energy costs behave over time when organizations occasionally implement energy savings actions in response to rising costs. Energy costs will continue to cycle and go out of control if an organization does not manage its energy use on a daily basis and make it part of normal business operations.

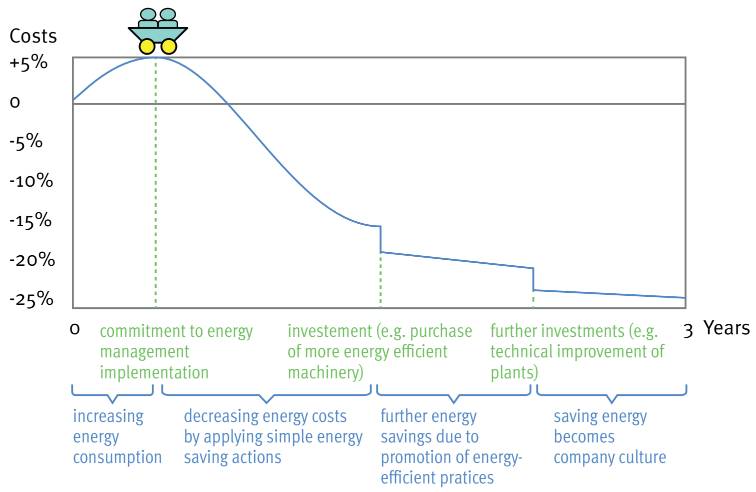
Figure III. Results of ad hoc energy management



Source: Sustainable Energy Authority of Ireland

In figure IV you can see that with a focus on continuous improvement through an energy management system, energy performance improvements can be maintained and costs continue to decline over time.

Figure IV. Results of a systematic energy management process



Source: Sustainable Energy Authority of Ireland

A systematic energy management approach gives the following benefits:

Direct benefits

- Energy cost savings
- Prioritization of no cost and low cost energy saving opportunities in day to day operations
- Reduced greenhouse-gas emissions
- Reduced exposure to changing energy prices
- Reduced carbon footprint
- Increased security of supply by reducing dependence on imported fuels
- Increased energy awareness among staff and greater participation
- Greater knowledge of energy use and consumption, and opportunities for improvement
- Informed decision-making processes
- Reduced uncertainty as future energy use is better understood

Indirect benefits

- Positive publicity
- Improved corporate image
- Improved operational efficiencies
- Improved maintenance practices
- Improved safety and health

2.1 Case studies and examples

Examples for direct effects of energy management

One plant reduced its compressed air use by over 50 per cent through repairing leaks. This allowed them to stop a 75kW compressor which had been running continuously and reduce costs significantly. This example illustrates that it is not always the high cost projects which save the most energy.

As a result of an energy audit a dairy equipped 203 electrical motors with a total power of 1,216 kW with frequency converters. The price of a 5.5 kW frequency converter is approximately € 600. The estimated annual saving is € 90,000 (1,325 MWh); the investment costs being estimated to € 311,000. The pay-back time is 3.4 years.

The combustion air fan of the biggest dairy in Styria (Austria) was operated by a motor with a nominal capacity of 30 kW, which was run up by a star-delta starting. The fan caused an annual energy consumption of about 152,400 kWh. By installation of a frequency converter the speed was reduced and the actual air flow was adapted to the necessary airflow. This action results in energy cost savings of about 86 per cent. With investment costs of $ 8,000 the payback period was 9 months.

At an Austrian dairy, one of the biggest cottage-cheese-producer in Europe, the compressed air was supplied by three compressors, which were controlled by adjusted pressure levels. There was no master controller and no use of waste heat. The strongly fluctuating workload and operating method of the compressors resulted in high consumption. The installation of highly efficient motor and of a master control optimizing the ratio between full load, part load and idle speed of the compressors, the waste heat utilization for heating the neighbouring hall and the reduction of the leakages induced costs of € 50,000,— resulting in savings of € 24,975,— per year. Thus within two years the investment costs were paid back.

The dairy "Namdalsmeieriet" invested in a combined heat recovery and purification plant. The combustion air is preheated by the flue gases and the sulphur dioxide is used for neutralization of alkaline waste water. Some 91 per cent of the SO_2 content in the flue gases are absorbed in the waste water. The energy costs are reduced by approx. € 25,000 per year and the chemical costs by approx. € 17,000 per year.

A large office building had a proposal to retrofit LED lighting with a payback of over six years, saving $40,000 annually. An alternative systematic review of the lighting system yielded savings of over $50,000 at almost no cost by eliminating many light fittings and avoiding investment. Lighting levels were maintained at required values throughout. Safety and comfort were not compromised. This is an example of both cost avoidance and energy saving through low cost measures.

A manufacturing company reduced heating, ventilation and air conditioning costs by over $50,000 at no cost by systematically challenging the specification of room conditions. This is a very common result.

A military establishment reduced its building heating requirements by over 30 per cent by challenging how heating systems were operated and controlled. This was achieved at no cost.

A manufacturing facility invested heavily in variable speed drives for fan motors believing the vendor's literature that typical payback times can be as low as 1 year. While this is often true, it wasn't in this case. There were no savings as the fan airflows required them to run at full speed at all times. It is critical to know that the duty is variable and that the motors can be slowed down. If the speed reduction is for a lower fixed speed the same savings can be achieved by changing belt pulley ratios or by skimming the impellor diameter on pumps. This will be at much lower costs.

Examples for indirect effects of energy management

As a result of energy management a dairy changed its chemical cleaning process, thus decreasing the water usage by 6 per cent, the lye by 46 per cent and the acid by 34 per cent.

A food market invested in more efficient freezers which not only decreased its electricity costs by 26 per cent, but also saved the total insurance for frozen food. Because of the new system that uses several aggregates the insurance was not necessary anymore.

The installation of variable speed drives on a boiler forced draught fan resulted in a fast payback in energy savings but also resulted in significantly reduced noise levels which resulted in the boiler house being reclassified and not requiring noise protection measures.

It is estimated that the non-energy benefits of energy efficiency can be up to two and a half times those of the energy cost reduction. Research on this topic is currently being completed.

Additional examples of energy management effects can be found at:

US Department of Energy

Sustainable Energy Authority of Ireland

3. Getting started

3.1 Self-assessment

One of the first activities to be undertaken when implementing an energy management system within an organization is to check the existing level of energy management in the company. The purpose of such self-assessment is to identify the main priorities for our organization regarding the implementation process.

The key questions are:

- Does the top management know that significant energy cost savings can be achieved by simple low cost measures without necessitating financial investment?
- Is the top management committed to energy cost reduction and is there an energy policy in place agreed on by top management?
- Have roles, responsibilities and authority been identified for all persons having an influence on significant energy uses and is this documented?
- Have the significant energy uses been quantified and documented?
- Has a baseline of energy performance been established against which progress can be measured?
- Have indicator(s) or metrics been identified to use in measuring progress against your baseline?
- Have the organization's energy objectives and targets been identified and documented?
- Have energy action plans been established?
- Is the energy management system evaluated at least once a year and are improvements made based on the results of the evaluation.

Toolkit—A sample Self-Assessment Checklist is provided to help with this step in the EnMS Tools spreadsheet.

3.2 Securing top management commitment

It is crucial that any effective energy management system has the full commitment of top management of the organization. This commitment can be demonstrated by signing the energy policy but in general more is needed from top management to make successful energy management possible.

To get full commitment and support it is important to convince top management that having an EnMS is an advantage for the organization (energy saving, cost saving, etc.). The business case for energy management implementation provided with the *Guide* is designed to assist in securing management support. This can be completed by adding some convincing data and information on:

- Trends of energy use, energy costs and other energy related issues;
- Saving data estimations from available generic saving measure data;
- Benchmarking data from the sector our organization is part of;
- Case studies describing energy management achievements.

The commitment is more than a statement of support—it should establish accountability among managers involved in the implementation of the system, and should require regular reporting on progress. Minimum requirements for showing top management commitment are:

- Establishing an energy policy (and implement and maintain it);
- Appointing a management representative (and identifying the additional core personnel required to successfully develop and implement the organization's EnMS).
- Providing resources (time, budget, personnel and information);
- Developing, agreeing and communicating all the roles, responsibilities and authorities that will apply to each task involved in developing, implementing and operating the EnMS. The importance of this activity cannot be overemphasised.
- Communicating the importance of energy management to the organization;
- Establishing energy objectives and targets;
- Making on-going decisions as required to support the improvement of energy performance.
- Conducting management reviews.

Having the full commitment of the top management does not mean that other organizational priorities are compromised. It means that energy performance issues are correctly prioritised and fit within overall objectives and challenges.

3.2.1 Build the business case

Before a company can start to implement an energy management system it has to get the commitment of the top management. For this commitment the manager will ask about the current status of the company's energy situation. Only if top management are convinced that there is a benefit in improving the energy situation will a decision to implement an energy management system be made.

By completing the business case the actual status of energy use and related issues is established, providing the starting point for the development of an energy management policy.

Necessary information for the business case are:

- The total amount of energy consumed, divided into fuels and electricity
- Energy prices
- Production data for the purpose of knowing growth or reduction rates in the future
- If relevant benchmarks are available for the organizations sector they can provide evidence that improvement is achievable.

The business case should include an estimation of the potential energy efficiency improvement and energy savings and corresponding increase in operational profitability. It should also include an estimate of implementation costs in terms of human, financial and technical resources.

It is important to emphasise to the top management that this is a significant change management process for most organizations and not a technical project.

Toolkit—A sample Business Case Presentation is provided to help with this step.

3.3 Establish scope and boundaries

It is necessary to define what will be covered by the EnMS. Sometimes an organization will decide not to include some aspects.

Examples of the decisions to be made on scope and boundaries are:

- Are all the buildings in the facility to be included?
- Are all factories in the organization to be included? This will only apply if a system is being developed at a corporate level. It might be decided to pilot the concept in one or a small number of facilities.
- Are all departments included?
- Are all processes included?
- Are all energy sources included?
- Is transport included?
- Is water management included? While water is not an energy source, its management is very similar to energy management and many organizations choose to manage it on the same system. The same applies to other utilities such as nitrogen or other process gases bought in bulk.

Once the scope and boundaries are decided upon they should be documented.

3.4 Appoint the management representative

The management representative is responsible for the establishment, implementation and improvement of the energy management system. He or she is appointed by top management and given the required authority and necessary resources to accomplish the task of implementation. The time of the energy management representative doesn't have to be exclusively devoted to the implementation of the energy management system. In practise he or she frequently also fills a function which has a very strong relation with energy management (e.g. engineering manager, environmental manager, production manager, operations manager, etc.).

The management representative should have the following responsibilities at a minimum:

- Implementing the energy management system;
- Reporting to top management on the performance of the energy management system;
- Reporting to top management on the energy performance of the organization;
- Formation of an energy management team whenever appropriate and possible;
- Plan and direct energy management activities.

The following skills are needed in the energy management team. They are often split between the management representative and the energy manager if the structure of the organization has both roles separated.

- High-level communication skills, including liaison, negotiation and consultation skills;
- Facilitation for managing meetings and team activities;
- Proven experience in project management;
- An understanding of energy costs and the tariff structures available,
- Familiarity with engineering systems and energy efficiency technologies;
- Knowledge and experience of change management;
- Other relevant skills, knowledge and experience may include:
    i. Experience with implementing energy management systems;
    ii. Motivation and willingness to undertake further training and skill acquisition;
    iii. Ability to use word processing, spreadsheet and database packages;
    iv. An understanding of operations and other areas such as safety, quality, finance and environmental issues.
    v. A willingness to question the status quo.

EXAMPLE: When is the management representative successful?

When he or she is able to:

- Gain control over the way energy is used. Ensure it is being purchased in the most economical way and promote good housekeeping and waste reduction.
- Measure and monitor energy performance, and compare it with previous years as well as internal and external benchmarks;

Report energy performance simply and clearly to line managers and supervisors. Report energy performance to senior management in a format that is integrated into other planning and business reporting processes. Ensure investment requests are backed by data and a realistic business plan;

- Involve staff—seek their input and ideas. Share the credit for achievements with those who have contributed to them. This will motivate, create enthusiasm and further achievement;
- Promote achievements to senior management and publicize success to staff to ensure on-going support and enthusiasm for the energy management system.

3.4.1 Roles, responsibility and authority

The successful implementation of an energy management system will require the commitment and effort of staff at every level of the organization. In the planning phase you will identify the people who have both a direct and indirect effect on energy use within the organization and the training needs for those staff.

For each of the job titles that are identified, list the roles and responsibilities in terms of the EnMS, starting with the top level of management and working through the rest of the organization.

When documenting roles and responsibilities, it is important to define clearly who has authority for which elements of the EnMS. This will avoid any conflict or misunderstanding between, for example, production and maintenance.

The management representative should ensure that each person involved in improving the energy performance of the organization clearly knows their own role, what their responsibilities are and what level of authority they have in support of the EnMS.

3.5 Establish the energy management team

Depending on the size of the organization the establishment of an energy management team might be considered. The purpose of forming an energy management team is to engage the various departments or work units of the organization (e.g. procurement, production, facilities) in the development and implementation of the EnMS. The energy management team provides visible evidence of the importance of cooperation across the organization to ensure the success of the EnMS and is often the first concrete step in changing the culture of the organization with respect to energy. The role of the team is to assist the energy management representative throughout the process of implementing the energy management system.

A Team is a cooperative group with a common purpose. They help each other to achieve the goals of the team

The team may include any or all of the following:

- Management representative;
- Energy manager or energy engineer (in smaller organizations, the management representative may also be the energy manager or the environmental, health and safety officer or all three);
- People who have shown interest and whose assistance will benefit a smooth implementation;
- A representative from each key area with significant energy use, so that all parts of the organization are represented. The size of the team will vary with the scale and complexity of the organization and its energy use;
- Financial manager;
- Production and/or operations manager(s);
- Quality and occupational health and safety manager;
- Communications or training staff;
- Other relevant departments who may have an impact on energy use or the potential to help.

In general an energy manager will have the following tasks:

- Provide guidance and advice to the management representative;
- Provide assistance in drafting an energy management policy, energy review and the action plan;
- Assist in the dissemination of information and programme progress reporting;
- Assist in the promotion of the energy management initiatives;
- Provide general support to the management representative.

Note that in most cases there is not a full time energy manager employed by the organization unless it is very large or its energy use is a very significant part of its operating costs. The energy manager usually has another role such as maintenance engineer, engineering manager, etc.

EXAMPLE: Roles and responsibilities

The roles and responsibilities of top management will be as follows:

- Establish the Energy Policy
- Designate an Energy Management Representative
- Ensure adequate resources are available for the EnMS to be implemented and maintained
- Communicate to the rest of the organization the importance of implementing the EnMS

The energy management representative and energy team will be responsible for:

- Identifying resources required to implement the EnMS
- Ensuring that the EnMS is implemented and maintained
- Reporting on the performance of the system at the management review
- Providing recommendations for improvement at the management review

Production staff will be responsible for:

- Participating in the successful implementation of Action Plans
- Participating in available training to improve energy management skills
- Follow-through on resulting changes in operations and procedures to improve energy performance
- Making recommendations for further improvements to the EnMS

Toolkit—A roles and responsibilities allocation tool is provided in the EnMS Tools spreadsheet.

3.6 Define the energy policy

It is essential that any effective energy management system has the full support of the top management of the organization.

The energy policy statement is an official document with which top management demonstrates its commitment and support to the energy management system for achieving continual energy performance improvement.

The purpose of the energy policy is to document the organization's commitment and overall approach to energy management at a high level. It does not need to have any detail on how the organization will manage its energy use. It forms the basis for all other parts of the EnMS.

The level of complexity of the energy management system will vary depending on the scale and complexity of the organizations energy using activities. It is not necessary, or desirable, that the EnMS is overly complicated and/or bureaucratic.

The policy requires the following:

- It needs to be appropriate to the nature and scale of the organizations energy use
- It needs to be reviewed and updated regularly (e.g. annually) to ensure that it remains relevant. This review will usually be part of the regular management review of the overall EnMS.

- It needs to be communicated to all employees and contractors to demonstrate to them that the senior management is committed to its energy management system.

Care must be taken that the policy is not just a symbol of management commitment without real commitment being in place to support it.

The policy needs to include reference to the following:

- Commitment to continual improvement of energy performance through the development and achievement of relevant objectives and targets.
- Commitment to provide the necessary resources to achieve its energy objectives and targets.
- Commitment to develop the necessary measures to demonstrate performance improvement.
- Commitment to comply with all legal and other requirements that apply to its energy using activities.
- Support for the purchase of energy efficient products and services where economically feasible.

The policy needs to be signed by top management to demonstrate its commitment to the EnMS.

An energy policy sample that could be used as a basis is provided in the *Guide*'s toolkit. It includes all the requirements of a good and practical energy policy. It is shown as a stand-alone policy for energy only. Many organizations may decide to integrate the energy policy into their environmental policy. This can be a good idea as there are often significant overlaps. The policy must still include all the elements described in this section to be effective.

Toolkit—A sample energy policy is provided to help with this step.

3.7 Establish the structure for EnMS implementation

A level of planning and project management will be required for the implementation of a successful EnMS. The scope of this project is likely to be close to the content of this *Guide*.

The plan should include keeping the EnMS as simple as possible in the first instance. Complexity can be added with experience in future years though it will probably be found that simplicity is always better.

The management representative needs to be engaged in this process and to support its implementation as required.

Note that the use of an EnMS is not a project with an end point; it is a continuous management process.

Toolkit—A sample project plan is included for consideration. It uses an open source project management application called OpenProj which can be downloaded from http://openproj.org/

3.7.1 Create organizational awareness

It is important that all staff and contracted employees of the organization are aware of the organization's commitment to improved energy performance. Many organizations will include awareness training for staff on the importance of energy management and energy cost reduction. Many also include the context of climate change and greenhouse gas (GHG) emissions and the connection between the organization's energy use and GHG emissions.

3.8 Understand the role of communication, documents and records

It is necessary for effective management and operation of the EnMS that many items are documented. The following is a list of typical documents that may be required; it will vary from organization to organization:

- Energy policy
- Energy review
- Copies of energy audit or assessment reports
- Objectives, targets and action plans
- Training plans
- List of critical operating parameters
- Technical drawings of systems and equipment including process and instrumentation diagrams (P&IDs) and/or process flow diagrams
- Technical specifications of equipment
- Purchasing specifications for energy using equipment
- Energy Performance Indicators (EnPIs)
- Baseline
- Operator logs
- Maintenance and service records
- Minutes of energy meetings
- And others as appropriate

This may seem overly bureaucratic to some but in the long term this information will be invaluable in helping the organization to improve its energy performance and to maintain this improvement trend. Once you have a system in place you will find it easy to maintain.

3.8.1 Control of documents

It is common for organizations to have difficulty in finding important documents such as technical drawings and operating manuals. This is a poor situation to be in and the following notes should help to put in place a simple systematic method of managing your documents. It doesn't matter if the documents are paper or electronic, the same principles apply.

Documents should be:

- Approved for use to ensure that they are correct. This approval should be in advance of use of the document.
- Periodically reviewed and updated to ensure that they are not out of date, for example that working practices have not changed. This does not have to be as laborious as it may sound. Many documents may not require updating but it is necessary to periodically review them to be sure of this.
- The current revision should be clearly identified and old revisions filed in an archive to ensure that the latest version is the one in use.
- They should be legible.
- They should be readily located and identifiable

It is worth maintaining a document index which is a simple listing of all relevant documents.

Toolkit – A sample document list is included in the EnMS Tools spreadsheet (see Documents worksheet).

3.8.2 Control of records

The purpose of records is to have a document to refer to when you need to check back on what has happened previously. Examples of records are the training plans, operator logs, action plans and the various other spreadsheet tools associated with this *Guide*.

Records are also the documented proof to demonstrate conformity with the requirements of the EnMS. They will help to easily demonstrate compliance when an (internal) audit is being performed on the energy management system. Examples of records are: reports, minutes of meetings, training schedules etc. For the organization's own convenience, and that of the auditor, it is recommended to have controls in place taking care that records are:

- Legible for obvious reasons
- Readily located and identifiable

4. Develop your energy information and plans

Planning—Translating the commitment and energy policy into objectives, targets and action plans

Planning is a key step in putting an energy management system in place. It is fundamental to know how much energy is being used, where, and for what purpose. Most organizations have good knowledge of the breakdown of their cost base but few seem to understand where their energy is being used. Many seem to feel that this is acceptable but which other significant and controllable cost is given such little attention?

The purpose of this step is to examine how you are using your energy. How are you going to measure performance improvements and to identify opportunities to reduce this use through a combination of housekeeping improvements, technical projects, training and other means? This process is called an energy review. You will also need to develop a baseline against which to measure improvement and also indicators that will demonstrate progress against your objectives and targets.

It also involves being aware of any legal or other (such as corporate or customer) requirements which need to be considered in planning your energy management activities.

Another way of putting this is to say that the purpose of planning is to translate the energy policy into a set of specific actions to be implemented over the coming period in order to improve your energy performance.

With real management commitment and a reasonable energy policy in place, you will have a good basis to plan your energy management activities.

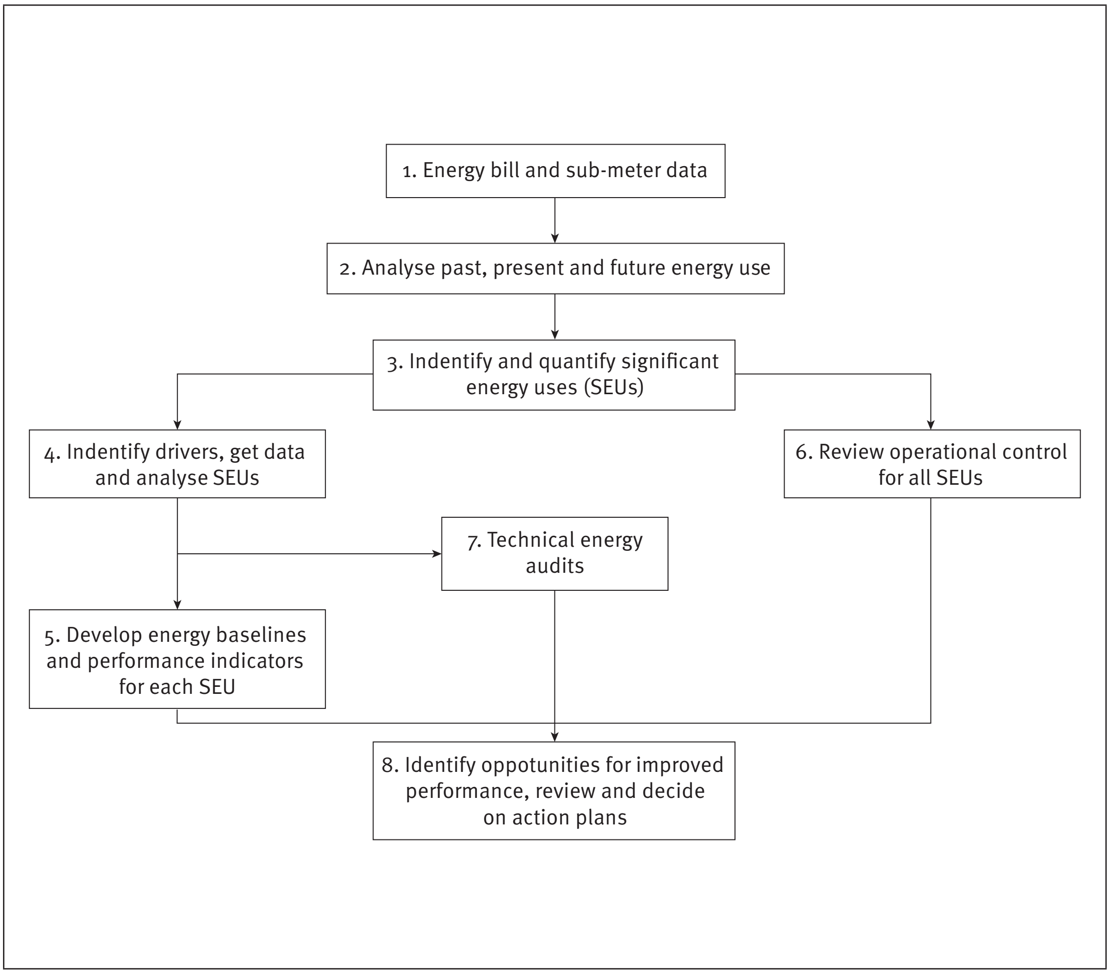
The purpose of the energy review process is to examine your energy use in a systematic way and to focus your efforts on the most significant energy uses and opportunities. It is worth putting effort into the energy review as it is the basis for all activities to be carried out over the coming period (usually one year).

The questions you need to be able to answer are:

- How much energy am I using?
- What is the trend of this usage?
- Where am I using it? This tells which are the most significant uses.
- What is driving this usage, i.e. what variable is causing energy use to change?
- Which people have a significant impact on the organization's energy performance?
- What indicators can I use to measure and manage the organization's energy performance?
- What opportunities do I have to improve the organization's energy performance?
- What are the organization's energy performance improvement objectives and targets?
- What are the organization's energy performance action plans for the coming period?

Figure V shows the workflow diagram of the energy planning process to be implemented.

Figure V. Energy planning process



This energy planning process (Figure V.) will be conducted initially as part of the implementation of the energy management system and relevant parts will be updated on an on-going basis as required.

1. Access energy bills and energy sub-meter data (if available).

2. Trending and data analysis will be employed to check past energy use to maintain an understanding of use, consumption and performance. Budgets for future years will be developed, typically annually.

3. Energy use and consumption will be analysed to identify and quantify the SEUs. This will be updated regularly.

4. Each SEU will have its driving factors identified, quantified and analysed. Regression and other analysis will be used to determine the effects of the energy driver(s). This will be updated regularly.

5. Baselines and EnPIs will be developed including the development of a metering plan to add any additional energy meters that may be required. Where possible EnPIs will be based on regression analysis. They will be updated regularly.

6. Operation, maintenance, design and procurement activities related to each SEU will be reviewed for effectiveness including development of a measurement plan for any critical operating parameters. All personnel who might affect the energy performance of each SEU will be assessed to ensure that adequate levels of competence are in place.

7. Technical energy audits (assessments) and inspections will be carried out occasionally as required to identify additional energy saving opportunities in addition to those identified on a day to day basis. The potential for renewable and alternative sources of energy will be considered.

8. In addition to the above sources of improvement opportunities, all staff and colleagues are encouraged to suggest opportunities. Development of action plans will include ensuring that objectives and targets are met. Selection of opportunities for inclusion in action plans will include consideration of all the above items in addition to technical feasibility, legal and other requirements and financial appraisal. Training plans will also be developed for those with the potential to influence the energy performance of the organization.

4.1 Acquire and analyse energy data

The purpose of this step is to establish your energy use and trends in absolute terms. Ideally the past three years of energy bills would be used to establish these trends. One useful method is to develop annualised trends of energy use. You will also need to be aware of current energy sources and how much energy you expect to use in the coming period.

In the EnMS Tool spreadsheet the worksheet ER1 Data provides an example of how record energy use. The use of this worksheet involves adding energy bills on a monthly basis. These will include electricity, fuel and other sources identified during the energy review.

Note that the ER1 Data worksheet may also be useful in managing water usage if that is outside the scope of your EnMS. The techniques used in managing water use are very similar to those for energy management.

Additional columns may be needed in the ER1 Data worksheet, depending on your organization's fuel sources. For example, many organizations use only electricity and natural gas as energy sources while others may have imported electricity, self-generated electricity, oil, coal, waste as a fuel, purchased waste steam from a neighbouring plant and others. All sources need to be recorded in order to track them and also to consider alternatives.

The ER1 Data worksheet can also be used for budget purposes in helping to predict energy use for upcoming periods.

Figure VI. Trend of energy usage (from bills)

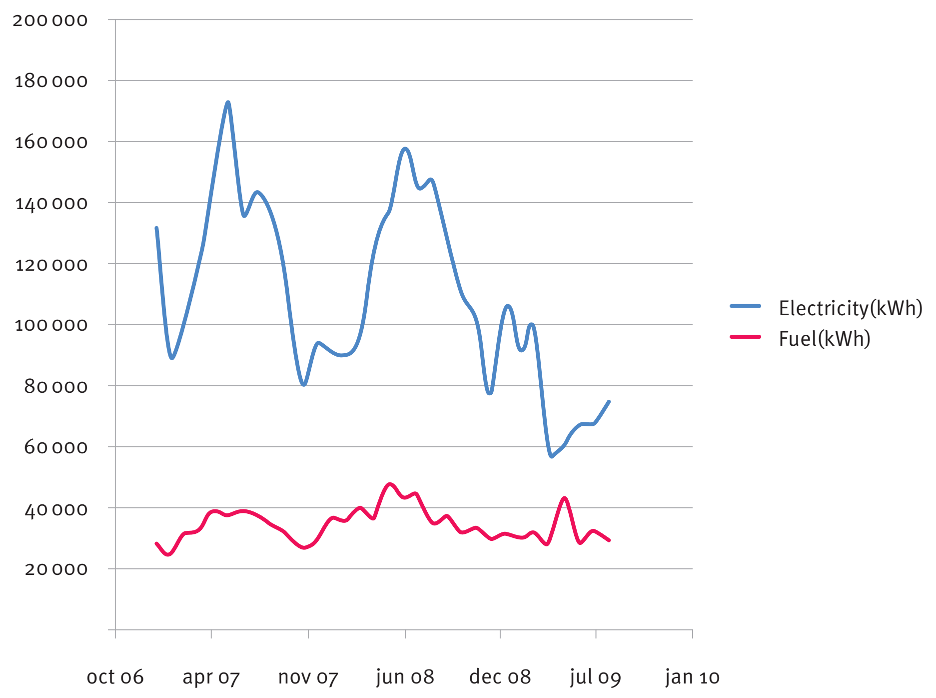
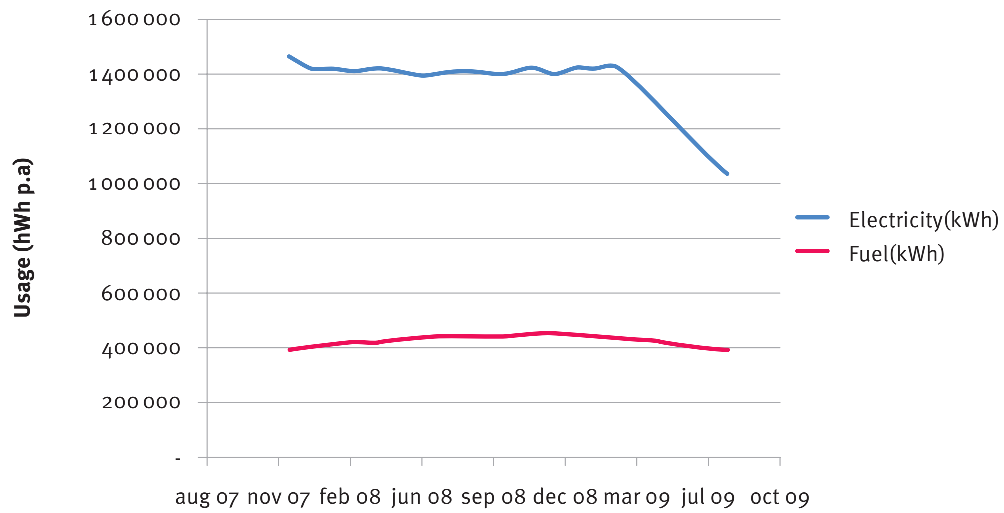


Figure VI shows the trend of monthly energy use of a factory. It seems to indicate a seasonal effect and a baseload in each energy use, i.e. about 60,000 kWh for electricity and 25,000 kWh for fuel use. In this case fuel use is shown in kWh. Some organizations do this to allow clear comparison while others use GJ.

Figure VII. Annualized energy trend



The trend in figure VII shows the same data but on an annualized basis, i.e. each point on the trend is the total of the previous 12 monthly bills. This view of the same data allows you to see overall trends of usage and is very useful for forecasting and budgeting usage.

The data in figure VII shows very stable usage in recent years but a reduction in electricity use on recent months. In your own facility you need to understand the underlying causes for these trends and changes.

Careful examination of these simple trends based on your energy bills will reveal some questions which may help you to reduce your usage. It is important to track both the quantity of energy used and its cost. The energy bills should be added to the ER1 Data worksheet (or equivalent) as soon as they are received and analysed as soon as possible after this.

Predicting future energy use—You need to be able to predict future use for a number of purposes including next year's budget. By including this forecast in your bill analysis work you will always be easily able to see where your use is heading.

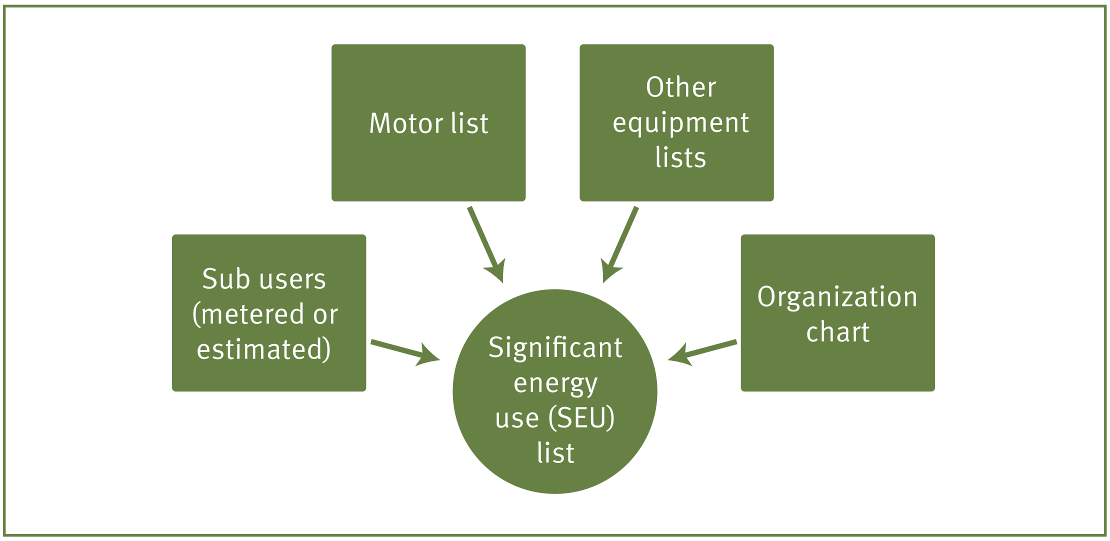
Toolkit—A sample worksheet ER1 Data is added in the EnMS Tools spreadsheet to help with recording billing data. Billing data is then analysed in the worksheet ER2 Trends.

4.2 Determine significant energy uses

The purpose of this step is to establish where most of the organization's energy is being used. Once you know which are your most significant energy uses (i.e. processes, systems, equipment, etc), you will focus most of your efforts on those uses. This will particularly include personnel who influence energy consumption of those uses. You will also focus attention on uses with significant potential to improve, these are areas which may not be your largest uses but which have high potential for saving energy.

In order to identify your significant energy uses (SEUs), you need to know how much energy each process or system uses. In an ideal world you will have energy sub-meters fitted to all large energy users and can then simply use these meters to quantify the consumption of each use. In reality, few or none of your uses will be sub-metered. In that case you need a way of estimating their consumption. You need to carry out this activity for each energy source, i.e. electricity and each fuel type. In some cases it may be more appropriate to think in terms of processes or systems rather than pieces of equipment.

Figure VIII. Significant energy uses



The EnMS Tool spreadsheet includes worksheets/tools to help with the task of determining SEUs. This spreadsheet will produce a pie chart of these energy uses and will sort them in order of energy consumption. You need to try to quantify at least 80 per cent of your billed energy by use, i.e. you want to know exactly where 80 per cent of your energy is going. If you can exceed 80 per cent that is even better. Some organizations may find the use of Sankey diagrams more useful than pie charts but any method is fully acceptable once you know where your energy is being used.

Grouping equipment by energy systems (e.g. process heating, compressed air, steam systems, etc.) is an important best practice. Understanding the dynamics of energy use in a system will lead to optimal energy savings. Process maps with energy flows identified are valuable for organizing equipment into systems.

There are many other techniques available to analyze energy data and create useful information. Tables, pie charts, bar charts, multiple year comparisons, process mapping and energy balances are some of the more important. More sophisticated techniques include statistical analyses that have become popular with six sigma programmes in industry.

Methodology for determining SEUs

There are a number of ways of identifying and quantifying your SEUs. These include:

- If you have sub metering of each or some energy sources then these meters may be able to help or even give a complete picture. You may also be able to identify gaps in your metering needs for future improvement. You may also have sub metering of, say, electricity but not fuel or vice versa.
- If you don't have sub metering, which is very common, you may have to estimate by other means. One of these is by totalling the estimated consumption of different uses. Examples are ER3 SEU Motors, Heat Users and Lighting worksheets in the EnMS Tools spreadsheet. The ER3 SEU Motors worksheet for instance requires each electrical motor of any significance (significance will vary with the size of the operation) to be tabulated and its energy use estimated. By totalling all significant motors you will see what proportion of your total electricity use you are aware of. Typically the principal other use of electricity besides motors is lighting. Some processes use electricity for heating also and if so alternatives should be investigated. Some production processes have no alternative to electrical heating. The same methodology can be used for determining significance of different heat uses.

EXAMPLE: Estimate of energy consumption

If a particular process has 6 electric motors with nameplate ratings of 7.5kW and these operate for 12 hours per day, 5 days per week for 50 weeks per year then the total consumption can be estimated by:

1. Power consumption of a motor is usually less than the nameplate, say, 10 per cent less
2. This gives 7.5kW X 90 per cent X 12 hours X 5 days X 50 weeks
3. Total 20,250 kWh per year.

This equation is very important for estimating loads:

Energy Consumption = Rated Load (kW) x LF x DF x Hours

Where,

LF = load factor

DF = duty factor

- If motor loads are stable then spot readings with a power meter will allow you to make accurate estimations. The use of ammeter readings to estimate power is considerably less accurate due to power factor variation. The breakdown can be illustrated using pie charts, Sankey diagrams, bar charts as preferred.

Once you have a breakdown of the different energy uses, it is a good idea to check the total against your energy bills.

Once you have identified your SEUs, you will focus most of your efforts on these. The selection of your SEUs as mentioned earlier can be either based on absolute energy use or on the scale of potential savings. This means that for these items you will:

- Find what variable(s) drive their use. Is it production, weather, occupancy, etc.?
- Find out which personnel influence these activities and check if they are adequately trained in how to operate and maintain these activities. This activity will feed into the development of training plans for all relevant personnel.

- Document the critical operating parameters for each SEU. In many utility systems the specification of delivery parameters is critical to energy use. The EnMS Tools spreadsheet includes a worksheet (ER6 Critical Op Param) with sample critical operating parameters for different SEUs.
- Establish baseline energy use. In some circumstances this may be in absolutes terms but ideally it should be in terms of its driving factors in order that changing circumstances can be corrected for when comparing progress against the baseline.
- Establish energy performance indicators for each SEU. Again these should ideally take account of the relevant driving factor(s).
- Identify opportunities to reduce energy use in each SEU.
- Establish objectives and targets for each SEU. It is expected that the energy performance of each SEU will be improved if possible. Review previous energy audit reports to help with this activity.
- If you haven't identified opportunities to improve the energy performance of any SEU you should carry out a more detailed review of that SEU in order to identify opportunities. This detailed review should review the whole system of that SEU using techniques such as system optimization.

Terminology note:

- The terms energy audit, energy review, energy profile, energy aspects review, energy diagnostic and others have similar, though not identical, meanings in this context. It is not important which term is used once the main activities are performed.
- The terms energy driver, energy factor, energy driving factor, energy variable are used more or less interchangeably in this context.

Toolkit—The worksheets ER3 SEU Motors, ER3 SEU Heat Users, ER3 SEU Lighting, ER6 Critical Op Param are provided in the EnMS Tools spreadsheet to help with the determination of SEUs.

4.3 Establish the influence of various drivers on energy use

The energy use of all facilities is driven by some activity to some extent. Two typical significant drivers are discussed in this *Guide* but specific circumstances may require the investigation of other drivers. The two drivers considered here are production activity and weather, which experience has shown to be the most common drivers. Drivers are those activities and/or factors which cause a change in energy use, e.g. in colder weather we might use more heat than in warmer weather. Drivers are also known as energy factors or energy variables. In ISO50001 they are called energy variables.

As a simple example we can know the energy performance of an automobile by knowing its fuel consumption in litres per 100 km. We can predict the fuel consumption by multiplying distance by documented fuel consumption. This will normally give an accurate result. However there are parameters that will cause differences including driving style, driving conditions, vehicle age and condition, etc.

Production activity

It is considered the simple case in which the organization produces only one product, it is also possible to work with more complex cases.

Weather

If a significant amount of the organization's energy is used for space heating or cooling then this should drive a significant part of its energy use. This will involve the application of the concept of degree days. It is beyond the scope of this *Guide* to fully explain this concept other than to say that degree days are a measure of how hot or cold it has been and thus should be related to how much space cooling and heating are required. At a very simple level, if outside temperatures are equal to or higher than the required internal temperatures then it should be not needed to add more heat. It is not uncommon to find space heating systems operating in warm or summer conditions and vice versa with space cooling systems.

Weather also has a significant effect on the energy performance of refrigeration systems and if these are a SEU then it may need to be considered. This is due to the effect on condensing temperature, where ambient dry bulb temperature affects air cooled systems and ambient wet bulb temperature affects evaporative condensers and cooling towers.

Heating and Cooling degree days

Base load and lean energy analysis

Base load energy use is that energy use when there is no activity driving its use i.e. which is independent of any beneficial driver. For example if 25 per cent of the organization's energy is used when there are no production or weather related activity then this 25 per cent should be a target for investigation and potential reduction. You need to investigate what is using this energy and why. It typically is not adding any value and should be reduced or eliminated, to the extent practically feasible. Many organizations are unaware of the large cost of base load energy use. The concept of lean energy analysis states that any energy which does not contribute to production output or is related to environmental conditions is waste and should be targeted for elimination or minimisation. This statement should be considered in your facility to decide on the extent that it may benefit your performance.

The causes of high base load are many and varied but might include air compressors left on when no air is being used, lights, PCs, fans, air handling systems, pumps, etc, etc. One often legitimate base load item is computer servers and possible associated cooling systems.

This concept is very important and feeds into other parts of your EnMS including:

- Baseline
- Energy performance indicator development and checking

In all cases it is necessary to identify and recognise what is driving your energy use.

It is beyond the scope of this *Guide* to give all the information on the use of spreadsheets and the interpretation of the statistics involved. It is recommended that more research and training is completed in this critical area. It is necessary to understand how to carry out regression analysis including multivariate regression and to interpret the results. Multivariate analysis is usually needed as there is often more than one driver of energy variability.

Toolkit—See ER4 Drivers worksheet in the EnMS Tools spreadsheet.

4.4 Establish an energy baseline and determine EnPIs

4.4.1 Energy baseline

The purpose of the energy baseline is to develop a starting point for measuring energy performance improvements. This can be a very complex subject but in this *Guide* we are trying to simplify the process.

At the simplest level the baseline could be the total amount of electricity and other fuels used in the year ending before the EnMS is implemented. The advantage of this is that future use is simply compared with this baseline year. The disadvantage is that it ignores the effects of the driving factors. For example production output could have increased or decreased significantly and this could be the reason for the change in energy use rather than any actual change in energy performance.

Another simple and often used baseline is to choose a measure of specific energy consumption such as kWh per unit of output. This has the advantage that it is simple and appears to offer the opportunity to compare with other similar organizations as a benchmark. There are instances where this is a good method but there are even more instances where it is not. In a large number of organizations, there is a high energy base load or a complex mixture of products. In the case of the large base load the level of production activity has a large effect on this indicator, i.e. if production volumes increase the ratio decreases and appears to show an improvement in energy performance when none has occurred. These indices are very popular during times of growth as they tend to show improving performance but do the opposite in times of falling output.

The best method of establishing a baseline is to use the driving factors which have been established earlier to predict the amount of energy that should have been used and to compare it with what has actually been achieved. In this method the baseline is the best fit straight line on the regression chart of driver against energy use. As performance improves this line will move downwards.

It is beyond the scope of this Guide to give complete details of how these methods work but some links are included below to allow the reader to go into more detail elsewhere.

Monitoring and Targeting—in-depth management guide—Carbon Trust

4.4.2 Energy Performance Indicators (EnPIs)

The purpose of this activity is to identify a small number of indicators of energy performance which will help you to be confident that performance targets are being met and if not to alert you of any problems at an early stage.

The most common and simplest energy performance indicator is conformance to financial budgets. In many organizations this might be interpreted as successful energy management….it is not! The overall purpose of the energy management system is to improve energy performance and to continually improve this performance.

Ideally you will have at least one high level EnPI for each energy source (electricity, fuel, etc) at the top level to indicate that overall you are in control. This is often very difficult depending on product and energy driver mix. You should also try to have an EnPI for each of your significant energy uses.

It is important that you develop these indicators during the planning phase so that you can monitor them during the checking phase. The indicators may require modification once you start using them in order to improve their effectiveness in showing you how you are performing.

Simple EnPIs

While it is desirable to keep all aspects of your EnMS as simple as possible, care is needed that you don't oversimplify to the point where no value is gained. EnPIs are one such area. One simple EnPI is the annualised view of usage. Depending on your measurement and metering capabilities you could have a daily annualised trend (i.e. each day add together the previous 365 days of usage) of each significant use, e.g. total electricity, boiler fuel, compressed air electricity, refrigeration electricity, etc. If your operation is very stable in terms of output this may be a good place to start and these indicators may prove very valuable.

Toolkit—See ER5 EnPI worksheet in the EnMS Tools spreadsheet.

Simple ratios

Opinion is divided on the merits of simple ratios as EnPIs. In the case of simple processes in high energy intensity industries with relatively low base loads, they have some merit. In these cases they are often used to benchmark energy performance of different plants in an organization against each other and against international best practice.

An example of a simple ratio which is commonly used and normally of little value is the specific energy consumption (SEC) of various utilities. As an example the SEC of compressed air in terms of kWh/Nm_3 of air produced is used. This can be very misleading as, for example, if we repair leaks or reduce our air consumption, we will almost always increase the SEC. Thus increasing SEC can be an indicator of improving or worsening performance. The use of these ratios can divert attention away from truly indicative indicators of energy performance. Even simple annualized trends of energy use are often of more real value.

Note that the use of SEC is of value in plants where SEC of individual compressors can be established and their performance compared. However the cost of instrumentation (especially the air flow meters) involved will usually make this level of information uneconomical to establish.

Energy Performance Indicators and the influence of (external) drivers

To picture the progress in your performance you can use regression analysis of energy use against its driver(s). It is suggested here that this is the ideal method to develop and monitor your EnPIs.

You want to improve performance and demonstrate this performance improvement. In order to do that the slope of the regression line and/or its intercept with the Y axis will need to be reduced. It is beyond the scope of this *Guide* to go into much detail on this topic. You will also use the principles of cumulative sum (CUSUM) to track performance on an ongoing basis.

Being able to show performance improvement is essential for getting or gaining management commitment. Management wants to see clear results and return on investment for the measures taken. When the energy performance results are polluted with other determinants that can't be controlled, the shown performance result gives a false representation. In practise this is one of the causes for management not to invest in energy saving measures any longer since they do not seem to pay out. When it can be made clear that they do, but that other determinants affect the energy performance of the organization negatively, this will help to keep management commitment.

4.5 Identify legal and other requirements

Many organizations have externally imposed requirements concerning their energy use. These will include local and national laws and corporate or customer requirements. In order to manage your energy effectively you need to be aware of these requirements.

It is recommended that these requirements be reviewed regularly (perhaps every six months) and plans be put in place to ensure compliance with them.

The following is a list of examples that might help you to carry out a review of these items:

- Building regulations might include requirements for insulation of building fabric.
- If the organization is based in Europe it may be subject to many EU directives including the Emission Trading Scheme (ETS).
- You may need to send regular reports of energy use for corporate management purposes. Specific customers may require statements of your approach to energy and carbon emission management
- The government may have requirements to report energy intensity factors, appoint appropriately trained energy manager, conduct energy assessment, submit energy management plans and/or other energy related actions
- By putting together a list of all these requirements it will make it easier to comply with the requirements and it may also make it easier to plan reports which have similar content for differing authorities.

Toolkit—See Legal worksheet in the EnMS Tools spreadsheet.

The legal worksheet includes the following headings:

- Identifier (ID); a running number to help identify each requirement.
- Title; the name of the requirement.

- Category: your own specification.
- Date identified.
- Relevant; Y or N, does this item require action or monitoring.
- Process, machine or site that is affected by this requirement.
- Action required; a short description of the impact and how it will be complied with.
- Resp.; who is responsible for the action items
- Action date; when will the action be completed.
- Compliance date; when was the action completed.

Note that this worksheet will be in continuous use as you develop and improve your EnMS and will be checked for compliance during the checking part of your system.

4.6 Identify opportunities for improvement

You will need to develop a register (list) of all energy saving opportunities or ideas. It is important to realise that this register is a live database and will increase in size on an ongoing basis. It is the main continuous improvement tool in the EnMS. In this *Guide* the term Energy Opportunities List is used for this register. The energy opportunities list will include at least the following for each opportunity:

- Identification number.
- Short description of each opportunity. This should be a specific as possible and be an action term.
- Service of opportunity, i.e. steam, electricity, management, compressed air, etc.
- Potential savings in terms of energy, money, carbon emissions and other possible benefits.
- Responsible person to bring the opportunity to a close.
- Status of the opportunity, i.e. idea, approved, cancelled, postponed, in progress, complete, closed.
- Dates; there are a number of important dates in the life cycle of each opportunity including origination, due for completion, completion.
- Method of verification of savings, i.e. how will you know that the opportunity has achieved its predicted savings?

Toolkit—A sample energy opportunities list template is provided in the EnMS Tools spreadsheet (please see worksheet ER8 Opportunities List) to help with this step.

This list can become quite complex and its management is central to the continuous improvement of your EnMS. If the register is to be electronically maintained then care is needed to ensure that it is backed up and protected against inadvertent or unauthorised editing. This also applies to all the other electronic documents used in the EnMS. The sample template provided here is a guide and does not include protection against accidental editing or deletion as would be included in more complex database applications.

All ideas that might realistically help to improve energy performance should be added to the opportunities list once they have had an initial review by the energy manager. Ideas will come from a variety of sources:

- Energy audits, assessments or diagnostics
- Suggestions from employees
- Review of successful ideas in other plants
- Attendance at conferences, training, networking, etc.
- Technical sales engineers (but beware that they are not usually impartial and independent)
- Literature, journals, magazines, best practice guides
- Internet web sites, searches, etc.

4.6.1 Good housekeeping measures

Good housekeeping is, as the words already indicate, taking good care of the resources of your company, in this particular case of energy. In principle good housekeeping measures are based on common sense and good technical ability, not on high-tech or large modifications.

> Good housekeeping options are easy to implement and usually (almost) free of cost! Pay back times are extremely short and savings are instant. The main barrier to their implementation is usually a resistance to question existing practices and to make the necessary changes.

Practice has shown that in many enterprises the amount of energy that can be saved by good housekeeping can be in the range of 25 to 50 per cent of the total energy saving potential. The total energy saving potential typically also includes more expensive measures and modifications of energy-infrastructure or production processes.

To see if good housekeeping measures are possible, you can ask yourselves the following questions for each item that uses energy:

- Do I have to use this device or system?
- What can I do to make it use less energy?
- Can I make it use a cheaper form of energy?

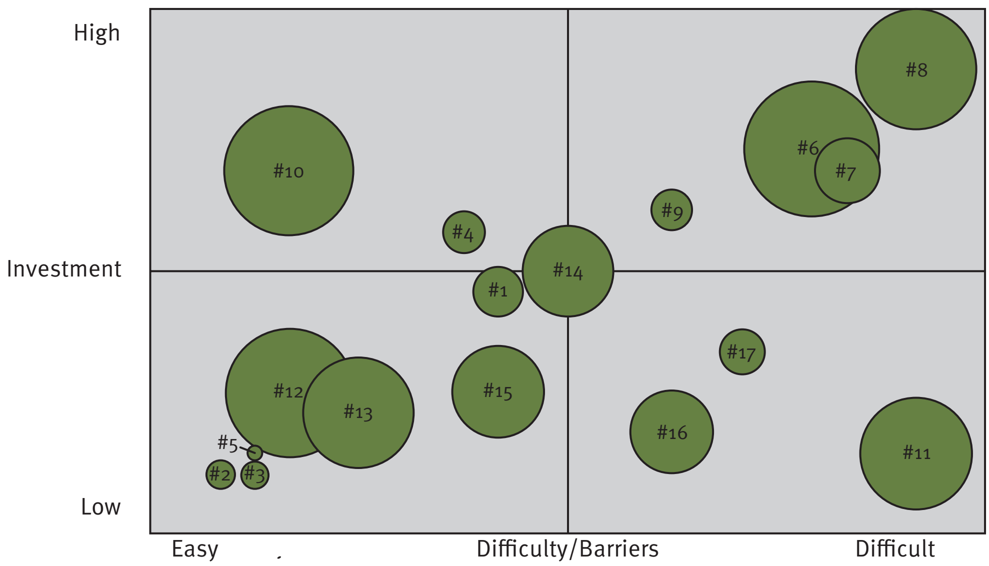
It may be beneficial to ask the help of an expert to answer these questions.

The results of good housekeeping are:

- Elimination of energy-uses that are not needed.
- Minimization of energy losses.

- Usually also improved operational procedures (also your production processes may benefit).
- Optimized production level (increased efficiency = less energy per product).
- Reduced energy costs.

Figure IX. Prioritization of opportunities



The diagram in figure IX shows all available opportunities plotted on a bubble diagram based on technical difficulty against investment cost. The size of the bubbles is proportional to the amount of savings. Those items in the bottom left section are low cost and technically easiest and should normally be completed first. This is very often not the case. Many engineers tend to like a challenge and may prefer to prioritise the difficult and high cost opportunities. From the organizations point of view this is poor management of resources. A bubble diagram of this type is a good aid but it is not critical to use this type of diagram.

4.7 Identify people who may have a significant impact on energy use

There are a number of people in all organizations who have a significant impact on your energy use. These people need to be identified and their level of training or competence evaluated to ensure that they understand their role and the influence they have on energy use.

These people can include the following:

- Operators of large energy using equipment or processes. They are typically in a position to have a direct significant impact on energy use by how they operate the equipment or process. They typically include boiler and other large utility system operators.
- Manufacturing or production process operators.
- Manufacturing or production process managers and engineers.

- Maintenance personnel including crafts people and their supervisors and engineers.
- Security, cleaning and safety personnel. They typically see facilities in a different way and at different times to most employees. They are often aware of energy waste out of normal working hours.
- People who can influence others. This category includes managers, supervisors, team leaders, etc. It is important that they understand their roles from an energy perspective and that they use their positions to positively influence others in the organization.

Once the relevant people have been identified, you need to check their knowledge of their role regarding energy use.

Where you identify gaps in their knowledge, you need to plan, deliver and document the relevant training to fill in these gaps.

Toolkit—A sample training matrix template is provided in the worksheet Training of the EnMS Tools spreadsheet.

4.8 Establish energy objectives and targets

4.8.1 Step 1 Objectives

In setting objectives you consider what you have learned about your energy use, its drivers and the potential opportunities you have identified during the earlier steps of planning. Objectives tend to be long term and less specific than targets. An example of an objective might be to train all your utility operators in the energy aspects of their roles over the next two years. Another would be to improve the efficiency of your steam system by 10 per cent over the next three years.

Figure X. Steps that feed into objectives and targets

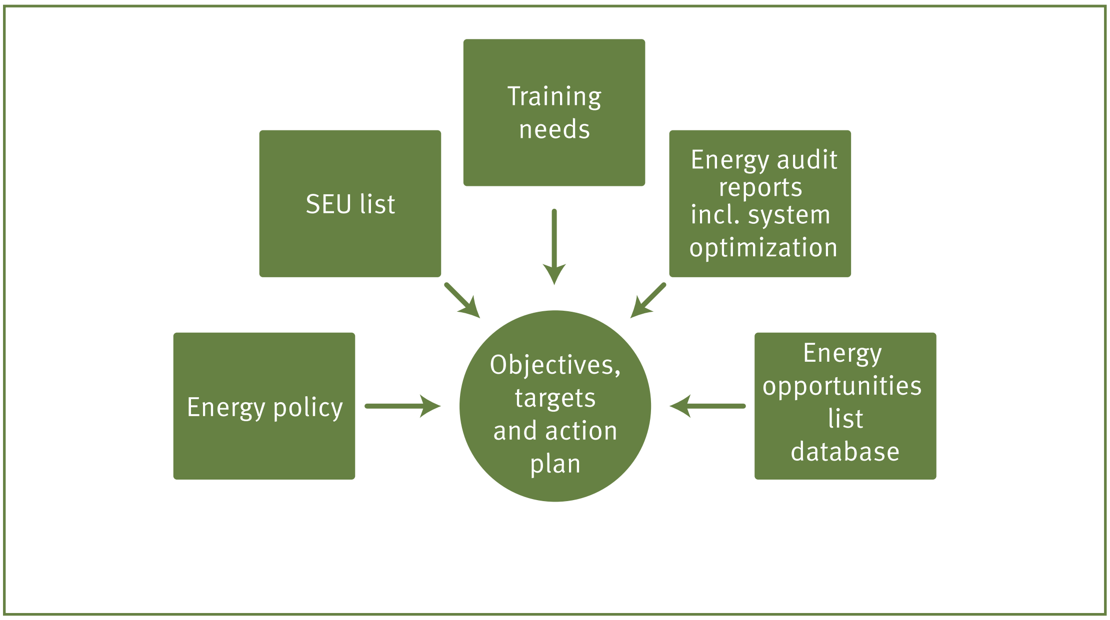


Figure XI. Relationship of objectives, targets and action plans

Objectives

- Longer term (maybe three years)
- Specific
- Consistent with the policy

Targets

- Specific
- Measureable
- Achieveable
- Relevant
- Timed
- Support the objectives

Action plans

- What?
- Who?
- When?
- Is it complete?
- Was it successful?

4.8.2 Step 2 Targets

Targets are often referred to as SMART targets as shown in the figure XII below.

Figure XII. SMART targets

Specific

- What is the task to be done (use action words)?
- What are the details?

Measurable

- How will we know it the task is complete and how well?

Achieveable

- Is it possible and fair?
- Is training or personal development required?

Relevant

- Which objective is it supporting?
- In what way is it improving your energy performance?

Timed

- When will it be completed or how?
- Does it need sub steps and are these SMART?

Targets should support the achievement of objectives, i.e. each objective will probably have a number of targets associated with it. An example of a target supporting the training objective mentioned above would be "to train five operators in refrigeration energy by the end of October". This is specific, measurable, achievable, relevant and timed.

4.9 Develop action plans

The purpose of this section is to translate all your other preparatory/planning work into action plans for the coming period, typically one year. These plans will form the basis of your energy saving activities. Please note that action plans are not entirely lists of technical investment projects and will include housekeeping, management and organizational activities.

The action plan is the specific action that will be taken to improve energy performance. Actions in this context are those activities that you are going to complete in the coming period.

Targets should be SMART as shown above but action plans should be SMARTER to include Evaluated (or verified) and Reassessed. This means that you should verify the actual savings made on completion of an action and reassess or check for further opportunities or improvements. The level of effort required to verify actual savings will vary with the value and complexity of the savings opportunity. Verification of savings can often be complex in that you need to separate the effects of the energy drivers from those of the saving itself.

Prioritization criteria for action plan items:

- Legal requirement
- Low risk, low cost
- High profile item that might raise awareness of the programme, e.g. lighting even if it is not a SEU.
- Other items that will affect decisions include stakeholder resistance, technical capability, targets, ease of implementation, etc.

Toolkit—The worksheet ER8 Opportunities List of the EnMS Tools spreadsheet can help in developing action plans.

5. Develop day-to-day operations

Doing—daily activities to improve energy performance

This is a key step in an EnMS. It is the part where the actual energy savings and performance improvements are implemented. It is part of a continuous improvement cycle in conjunction with the next phase "checking" where the system and the energy performance are checked.

5.1 Determine operational controls

This is a very critical part of the EnMS. It is the part where you operate your energy using equipment and where there is often significant opportunity to affect the organization's energy performance. Many organizations assume that if they purchase energy efficient equipment then their operations will automatically be energy efficient. This has been repeatedly found not to be the case. In fact in many cases less efficient equipment operated well will consume less energy than more efficient equipment operated badly.

It is critical that all significant energy uses are operated and maintained in the most energy efficient way feasible. This area is very commonly neglected.

5.1.1 Operation

How your equipment and energy using processes are operated can have a very significant effect on your energy performance. It is very possible to operate boilers, refrigeration plant, air compressors, pumping systems, etc in such a way that they consume much more energy than they need to. SEU operation is often carried out by maintenance personnel. The same commentary applies regardless of who operates the SEUs. The following are items that need to be considered.

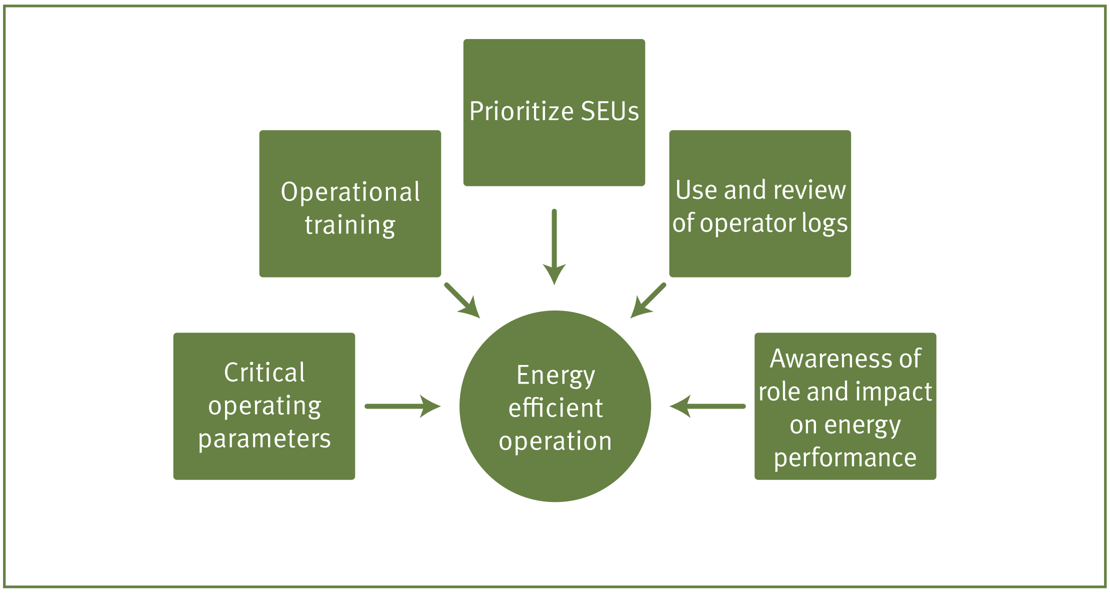
- Each SEU needs to have its critical operating parameter listing developed during the planning phase. These operating parameters need to be understood and adhered to.

- How control systems work is often misunderstood resulting in equipment being operated in manual control. This is rarely a good idea if the control system has been correctly set up in the first instance.

- Operating parameters which affect energy use should be recorded. They should be reviewed regularly by a competent person. It is common to find plants having good operator logs but not so common to find anyone looking at them except when problems have arisen.

Each of these items needs to be developed, documented and communicated to the relevant operational personnel

Figure XIII. Schematic of Energy Efficient Operation



What all this is saying is that the people operating the SEUs need to understand their impact on energy use and the effects of their actions on the energy performance of the organization. These people are invariably among the most significant in the plant from an energy point of view and very often have not been trained on the energy aspects of their job.

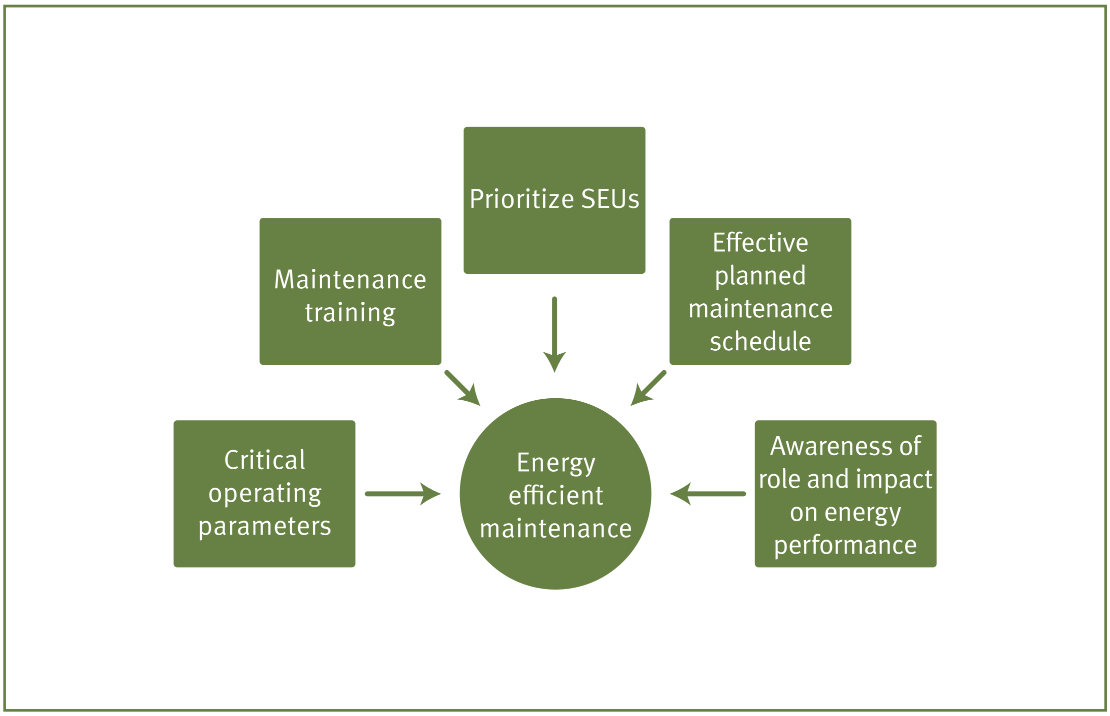
5.1.2 Maintenance

It seems fairly obvious that ineffective maintenance will increase the energy consumption of most technical systems and equipment. However it is rare to find this taken into account when planning maintenance activities. It is similar to the energy performance of an automobile, if tyre pressures, air filters, fuel filters, exhaust system, bearings, lubrication, etc, are not correct then the vehicle will consume more fuel than necessary.

External Service Companies

It is not unusual to find that the servicing of some typical SEUs is outsourced to external service companies. The issues raised in this section apply equally to external maintenance service providers as they do to your own maintenance personnel. External providers are often chosen on the basis of lowest cost. Where technical ability is taken as a selection criterion it does not often include technical ability in the area of energy performance. Typical SEUs that are often externally serviced include air compressors, refrigeration chillers and boilers. Even when the original manufacturer services these items they often are not focussed on their energy performance, especially of the system in which the equipment is only a part. A very common and simple example in this area is the setting of condenser pressure on refrigeration systems. Service companies (and internal staff) typically set a value higher than required as they have been taught that it is important to keep the pressure drop across the expansion device as high as possible. This leads to excessively high condensing temperatures, which leads to excessive energy consumption. It is often possible to reduce condensing temperatures to such an extent that savings of 10 to 20 per cent of energy consumption can be made at no cost. Further reductions may require investment in technical changes depending on the type of refrigeration system in use.

Figure XIV. Schematic of Energy Efficient Maintenance



The main components for a maintenance management system that supports effective energy performance are as follows:

- Planned preventive maintenance should be carried out in accordance with the manufactures recommendations. This will require planning, completion and recording of maintenance activities. This may be computerized or not as appropriate to the organization.
- The people carrying out the maintenance need to be aware of the impact of their work on the energy performance of the SEUs.
- Settings which will affect the energy performance of the equipment need to be known and set correctly.

5.2 Ensure competence and awareness of personnel

You need to ensure that all persons who may have an impact on your energy performance and in particular those people who can affect the performance of your SEUs are appropriately competent and aware of their roles. This includes all employees and external staff.

During the planning phase you identified the people who were most significant to your energy use and decided on what level of training each would require in order to ensure that they are competent to carry out their roles in so far as they impact energy performance.

The implementation of this training is often the single most onerous activity in implementing a viable EnMS in terms of employee time attending training and in terms of cost of training providers. However, it is also the part where very considerable savings will be achieved if carried out effectively.

5.2.1 Awareness

All employees and contractors should be aware of your commitment to improving your energy performance. This can be easily achieved by making the energy policy available and giving people regular updates on your progress. This does not need to be an overly onerous activity. It is merely a good idea that all concerned have an overview of what is happening. Everyone should also be aware of the benefits to the organization of improved energy performance.

> Regular updates of achievements in improving energy performance can also give employees a feel-good factor if they are interested in improvements in the company's performance and its environmental impact.

Everyone should understand their own role, responsibility and authority in relation to the EnMS.

5.2.2 Training

All employees working on SEUs should be trained on any operating procedures or practices that affect the performance of their job and in particular their impact on energy performance. For example boiler operators must be trained on the various operating parameters that they have control over and which affect boiler efficiency such as total dissolved solids, boiler pressure, combustion settings, manual blow down operations, use of heat recovery, etc.

Specific training topics for people with potentially significant energy impact:

- Critical operating parameters for their processes.
- Operating methodologies or procedures for their own processes.
- Impact of not operating to these criteria and procedures.

This training should be developed and delivered by someone with energy engineering expertise in the specific technology. This may be a project engineer, process engineer, operational supervisor, external consultant, etc. Beware of using the manufacturers of specific technologies, e.g. air compressors, boilers, pumps, etc. as they will often not understand the specific application and thus their training is limited to the technology itself rather than its specific application in your plant.

Documentary records of all training completed should be maintained. This can be paper based or electronic and in most cases will utilize existing training management processes.

5.2.3 Competence

This means that all relevant people are able to do their jobs on the basis of appropriate education, training, skills or experience. It is the responsibility of the management of the organization to ensure that all people working for it are competent to carry out their assigned roles and tasks.

It is also necessary to ensure that external contract employees and service providers are competent in those areas that might affect your energy performance. This can be achieved by checking CV information or by specifying requirements during the tendering or vendor selection process.

5.3 Implementation of action plans

It is part of the day to day operation of the EnMS to ensure that the items scheduled for completion in the action plan are being addressed, completed and verified to be performing as expected. The energy manager should regularly check progress of the various action items for progress and completion. This should include updating progress and communicating successes and addressing items that are not progressing to schedule.

Causes of failure to complete action items

These are many and varied but some common problems are listed here and may be of interest:

- Lack of real management commitment which may lead to people not being really focussed on completing assigned duties in the knowledge that this will have no effect on their own performance rating.
- Lack of sufficient technical ability to overcome the inevitable barriers that will be encountered.
- "I'm too busy and have other priorities" is an indicator of lack of real management commitment if this is an acceptable response to delays.
- Lack of finance that should have been addressed when the plans were being agreed at the planning stage.

- Lack of communication and understanding of expectations. You need to ensure that everyone understands their own role and your expectations of them.

If effective preparation and planning are completed these barriers should be less problematic.

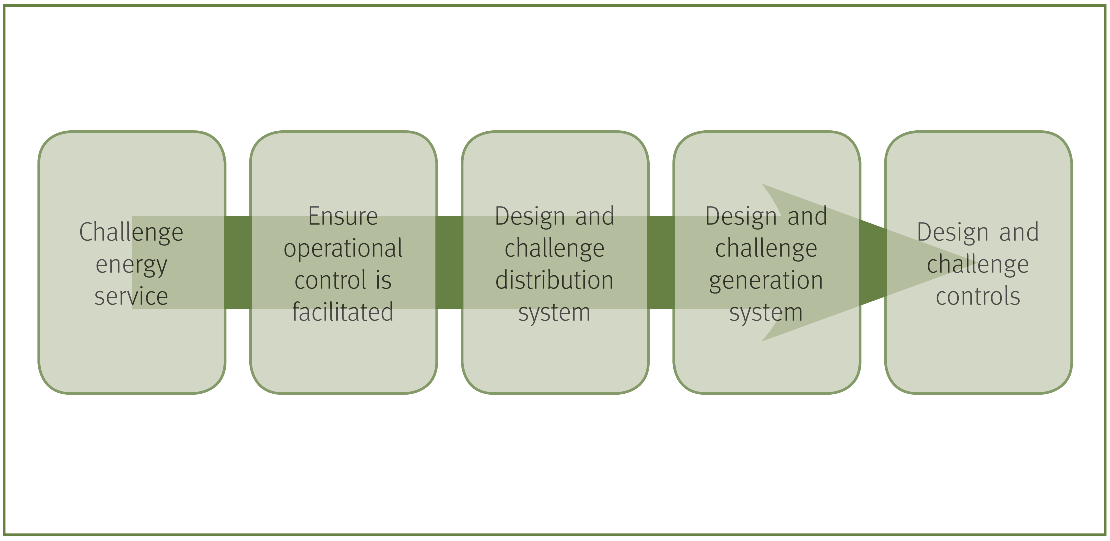
5.4 Design for energy efficiency

It is much easier and cheaper to design good energy performance into a new process or facility from the beginning than it is to retrofit it later. However it is a very significant business opportunity that is rarely taken. It is not necessary to spend more capital in building an energy efficient process than a less efficient process. It is not all about adding extra technology to save energy, though this is part of the process. The major opportunity is in challenging the specification and size of what is required in the first instance.

5.4.1 Energy Efficient Design (EED)

The following steps can be used to implement a systematic approach to EED.

Figure XV. Energy Efficient Design Flow Diagram



These steps entail the following:

Step	Description
Challenge energy service	It is very important that the user specification for the energy service is correct and not over specified. The energy service is the activity that is required, e.g. lighting or cleaning. Examples are; what steam pressure is required? Is steam required? What compressed air pressure is required? How many air changes are required? It is worthwhile putting effort into this step as it is the basis of all other decisions.

Step	Description
Ensure operational control is facilitated	Correct operational control of all system is critical to its efficient operation. At the early design stage it is important to consider operational control. Examples are: can load variation be catered for? Can setback occur at night or weekends? Are there local switches so that equipment can be switched off when not in use? Is it maintainable and accessible? etc.
Design and challenge distribution system	How will the service be distributed to the user? Is insulation adequate for the specific service? Are special precautions needed to minimise the risk of leakage such as all welded pipelines? etc.
Design and challenge generation system(s)	One of the last steps is to specify and design the generation equipment such as boilers, chillers, pumps, air compressors, etc.
Design and challenge controls	Ensure that automation is as simple as possible and will be understood by engineering and operational personnel. It very often is not. A well-documented User Requirement Specification (URS) will help with this.

5.4.2 Commissioning

Commissioning is an often neglected step in projects. The goal is simple, to ensure that the installed equipment or system is operating as designed. It is not uncommon to find well designed and constructed facilities and buildings operating in a very inefficient manner because the commissioning engineers do not understand the full complexity of the design.

> Lack of adaquate comissioning is a very common cause of systems which may be well designed and constructed not performing as the designers intended.

5.4.3 Communication

Operational staff, engineers, supervisors, operators, etc. need to be fully conversant with the design intent of the systems that they are to operate.

5.5 Define procurement practices and purchasing specifications

The procurement or purchasing process in your organization has an important effect on both the amount of energy you use and on its cost. It affects your usage through the purchase of energy efficient products, services and equipment and your cost both through reduced usage and through energy purchase costs.

You should consider this opportunity in preparing your purchasing methodologies. Many organizations do not have a systematic approach to this important area.

Life cycle costing is a critical aspect of how you procure energy using equipment and systems. For example an electric motor typically uses more energy in its first year of operation than its capital cost and thus its capital cost is of less importance than its energy efficiency. The same usually applies to air compressors and pump systems also.

5.5.1 Services

Most organizations routinely procure the services of other companies to help them with a variety of tasks where internal resources or expertise is not available or appropriate. Some of these can have a significant impact on your energy use. These include:

- Service companies for SEUs.
- Energy efficiency consultants.
- Project managers and designers for plant expansion, modifications or upgrades.

When selecting these services it is very worthwhile evaluating their capabilities in the area of energy efficiency knowledge. This should be a criterion in their selection.

The savings in energy can outweigh the savings in hiring the cheapest service provider.

5.5.2 Equipment

When purchasing energy consuming equipment you should consider the potential for lower energy alternatives. This includes everything from large energy intensive items such as electric motors, air compressors, etc to small items such as light bulbs.

- Do you have a policy for purchasing new and replacement light fittings and bulbs? Projects will often buy the cheapest option and then it is replaced in operation.
- Do you have a policy for purchasing IT equipment such as PCs, printers, photocopiers, servers, etc.?
- Do you have a policy on purchasing electric motors? Are they always the most efficient type? Rewinding v replacing electric motors, rewinding motors reduces their energy efficiency. It is usually better to replace smaller motors and to rewire larger motors only once and then replace them. Tagging motors for repair or replacement in advance of failure can be very effective.
- Do you evaluate full life cycle cost (LCC) when purchasing larger items?

5.5.3 Energy

The purchase of energy can be a complex topic in particular in open competitive energy markets. The purchasing opportunities vary considerably from country to country and thus it is beyond the scope of this *Guide* to give detailed instruction on how to go about purchasing energy in any given country or region.

The main principles (these will vary) in improving your purchasing methodology are:

- Research the various suppliers who can meet your needs for each of your required energy sources.

- Develop detailed profiles of your energy use of each source. These will be an aid in estimating the cost of each energy type from each supplier.
- Get each potential supplier to quote to supply the same projected profile. This will serve as the basis of comparison for each supplier.
- In more complex situations the help of a professional consultancy may be required to support your efforts.

6. Determine if the system is performing

Checking—Are you improving performance and saving energy or not? If not, why not and what do you need to do to improve.

This is another key step in an EnMS. In your daily operations energy savings and performance improvements are implemented. In this phase the projected improvements, of both the system and the energy performance, are checked in reality: Is my organization really improving performance? The answer to this question is of key influence on the (remaining) commitment of the organization to energy management: Are the taken measures really paying off?

This checking phase consists, in short, of the following key elements which should give an answer to the corresponding questions:

- Monitoring, measurement and analysis: "Is the organization's energy performance really improving?"
- Evaluation of legal/other compliance: "Does the organization comply with legal and other requirements it committed itself to adhere to?"
- Internal audit: "Is the organization's EnMS operating as required and specified?"
- Nonconformities, correction, corrective and preventive action: "Does the organization take appropriate action to occurring and potential non-conformities?"
- Control of records: "Can the organization prove conformity to the requirements of its energy management system?"

6.1 Measure, monitor and analyze

Monitoring and measurement is the management of energy performance by means of regular comparison of actual and expected energy use.

6.1.1 Monitoring and measurement

The key characteristics of an energy management system that indicate successful energy performance improvement must be monitored and measured. These key characteristics include:

- The outputs from energy planning including action plans.
- Relation between significant energy uses and driving factors.
- Energy performance indicators.
- Effectiveness of the action plans in achieving objectives and targets.
- Monitoring of the effectiveness of operational control.

In setting up monitoring and measurement system that can fulfil the task the organization should answer the following questions:

- How will usage in SEUs be measured and recorded?
- Who will be responsible for the monitoring, measurement and analysis?
- How can I relate the monitored driving factors with my energy use?
- What monitoring frequency do my operations require?

Monitoring and measurement doesn't automatically imply energy metering. It is not necessary to install energy meters on all machinery or equipment. Sometimes there might even be no need to install a meter on a complete production line or section of your organization, for example when the energy use is not significant or it cannot be influenced or it does not vary significantly. In the last case a one off portable meter reading may be sufficient.

Examples of energy instruments to be monitored can include:

- Electrical power meters
- Steam flow meters
- Condenser pressure
- Room temperature

In order to determine the cost-effectiveness of metering the cost should be weighed against the estimated energy cost savings. Metering costs include costs of: design, purchase, installation, operation and maintenance and calibration of the meters, data storage and analysis of the data output.

EXAMPLE: Energy metering

When do we install energy meters?

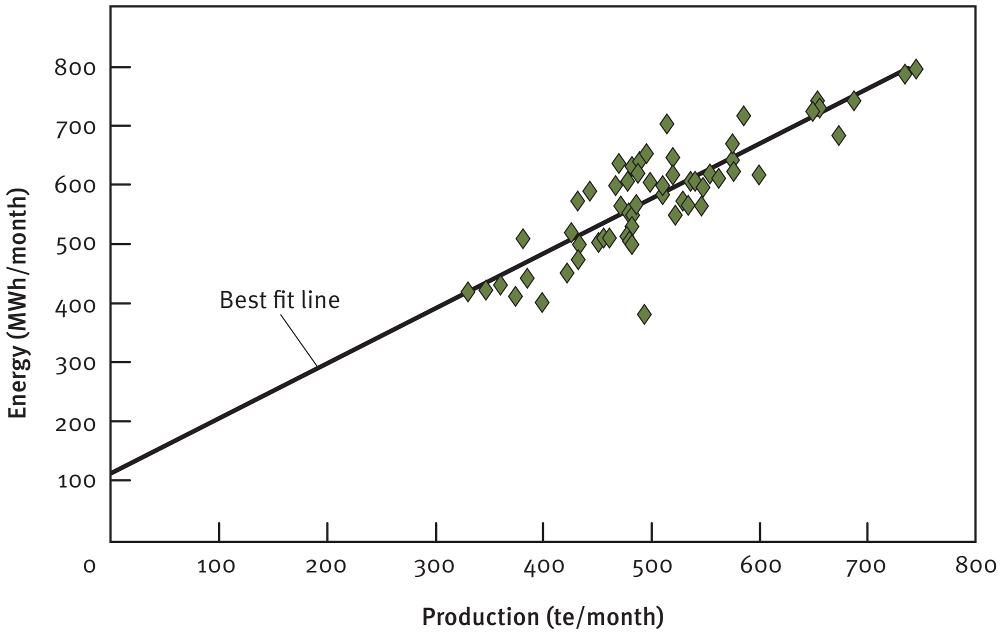
- Does the installed meter have the potential to pay for itself through energy savings?
- Is the meter required to monitor an EnPI?
- Is the flow being measured vey critical for example in short supply?
- Is it required to monitor a critical operating parameter?

Alternative ways to monitor and measure energy use, instead of permanent metering, are instant metering with hand held meters when no major fluctuations are to be expected or estimations (name plate readings).

6.1.2 Analysis (monitoring and targeting)

Analysis transforms data into useful information upon which action can be taken. Standard spreadsheets are quite adequate for many applications. Different charts can be drawn e.g. energy use vs. production, specific energy consumption vs. production, CUSUM graph (this technique provides a trend line, it calculates savings/losses to date and shows when the performance changes; CUSUM represents the difference between the baseline and the actual consumption data points over the baseline period of time), etc. Best fit lines (targeting) are used to predict expected energy consumption and regular control (monitoring) discovers non-conformance of the process leading to action to improve the performance.

Figure XVI. Graph representing measured data including best fit line



There are three important features on the chart of figure XVI:

- *Intercept*—The energy that would still be required even if production was reduced to zero (in this case it is 113.5 MWh/month).
- *Slope*—The amount of energy required to process each additional unit of production, leading to the process efficiency.
- *Scatter*—The distribution of the data points away from the best fit line, indicating the variation in energy per unit production from one period to another. Large differences between scatter and best fit lead to the conclusion of poor process control.

6.2 Calibrate instruments

For reliable monitoring and measuring, equipment being used should provide data that is accurate (Is the measured 1 kWh really 1 kWh (or less/more)?) and repeatable (Does the equipment represent 1 kWh as 1 kWh every time it is being measured or do changes occur after repetitive monitoring or measurement?). A one degree centigrade error in the evaporating temperature of a refrigeration plant can represent a 3 per cent variation in energy use, which will be significant with a large plant.

When determining the accuracy of your metering system you can simply ensure that the meters in place are calibrated as required, or you could consider conducting a simple risk analysis:

- How will I know my EnPI's and critical parameters are being monitored?
- How can I know if these meters are accurate?
- What are the critical instruments being used?
- Can the instrument have a significant effect on energy usage/energy monitoring results if it goes out of calibration?
- What is the likelihood of the critical instrument going out of calibration?
- Is it possible to ascertain the accuracy of meters using data provided from other meters and including utility bill information?

You can then determine which instruments should have the most frequent maintenance and calibration routine.

The physical calibration activity would normally be carried out as a maintenance activity under operational control.

6.3 Evaluate compliance with legal and other requirements

Routine checking is required of legal and other compliance. You need to check if you are compliant with all relevant requirements. A number of times a year you need to review your list of requirements to ensure that you are in compliance. You also need to monitor changing requirements to ensure the list is up to date.

6.4 Conduct internal audits

The purpose of an internal audit is to check that the EnMS is operating as designed. It is not unusual to have designed a very good management system but to have it ignored in practice. There is no point on having an EnMS if it is not going to be used effectively.

An internal audit of an EnMS is an independent, systematic review of part or an organization's EnMS. The purpose of the audit is to determine if the plans, activities and procedures described in the system are being conducted in the manner which the EnMS requires, for example:

- Are the expected targets being achieved?
- Are the plans and controls established by the organization being followed?

- Is it realistic to suggest that the organization's procedures and plans will achieve the stated objectives of the EnMS?

In your internal audit process you should describe the following:

- The audit schedule to ensure that all sections of system are audited annually;
- How areas that contribute most to significant energy usage should be audited more frequently;
- The competence requirements for internal auditors;
- How audits scopes and objectives are agreed;
- How audit findings are recorded, reported and addressed;
- How the required corrective action is managed during subsequent audits;
- The person(s) responsible for ensuring that follow-up actions are taken without undue delay to eliminate detected non-conformities and their causes;
- How verification of the actions taken to address issues were raised in the audit process and the reporting of verification results.

The process for internal audits can easily be integrated with other existing management system audit processes.

The person(s) carrying out the internal audit needs to have some experience or training in systems audits and to understand the EnMS requirements.

6.4.1 Nonconformities, correction, corrective and preventive action

A non-conformance can be defined as failure to fulfil a specific requirement. Deviations from specific targets may not necessarily be a non-conformance, but they usually warrant investigation when the deviation is outside existing/planned values.

EXAMPLE: Non-conformance

A dairy plans to reduce the amount of water required to process 1 litre of milk from 10 llitres to 8 litres. It sets this target and monitors fluctuations from it, setting a lower alarm level of 7:1 litres water to milk and an upper alarm level of 12:1 litres water to milk. It knows from its operational history that these alarm levels represent normal fluctuation related to milk quality and ambient temperature. It is only when the upper or lower limit is breached that a non-conformance is raised. Variations in between are subject to routine investigation.

The correction, corrective and preventive-action process is a means by which you can correct any deviations from the requirements of your EnMS, to ensure it meets the requirements of the system as well as the commitment to continual improvement in your organization's energy policy.

Issues that need to be raised in the corrective and preventive-action process can be identified from several sources in your EnMS, including:

- Results of internal and external audits;
- Results of evaluations of compliance reviews;

- Failures to reach specified targets in monitoring and measurement processes;
- Failures to comply with operational control procedures, as identified in site inspections;
- Failures to meet target dates relating to the energy management action plans.

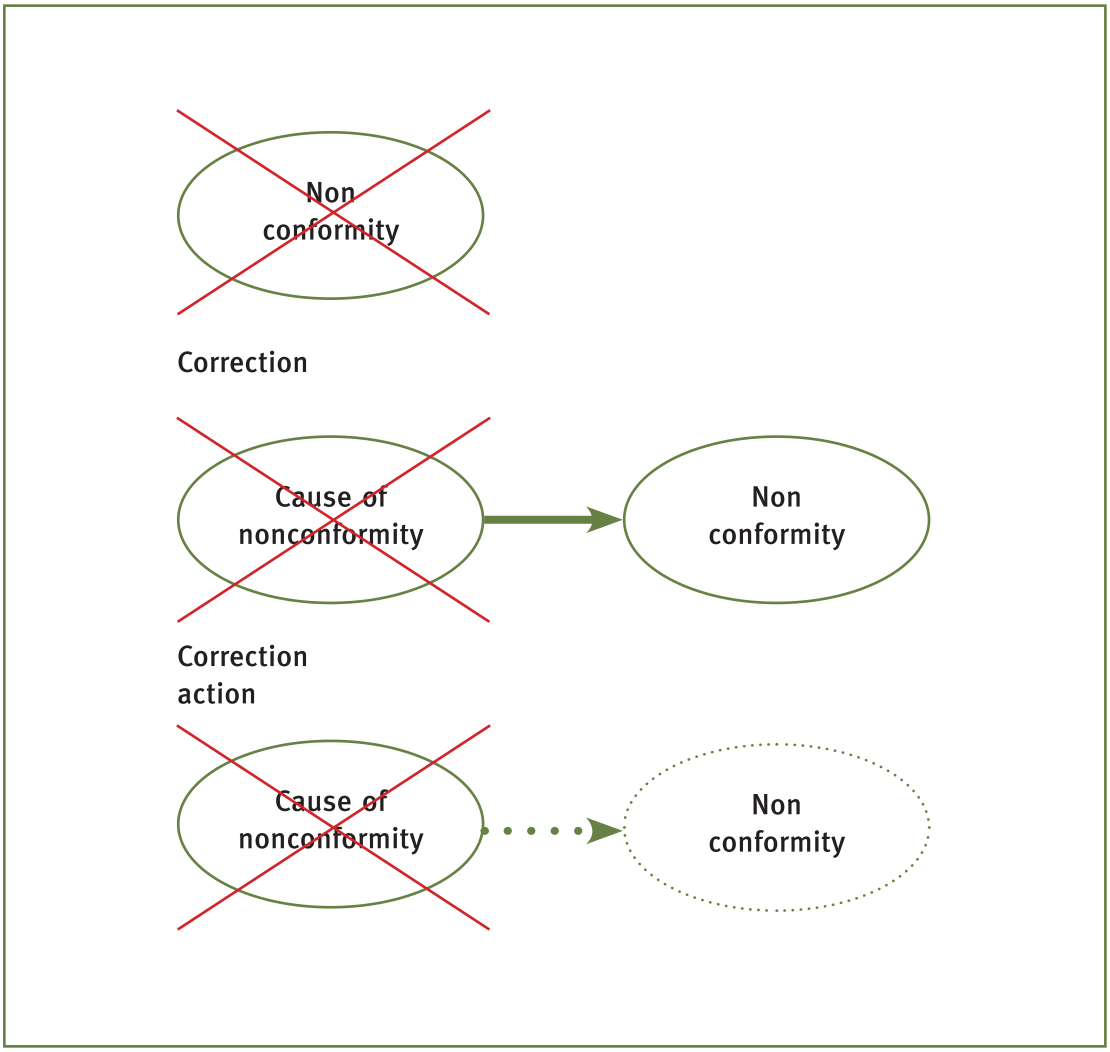
In the next section of this *Guide*, you will see that you will need to provide at the management review an analysis of the status of correction, corrective and preventive actions. Therefore, you will need to manage these actions to ensure easily accessible data for this reporting process.

The used terms in this process are defined as follows:

Nonconformity: non-fulfilment of a requirement;
Correction: action to eliminate a detected nonconformity;
Corrective action: action to eliminate the cause of a detected nonconformity;
Preventive action: action to eliminate the cause of a potential nonconformity.

For clarity the above mentioned terms are explained schematically in figure XVII below.

Figure XVII. Schematic: correction, corrective action and preventive action



This is how the correction, corrective and preventive-action process can be managed:

- List each action by source—audits, inspections, evaluations of compliance, etc.;
- Describe the nonconformity or potential nonconformity briefly—e.g. chiller 3 was left running for five weeks when chiller 2 was known to have a better performance or the operator log was not checked by the supervisor in the previous four weeks;
- Identify the locations at which the nonconformity arose—e.g., office, compressor room, extruder machine, etc.;
- Identify the persons responsible for the area concerned—e.g., security/process operator;
- Identify the cause of the (potential) nonconformity;
- Evaluate the need for action to ensure the nonconformity do not occur or reoccur;
- Identify the person responsible completing the correction/corrective/preventive action;
- Identify the agreed date to close the corrective action;
- Identify the actual date the corrective action was closed;
- Identify the date when the action was reviewed for closure.

Toolkit—A sample Non-conformities worksheet template is provided in the EnMS Tools spreadsheet to help with this step.

7. Sustain and continuously improve

Acting—Continuing to build support for the system and its improvement

7.1 Conduct management reviews

The purpose of the management review is to:

- Demonstrate to the top management how well the EnMS is working.
- Highlight problem areas where there may be barriers to improvement.
- Continue to build support for the system.
- Propose and agree plans for the coming period, usually the next year.

The management review should first be held soon after completion of the initial planning phase and annually (typically) thereafter. In some organizations this may be tied in with the annual budgeting process.

It should be attended by all the members of the senior management team including the management representative and the energy manager. Additional attendees may also be appropriate depending on how the EnMS is structured. It is probably not necessary that all members of the energy team attend but some organizations will see a benefit in having the full team there.

The format of the meeting will probably be a presentation by the energy manager or management representative followed by discussion and decision making (in the following it is assumed that the energy manager makes the presentation).

Records need to be kept of the presentation materials and the minutes of the meeting including action items and decisions made.

7.1.1 Inputs to the review

As stated above the energy manager or management representative will make a presentation to the top management team. This presentation should include the following items:

- Review of the energy performance since the last review meeting. This will probably include trends of bills of each energy source and trends of EnPIs compared with targets. Is the organization's performance improving as predicted and if not, why not and what needs to be done to improve? Keep it as simple and clear as possible.
- Review of the current status of objectives and targets. Are they being met and if not, why not and what is required to get back on track?
- What is the status of follow up items from the previous management review meeting? Obviously all should be completed by their due dates and if not, why not.
- Is the energy policy still adequate for purpose or does it need updating? Recommended updates should have been prepared for discussion.
- Review of the status of legal and other requirements. Discuss any significant changes to keep the management informed.
- Review the results and major findings of any internal or external audits of the EnMS. It is not necessary to go into too much detail.
- What is the status of any corrective and preventive actions? Again a summary is required. It is not necessary to go into detail unless a specific time (action) is very significant.
- What is needed to be done to further improve performance over the coming period (year)? Tell them what is needed. This will be discussed at the meeting and the appropriate decisions made.
- What resources are required over the coming period? This includes financial, technical and human resources. How much internal time is required from various personnel?
- How is performance going to improve over the coming period assuming the management agree to support the EnMS as appropriate?

It is best to keep all the above items as short and simple as possible. The objective of the meeting is to focus the top management's attention on the EnMS and to get them to make decisions to support the system going forward.

While there is some work required to prepare the above material for the meeting, once your EnMS is operational, all these details will be readily available. It is basically a short summary of how the system is performing.

There should be no major surprises at the review. If there is a significant problem in the EnMS or in energy performance it should be brought to the attention of the appropriate management person at the relevant time.

Toolkit—A sample Power Point template for this presentation (using the sample data developed in earlier chapters) is provided to help with this step.

7.1.2 Outputs from the review

Basically the outputs from the review meeting are the decisions and actions needed to improve performance over the coming period and to address any problems or barriers raised during the presentation.

The outputs are as follows:

- What is the organization's performance going to be in the coming year? It is important that objective EnPIs are in place which will demonstrate success or otherwise in meeting the targeted performance improvement.
- Do baseline and/or EnPIs need to be updated?
- Are there any changes to be made to the energy policy?
- Are there changes required to the organization's objectives and targets or other elements of the EnMS?
- What resources will be allocated to the improvement of energy performance over the coming period? This is a critical decision. If adequate resources are not made available then it may be difficult to achieve the projected performance improvements. In some ways this decision is like a contract between the management and the energy manager in the form of "I will make the following improvements but I need your help in giving me the necessary resources"

This is the end of the manual; it is not the end of your effective EnMS. Implementing an EnMS is not a project with a specific end point; it is a process of continual improvement. The output from the annual management review is the starting point for the following year's activities.

Toolkit—A sample Management Review meeting minutes showing how decisions might be made, actions agreed, etc. is provided to help with this step.

Appendices

1. *Guide* Toolkit

In the CD which accompanies the *Guide* the following tools, samples and templates are provided to help with the implementation of an EnMS:

1. EnMS Tools.xlsx
2. Energy Policy sample
3. Project Plan sample
4. Business Case presentation
5. Management Review presentation template
6. Management Review minutes template

2. Abbreviations used

CUSUM	Cumulative Sum
DF	Duty Factor
EED	Energy Efficiency Design
EnMS	Energy Management System
EnPI	Energy Performance Indicator
ER	Energy Review
ETS	Emission Trading Scheme
GHG	Greenhouse Gas
ISO	International Organization for Standardization
LED	Light Emitting Diode

LF	Load Factor
PDCA	Plan, Do, Check, Act
P&IDs	Process and Instrumentation Diagrams
SEC	Specific Energy Consumption
SEU	Significant Energy Use
SMART	Specific, Measurable, Achievable, Relevant, Timed

3. Additional resources

US Department of Energy (DOE)
http://www1.eere.energy.gov/industry/bestpractices/case_studies.html

Sustainable Energy Authority of Ireland
www.seai.ie/Your_Business/Large_Energy_Users/Resources/Energy_Management_Systems/

Heating and Cooling Degree Days
www.degreedays.net

Monitoring and targeting—in-depth management guide; Carbon Trust
www.carbontrust.com/media/31683/ctg008_monitoring_and_targeting.pdf

Making the business case for a carbon reduction project – how to win over the board and influence people; Carbon Trust
http://www.carbontrust.com/about-us/press/2012/08/making-the-business-case-for-energy-efficiency

Make the business case, DOE eGuide ISO 50001
https://save-energy-now.org/EM/SPM/Pages/Step1.aspx

4. EnMS summary table

The following table is a summary of all the tasks required to implement, operate and improve an EnMS. This list can be used for a number of purposes to ensure effective implementation. These purposes include:

- Basis for roles, responsibilities and authorities, where each task is assigned to relevant members of the organization. It should be indicated who will lead each task, i.e. have overall responsibility for the task, who will participate in the completion of the task and who needs to be informed of progress or completion.
- Basis for project management of the implementation project where each task is assigned and given a completion date. The left column could be pasted into a project management package such as "OpenProj" to facilitate effective management.
- It can be used as an internal audit checklist, where each task is audited to check for conformance.

The table also highlights (green shade) those tasks that are regarded as key ones for the successful implementation of an EnMS and the continual improvement of energy performance.

Task	What is required?	Frequency of the task	Relevant documentation	Communication
Preparation and Commitment				
Define scope and boundaries of the EnMS	"Scope: what energy sources and uses are included. Boundaries: what parts of the organisation are included"	Review annually	Scope worksheet	Energy Team
Manage roles and responsibilities	Ensure that relevant personnel understand their roles, responsibility and authority and are resourced and supported in their roles in the EnMS implementation	Continuously	This worksheet	All affected staff and contractors
Develop the energy policy	Develop and periodically review the energy policy document	Review annually prior to management review	Policy worksheet	As appropriate
Review/Approve the energy policy	Review and approve the policy document	Annually	Energy Policy	All staff and contractors
Participate in management review	Attend the management review meeting	Annually	Presentation and minutes	Energy Team and top management team
Consider energy performance in long term planning	Ensure that energy performance is con-sidered in long term and strategic planning	As required	Energy Strategy	Energy Team, project management team
Set objectives and targets	Based on available opportunities but aligned with relevant commitments	Annually		Top mangement and energy team

Task	What is required?	Frequency of the task	Relevant documentation	Communication
Planning				
Legal and other requirements	Identify and document all legal and other requirements applicable to the organisation's use of energy	Quarterly	Legal worksheet	Energy Team
Complete the energy review steps (ER1 to ER8)	Complete all the steps in the energy review process	Annually	ER worksheets	Energy Team
Operating				
Implement training	Ensure that all personnel including contractors who may significantly impact the energy use are competent to carry out their roles through a mixture of education, training, experience and skills	As planned	Training worksheet and training records	As appropriate
Internal Communication	Ensure that relevant people are aware of the EnMS activities and have an opportunity to contribute to the improvement of energy performance	Continuously	Records of communication, screens, email, posters, suggestion boxes	As appropriate
External Communication	Decide on the level and content of any external communications related to energy management	As required	Records of decision (who, what, when) and communication	As appropriate
Promote energy awareness	Ensure that an appropriate level of awarenesss of energy matters is promulgated	Continuously	Awareness materials	As appropriate
Document Control	Ensure that critical documents and records pertaining to energy performance and the EnMS are maintained and available to those requiring them	Continuously	Documents worksheet	As appropriate

Operational Control—Operation of SEUs	Ensure that all significant energy using equipment and systems are operated efficiently	Continuously	Operational records, op cont worksheet, ER6	Operational staff
Operational Control—Maintenance of SEUs	Ensure that all significant energy using equipment and systems are maintained efficiently	Continuously	Maintenance records, ER6 tab	Maintenance staff
Critical Operating Parameters	Identify, quantify, document and communicate the critical operating parameters for all significant energy using equipment and systems	Continuously	Critical operating parameters list, ER6	As defined in the list
Energy Efficient Design	Ensure that new projects with a significant energy are evaluated from an energy perspective	As required	Energy design work-flow, design review records	Energy Team and project team
Procurement—Energy	Ensure that energy procurement is managed efficiently and effectively	Continuously	Bidding and contract documents	Energy and finance personnel
Procurement—Equipment	Ensure that energy performance is taken into account in the procurement of energy using equipment	Continuously	Equipment purchasing specifications	Procurement and energy personnel
Procurement—Services	Ensure that energy performance is taken into account in the procurement of services that could affect energy performance.	Continuously	Service procurement specifications including competence requirements	Procurement and energy personnel
Checking				
Monitor energy metrics	Monitor and take action related to energy bills, EnPIs and other energy metrics	Continuously	Bills, EnPIs, EnPI worksheet, etc.	
Internal Audits	Schedule and organise internal audits of the EnMS	Quarterly	Internal audit worksheet, records and corrective actions	As appropriate

Task	What is required?	Frequency of the task	Relevant documentation	Communication
Review action plan progress	Ensure that all action and training plan items are progressing according to plan	Monthly	Action plan progress, ER8 Opportunities List worksheet	As appropriate
Monitor operational control	Review maintenance and operational records and operating parameters	Continuously	Operation and mainteinance records	Operation and maintenance staff
Manage non-conformities	Manage corrective and preventive actions related to the EnMS. These include deviations from plans, EnPIs and 2nd or 3rd party audit findings, etc.	Continuously	Non-conformity worksheet	As appropriate

Printed in Austria
V.13-80087—February 2013

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Telephone: (+43-1) 26026-0, Fax: (+43-1) 26926-69
E-mail: unido@unido.org, Internet: www.unido.org