Guidebook on Energy Management for SMEs
# Guidebook on Energy Management

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1. General requirements and introduction

1.1 Overview Energy Data

The following table gives an overview of typical consumption data for individual areas.

<table>
<thead>
<tr>
<th>Value</th>
<th>Domestic</th>
<th>SME</th>
<th>Large industry</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>3.000</td>
<td>1.500.000</td>
<td>200.000.000</td>
<td>kWh/a</td>
</tr>
<tr>
<td>Max. electrical capacity</td>
<td>6</td>
<td>800</td>
<td>35.000</td>
<td>kW</td>
</tr>
<tr>
<td>Price</td>
<td>20</td>
<td>10</td>
<td>7</td>
<td>€ Cent/kWh</td>
</tr>
<tr>
<td>Gas consumption</td>
<td>20.000</td>
<td>8.000.000</td>
<td>250.000.000</td>
<td>kWh/a</td>
</tr>
<tr>
<td>Boiler capacity</td>
<td>20</td>
<td>3.000</td>
<td>50.000</td>
<td>kW</td>
</tr>
<tr>
<td>Price</td>
<td>8</td>
<td>4.5</td>
<td>3.0</td>
<td>€ Cent/kWh</td>
</tr>
<tr>
<td>Cost of electricity + gas</td>
<td>1.500</td>
<td>500.000</td>
<td>25.000.000</td>
<td>€</td>
</tr>
</tbody>
</table>

Common units

<table>
<thead>
<tr>
<th>Value</th>
<th>Domestic</th>
<th>SME</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>2.500</td>
<td>kWh</td>
<td>1.500</td>
</tr>
<tr>
<td>Power capacity</td>
<td>6.000</td>
<td>W</td>
<td>800</td>
</tr>
</tbody>
</table>

1.2 Saving potential of primary energy in the industry by 2020

The German Wuppertal Institut identified typical savings for industrial plants and processes and the following graph shows where savings typically occur.

1.3 Characteristics of different industries

The following table gives an overview of energy intense industries and the proportion of energy costs as a percentage of total costs:

<table>
<thead>
<tr>
<th>Industry</th>
<th>Energy Cost as %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>8.7%</td>
</tr>
<tr>
<td>Metal production and processing</td>
<td>6.2%</td>
</tr>
<tr>
<td>Glass, ceramics and processing of stones and earths</td>
<td>5.6%</td>
</tr>
<tr>
<td>Paper</td>
<td>5.1%</td>
</tr>
<tr>
<td>Chemical</td>
<td>2.9%</td>
</tr>
<tr>
<td>Food</td>
<td>1.8%</td>
</tr>
<tr>
<td>Producing industries average</td>
<td>1.6%</td>
</tr>
</tbody>
</table>


Energy consumption in industries occur in different areas, however, individual sectors show the same energy structure and consumption. The following graph shows which energy systems offer high potential for savings and which areas to prioritise.

**Chemical industry**
Process and space heating, electricity for diverse drivers and processes, cooling, compressed air, lighting

**Chemical**

[Diagram showing energy consumption breakdown for Chemical industry]

**Paper industry**
Heat for drying (steam), electricity for diverse drivers and processes
**Food industry**
Heat for processes (little space heating), electricity for diverse drivers and processes, cooling, compressed air

**Plastics processing industry**
Electricity for extrusions, diverse drivers, lighting, little heat (except for varnishing)
1.4 Energy price trends

Energy has become an ever more important cost to consider. The following graphs show the price increase for electricity and gas during the past 7 years in individual European countries.

**Electricity price development 2001-2007 (industrial customers)**

Source: EUROSTAT, 2007

**Gas price development 2001-2007 (industrial customers)**

Source: EUROSTAT, 2007
1.5 Reasons to establish an Energy Management System

Regardless of a company’s size, a structured analysis of its energy system is very important, since energy systems can be complex and include factors such as:

- A different number of energy sources such as electricity, natural gas and oil frequently delivered by different companies and measured in different units.
- These sources might have to be converted to a different form before they can be used, e.g. steam, hot water or compressed air.
- A comparison of costs is not easy as the price for individual energy sources is based on different units and composed of various factors.
- There is an interaction between the different energy flows within the company. Waste heat from a process, for example, can influence the amount of energy required for space heating.
- Quite often the development of an energy system is linked with the company’s development over time, which can result in a complex energy system. This in turn might make the analysis of flows more complicated.

As energy becomes more and more expensive, improvements in energy efficiency become more attractive.

Following a German study the following picture shows the reasons given for establishing an energy management system:

Source: KfW-Befragung zu den Hemmnissen und Erfolgsfaktoren von Energieeffizienz in Unternehmen, Dec. 2005
1.6 Getting started

Before top management decides to implement an energy management system, experience shows that energy consumption has commonly become a problem which can’t be handled. From a certain point on these problems become severe and individual actions do not help to improve the situation. Typical situations are:

- A lack of overview of the energy system and no information on where energy is consumed
- Energy costs increase and top management wants to cut these costs
- Benchmarks show that energy consumption is too high in comparison to comparable sites.

In some cases top management initiates the implementation of an energy management system and as pressure comes from the top this will happen quite fast.

In many cases the responsible person for energy consumption is the driving force behind such initiatives. He or she has to handle supply and cost problems and has to convince staff and top management to focus on energy. Only with a structured approach is it possible to improve the existing situation, to motivate colleagues to deal with energy efficiency and to receive a budget for necessary investment.

Due to the complexity of energy systems, a step-by-step approach is recommended:

1. Appoint an energy manager and an energy team
2. Define the goal of the analysis
3. Define the system boundaries
4. Collect data
5. Develop an Input-Output analysis and a flow chart
6. Set up the basis for the Energy Information System
7. Prepare a register of legislation
9. Develop a communication strategy
10. Carry out an Internal Audit
11. Implement a review by top management.
2. Energy policy

The development of an energy policy is the starting point for effective energy management. Although some companies may already have taken action to reduce their energy bill, few have recognised the need to formalise this in an energy policy.

An energy policy is similar to any other company policy in that it formally states the company’s position by setting out guiding principles and key aims and objectives. Without formalisation in a policy, energy management remains vulnerable to conflicting priorities or resource constraints. Progress will be particularly vulnerable if the energy management cause is championed or driven by only one or two key staff. A change in personnel may mean that action ceases completely. A formal energy policy endorsed by senior management ensures accountability.

In addition, a policy is more likely to be accepted and acted upon within the organisation if it is seen to be endorsed by senior management. A clear statement of direction and intent helps to focus action and also provides a framework against which progress can be monitored.

An energy policy should not be viewed in isolation. It should be seen as an integral part of the company’s wider business policies and as such should be:

- companywide in that it relates to all the activities of the company rather than being restricted to particular processes or individual departments (departmental policies may also be appropriate but they should be viewed as sub-policies, perhaps adding department specific aims to the corporate framework).
- strategic in that the aims and objectives should be relevant to the company’s activities, products and services.

Policies often serve more than one purpose and should take into account internal and external drivers.
External drivers to an organisation
The policy should be both:

- a public expression of the company’s commitment to efficient energy management which recognises the importance of energy management not only to the company but also in a global context; and
- a document which will guide the company’s energy management practices and provide a framework for continuity.

To an extent, development of the policy will depend upon the organisational structure and culture of your company. In some companies policies are simply written by senior management and imposed on the workforce with little or no intervening communication. At the other extreme, policy development in some companies involves wide, and sometimes protracted, consultation between the workforce and management until a compromise position is reached. The method which you use to develop your energy policy will probably be influenced by the procedures and communication structures already in place within your company but there are a number of key steps which are essential if the policy, once developed, is to be successfully implemented.

Without the commitment of senior management and the board of directors, it is highly unlikely that an energy policy will be successful. It is therefore important at an early stage in the policy development process to seek this commitment. Ideally a member of senior management should take responsibility for allocating resources and personnel to the energy management process and should communicate management’s commitment to the workforce. Quite often policies fail to be implemented because they are impractical when it comes to translating the aims and objectives into action or because people have no ownership of the policy and so choose to ignore it or fail to understand what they are required to do. Many of these problems can be overcome if effective consultation takes place during policy development.

Often it is those staff who perform tasks on a day to day basis who have the best understanding of how processes work and hence what is likely to be achievable. These people will also be key players when it comes to implementing the policy. It is therefore important that they get the opportunity to contribute to the development of the policy. A variety of consultation methodologies could be used in policy development, each of which may have both advantages and disadvantages depending on the size and nature of the company. You may feel that a combination of methods would be most appropriate in your company. Some methodologies which could be used and their associated advantages and disadvantages are described below:

- Discussion sessions - large company wide group
- Discussion sessions - small team or departmental groups
- Inter-departmental Committee
- Circulation of questionnaire or draft document

The next step is to translate the views expressed into a policy. The detail of an energy policy will vary from company to company in accordance with the nature of the organisation’s activities. However, there are a number of general points which should be included:

- **A declaration of commitment** - a broad statement of intent which commits the company to efficient energy management
• **Guiding principles** - the key concepts upon which the policy is based which will probably contain reference to issues such as cost effectiveness and improved environmental performance

• **Aims** - the company’s overall aims in relation to energy management. These provide the direction for the policy and should be specific to the company and its activities. The company’s action plan for energy management will develop from these aims so it is important that they focus on issues which the company is able to deal with and from which realistic targets can be developed.

• **A brief outline of structure and responsibilities** - It is important that roles and responsibilities for energy management are formalised. The basic structure for energy management within the company should be described in the policy. This will differ from company to company but may include reference to some or all of the following - a senior member of management has overall responsibility for energy management; the energy management committee will be responsible for overseeing the implementation of the policy; the energy manager will be responsible for day-to-day energy management; and that all staff have a responsibility for effective energy management in relation to their particular job. A commitment to providing appropriate training is also important.

• **A commitment to continuous improvement** - Effective energy management requires a commitment to ongoing improvement rather than one-off actions.

• **A commitment to evaluation** - Energy management systems, as with all other management systems, are ineffective if static. They need to adapt as progress is made and as company circumstances change. A commitment to evaluation of energy management activities, perhaps on an annual or biannual basis, should be contained in the policy.

• **A commitment to effective communication** - If the profile of energy management within the company is to be maintained, it will be necessary to communicate the results of past actions to appropriate parties. The policy should contain a commitment to effective communication, perhaps by stating that an annual progress report will be produced. Whether reports will be public or internal should also be made clear.

• It is important to ensure that the energy policy is compatible with other company policies. If the company has an environmental policy, for example, it is important that the two policies contain the same aims in relation to energy efficiency and environmental protection. The content of health and safety and financial policies may also need to be considered.

The policy must be ratified by senior management and formally adopted by the company. The signature of the company director(s) at the end of the policy is an effective means of illustrating this. The policy document should be circulated to all departments or sections. Since the energy policy is intended to provide the framework for action rather than be a detailed action plan, it should not need to be amended regularly. Over time, however, the circumstances of the company may change and effective progress may mean that the overall aims need to be revised. Dating the policy can help to ensure that the most up to date version is being used.
3. Review, legal obligations and programme

3.1 Identification and review of energy aspects

The initial review should be regarded as a step by step process. The following steps are helpful and will be explained in detail:

1. Defining the goal and the scope
2. Collecting and measuring data
3. Data preparation and indicators
4. Developing an input-output analysis and a flow chart
5. Analysis and interpretation

1. Define the goal of the analysis

For a company that has no understanding of its energy consumption, it is useful to begin with a general review. The aim of the review is to determine the quantities, types and costs of energy used within the company. The following factors are to be considered when determining the scope of an energy study:

- **Intensity of energy consumption.** It is useful to begin the study in areas of high energy consumption. Generally it will suffice to analyse those machines and processes with the highest energy consumption. Experience has shown that 20% of machines or processes use about 80% of the total energy consumed.

- **Structure of energy consumption.** In many areas energy consumption does not have a direct link with production levels. Often this is misinterpreted as having no potential for energy saving. In some areas there is no detailed knowledge about energy consumption. Systems largely influenced by variable factors (e.g. outdoor temperature, daylight), and systems for which no detailed knowledge of fixed and variable factors exist should be analysed.

- **Maintenance systems or electronic office equipment** are often regarded as fixed factors. Although savings are relatively low compared to those of production processes, they can often be achieved with little or no investment. A change in behaviour does not require investment and can be attained with minimum effort and will add directly to the bottom-line.
Figure 1: Electricity consumption in a company – concentrate on main consumers and evaluate areas lacking in knowledge

In the example above more than 50% of the electricity use cannot be allocated to a specific consumer. This energy use should be analysed.

Beside the technical goals, the energy manager should look at both the organisation and at "human factors". Organisational aspects influence energy consumption due to low co-ordination between the individual departments or unstructured and irregular team work.

Human factors should consider:
- Motivation,
- Activities undertaken in the past,
- Opportunities to train in energy conservation.

Therefore the goal of the review may be to focus on human factors. An example is competencies and staff motivation for energy conservation in individual areas. The energy manager should identify staff with appropriate knowledge to support activities during the analysis; staff needing improved awareness; and how the team should be organised to increase efficiency.

Another important factor is green procurement. The goal of the analysis might be to identify areas for which purchase criteria for energy savings can be used. Household appliances, air-conditioning appliances, lighting sources and other equipment may be purchased with reference to the “European energy” label. The label categorises appliances from A (most efficient) (or in some cases A++) to G (least efficient) and shows how much energy is used under standard operating conditions. Higher initial investment in energy saving equipment can be quickly off-set against lower operating costs. Another label which helps to identify energy saving equipment is the “Energy Star” label, often found on office equipment. There are also national labels which help to identify energy saving appliances and which could be used as purchase criteria.
At this stage the senior management might be interested in knowing how much an analysis will cost and the savings that can be achieved. Unfortunately there is no general answer, every organisation is unique and every energy system is different. For a preliminary estimate of energy costs, and potential savings only, data available on site or data from the energy supplier should be used. This will not require a cash investment. Subsequently the energy manager will recognise areas where measurement will be needed to get more detailed information. The costs of an analysis must then be balanced against the potential savings that are likely to be generated. However, the reason for undertaking a review is to get an overview of the system and to minimise losses – if the company does not finance the analysis it will never identify its energy losses and potential savings. Once the scope of the study has been determined, the next step is to decide which areas will be considered and in how much detail.

2. Define the system boundary
Defining the system boundaries of a small company will be quite simple. Small companies usually focus on all areas at once and there is no advantage in dividing the company into several separate units. Senior management will be responsible for all areas and all fuels. Larger organisations will find this more difficult. At the beginning they should determine areas to be looked at or define and exclude irrelevant areas. It is good practice to define and include production units, storage facilities and office buildings in the initial review and to be aware of energy intensive areas. Care must be taken if energy consumption is not separated for private and company units or where floor space is shared. This might be the case when the owner of the plant lives on the site or two retail outlets trade from the same building, and only one measurement is taken for the whole plant. If appropriate, the company’s vehicle fleet should also be considered separately.

Another criterion is the current structure of the company. The specific structure will influence the relationship between departments, profit centres, cost centres, what data are available and hence which should be considered in a review. The structure of profit centres may differ from energy consumers. In this case the energy manager should consider that, since data for profit centres is already available, they should try to undertake the analysis following the given structure.

Before measurements can be undertaken the energy system and the distribution net must be known understood in detail – very often it might be necessary to update existing documentation. On this basis a measurement plan should be prepared including dates, responsibilities and measurements to be taken. The following example shows such a concept.

3. Collecting and measuring data
Structured data collection is fundamental to the energy review. In a first step only existing data sources should be used. Sources of existing information are:

- Invoices
- Meters
- Manuals
- Measurement documentation, e.g. meter readings
- Audit reports

It is also important to determine which kind of data should be collected and recorded:
Energy suppliers

- Collection of all bills for energy supplies of the last 2 years
  - Load \([\text{kW}]\)
  - Day, night, peak tariffs \([\text{kWh}]\)
  - Prices \([\text{€/kWh, €/kW·a}]\)
  - Costs \([\text{€}]\)

- It is highly recommended to assess energy supply contracts on a yearly basis and to check accuracy of prices

- Internal costs of energy supply should be clear, including
  - Internal costs of energy transport and transformation
  - Costs for staff and maintenance
  - Capital costs

- Be sure to keep the reference periods comparable for all energy sources

Infrastructure

Energy systems are often divided into production processes (consumers) and infrastructure. Infrastructure equipment provides necessary energy to run processes or to supply production processes and include systems such as boilers, compressed air, heating and lighting. The following data of should be summarised to get an overview about consumers of the infrastructure:

- Name of the equipment
- Manufacturer, type, year of construction
- Load
- Location
- Fuel
- Efficiency
- Relevant loads and levels (temperature, pressure, humidity)
- Maintenance intervals, maintenance contractor
- Additional remarks (technical condition etc.)

Consumer

According to the German standard VDI 3922 consumers should be separated into the following groups:

<table>
<thead>
<tr>
<th>Building equipment and services</th>
<th>Production equipment and machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Air conditioning and ventilation</td>
<td>• Drive systems</td>
</tr>
<tr>
<td>• Cooling</td>
<td>• Industrial furnaces</td>
</tr>
<tr>
<td>• Lighting</td>
<td>• Thermal processes</td>
</tr>
<tr>
<td>• General infrastructure such as lifts and kitchens</td>
<td>• Cooling processes</td>
</tr>
<tr>
<td></td>
<td>• Ventilation technologies for processes</td>
</tr>
<tr>
<td></td>
<td>• Compressors</td>
</tr>
</tbody>
</table>
Consumers might be also separated according to:

- building structure
- production processes
- cost centre

Data to be collected for consumers:

- Name and type of construction/machine
- Manufacturer, year of construction and technical condition
- Capacity or performance
- Peak demand
- Energy consumption
- Type of operation (full load, part load)
- Operation periods
- Load curve (suitable for load management)
- Control options

**Emissions**

The company's energy consumption contributes to global warming and therefore emissions have to be calculated, including:

- Unburned hydrocarbons (CnHm)
- Dust and soot
- Carbon dioxide (CO2)
- Carbon monoxide (CO)
- Sulphur dioxide (SO2)
- Nitrogen oxide (NOx)

Emissions might be identified by:

- Metering protocols (possibly a legal obligation)
- Calculations

CO2 emissions can be easily calculated on the basis of energy consumptions. The following table provides the relevant calorific values:

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Calorific value</th>
<th>max. CO2 emission according to calorific value [kg/kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light fuel oil</td>
<td>10,57 kWh/l</td>
<td>0,298</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>11,27 kWh/l</td>
<td>0,273</td>
</tr>
<tr>
<td>Natural gas (low)</td>
<td>9,76 kWh/mN3</td>
<td>0,182</td>
</tr>
<tr>
<td>Natural gas (high)</td>
<td>11,42 kWh/mN3</td>
<td>0,182</td>
</tr>
<tr>
<td>Coal gas</td>
<td>5,00 kWh/mN3</td>
<td>0,179</td>
</tr>
<tr>
<td>Brown coal</td>
<td>3,20 kWh/kg</td>
<td>0,343</td>
</tr>
<tr>
<td>Electricity</td>
<td>-</td>
<td>0,514*</td>
</tr>
</tbody>
</table>

*Source: Recknagel, VDEW*
A considerable amount of energy information is readily available to an organisation, but it often requires collating and interpreting. By simply gathering appropriate information, a clearer picture of energy use and costs will begin to emerge.

There are, however, problems associated with data collected from invoices, these might include:

- Invoices not copied for staff reference
- Data illegible, e.g. poor quality copying
- Confusion between accounting and consumption time frame
- Non-consumption billing for account adjustment (e.g. flat rates charged during the year)

**Calculating data**

Having collected invoice data, the energy manager will need to fill gaps in required data. This step will help to get a better overview of all areas involved. Calculations can be undertaken for areas where the power requirement and the operating hours are known. The following options exist:

- To obtain an estimate for light consumption, count light bulbs and multiply the number by operating hours and wattage.
- A rough estimate for engines and cooling equipment can be obtained by multiplying their power rating by operating hours.

**Meter**

As a next step, the energy manager will identify areas where no or little knowledge about energy consumption is available. It will then be necessary to think about metering the energy consumption of individual processes, plant or devices. If so, the following issues should be taken into account:

- The meter location depends on the structure of the system, and what is being measured. It should be as close to the energy consumer as possible.
- If it is necessary (e.g. due to high energy costs) to collect data regularly, an automatic system should be installed, e.g. for heating and air conditioning systems.
- Only suitable metering will deliver a reliable basis for identifying saving potentials and plan measures.
- Reading cycles must be representative. All shifts, peaks and seasonal differences have to be covered.
- For equipment/machines with low consumption, missing data could be calculated on the basis of existing information.

Separate metering is recommended, if:

- Consumption can only been calculated and is significant
- Potential consumption peaks must be identified

Metering electric consumers can be performed with a meter installed between the equipment and the bus bar. In this case it will be necessary to interrupt the power to install the meter.
Metering without power interruption can be performed in 2 ways:

- for resistive loads: using clip-on ammeters
- for reactive loads, such as motors: ammeter to measure reactive power

**Metering of electric active power**

The electric active power is calculated in case of **direct current** as the product of voltage and amperage:

\[ P = U \times I \]

- \( P \) = electric active power
- \( U \) = voltage
- \( I \) = amperage

In case of three phase current the electric power is calculated the following way:

\[ P = U \times I \times \cos(\psi) \times \sqrt{3} \]

An ammeter is necessary for metering the amperage for each of the three phases. The voltage between two phases is usually metered on the engine control and preferably at the same time as the amperage. The load factor of electric motors in partial-load operational range is in general 0.7 and in full-load operational range 0.9.

**Example:**

Metering under full-load operational range

Electricity consumption (kWh) = \([U \times I \times \sqrt{3} \times \cos(\psi) \times \text{operation hours} \times \text{load factor}] / 1000\)

e.g.:

90 A x 400 V x \( \sqrt{3} \) x 0.85 x 7000 x 0.8 = 296795 kWh

To meter the **power consumption** of the electric motor in case of **three phase current** the partial-load of two of the three phases has to be identified with two wattmeters. The total sum of the partial-loads is the total power consumption. Not many motor installations allow this metering procedure.

Load metering devices for electronic metering of amperage and voltage and calculation of the average value cost from 350 Euro. Cheap devices of low quality often show incorrect values.

**How to calculate the load factor?**

\[ LF = \left( \frac{P_{in}}{P_{rated}} \right) \]

\[ LF = \left( \frac{P_{in}}{P_{rated}} \right) \]

\[ \eta = \frac{V_{line} \times I_{line} \times PF \times \sqrt{3}}{P_{rated} \times 1000} \]

\( LF \) - Load Factor

\( Pin \) - Input electrical power (kW)

\( Prated \) - Motor rated power or nominal power (kW)
\( \eta \) - Motor full load efficiency (decimal)
Vline - Line voltage (V)
Iline - Line current (A)
PF - Power factor (decimal)

**Equipment required:** Wattmeter or Ampere meter, Voltmeter or Power Factor meter

source: http://promot.cres.gr/promot_plone/motors/overview/sizing
Use of characteristic curves of pumps and ventilations

One way to calculate the electricity consumption of pumps and ventilators is to meter the volume flow rate or the delivery flow rate with installed meters, triggers or ultrasonic measurement equipment. Characteristic curves of pumps and ventilations can then be used to read the required load for the pump or ventilator. Theoretically it is similar with the delivery height. As many pumps have a flat characteristic curve the consequence of a minor mistake in estimation would be considerably.

Part load characteristics of pumps

Pumps are always defined by the basic Pump characteristics below. They show the relationship between head, power and efficiency against flow. It is important to see just how "peaky" the efficiency might be; that running at part load (head and/or flow) is likely to lead to a significant reduction in pump efficiency. The Best Efficiency Point (BEP) of a pump is ideally at the rated load point.

![Centrifugal pump characteristic](source: http://promot.cres.gr/promot_plone/pumps/relevant-studies)

Figure (A3.1) – Centrifugal pump characteristic

Metering of Lighting
- Illumination can be metered with a luxmeter
- Light consumption can be calculated taking into account different times of the day and seasons
- Take into account relevant legal requirements and standards for illumination intensity

Metering of temperature
- Metering the ambient air, air and water flows, surfaces
- Taking into account different times of the day and seasons
- Take into account minimum temperature needs and legal requirements

Metering of Volumes
- Metering using inductive flow meter
- It is important to measure the flows throughout the day
Metering Compressed Air

- Usually electricity consumption of the compressor will be metered (e.g. using ammeter to measure reactive power)
- Energy consumption will be compared with the volume of compressed air produced
- Leakages should be identified by identifying the amount of compressed air produced within 24 hours with switched-off consumers, but switched-on compressors
- Leakages can be identified with ultrasound microphones

Methods of collecting metering data

There are some principles in collecting and metering data:
- At least two people should know the location of all meters and be trained to read them.
- Meter readings should be taken at such time that metered consumption corresponds with normal reporting (or invoicing) periods, e.g. month end, week’s end etc.
- Sufficient time has to be allotted to meter reading.
- Manual data collection means that the whole site is walked regularly. This provides an opportunity to observe and report faults that might otherwise remain undetected.

Data quality

As these data will be important for future comparisons, they must be collected systematically. It must be clear what data will be collected, by whom and at what time. Experience has shown that the person responsible for the process or the department being studied should be in charge of collecting data.

The system analysis is only as good as the quality of data used; information based on the analysis of poor data will be meaningless. The accuracy of data is of considerable importance as is the consistency of data collection methods. There is little point ensuring that a meter is 100% accurate, or that cost data are calculated to five decimal places, if the person responsible for collecting data reads the wrong meter or calculates costs from estimated invoices. It is important that follow-up calculations and the development of indicators are based on real data rather than on estimates.

4. Data preparation

In this step of the review the data for the company have to be prepared in a way that it allows the performance of the company to be evaluated. Very often it is helpful to use diagrams to summarise the data.

When preparing data the following points should be taken into account:
- Use only that data which is essential for the analysis
- Reduce data to small units
- Clearly label all data
- All columns and rows in a table must have a heading
- Describe the source of the data used, any assumptions made and calculation used during its collection
- Note the date of collection and the date of preparation of the data, the name of the person who collected and prepared the data and the file name.
Guidebook on Energy Management

Build indicators

Indicators can be compiled for:

- the whole company
- divisions of the company
- processes

Indicators are a helpful instrument to compare processes, machines or companies. Some examples of the usage of indicators are to compare:

- Machines with different capacities
- Processes which use different technologies
- Machines which produce similar products
- The efficiencies of similar machines.

Indicators are built with measured data and reference units. For example, energy consumption of the heating system per total floor area.

There are two types of indicator:

**Absolute indicators.** The goal is to decrease energy consumption from 80 MWh to 70 MWh within the next 12 months.

**Relative indicators.** The goal is to decrease energy consumption from 80 kWh/unit to 70 kWh per unit of production within the next 12 months

It is common practice to use relative indicators in order to be able to compare different systems. You can, for example, refer to quantities of pollutants and energy use of products, employees, departments, other companies etc. The following table provides examples of possible absolute and relative indicators.

<table>
<thead>
<tr>
<th>specific energy consumption</th>
<th>total energy consumption</th>
<th>kWh/PQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage use of energy carrier</td>
<td>individual energy carrier in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Energy intensity</td>
<td>energy consumption of processes/products in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Percentage use of renewable energy carrier</td>
<td>renewable energy in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Specific energy cost</td>
<td>total energy costs in Euro</td>
<td>%</td>
</tr>
<tr>
<td>Specific energy costs for energy carriers</td>
<td>costs per energy carrier in Euro</td>
<td>€ / kWh</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage use of energy carrier</th>
<th>total energy consumption</th>
<th>kWh/PQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage use of energy carrier</td>
<td>individual energy carrier in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Energy intensity</td>
<td>energy consumption of processes/products in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Percentage use of renewable energy carrier</td>
<td>renewable energy in kWh</td>
<td>%</td>
</tr>
<tr>
<td>Specific energy cost</td>
<td>total energy costs in Euro</td>
<td>%</td>
</tr>
<tr>
<td>Specific energy costs for energy carriers</td>
<td>costs per energy carrier in Euro</td>
<td>€ / kWh</td>
</tr>
</tbody>
</table>
The selection of the correct reference unit is important. The reference unit should:

- have a clear link with energy consumption;
- be simple to calculate (for example production units, resource input);
- have a link with the output of the aspect of energy consumption which is being evaluated (for example for production units, kg per final product).

5. Input Output Analysis

The development of an input-output analysis helps to provide a clear picture about the company’s overall position and show the yearly emissions. The analysis should contain

- Energy inputs
- Emission and waste heat outputs

Inputs consist mainly of non-renewable energy such as oil, natural gas and electricity. If appropriate, renewable energy such as wood should be mentioned. On the output side, mainly emissions and waste heat will be mentioned. Emissions such as carbon dioxide are directly linked to the company’s energy consumption and contribute to negative environmental effects. Staff should be aware of these effects and realise that their activities do not only have an influence on consumption but also the environment.

**Input**
- Coal
- District heating
- Electricity
- Natural gas
- Oil
- Wood

**Output**
- Emissions
- Waste heat

Table: Input-Output analysis

Waste heat occurs in several industrial processes, machinery and compressors and can be used in other applications including space heating. Recovering this heat can prove highly cost-effective, resulting in a reduction in overall energy bills. However, as it is not easy to identify the available waste heat, an expert should be contacted for detailed advice and analysis.
Design a flow chart
With the data collected to this point, the energy system should be visualised with an energy flow chart. This is a graphical representation of all relevant energy flows in the company.

A simple flow chart can be designed to illustrate energy flows as shown in Figure above. This kind of illustration can be prepared using professional software or by hand. The goal is to identify the organisation’s energy flows and the associated quantities. The flows must have the same physical units. The width of the flow depends on the energy consumption of the system or machine.

6. Analysis and interpretation methodologies
Simply to gather information is not enough. To be of benefit the information must be analysed and interpreted. A variety of methods for analyzing are available, which have varying functions and degrees of sophistication. By selecting appropriate methodologies, patterns of variation and the relative importance of energy use within the organisation can be identified.

Once data on energy consumption and cost has been collected, the next step is to apply appropriate methods of analysis in order to interpret the data and identify any gaps in the data set. Data can be analysed for variation patterns including:

- Daily patterns
- Weekly patterns
- Seasonal patterns

The use of these patterns depends on the importance of the data in terms of quantity and costs. A daily or weekly pattern is useful when data are collected automatically, when significant costs are involved or when immediate reaction is required.
Other techniques which can be used to analyse energy data include:

- **Simple bar charts** (Example of the energy consumption for district heating)
Degree day analysis (see chapter II-2)
Specific energy charts (see figure 1-5)
Percentage variance charts (see table 1-4)

- Benchmarks (Example of warm and hot water consumption in industries)

<table>
<thead>
<tr>
<th>Building</th>
<th>Consumption</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>10 - 40 l/day/person</td>
<td>45°C</td>
</tr>
<tr>
<td>Stores</td>
<td>10 - 40 l/day/person</td>
<td>45°C</td>
</tr>
<tr>
<td>Bakery</td>
<td>105 - 150 l/day/employee</td>
<td>45°C</td>
</tr>
<tr>
<td>- for cleaning</td>
<td>10 – 15 l/day</td>
<td>45°C</td>
</tr>
<tr>
<td>- for production</td>
<td>40 – 50 l/100 kg flour</td>
<td>70°C</td>
</tr>
<tr>
<td>Hairdresser</td>
<td>150 – 200 l/day/employee</td>
<td>45°C</td>
</tr>
<tr>
<td>Laundry</td>
<td>250 – 300 l/100 kg linen</td>
<td>45°C</td>
</tr>
<tr>
<td>Brewery including production</td>
<td>250 – 300 l/100 l beer</td>
<td>60°C</td>
</tr>
<tr>
<td>Butcher excluding production</td>
<td>150 – 200 l/day/employee</td>
<td>45°C</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>400 – 500 l/day/employee</td>
<td>45°C</td>
</tr>
</tbody>
</table>

- **Current year against last year** (Example of Calculating specific energy consumption and specific gas consumption)

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry cleaning PQ</td>
<td>2 869 kg</td>
<td>2 960 kg</td>
<td>3 482 kg</td>
</tr>
<tr>
<td>Total Electricity consumption</td>
<td>703 MWh</td>
<td>743 MWh</td>
<td>858 MWh</td>
</tr>
<tr>
<td>Spec. Electricity Consumption</td>
<td>245 kWh/kg</td>
<td>251 kWh/kg</td>
<td>246 kWh/kg</td>
</tr>
<tr>
<td>Total Gas Consumption</td>
<td>7.034 MWh</td>
<td>7.932 MWh</td>
<td>8.388 MWh</td>
</tr>
<tr>
<td>Spec. Consumption of gas</td>
<td>2.45 kWh/kg</td>
<td>2.68 kWh/kg</td>
<td>2.40 kWh/kg</td>
</tr>
</tbody>
</table>

Comparison of current data with data from previous years and with benchmarks will indicate the company's performance over time and in relation to other similar companies. Data evaluation aims to identify energy reduction opportunities in order to reduce costs, improve environmental performance and secure energy supply.

**Analyse selected areas in detail**

For particular industrial processes, benchmarks and comparison data are unlikely to be available. The only way to identify possible savings is to determine the theoretical energy consumption of the individual production processes from literature and compare these figures with real consumption. If the consumption differs, it is necessary to identify the reason and to try to improve the process. This should only be undertaken by well trained staff or by external experts.
3.2 Legal obligations

Legal obligations are one of the key driving forces for improving performance within companies. With increasingly severe penalties for breaches of legislation and greater disclosure of information concerning non-compliance, companies can no longer afford to ignore their statutory duties. Costly adaptations to plant and processes in order to meet new standards can also reduce competitiveness if companies do not plan ahead for such changes. A good knowledge of both current and proposed energy related legislation is, therefore, essential.

Only with such procedures in place will the organisation be able to gain EN16001 registration. There is now a vast array of energy related legislation in force and this continues to grow yearly. By no means will all of this be applicable to an organisation, so you will need to spend some time going through the legislation to see what is relevant. Only legislation relevant to the activities, products and services of your company should be included in the register. Any breach of legislation will be viewed as a failing of the EMS and registration will be withheld. A breach after registration has been received could result in deregistration. It is important, therefore, that the register not only identifies which legislation is relevant but, in addition, provides an interpretation of the legislation and translates the requirements into company specific actions. Similarly, any proposed legislation which is likely to impact on the company’s operations should be identified and interpreted in the register.

If the company has planning conditions attached to its operations at the site, discharge consents to meet, or process authorisations which it must adhere to, these requirements should be included in the register. Any policy requirements, whether internal or corporate, should also be recorded. These may include codes of practice, charters, and industry standards which the company is committed to. Again, the implications of these for the day to day operations of the company should be assessed and recorded.

Compiling the register

There should be a register of regulations in place or a description of the procedure used to identify relevant legal obligations. Changes in legislation are occurring rapidly so it is important that procedures are also established for ensuring that the register is up-to-date. These procedures should also be documented. In practice, a step by step procedure could help to comply with environmental legislation:

- Identification of materials, plant, waste, emissions, general planning which are covered by legislation
- Decide what actions are required in order to ensure compliance with legislation and define roles and responsibilities for these;
- Decide how to update the register of regulations

Since the register must be applicable to the organisations activities, products and services, a useful starting point when compiling the register is to consider the environmental aspects of the organisation. These aspects can be grouped within 2 different areas:

- Plant and machinery (e.g. regulations for machines, maintenance; emission levels, )
- Products and services (e.g. potentially harmful during use; discharge..)

Consideration should be given to impacts arising from emergencies and accidents as well as from normal operating conditions. For each of the aspects which you identify, legislative and policy requirements should be assessed. For some aspects the legislation may be extensive and complex. Regulatory authorities and trade associations are good sources of expertise.
Defining roles and responsibilities helps to guarantee that possible areas of concern are eliminated and appropriate actions are taken. In practice it could be helpful to note which units within the organisation are affected by a regulation so that all staff are aware which areas of work are regulated. Within the audit process legal compliance will be verified. Comments from staff identified as responsible should be noted in the register of regulation to explain how action will be undertaken to guarantee legal compliance and how updated or new legislation will be communicated to appropriate staff.

The last step is to define how the register of regulations will be updated. There should be a system in place which states by which person and at what intervals the register should be updated. In addition the necessary resources must be available to complete this task. The format which the register should take is not prescribed. It is, therefore, up to you to develop a format which is appropriate for your organisation.

From the initial review it should be possible to determine the organisation's current position with respect to legislative and policy requirements. The register should include a brief summary of the current position and an action plan detailing what needs to be done. A target date for reviewing progress should also be included. The following suggests a possible layout for the register.

**Topic**

**Relevant areas, activities, products, services**
1
2
3

**Relevant Legislation, regulations, policies**
§
§
§

**Compliance requirements**

**Regulatory Authority**

**Internal responsibilities**

**Appropriate procedures and documentation**

**Current position**

**Action**

In summary, the following points should be mentioned in a register:

- Organisational unit, product, activity or aspect as identified within the energy review to which the regulation is relevant
- Name of the law, directive, legal regulation or administrative regulation including clear identification (e.g. name, publication date..)
- Explanatory remarks
- Description of activities and tasks which have to be undertaken to comply with the regulation
- Description of any corrective actions which must be undertaken to meet the requirements of the regulation
- Appropriate regulatory authority
- The person responsible for ensuring legal compliance
- Date of progress review
3.3 Energy programme

A policy alone is not enough to achieve change within an organisation since it is too broad to be of use on a day to day basis. The company will be unable to tackle every issue at the same time and so must prioritise its work. In order for potential environmental and cost benefits to be realised, the principles and aims contained in the energy policy must be translated into action through the development of objectives and targets. The information collected during the survey phase can be used to establish priorities and develop a costed plan for improvement within the framework of the policy.

The objectives and targets in the action plan or work programme should identify how the aims in the policy will be achieved. Objectives and targets should be realistic, achievable and should provide a basis for monitoring improvement. This means that wherever possible they should be quantitative, stating what level of improvement will be achieved within a given time scale. Where applicable, actions should be costed.

An objective defines what is to be achieved in a particular area. For example, one of the company’s objectives in relation to energy may be ‘to reduce energy consumption for lighting’. The number of objectives which the company establishes will depend to a large extent on the amount of resources it has available for energy management.

A target quantifies an objective by specifying a quantity and a time frame. Using the example above the target may be ‘to reduce energy consumption for lighting by 10% by April 2010’. The targets established should reflect the company’s priorities for energy management and should be challenging enough to ensure a visible improvement in performance but at the same time must be achievable.

Identifying Priorities

In order to identify those areas on which action should focus first, the company must establish a set of priorities. This will require a certain amount of information about the company’s current performance in relation to energy management which should be available from the energy survey or review. The company will also need to establish a set of criteria against which priorities can be determined. These may include:

- legal compliance
- industry standards
- ease of implementation
- cost benefit
- basis for future action
- environmental improvement

Legal compliance

A key priority for any organisation must be to comply with legislative requirements so as to reduce the risk of prosecution and prevent environmental damage. This is particularly important for those companies in which the energy management system forms part of a wider environmental management system which is, or is intended to be, accredited to EMAS or ISO14001.

There is not a large quantity of legislation relating directly to energy management. Legislative breaches are most likely to relate to exceedance of legal maxima or minima for lighting, heating or ventilation levels or to Building Regulations or Health and Safety requirements. However, the use of energy may have implications for compliance with broader environmental legislation.

For example, if the company decides to use oil as a source of fuel this will need to be stored on site. In order to prevent the risk of water pollution or land contamination from spillage or
leakage, the oil tank will need to be properly contained and filling adequately controlled. If pollution or contamination does occur prosecution under a number of pieces of environmental legislation may result.

**Industry standards.** Energy conservation and good energy management has to a large extent been policy rather than legislation driven. The result has been the development in a number of countries of best practice standards, benchmarks and award schemes. These provide a good indication of what can be achieved through effective energy management over a range of industrial sectors. Achieving a good performance against industry standards may be of priority for your company, particularly if you are operating in a sector where competition is high.

**Ease of implementation.** The company may wish to prioritise those objectives which it can implement quickly and easily. It can take some time from the endorsement of a policy to the point where actual savings or improvements can be demonstrated. Maintaining staff motivation during this period can be difficult. Acting upon objectives which need few organisational changes and which give quick, even if small, results can be beneficial.

**Cost benefit.** Those actions which bring greatest cost benefit may at first sight appear the most attractive but this does not necessarily mean they should appear near the top of a priority list. Objectives which require high capital expenditure, even if bringing large gains, may not be feasible or desirable in the early stages of implementing an energy management system. If the company has very little available capital it will need to focus on no or low cost actions first. Reinvesting the savings will enable more capital intensive projects to be funded at a later date. Demonstrating the potential for savings with little capital risk can also be a good motivating factor at the start of an energy conservation campaign. However, it should be noted that low and no cost actions often require high levels of staff involvement which may not always be easy to obtain in the initial stages of an energy management programme.

**Basis for future action.** In some circumstances it may be necessary to achieve certain objectives before others are feasible. For example, the company may need to determine appropriate lighting levels for certain tasks before it can take action in relation to an objective to save energy on lighting.

**Environmental improvement.** A company’s action in relation to energy management may be part of a broader environmental action programme. It may, therefore, wish to prioritise those energy related actions which bring about the greatest environmental improvements.

**Setting Realistic Targets**

In order to monitor improvements in performance it is essential that the targets set for achieving objectives are quantitative and realistic. They must set the level of and timescale for improvement. It is important to avoid setting unrealistic targets. They must be feasible within the constraints of financial and other resources. Lack of achievement can act as a strong demotivator. At the same time targets must include some rigour. If they are achieved too easily significant change may take a long time to achieve and the actions which are taken will lack credibility.

In setting targets it is important to consider the wider context within which the energy management system operates. Factors which should be considered include:

- economic constraints
- process and equipment constraints
- technological advances
- availability of personnel
- conflict with other interests
- absolute and proportionate targets
**Economic constraints.** The funds which the company has available may determine how realistic a target may be. For example, if to achieve a target of 20% reduction in energy use the company has to purchase a new piece of equipment, it may be more realistic to fix a target of 10% reduction in the short term if this can be achieved simply by modifications to the existing plant. Replacement of the plant may remain a long term objective. It could be argued, however, that this strategy will cost more overall. A full cost benefit analysis should be performed on those objectives which require a large capital outlay.

**Process and equipment constraints.** Certain high energy use processes or pieces of equipment may have a significant influence on a company’s overall energy consumption. Fixing a target of, for example ‘a 10% reduction in energy use during the next 12 months’ for process energy may be unrealistic if the company is not in a position to make changes to these key sources of energy use. Fixing separate targets for individual processes or for individual pieces of equipment may result in more realistic targets.

**Technological advances.** Assumptions should not be made about the future availability of technology and the potential savings which its use may bring. Targets should be based upon what can be achieved using currently available technology. They can always be adapted at a later date to take account of changes.

**Availability of Personnel.** It is not just capital which can constrain what a company is able to achieve. If a particular target requires a large input of staff time, it is essential to ensure that this will be available when needed. It is also important to ensure that the necessary skills and knowledge base is in place. Senior management commitment is essential.

**Conflict with other interests.** Objectives and targets set in relation to the energy management system may come into conflict with those set in relation to other policy areas. For example, changing operating procedures to reduce energy consumption may result in a conflict with health and safety procedures, or introducing a different fuel in order to reduce the cost of energy consumption may result in higher air emissions.

Other policies may act as a constraint to what can be achieved so it is important to maintain an overview of company policies and consult with staff responsible for these areas of work before targets are implemented. The aim should be to achieve a balance between all interests.

**Absolute and proportionate targets.** The company’s circumstances are likely to change over time. Production, for example, may increase. Proportionate rather than absolute targets may, therefore, be more meaningful. For example, if the company set a target to reduce energy consumption on a particular process by 10% within two years (an absolute target) but in that time production doubled, a reduction of 20% would have to be achieved in order to meet the original target. It may be more appropriate, therefore, to define the target in terms of units of production so, for example, the above target may become ‘to reduce energy use by 10% per 100 Kg of X produced within two years’ (a proportionate target).

Future additions or alterations to products or services may also influence the targets which have been set. Clearly defined boundaries are therefore essential.

Once fixed, it does not mean that objectives and targets cannot be amended. It is unlikely that the company will meet every target which it sets out to achieve. The energy management process is cyclical. The evaluation procedure will determine how effective the system has been in achieving the targets set, whether the targets are appropriate and what changes need to be made.

Once objectives and targets have been established, the mechanisms for achieving them must be considered. Even in a small company there may be a number of different ways in which a particular target can be achieved. A reduction in energy consumption for lighting, for example, could be achieved by fitting remote sensors to control when lights come on or by fitting low energy luminaries.

The first step then is to assess the options available in order to determine which is most
appropriate. In practice it is likely that a number of different actions will be used together to achieve the target.

The constraints of capital, equipment and personnel outlined above in relation to targets apply equally to actions. Some actions, although resulting in the desired effect, may not be possible because the capital or personnel to implement them is unavailable. Most actions will have a fixed budget requirement which will depend on the technological and staff resources which need to be input. Availability of capital and other resources will determine the timescale within which an action can be achieved.

Once actions have been identified, responsibility for their implementation must be assigned and the necessary funds allocated. All of this information should be collated into an action plan. This could be in a tabular form such as the one illustrated below.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Target</th>
<th>Action</th>
<th>Responsibility</th>
<th>Budget</th>
<th>Deadline for completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce energy use for lighting</td>
<td>Reduce energy use for lighting by 10% by April 1999</td>
<td>Assess lighting levels needed for all processes and tasks; Fit low energy luminaries; Fit remote sensors to control when lights come on</td>
<td>Heads of Department /Energy Manager; Chief Engineer</td>
<td>€600; €400</td>
<td>September 2008; December 2008; March 2009</td>
</tr>
<tr>
<td>Reduce energy consumption during production</td>
<td>Reduce energy use by 10% per 100 Kg of product X by January 2009</td>
<td>Assess all sources of energy use in the production process of product X; Additional action to be determined following identification of energy uses</td>
<td>Production Engineer</td>
<td>€150</td>
<td>August 2008</td>
</tr>
</tbody>
</table>

The plan will need to be modified over time, particularly if new products or processes are added or in light of the results of preliminary actions.

An action plan alone will not result in action. The structure for energy management within the company will need to be established and training provided to ensure that staff can undertake their allocated tasks. Awareness raising is essential to motivate staff. Incentive schemes can also prove useful. In cases where objectives and targets will be achieved through changes in working practice rather than the installation of new technology, it may be necessary to write procedures which describe how a task should be undertaken. Progress towards achieving the action plan will also need to be monitored. It is possible that the company will not achieve all its targets. This may be because they were too ambitious, because of changes in external circumstances or because other elements of the energy management system (e.g. the provision of training) failed to support action. The effectiveness of the whole system should therefore be checked periodically and appropriate amendments made.
Writing Procedures

Written procedures provide a valuable means of control in an energy management system. Where an objective or target requires a task to be undertaken in a certain way, a procedure should be written so that all staff are aware of what is required of them. Written procedures also provide a means of communicating the company’s requirements to suppliers and contractors.

Each procedure should contain the following:

- An outline of the purpose of the procedure
- A description of the tasks or activities which it relates to - the scope of the procedure
- A summary of roles and responsibilities in relation to the procedure
- A description of what has to be done

The standard proforma given in the table below can be used as the basis:

<table>
<thead>
<tr>
<th>Procedure for:</th>
<th>..........................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date: (when procedure approved)</td>
<td>Ref: (reference number or code)</td>
</tr>
<tr>
<td>Purpose:</td>
<td>(State what the procedure aims to achieve.)</td>
</tr>
<tr>
<td>Scope:</td>
<td>(State the situations to which the procedure applies.)</td>
</tr>
<tr>
<td>Responsibilities:</td>
<td>(State the responsibilities of all persons who have a role in implementing the procedure.)</td>
</tr>
<tr>
<td>Procedure:</td>
<td>(Describe what should be done, how it should be done and when it should be done.)</td>
</tr>
<tr>
<td>Related Procedures:</td>
<td>(State title and reference number of any relevant related procedures.)</td>
</tr>
</tbody>
</table>

Gathering proposals

During the first data collection and the preparation of the data sources, the energy team will identify definite weak points within the energy system and improvement possibilities for energy use. Some ideas will focus on simple actions which could be implemented immediately and which do not need additional funding.

Other problems will consider more complex solutions and will need more detailed analysis of their cost/benefit ratio. The first step in this process therefore is the collection of ideas which will be evaluated at a future date.
There are 2 useful techniques to collect ideas:

- Brainstorming
- Improvement proposals

Brainstorming:
Brainstorming is a technique to spontaneously collect ideas for the solution of a problem. A brainstorming starts with a warm up and a clear briefing (targets, procedure, rules) by the Energy Manager. The process consists of two steps:

1. Collection of ideas
2. Assessment of the ideas

During the collection phase the Energy team states all possibilities to decrease the energy consumption. The Energy Manager notes all ideas on a flip chart and stimulates all participants to provide as many ideas as possible. In case of uncertainties only the author is allowed to explain. One advantage of this technique is that also new and creative ideas will be detected which could present a new approach to solve a problem.

Improvement proposals on site:
Energy management requires active participation of staff throughout the whole organisation and at all levels. This intellectual potential is often underestimated. Employees know their working areas, plant, and machinery better than many others and normally have a very clear understanding of possibilities for improvement. Therefore improvements suggested by employees in different departments must be considered and analysed.

Staff must be given the opportunity to post improvement proposals. All ideas will be collected within the departments or directly beside the machinery. Meetings or a regular time could be allocated to discuss the ideas and to explain possible steps in more detail. The member of the energy team checks each suggestion following pre defined criteria and presents the idea to the energy team. It is important to...

- describe the weak point
- describe the solution
- describe how the improvement could be carried out
- underline very clearly who has mentioned the idea

And do not forget to give feedback to the author of the idea about further steps.

Financial evaluation:
At some point a decision will have to be made as to whether an opportunity to improve efficiency is to be implemented or not. Assuming that the opportunity is otherwise feasible, it will be essential that a financial evaluation takes place. The purpose of the evaluation will be to determine the net financial costs and benefits of an action. In the simplest terms, the lower the investment (costs) and the higher the savings (benefits) the more likely it is that a given action will be implemented. Having determined the costs and benefits, the viability of the action will be determined according to established financial criteria. What these criteria are should be ascertained prior to applications for funding as knowledge of their attendant calculations will be required.

There are several methods for calculating the financial viability of an action or project. The simplest, most often used by smaller organisations but the most unreliable, is payback. Although more reliable, other methods are more complex and include Net Present Value and Internal Rate of Return. For smaller organisations, acceptable payback periods are unlikely to exceed three years and will often be considerably shorter.
When deciding which calculation method suits the company best, it is important to understand the capital value:

If you consider an investment, you consider benefits over the year; you consider the interest rate for the money you have to borrow from the bank.

First of all it is necessary to choose the appropriate interest rate. A good idea is to look for another project where you can profit or to look for what interest rate is available from the bank for an investment of a similar amount. The following example shows which effect an interest rate of 10% will have on an investment and benefits in a 5 year period. While a static calculation method results in a profit of € 5000 the dynamic method shows that, including the value of money over time, profit is only € 864.

Example 1:

<table>
<thead>
<tr>
<th>t₀</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10000</td>
<td>1000</td>
<td>3000</td>
<td>3000</td>
<td>4100</td>
<td>3900</td>
</tr>
</tbody>
</table>

= -10000 + 1000* $\frac{1}{1.1}$ + 3000* $\frac{1}{1.1^2}$ + 3000* $\frac{1}{1.1^3}$ + 4100* $\frac{1}{1.1^4}$ + 3900* $\frac{1}{1.1^5}$ = 864

€ 1000 after one year = 1000 + 0.1*1000 = 1100. The money remains the same and interest rate will be added.

Example 2: € 1000 for 4 years
Interest rate 10%

Yearly 10% = $\frac{10}{100}$ = 0.1

= 1000 * 1.1 * 1.1 * 1.1 * 1.1 = 1000 * $1.1^4$ = 1464

Final amount = Initial amount* $q^n$

q = Factor by which money increases
On the other side it is sometimes more important to identify the value of money which will be paid in the future. How much is € 1464 worth today when it will be paid in 4 years? Interest rate = 10%
In this case it is necessary to calculate backwards:

$$1464 \times \frac{1}{1.1^4} = 1000$$

$$\frac{1}{q^n} = \text{discount factor}$$

The following example shows that, considering an interest rate of 8%, payments over 4 years results in money worth € 4904.

<table>
<thead>
<tr>
<th>Year</th>
<th>Savings</th>
<th>Savings accumulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>6000</td>
</tr>
<tr>
<td>3</td>
<td>4000</td>
<td>10000</td>
</tr>
</tbody>
</table>

1. Static investment calculation does not consider interest rates. For short periods with continuous money flows this is ok, however for longer periods with irregular money flows this financial calculation should not be used.

2. Dynamic calculations consider interest rates

Static methods:
The costs of an investment the benefits over the years will be considered:
Example: Investment of 10000; Savings of
First year: 4000
Second year: 2000
Third year: 4000
Fourth year: 5000

In case of an investment of € 10000 in this example there would be a payback time of 3 years. However, this does not tell if the investment is of advantage because no interest rate is considered. The payback is also achieved if after the period of 3 years no other benefits occur. In this case you do not lose or win anything.

Dynamic pay back:

Example: Same figures as above, Interest rate of 10%:
Pay back can be achieved after 3.5 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Savings</th>
<th>$\frac{1}{1.1^t}$</th>
<th>Savings</th>
<th>Savings accumulated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4000</td>
<td>$4000 \times \frac{1}{1.1}$</td>
<td>3636</td>
<td>3636</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
<td>$2000 \times \frac{1}{1.1^2}$</td>
<td>1653</td>
<td>5289</td>
</tr>
<tr>
<td>3</td>
<td>4000</td>
<td>$4000 \times \frac{1}{1.1^3}$</td>
<td>3005</td>
<td>8294</td>
</tr>
<tr>
<td>4</td>
<td>5000</td>
<td>$5000 \times \frac{1}{1.1^4}$</td>
<td>3415</td>
<td>11709</td>
</tr>
</tbody>
</table>
4. Management, communication and controlling

4.1 Resources, Roles, Responsibilities

Appoint an energy manager
Irrespective of a company's size, it is necessary to appoint an energy manager. He or she will be responsible for all activities undertaken within the initial review. If the company does not appoint a specific person for these tasks, nobody will feel responsible and the chances are that required tasks will not be carried out.

In addition, the role and competency of the energy manager must be communicated throughout the organisation. The energy manager must have the power to ask for support in areas in which he/she has no detailed know-how. Practice has shown that the initial review takes less than a week in very small companies (< 50 employees), at least two weeks in medium-sized companies (50 – 250 employees) and around a month in large organisations (> 500 employees).

One of the first tasks of the energy manager will be to get an overview of the information and data already available in the organisation. Apart from written documents there will be a lot of knowledge within the workforce. If appropriate, the energy manager should therefore identify people working in energy-intensive areas and in areas over which have an influence on energy consumption.

Typically, these areas are:

- Production
- Infrastructure
- Maintenance departments

In medium-sized organisations (> 250 employees), the energy manager should constitute a formal energy team which supports related activities and which acts as a link between the energy manager and other departments. The energy team consists of people who have a sound knowledge of individual processes and technologies. Their knowledge might be used to influence energy consumption in their departments and to contribute to the development and support of a company-wide strategy. This is necessary as practice shows that individual departments rarely co-operate to increase efficiency. Secluded production processes and a cost accounting system following profit centres act as a barrier to a common strategy to increase the overall efficiency of the energy system. In smaller organisations the energy manager will already be familiar with the organisational structures and co-operate on an informal basis.

External exerts are often contracted when the organisation does not have relevant know-how or faces a lack of resources. Main advantage of an external expert is an open minded view on the energy system and organisational structures. Practice shows that areas of improvement can be often identified by external consultants. Main disadvantage of this solution are high costs, the fact that staff often blocks actions recommended by an external expert as this is seen as interferences of proved procedures and time needed to familiarise with the job.
Beside the energy manager and his team all other players in the organisation must have clear roles and responsibilities to guarantee a successful energy management system.

- **Top management**
  - Definition of strategic objectives
  - Definition of project management
  - Allocating resources

- **Middle management (e.g. heads of department, energy manager)**
  - Organisation of data collection
  - Planning of energy demand
  - Development of an action plan
  - Controlling

- **Operative level (e.g. operators, caretaker)**
  - Support of decision making process, development of measures and data collection
  - Implementation of measures

The relevant stakeholders of an energy management system are:

- **Top Management**
  - „smooth run“, meeting financial targets, making profits

- **Production**
  - Meeting product quality and delivery targets, optimising production costs, reliability of the equipment and machines

- **Machine Operator**
  - Reliability and good usability of the equipment, decreasing failures and malfunctions

- **External: Manufacturer**
  - Sale of machines/equipment with the best price, customer satisfaction

- **Supply Engineering**
  - Reliability of the supply chains, optimising energy costs (staff, fuels, etc.)

- **Sales**
  - Improving selling and buying conditions, “one stop shop”

- **External: Advisor**
  - Identifying improvement potentials, customer satisfaction
Main tasks of the energy manager and his team are:

- Development and implementation of energy management strategies
- Development and implementation of an energy information system (energy bookkeeping system)
- Internal and external communication
- Development of the energy program, identifying improvement proposals and implementing actions to increase energy efficiency
- Purchase of energy and implementing guidelines for the purchase of energy efficient equipment
- Development of an energy report
- Staff training and awareness training
- Contact point for staff

Energy management structure:

Allocating roles and responsibilities will depend on the organisational structure. This will strongly depend on existing hierarchies and the organisational culture.
Resources
Resource management requires the planning of a project and the investigation of its feasibility. It can involve varying degrees of detail and will be influenced by the culture of the company. Resource management is a part of project management. It deals with either input and distribution of resources which are a priori defined or with the search for potential resources. Resources include personnel (qualifications and competencies), money, time and material/equipment.

The increasing drive towards shorter schedules and rigid quality performance generates a greater demand than ever for productive projects and cohesive project teams. A critical ingredient to achieve higher levels of performance, however, is the implementation of strategies that encourage projects and team work. Experience shows that if the cost and time estimates are accurate in the first place, there are fewer overruns and less expense. This may involve investing some time and money in a proper planning base (feasibility study). This could amount to three to five percent of the total project cost, but it is better than abandoning a project halfway through.

The outcome of a resource management study should be a draft concept consisting of:

- timetable
- budget
- personnel / qualifications
- material / equipment
- external support - specific requirements
- project specification / objectives and goals

4.2 Awareness raising

All groups need to know:

- How to implement energy savings,
- Background information about the energy consumption,
- Energy costs and the performance of improvement activities.

Information should be prepared for top management, staff, and external stakeholders. It is obvious that the individual target groups need different information for their respective areas. One reason for this is that each group uses different terms and ways to communicate. It might be necessary for top management to focus on key figures of the company in a very technical way. It will be more helpful for other staff to receive practical advice of how to act, and to receive graphically prepared information about performance.

In addition to top management, staff must be informed about the Energy Management system as soon as possible in order for them to accept and support the system. Unfortunately this rarely happens in larger organisations and leads to a rejection of the system. The Energy Manager has to set up a continuous information and awareness raising system as early as possible. This system is the basis for future activities in the area of energy savings and shows the results of actions.
Information for company staff could cover many areas such as:

1. Information about the Energy Management System
2. Data, indicators and performance
3. Information and advice for correct use of equipment
4. Opportunities to reduce losses
5. Contact points for staff with improvement proposals

First of all it must be clear for all staff that energy is a key topic for top management and will be actively supported and controlled.

Secondly the Energy Manager must specify which information will be given to staff and how it will be prepared. This may include data such as quantities, costs and emissions, presented clearly using pictures and graphs. Although this sounds simple, transforming boring energy data into an interesting picture which attracts people who have never dealt with energy topics is a very time intensive and creative activity. In addition, staff should be informed and trained to know how their activities influence energy consumption.

The third topic concerns awareness raising. This kind of information does not necessarily focus on energy data and company related activities directly but should help people to understand why energy efficiency is an important topic. This may include topics including environmental problems linked with energy use (e.g. the Kyoto protocol), the energy consumption of private households compared with industrial consumption, local initiatives to decrease energy consumption, and emissions trading.

The fourth topic considers documentation. When talking about information the Energy Manager must also set up a system to collect, analyse and store the information. This will mainly happen when implementing an Energy Book Keeping (EBK) system but must be considered right from the implementation of an EMS. In addition it could be helpful to document the system in a manual.

Information about the EMS should include the name and telephone number of the energy manager, the energy team and their roles and authority, the company's energy policy, the current energy goals in the programme, the necessary activities to be undertaken to achieve these goals, dead lines and performance to date, and the results of the energy audit.

Data about the company’s energy consumption will come mainly from the Energy Book Keeping System. The Energy Manager should bear in mind that this information may need to be prepared for the individual target groups and that not all information is relevant. As staff is normally overloaded with work, information must be precise and well prepared. There is, for example, no use giving staff in the production area exact data about the heating consumption in the administration building. It is the task of the Energy Manager to prepare and visualise data for the respective areas, to agree targets and to monitor performance. A good way to do this with the group concerned is to elaborate on how information should be prepared and presented. This should include not only be information presented on the intranet and in hard copy but also consider personal preferences. Be aware that it is difficult for staff to visualise information that is given only in quantities such as Kilowatt hours or cubic metres. An option is to present quantities as a comparison with household quantities or to express consumption data in monetary terms. For example, “the energy consumption of all PCs in our company (40 000 kWh) is equal to the total annual electricity consumption of 5 households!”
Correct equipment use: Staff who work with machinery and in areas where significant use of energy is made should be trained. This includes training in how activities must be carried out to have a positive influence on energy consumption. General advice might be given for use of office equipment but it should be linked with company data. It is, for example, a good idea to present the energy consumption of printers and to describe what energy savings may be achieved by switching them off during nights and week-ends. It is clear for everybody that different raw material qualities, different temperatures in a process, different product qualities and other variables will have an influence on energy consumption but these facts are often never analysed in detail. Practice shows that it needs a highly motivated team and an ineffective energy manager to launch measurements and tests on how material input, changed processes and the decrease of machinery use might influence energy input.

Losses occur in all areas and are closely linked with incorrect equipment use. General advice might be given for heating and lighting. Turning off the lights when leaving the office or in unused rooms and closing windows and doors in heated areas are typical examples for reducing losses in office buildings. Losses in production areas are more sophisticated, and normally depend on the machinery and the production process. An example for this is compressed air and losses due to leakages. Practice shows that staff often realise there are leakages in compressed air pipes but are not aware of the costs or the procedure repairing the leak.

Another possibility is a contact point where staff may discuss and develop improvement proposals. The information about such a contact point or hotline must be announced internally and results should be published to keep the system alive. In many cases the office of the Energy Manager may act as such an info-point. An info-point has the advantage that staff will be encouraged to express their ideas in a proper way. In addition, ideas and proposals may only be described in a very basic way so that the energy team can investigate and develop the concept itself.

The key element of an awareness raising campaign is information. Firstly it must be demonstrated to staff that there is a problem and, subsequently, that their actions are having an effect. Appropriate methods for awareness raising could include:

- An energy newsletter
- Posters and leaflets
- Competitions and reward schemes
- Suggestion boxes
- Informal discussions during lunch and coffee breaks
- Involvement of employee representatives in energy management meetings
- Presentations by external specialists on selected topics

4.3 Communication

A very important function of an energy management system is to communicate consumption and performance data. Information which is not forwarded is useless. Internal communication helps staff to evaluate activities and be aware of the results achieved. Information is also crucial for motivation. If targets are not met the reasons why should be analysed in order to avoid future failures.

Information to external parties helps to create confidence in the company and can be used to promote its services and activities.
Reports should be compiled for a well defined target group. General reports or very detailed reports are not often widely read. Before a report is compiled the following should be considered:

- Who requests the information?
- What kind of information is necessary?
- How should information be provided?
- When should information be provided?

In larger organisations information will be targeted individually to 3 groups:

- Staff and external groups
- Staff who control energy consuming plants and equipment
- Top management

**Staff and external groups**
General information about energy for all staff and external groups is difficult to prepare. Staff are overloaded with information, papers and emails and do not deal with additional general information, especially if this information is not obviously relevant for their work place. It is therefore a challenge to prepare this information clearly and concisely. The goal is to motivate staff to deal with energy in an efficient way.

**Staff who control energy consuming plants and equipment**
This target group needs clear information about the energy consumption of plant and equipment. It is important to explain how to influence energy consumption directly and how to run equipment efficiently. This information cannot be provided once a year in an energy report but must be provided on a day to day basis and in a way that is convenient for staff. In general it is better to provide details of current energy consumption, compare it with indicators, and discuss how to reach consumption targets. Managers should have the opportunity to monitor energy consumption on an ongoing basis.

**Top management**
Top management is interested in costs, targets, performance and future activities to increase efficiency. This information should be prepared in a summarised report and presented to top management and discussed at least once a year.
**Communication options**

The choice of certain media to launch and disseminate information depends on the size of the company and the strategy in place. The decision must be taken by the managers responsible. The following media are a selection of possibilities for small and medium sized companies:

- **Intranet** – This option is becoming more and more important in the area of energy use as consumption data can be monitored in real time.
- **Press summaries (clippings)** will be collected for concerned staff inside the organisation, e.g. the energy team or the general manager, and will focus on energy management articles in newspapers and magazines.
- **Letters** are a very old fashioned way to communicate, but in today’s electronic world with floods of emails they are a very good way to attract attention.
- **Leaflets** help people to remember specific topics, and by signing the document top management makes sure that everybody takes notice of them.
- **External Media**: Articles in newspapers and brochures and Company magazines.
- **Direct communication**: Telephone – considerations include how and what information will be disseminated via telephone and how staff should react in the case of a telephone enquiry.
- **Speeches**

When developing materials the person responsible should take some time to ensure a standardised design - especially small and medium sized companies who tend not to pay attention to layout and graphics – as staff identify topics by the design of the document and can handle this information more easily.

**Other activities:**

- A system of staff energy efficiency improvement proposals helps to increase awareness among staff. This system needs the committed support of top management because good ideas must be awarded.
- **Public relations (PR) activities** in the area of energy management focus on external target groups and need a more intensive input of time and resources. A PR activity combines individual elements such as press releases with an event about Energy management in the company.
- **Events, Seminars, and Workshops** can be held to focus on the importance of Energy management. Different kinds of events offer the opportunity to underline the responsibility of each individual staff member and to collect improvement proposals.
- **Company celebrations** could not only be undertaken if there are specific festivals or holidays but also if the staff can celebrate a specific success. Such a party is a very good opportunity to focus on the topic of energy from a different perspective and to discuss it in a relaxed atmosphere.

**Energy report**

The energy report should be compiled on a regular basis and summarise all activities and data about the energy consumption of the past period. The main goal of the report is to inform management about the energy management system. The findings should be presented to top management including planned activities and the budget required to increase energy efficiency.

An energy report should not only summarise key figures but also pay attention to the activities undertaken and to the planned activities. The Energy Report may be a decision
basis for the top management on which activities to support and which budget to dedicate to energy related activities. Environmental Reports will normally be published if the company follows EMAS or ISO 14001 (both environmental management standards). Within those reports the energy management system could be described for external groups.

An energy report should have the following structure:

**Energy Report**

**Executive Summary**
- Motivation for developing an energy report
- Main findings and areas of improvement

1. **Introduction**

Overview on the company including:

- Address
- Number of employees
- Products and services offered
- Building area (m²)
- Sales, main markets
- Main responsibilities
- Energy Manager / Energy team
- Activities implemented and success stories

2. **Energy price & development**

Supplier and net price of:

- Electricity (Euro/kWh)
- Gas (Euro/kWh)
- Oil
- District heating
- Petrol
- Renewable energy / usage

- Description of energy prices for the past 5 years and outlook for the coming year
- Description of the price structure (e.g. transmission costs, costs which can be influenced, costs for measuring)

3. **Total Consumption (Excel template)**

- Cost structure of the company (staff, energy, investments, capital)
- Energy consumption for the last 5 years.
- Energy benchmarks (energy consumption/product; energy consumption/m²)
- Explanation for energy consumption changes, e.g. increase of production, outdoor temperatures, losses, improved technology
4. Energy Consumption of Individual Areas

Energy Bookkeeping System for:

**Infrastructure:**
- Heating
- Cooling
- Compressed air
- Illumination
- Air conditioning
- Electric motors

**Production:**
- Electricity, heat, cooling, water consumption of main production processes

*Figure 5: Example of a Sankey diagram to visualise the energy system*
5. Areas of Improvement

- Power management
- Boiler
- Air rate of ventilation systems
- Compressed Air
- Replacement lighting
- Switch to a more economic electricity tariff
- Reduce unnecessary lighting
- Replace ordinary bulbs with fluorescent lamps
- Repair leaks in compressed air networks
- Prevent unnecessary heating especially in frost protection systems
- Clean condensers on cooling systems
- Reduce unnecessarily high room temperatures
- Prevent unnecessary heating by checking set points and overhauling control equipment
- Control ventilation running times
- Clean boilers and overhaul burners
- Switch from electrical heating to district heating

Example of an overview for improvement proposals:

<table>
<thead>
<tr>
<th>Action</th>
<th>Pay back time (years)</th>
<th>To do</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>New boiler and change to natural gas</td>
<td>&gt;5</td>
<td>Boiler needs to be changed during the coming 2 years and new boiler should be a condensing boiler</td>
<td>20-25% of current heat consumption</td>
</tr>
<tr>
<td>Heat recovery from the ventilation system</td>
<td>5&gt;..&gt;3</td>
<td>Install heat exchangers in air outlet and air intake tube</td>
<td>Up to 50% of heat consumption of production process „spraying“</td>
</tr>
<tr>
<td>Thermostatic valves on radiators in office building</td>
<td>&lt;3</td>
<td>Install thermostatic valves in office</td>
<td>3-5% of heat consumption in office building</td>
</tr>
<tr>
<td>New energy efficient lamps in production hall</td>
<td>&gt;5</td>
<td>Install new energy efficient lamps with electronic ballast and reflectors</td>
<td>1.440 kWh</td>
</tr>
<tr>
<td>Optimize compressed air</td>
<td>&gt;5</td>
<td>Reduce pressure to 8 bar, limit engine idling speed to 10 min</td>
<td>10% of electricity for compressed air</td>
</tr>
<tr>
<td>Peak Power management</td>
<td>&gt;5</td>
<td>Reduce peak demand through better demand management: Stagger use of large electrical loads.</td>
<td>Savings of 6x per KvAr reduction in available supply capacity.</td>
</tr>
</tbody>
</table>
4.4 Energy Management System documentation

Developing an Energy Management System (EMS) will generate a lot of documents. Documents are important as they are the record of events in developing and operating the EMS and they are evidence of what has been done. For example, documentation of training will show what kinds of training programmes have been conducted, why they have been conducted, who has attended and when they attended. An EM System requires a full hard copy, summarised in a manual or related documents.

The Energy Management Manual

The primary purpose of energy management documentation is to provide a good description of the energy management system. The energy management manual should act as a permanent reference to the implementation and maintenance of the system. Documentation of policy, objectives and targets, management programme, key roles and responsibilities and the interaction of system elements is a necessary part of a management manual. The energy management system does not need to be contained in a single manual. It should provide directions to other documentation that contains more specific information on parts of the energy management system. It can also point to related documentation, which may include:

- process information
- task descriptions
- internal standards and operational procedures
- site emergency plans

The nature of documentation can vary depending upon the size and complexity of the organisation. The manual should contain information on the following areas:

- A description of the management system, detailing its scope and purpose and its relationship to the organisation’s energy policy, objectives and targets
- A copy of the energy policy
- The organisation’s objectives and targets
- An organisation chart, depicting the organisational structure with respect to energy management. This should include a list of the names of current job-holders
- Criteria for assessing significant energy consumers
- A list of significant energy consumers
- A register of legislative, regulatory and other policy requirements
- A list of procedures and work instructions with energy relevance (the detailed documents themselves may be annexed)
- A description of the organisation’s energy management programmes
- A description of the system for keeping energy management records
- Arrangements for regular audits, including reports or references to the location of reports
- Arrangements for management reviews

To achieve the document control outlined above, it is important to ensure that all documentation is:

- Date stamped (including any dates of revisions).
- Readily identifiable for example, by named procedures, clear reference numbers, specified ownership, etc.
- Maintained in an orderly and easily referenced manner, i.e. by providing numbered and lettered references to individual procedures, schedules etc. in a systematic way
4.5 Document Control

The documents related to the EMS must be reviewed, revised and approved on a regular basis so that up-to-date information is available on the task or work activity being performed. To ensure against unintended use, obsolete documents should be promptly removed from all points of issue and points of use, while any obsolete documents retained for legal and/or knowledge preservation purposes should be identified as such.

The organisation should ensure that:-

Documents can be identified with the appropriate organisation, division, function, activity and/or contact person
Documents are periodically reviewed, revised and approved prior to issue
Current versions are available at all appropriate locations
Obsolete documents are promptly removed

4.6 Operational control

Every organisation will have processes or procedures which are the main energy consumers. As a rule of thumb 20% of equipment consumes 80% of the energy used. It is necessary to identify the equipment and processes and ensure that they are operated in an efficient way.

For the main equipment and operations written operation procedures (including advice on how to deal with energy responsibly) need to be developed. In addition a maintenance plan has to be developed and followed to secure the efficient operation and minimise breakdowns.

In addition to the energy efficient operation of existing equipment, it is important to ensure that energy efficient equipment is procured. This is easy for household appliances which are labelled with the EU label for energy efficiency (rated A or A++ (best) to G (worst)). Industrial equipment is often designed and built on demand with no considerations given to operating costs. In this area it is of importance that the energy manager includes purchase criteria such as “energy efficiency” or “water consumption” in procurement guidelines.

The last area concerns the construction of new buildings and the refurbishment of existing facilities. The future energy consumption of facilities, buildings and halls need to be taken into account during the design phase and the energy manager must make sure that not only investment costs but also operational costs are considered.

It is the duty of the energy manager and his/her team that information about the correct operation of plants and equipment, maintenance procedures, procurement principles as well as the design of new buildings is communicated effectively to concerned staff.
5. From Monitoring to Review

5.1 Energy Monitoring

Energy Monitoring refers to how energy management data is derived, recorded, and stored. Data will relate to a number of different areas of the business and is ultimately intended as the basis from which energy management decisions can be made. Fundamentally, data is most likely to relate to energy consumption and costs, however other pertinent data is likely to be required, such as production levels, degree day data, and the purchase price of energy saving technology.

Since energy management is a continuous decision making process intended to control and improve energy consumption and costs, a system for ongoing data monitoring will need to be put in place. The data will be used to monitor improvement against the objectives and targets set out in the action plan.

New areas of opportunity can also result. Initial monitoring and analysis to establish baselines for comparison with standards will help to determine the areas with opportunities for improving consumption. When opportunities are identified they will be listed and prioritised according to a set of established criteria. Prioritised opportunities provide the basis for objectives and targets which, once set, will need to be continuously compared to current performance. The policy expresses the overall goals of the company, objectives and targets are established to translate these goals into practical action.

Monitoring and targeting

A full monitoring and targeting process involves a series of stages. Whether such a system is developed using bought-in expertise or by relying on in-house expertise, monitoring and targeting systems can vary. The process in this guide guide uses a series of logical steps that can be developed further to ensure that monitoring is not a one-off process but is continual. The main steps are described briefly below:

The first step is the identification of energy costs and consumption according to fuel type, and the recording of the data derived on tables and stored in an appropriate form. Data can be represented in graphical form to give a more readily understandable picture of consumption and costs. This will help to identify which fuel type accounts for the greatest proportion of energy consumption and cost.

The second step involves using ‘degree day analysis’ to determine how the cost and consumption of energy are related to the weather. This is most likely to be associated with the analysis of space heating. The plot derived from the relationship between degree days and cost/consumption can provide a useful insight into energy consumed by those activities that vary (or do not vary) according to the weather.

Boiler efficiency is then determined, followed by the comparison of production with energy consumption. This is used to find the fixed and variable costs associated with production. Clearly this will require production data. Data on electricity use and transport fuels are then analysed.

A control chart is in the recommended choice for the fourth step as the basis of a monitoring system. The correlation, if one exists, between production and energy consumption is used to construct a control chart. The chart incorporates upper and lower limits which will indicate times of unexpected consumption, whether too high or too low. If records of sufficient detail are maintained then the causes of these unexpected variations might be identified.
Demand for space heating, evaluation of process efficiency and the establishment of an action plan are then advised. Clearly there are a number of techniques which require some knowledge. Regression to determine ‘lines of best fit’ when relating consumption to either weather or production is one.

This then is the basis of a monitoring and targeting system: The collection of raw data, which will include energy consumption and costs, production figures, and the recording and storage of that data in an appropriate format. Targeting the use of appropriate analysis techniques to translate data into more meaningful information for identification of opportunities and comparison with targets follows. Finally comes reporting, which might occur at various stages of the process. If information is relevant and reported to appropriate personnel, understanding and action should follow.

The system
As technology has developed over the recent past so the number of ways a monitoring system can be set up has increased. Large energy users can justify the cost of computer-based systems and the associated training and expertise. For smaller users, too much automation can be counterproductive. In choosing the appropriate system, it is worth considering whether the cost savings will justify the costs of technology, training and staff time. The amount invested in the system should correspond to the potential energy savings. Whether the options available are applicable to a company will depend upon their individual requirements with regards to level of coverage and/or sophistication.

Coverage
The following list may help determine the situation that applies to your company and generate ideas in respect of your system needs:

- The site is treated as a whole and data is monitored using only the most basic of sources, e.g. the utility meters for general consumption data and invoices for general cost data. Information is obtained for the site only.
- Single site with sub-metering. Sub-metering, or other applicable measuring techniques, is put in place or is already in place so that each specific area is monitored independently. Information can be obtained for both the whole site and each area.
- Multi-site utility based. The company has a number of premises and each site is monitored separately, but utility meters and invoices are used for data collection. Information is obtained for each individual site but not for each specific area.
- Multi-site with sub-metering. The system covers a number of areas within a number of sites. Sub-metering is used to monitor each area separately; information ranging from a specific area to the whole organisation can be obtained.
Level of sophistication
The following list describes the different levels of sophistication and can be used to determine which most readily applies to your situation. Again it might help as a starting point for generating ideas in respect of your company needs:

- Manual systems. These monitoring systems are paper based and require tabulation of data on forms. They depend on manual recording of data and scrutiny of invoices for raw data.
- Keyboard input systems. These are an extension of the above and depend on the same process for data collection. Computers are used for data storage, manipulation/analysis and reporting via either a keyboard or portable data capture unit.
- Automatic input systems. Data is monitored automatically; meters are connected to a computer via a data logger or other interface. Costs and other variables can be entered either by keyboard or automatically, although data can be provided ‘second-hand’ by other applications. In this context, “automatic” means that data is input directly from meters rather than indirectly from other applications.
- Advanced systems: This refers to automatic systems that are integrated with other ‘expert’ - e.g. accounting and order processing - systems.

Data quality
The system is only as good as the quality of data used. Information based on analysis of poor data will be meaningless. Accuracy of data is of considerable importance; however consistency of data collection methods is of equal importance. There is little point ensuring that a meter is 100% accurate, or that cost data are calculated to five decimal places if the person responsible for collecting data reads the wrong meter or calculates costs for estimated invoices. Ensure that adequate procedures are put in place, documented, stored and updated as necessary.

Recording and Storage
Already discussed in part is the recording of data. Clearly there is little point in ensuring that data is being produced and is accurate and pertinent if it is not recorded and stored in an appropriate form. Storage of data will be required since data might be gathered over a number of time periods e.g. immediate or ‘run-time’, hourly, or weekly and be required for analysis over a longer time period. Clearly the way in which data is recorded and stored will depend on and/or influence the system that is put in place to gather data.

Whatever system is selected, it will need to take account of the energy management decisions that are to be made, one of the fundamental decisions being where to focus energy reduction. It is advised that for most manufacturing Small to Medium Sized Enterprises it is likely that the total energy consumption and costs across the whole company will be monitored as well as the target areas. One reason for this is that it is assumed that identification of the activity in which the greatest potential for energy reduction measures is yet to be identified. Additionally, since energy management is a continuous process, once opportunities in one area have been exhausted other areas should be considered, or several areas might present sufficient and/or significant opportunities simultaneously.

To calculate the total consumption, cost and consumption data for all delivered fuels will need to be gathered and converted to common units. Recording and storing this information will depend on the level of sophistication that is appropriate to the company and will be dependent on potential savings and available resources. It is likely that for smaller companies initially data will be gathered, recorded and stored using manual systems. If invoices are required then the energy manager will need to ensure that copies are obtained.
If a computer with a spreadsheet facility is available then it may be appropriate to use this for analysis. If this is the case then inevitably someone will require the necessary skills. As energy management continues and savings are realised consequently then more automated systems might become a viable alternative.

As costs and consumption become more precisely defined according to specific activities, so monitoring, recording and storage will need to be adapted. For example, if it is decided that sub-metering is needed to monitor energy used in compressed-air, then additional documentation will be required to record compressed air consumption figures.

Since the primary objective of monitoring is the provision of information to measure performance against objectives, targets and actions, then the energy manager will need to ensure that not only are these measurable and are monitored but also that regular comparison takes place. In addition, action will need to be taken to rectify any situation in which objectives, targets and actions are not being met. This will include a financial element in respect of budget allocation.

It is essential that budgets are not overspent. To minimise the chance of this occurring information will need to be of sufficient integrity, e.g. regularly updated and accurate. Any under spend will need to be accounted for to ensure that moneys are redirected into other energy management initiatives. There will be a requirement for storage of additional documentation, not only records of raw cost and consumption data. Documentation from other sources will include training, procedural, legislative, process specification, revised action plans, etc. Thought should be given to the way in which these are stored. Experience suggests that although companies have all the necessary information available in some shape or form it is very rarely the case that there is a system in place so that it is available in a useful or easily accessible form.

Data analysis is covered in the initial survey stage. Many of the principles referred to in that unit are applicable to the monitoring stage. Communication of performance in relation to objectives and targets is essential; information that is not communicated serves no purpose. The primary function of reported information is to encourage action through understanding.
Structure of an energy monitoring system
The following example visualises how a simple system could be structured to monitor performance over time:

<table>
<thead>
<tr>
<th>Energy Book Keeping</th>
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<td>11</td>
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</tbody>
</table>

5.2 Evaluation of compliance

Evaluation of compliance is needed to make sure that up to date information about legal requirements is available to the organisation. Broadly, there are two types of procedures:
- Management procedure – deals with issues including the updating of documentation and the identification of new laws, regulations, and requirements
- Control procedures – deal with the way in which certain tasks are carried out to comply with legal requirements – e.g. the operation of the boiler house or the storage of heat oil

For these areas documented procedures are needed: For example, the receipt, storage and handling for heating oil and the procedures for operations during abnormal conditions such as start-up, shut down and maintenance.

You should also consider having procedures for onsite contractors so that they understand what they have to do to comply with your energy policy: For example, how they should deal with, and who they should inform, when there is either an accident or incident, for example, the accidental spilling of a liquid.
5.3 Nonconformity, corrective action and preventive action

The organisation must have procedures in place to identify the potential for nonconformity and to respond to it appropriately. Typically nonconformity will occur in several areas:

- Energy consumption and energy costs for predefined areas and production processes
- Operation and management practices (operation plans for machines, procurement practices)
- Maintenance and servicing procedures
- Inspections

When there are problems or failures in plant or equipment, caused by human error or deficiencies within the management system, these need to be investigated to establish what happened. The investigation procedure will:

- Determine the cause
- Draw up a plan of action
- Initiate preventive actions, to a level corresponding to the risks encountered
- Apply controls to ensure that any preventive actions taken are effective and reoccurrence is avoided
- record any changes in procedures

An example of a problem could be if an emission limit set by legislation was exceeded. Reasons for this could be:

Technical: Equipment failure leading to the limit being exceeded

Human error: An incorrect action, such as a procedure not being followed, resulting in the limit being exceeded

EMS deficiency: Limit is exceeded at certain times, usually at shift change. Investigation shows that there is insufficient hand-over time between staff – job descriptions and work procedures were deficient in setting out requirement for a proper hand-over period.

Once the cause of the problem has been identified, appropriate procedures need to be put in place to prevent reoccurrence. Any changes to equipment, operating procedures, job descriptions, etc will need to be properly documented.
5.4 Control of records

The purpose of record control is to make sure that necessary documents are available to staff so that EMS goals and targets can be achieved. There has to be a system in place so that records are up to date and available.

The following documents should be included in this system:

- Organisational charts
- Process information
- Internal standards and procedures
- Emergency plans

Records describe procedures which will be repeated and include:

- Training records
- Process information
- Inspection, maintenance, calibration records
- Pertinent contractor and supplier information
- Incident reports
- Information on emergency preparedness and response
- Audit results
- Complaint records
- Management reviews

For all the above mentioned areas record templates should be available. In addition storage, revision of templates, a version control, archiving and disposal should be defined and clear. The energy manager and the EMS team are responsible for identifying all document and record requirements appropriate to its EMS. The document and record requirements are determined from the applicable regulatory and policy requirements as described in the EMS Requirements and EMS Policy. Environmental documents/records are maintained by each Division and are made available to auditors/inspectors, contractors, and staff upon request.

Document Control

The current version of each controlled document should be maintained electronically on the designated electronic storage system. The primary site for EMS information and updates should be located on the company’s Intranet server.

All controlled EMS documents should contain a Document Change History Table. This table can be used to track the nature and date of each document revision. Each time a controlled document is revised, the following information should be added to the Document Change History Table:

- Revision Dates - the date of each document revision
- Nature of Revisions - a brief description of the nature of the revision
- Names of Document Review Participants - list the name of each individual who participated in the document review/revision

Controlled documents can be originated by anyone who can demonstrate the value and need for such a document. The energy manager is typically responsible for reviewing, approving and managing documents related to administration of the EMS.

When document revisions are needed, the document approver makes appropriate revisions to the document and routes a draft revision to Unit Energy Coordinators likely to be affected by the changes for review, with a specified timeframe for providing comments. Comments
received on the document revision are reviewed by the document approver and incorporated, as appropriate. The document approver shall notify the provider(s) of comments which are not addressed in the revision of the reasons why the comments were not addressed. Upon approval of document revisions, the document approver posts the revised document to the electronic storage system and notifies affected individuals that a change has been made. Notifications are made via email or other appropriate form of communication. Unit Energy Coordinators are responsible for notifying affected personnel, under their direction, of relevant document changes.

Staff may print documents from the system. However, personnel are responsible for understanding that printed documents are current only as of the date and time printed. Staff must verify that printed documents are current prior to use. This can be accomplished by checking the Document Change History Table included at the bottom of the controlled, electronic version of the document. Individuals who print controlled documents are responsible for destroying those documents immediately after use.

Documents are periodically reviewed to ensure they are up to date. Document approvers establish the frequency for and ensure the performance of these periodic reviews.

Record Control

**General Responsibilities** - The Energy Manager has overall responsibility for the identification, storage, protection, retrieval, retention and disposition of all EMS records. Certain types of records may be generated and managed by responsible personnel (i.e., assigned document owners) and may be stored in the individual’s respective area(s).

**Types of Records** - Records are generated and maintained in an electronic format where possible. However, hard copy records may be generated and maintained where the maintenance of electronic records is ineffective or unfeasible.

**Identification of Records** - The Energy Manager identifies records that must be generated and maintained to demonstrate the effective operation of the EMS. The Listing of Records identifies the record owner(s), storage location, storage format (e.g., electronic or hard copy) and retention guidelines for each required record.

**Maintenance of Records - General requirements for all records**

Records must be maintained in a manner that ensures that they are:

- Readily retrievable
- Reviewed and updated as necessary (documents)
- Protected from alterations or damage (records)
- Available when and where needed
- Removed or archived, as appropriate, when obsolete
The following requirements are specific to the maintenance of hard copy records:

- Hand-written entries shall be screened for legibility by document owners and/or reviewers during normal record processing. If illegible entries are identified, the occurrence will be handled as a non-conformance item.
- The Energy Manager shall review all areas where hard copy records are stored. Storage of records is provided in secure filing and/or storage cabinets in an environment which prevents damage, deterioration or loss or in an electronic data file with appropriate access control. Record storage areas shall be secure from unauthorised access and free from reasonable environmental threats (e.g. water leaks, extreme temperatures, etc.)

The following requirements are specific to the maintenance of electronic records:

- Each controlled document is maintained electronically on the designated electronic storage system (e.g. computer disk drive, web server, etc.). The primary site for EMS information and updates is the local Intranet server. Any changes made to the EMS information intranet site will automatically update the EMS information that the Intranet web site is linked to.
- Electronic records that are under the control of persons that do not have read/write permissions to the Intranet are maintained in a designated electronic storage location.

**Retention of Records**

Record retention requirements may be established by regulatory agencies, staff, customer contracts, etc. The record retention guidelines included on the Listing of Records represent the minimum duration that each type of record must be maintained. At a minimum, the organisation ensures that applicable regulatory-required retention times are met. Staff periodically assess record retention requirements during internal audits.

Records retained beyond the assigned retention requirement are not considered to be EMS records. They are “Historic Records” and will no longer be managed under the requirements of this EMS.

**Disposal of Records** - Records that have been maintained in excess of applicable retention times are to be archived. Potentially sensitive records, such as personnel-related or legal records, are destroyed prior to their disposal. Non-sensitive records are managed with other waste office papers.

**Document history table example:**

<table>
<thead>
<tr>
<th>Revision Date</th>
<th>Nature of Revision</th>
<th>Document Review Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/10/2007</td>
<td>Update content</td>
<td>Energy Manager</td>
</tr>
<tr>
<td>19/10/2008</td>
<td>Update content</td>
<td>Energy Manager</td>
</tr>
</tbody>
</table>
5.5 Internal Audit

Every system must be evaluated from time to time to ensure that it is functioning as planned and is achieving the outcomes which the company desires. An energy management system is no exception. Essentially the audit process provides a means of ensuring the adequacy and efficiency of the systems which the company has put in place to ensure compliance with its energy policy. The process of auditing brings a number of benefits to a company:

Areas of non compliance with legislation and policies are identified, reducing the risks of prosecution, environmental damage, and unnecessary costs.
It focuses employee’s attention on practices and procedures and improves awareness and understanding of energy related issues.
Key areas of risk are highlighted and areas of strength and weakness identified.
It ensures that senior management are kept informed of performance in relation to energy management.
It ensures that the management system is updated and improved rather than being treated as something static and inflexible.
It ensures that the company’s energy policy, objectives, and targets are relevant.

The audit process involves three basic elements:

- Planning
- Information collection and evaluation
- Reporting and corrective action

As with any piece of work, the initial step in the audit process is to define its objectives and scope. In order to ensure that the energy management system is functioning properly, all elements must be checked. However, the company may not have the resources to look at the whole system at once and there may be some elements which merit more frequent checks than others. It will therefore be necessary to identify precisely what each audit will cover.

Establishing the Objectives and Scope of the Audit

Objectives: The basic objectives of the audit process will remain constant over time. These should be to:

- Assess the management system in place
- Determine conformity with company policies and the site programme
- Assess, where applicable, compliance with relevant legislation

In addition, the company may decide to add further objectives which may relate to specific issues or problems or to particular company priorities. The company may, for example, wish to concentrate on the effectiveness of training and awareness raising strategies. Alternatively, if areas of concern were highlighted in a previous audit exercise the company may wish to establish specific objectives in relation to those.
**Scope:** For each audit exercise it will be necessary to define:

- Which activities are to be considered (this may be a particular production process or activity or may be a corporate energy use such as lighting)
- Standards to be considered (for example, will the audit focus on compliance with the company procedures and indicators or assess performance against industry best practice)
- The period covered by the audit (this would normally be the period which has elapsed since the previous relevant audit exercise)

**Selecting the Audit Team**
The next step is to decide who should carry out the audit. The number of people involved will depend upon how much of the energy management system is being audited and the size of the company. In small companies one or two people will probably be able to audit the whole system. In larger companies a team of people may be needed. It is important that the right people are selected to conduct the audit.

Members of the team should:

- Be sufficiently independent of the activities being audited so as to be able to make an impartial judgement
- Have appropriate knowledge of the activities being audited. Individual members of the team do not need to have detailed knowledge about every activity but this should be possessed by the team as a whole.
- Have the necessary skills to undertake an audit.

The team may consist of the company’s own staff, external consultants or a combination of both. The use of external consultants would ensure that the above criteria are met and can help to provide a new perspective on the company’s activities. They are also less likely to experience conflicts with other work loads and priorities. On the other hand, using an internal team will significantly reduce the cost of the audit exercise and has the advantage that in-house staff are already familiar with the company’s activities and general policies and procedures.

**Preparing the Audit Programme**
Before information collection and auditing begins it is essential that senior management are aware of, and committed to, the audit process. They will need to ensure that the appropriate resources are allocated to the exercise, including time away from other duties for in-house staff, and that the team have access to all relevant areas of the site, staff and information.

The team should prepare in advance a programme for conducting the audit which may include interviews with relevant staff, observation and monitoring. A briefing for senior management and for appropriate personnel should be arranged in order to explain why the audit is being undertaken, what will happen and what the role of all parties in the process will be.

Any safety and security issues should be raised and resolved at this stage.

**Document Collection**
Before the audit team begins to collect evidence on-site, it is important that they are familiar with the activities being considered and with the policies and programmes in place within the company. The team should consider appropriate documentation such as the policy and the company’s energy management targets before beginning the audit. Factual data about the company’s performance in relation to energy use should also be considered.
The information required will be determined to a large extent by the scope of the audit and the level of association which members of the audit team have with the company.

The following is indicative, however, of the type of information which is likely to be needed:

- Plans of the site including location of processes, meters, and sub-meters etc.
- Structures and responsibilities relevant to energy management
- Operating procedures / process outlines
- Energy consumption records and profiles
- Maintenance records
- Previous audit findings
- Details of the management system in place
- Details of training and awareness programmes
- Company performance versus established objectives and targets

Information collection and evaluation is the most important element of the audit process. It is during this phase of the process that the team will gather the evidence which they need to assess performance at the site.

Site Tour
If outside consultants are being used they will probably require a brief orientation tour to provide an overview of the operations at the site and to allow them to familiarise themselves with the site layout and location of key processes and control measures. They will probably also need an office to work from during their visit and someone within the company to act as primary contact.

Collecting Evidence
The team must evaluate performance at the site in order to ensure that it meets the standards set out in the company’s policies and procedures or in best practice standards and that the systems to manage energy use are effective. In order to do this they must gather appropriate evidence.

There are three basic ways in which evidence can be collected:

- Inquiry
- Observation
- Testing

**Inquiry:** This will involve interviews with staff and consideration of appropriate documentation. Interviews may involve the completion of checklists or may take the form of a general discussion. The purpose is to gather evidence on a range of issues which may include the following:

  - That the procedures followed on a day to day basis by staff are consistent with those documented
  - That the documented procedures are appropriate to the company’s situation
  - That staff are aware of their roles/responsibilities in relation to energy management
  - That staff have the appropriate knowledge and skills to fulfil the requirements of their role
  - That staff have appropriate awareness and understanding of the company’s energy policy and programmes

**Observation:** The purpose of observation is to verify information gathered during interviews and collect additional evidence by studying operations and procedures at the site. Any points
of concern noted during observations should be followed up either by further interviews or by testing.

**Testing:** The evaluation team may find it necessary to verify the results of interviews or their observations by carrying out measurements and testing on site. They may also wish to verify the results of monitoring reports by conducting tests. The following give an indication of the type of measurement and testing which may be undertaken:

- measurement of electricity consumption for individual areas
- leakage testing on compressed air systems
- temperature measurements (to identify waste heat sources)
- checks of thermostat settings

**Evaluation of the Findings**
The next step is for the team to evaluate the evidence which it has collected. Each member of the team should summarise their findings and highlight areas of concern that they have identified. The team should then present its findings to appropriate staff and to senior management.

Where issues of concern were identified, the presentation should cover each of these in turn. Evidence to support the findings should be presented and any major areas of concern highlighted. Guidance on appropriate steps to deal with such problems should be given.

The outcome of the audit process should be a report of findings which should be presented to the senior management of the company. The objectives of this report are to:

- Describe the scope of the audit undertaken
- Provide company management with information about performance at the site
- Provide information on the effectiveness of energy management procedures at the site
- Provide evidence, where appropriate, of the need for corrective action

The report will only bring benefits to the company if it acts upon the findings contained within. The company should:

- Produce an action plan to implement the recommendations of the audit exercise;
- Define timescales for the necessary corrective action;
- Determine what monitoring procedures are needed to verify that action has been taken;
- Make appropriate amendments to its energy policy, programme of action, and management procedures.

The audit of the energy management system should not be viewed as a one-off event. It is an important component of the cycle of continuous improvement. Thus, it is important that a timetable for auditing is established which takes account of the results of previous audit exercises and the energy related impacts of the company’s activities.

Where serious concerns have been raised during a previous audit exercise, or where an activity is of great concern in terms of the cost or environmental impact associated with its energy use, the period between evaluations will need to be short, perhaps annual. Where activities are of lower significance a longer cycle may be appropriate.
5.6 Review of the energy management system by top management

The periodic review of the management system by the top management is followed up by actions, including changes to the EMS as indicated by the review. The management review process is designed to ensure the EMS is suitable to the current mission and is effective in achieving the organisation’s policy, objectives, and targets.

Top management will normally focus on the following areas which are partly covered by the energy report:

- Energy policy
- Results of the energy review (including register of significant areas of consumption and register of regulations)
- Energy programme and the extent to which energy objectives and targets have been met;
- Corrective and preventive actions;
- Energy management system documentation
- Audit report

Top management will specify:

- Cases of non-compliance with the provisions of the regulation
- Technical defects in the first energy review, or audit method or environmental management system and any other relevant process
- Points of disagreement with the energy report and suggested amendments and additions
Annex

Guideline D1
Energy Check for SME

Guideline D2
Energy Audit