Within 18 steps
over 3 stages

to Efficient Energy Management according to ISO 50001

Guideline

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GUTcert

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These guidelines are not intended to replace the standard and do not claim to be exhaustive. These guidelines are available on the Internet at: http://www.gut-cert.de/

Text GUTcert, design in association with AFNOR groupe

We expressly welcome suggestions for improvement as well as information about any errors or mistakes! Please send them to energie@gut-cert.de

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Preface

Dear Reader,

Rising energy prices and political pressure have made saving energy a top priority. However, how can companies efficiently meet this challenge in a feasible way, without having to take time-consuming and expensive detours? How is it possible to efficiently set up an energy management system in addition to the many other tasks that also have to be taken care of "*en passant*"?

Enough experience and findings have now been gleaned from the implementation of energy management systems (EnMS) in accordance with ISO 50001 and various preceding regulations to provide a definite answer to these questions. We have compiled these findings and experiences for you in the following guideline. The current 4.2 version of our guideline is based on more than 450 energy management systems (EnMS) that were tested and audited in recent years at small and medium, and many very large companies, from both the manufacturing industry and the service sector. The guideline now also incorporates the experiences arising from training more than 500 energy managers, energy management officers and energy auditors, some of whom have already conducted the 18 steps over three stages within their company, successfully implemented an EnMS, and for the most part have already obtained certification.

Anyone who is involved in energy management does not want to merely meet a "standard". Rather, the objective is to constantly work in a more energy-efficient manner, in order to benefit economically and at the same time reduce the impact on the environment. The ISO 50001 standard is an excellent tool for this. None of its sister standards, e.g. ISO 9001 or ISO 14001, are as efficient in helping achieve the objective of the standard. All of the requirements merge to form a practical system that supports each individual element in dealing more efficiently with energy.

Unfortunately, the rigid structures of the standards are not aligned with the actual operating processes and workflows in the companies and therefore are often not geared to practical application. It is for that reason that we developed this guideline, which offers a step-by-step guide on how to be more energy-conscious and identifies potential that surely exists. On the basis of our experience, we have developed a step-by-step, practical guideline that comprises individual steps that all employees can easily follow in order to save energy and lower costs.

Start today and take each step successively to systematically reach your goal:

Stage I: Analyse your energy situation and already identify potential savings during this basic assessment. *Stage II:* Integrate the procedure into your own planning processes and start saving systematically. *Stage III:* Embark on a process of continuous improvement to steadily increase energy and economic efficiency - and in parallel easily qualify for certification under ISO 50001!

My tip: Read through this guideline first in order to get an overview of the contents, and then follow your own step-by-step "introduction path" at your own pace. Depending on the organisation's purpose, size, situation or objective, you can take a break at each stage or quickly tackle the corresponding steps successively, and some of them simultaneously.

Once the third stage is reached, you will have "incidentally" implemented the requirements of ISO 50001 and can be certified at any time. That would then be the last step needed to continuously improve your energy efficiency, obtain additional recognition and, if applicable, receive government subsidies as well. Moreover, qualified external energy auditors will continue to help you find new and motivating ways to save.

I wish you every success in savings of all kind.

Yours faithfully,

[redacted]e Lieback

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Introduction

Over the past few years, systematic energy management has evolved into a proven effective method for lowering specific energy consumption and thus reducing energy costs. As a result, energy efficiency has become an important factor for economic success. As energy efficiency increases, the direct and indirect CO_2 emissions of an organisation, called the "corporate carbon footprint" (CCF), decrease at the same time

In Germany, the issue was therefore taken up in 2003 as part of a research project, leading to the creation of the first version of this energy management guideline in 2006. Within the area of European standardisation, the “Energy Management” Sector Forum of the European Committee for Standardisation (CEN) was initiated in May 2005, so that by 1 July 2009, the European standard for energy management (EN 16001) came into force. This in turn accelerated international standardisation. In 2008, an ISO working group began developing a global ISO 50001 standard on energy management. In June 2011, the ISO 50001:2011 was finally published. As a result, there is now a worldwide, uniform standard in place for the EnMS.

In parallel, the guideline was updated by GUTcert and adapted to the current developments and new experiences that have been amassed. In 2009, the second version was published, which integrated the requirements of EN 16001. The third version of the guideline was already based on the ISO 50001:2011 standard. This fourth version was developed following many projects with companies using this guideline, and its structure and organisation are aligned with the experience with practical implementation that has been gathered in recent years.

Moreover, this guideline also ensures the introduction and implementation of a system which reliably complies with certification under ISO 50001 in every regard and supports an energy audit in accordance with EN 16247-1.

What exactly is energy management and what is an energy management system?

According to the definition (VDI 4602), energy management (EnM) is:

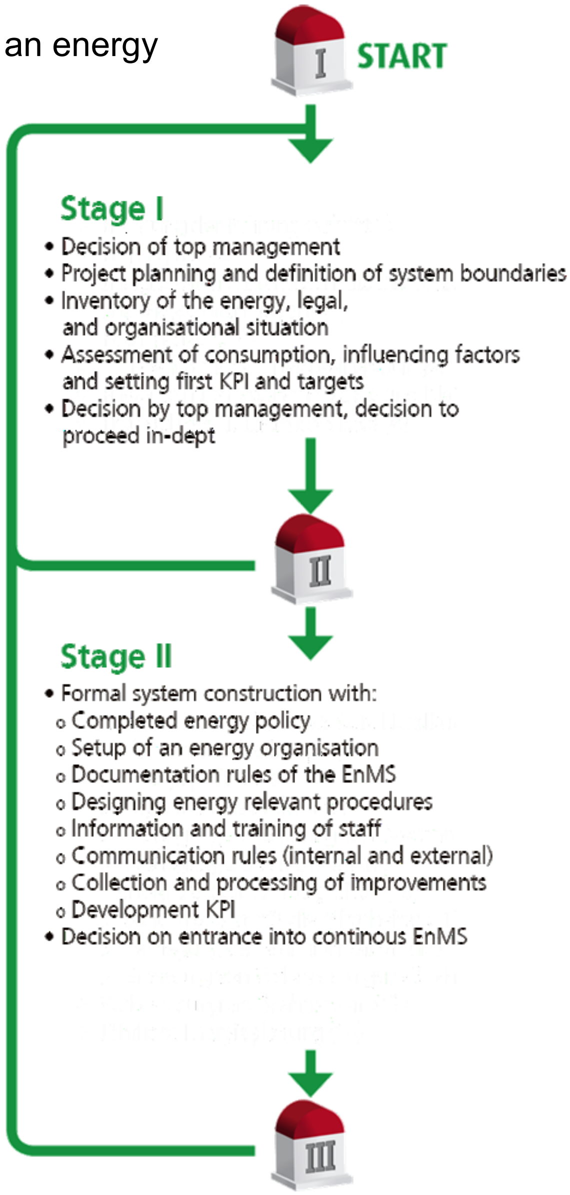
"…the anticipatory, organised, and systematic coordination of the procurement, conversion, distribution, and utilisation of energy to cover the demands under the consideration of ecological and economic objectives."

It should lower energy costs and increase energy efficiency, whilst reducing energy-related environmental impact and fulfilling customer requirements at the same time.

An energy management system (EnMS) provides the necessary resources to anchor the energy efficiency concepts in all processes and with all employees. ISO 50001 (3.9) states that an EnMS consists of a:

"set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those strategic objectives."

The EnMS must be structured in a way similar to the environmental or quality management "Plan-Do-Check-Act" (PDCA) cycle. This allows the users to continuously improve their energy–related performance.



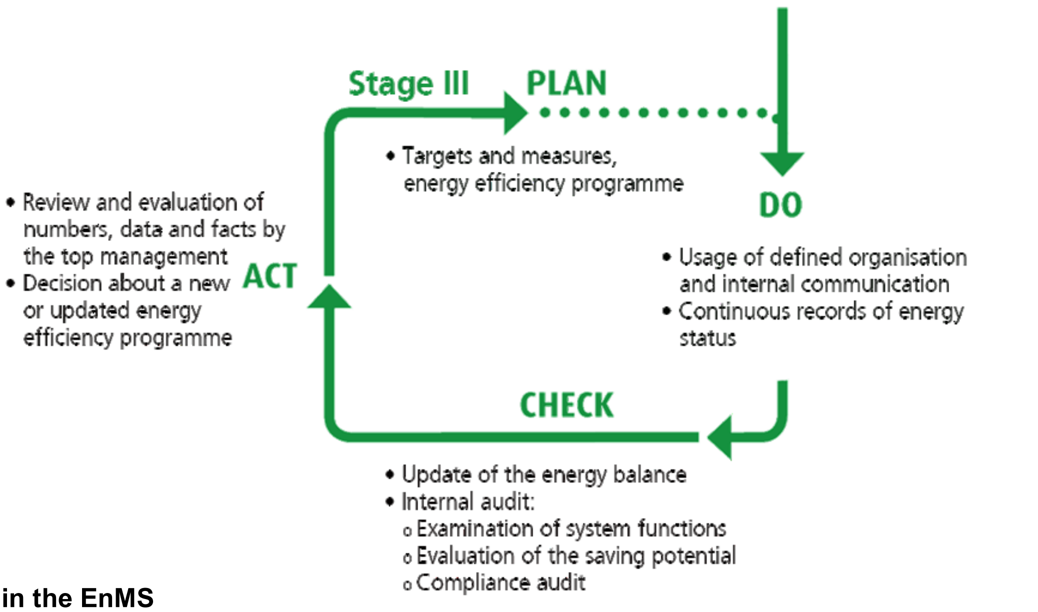


Figure 1: PDCA Cycle in the EnMS

Implementing the PDCA cycle in the EnMS of an organisation means to determine its energy flows, identify the relevant factors that influence its energy consumption, derive targets and measures from that, systematically monitor their implementation, and to continuously obtain information for defining new objectives, targets and measures.

“**Plan**”: Implementing goals for the energy strategy and defining energy saving targets, taking into account any factors that significantly influence your energy consumption; determine measures within the scope of an action plan, designate the responsibilities, and provide the required resources.

"**Do**”: Create/maintain management system structures for the purpose of monitoring and maintaining a continuous improvement process.

"**Check**”: Internally assess the operational capability and feasibility of the EnMS, monitor the goal attainment progress, and collect new ideas for improvements (energy audit), where appropriate by including external energy and system experts.

"**Act**”: Summarise the current energy data, audit results, and recent findings (new methods, systems and equipment), evaluate the status and progress, adapt the energy strategy (policies/guiding principles), derive/determine new goals.

All management system standards are structured based on the step-by-step mapping of the essential elements of the PDCA (Plan-Do-Check-Act) cycle. An implemented and operational management system is aligned with this structure. When introducing a system, however, this PDCA sequence is not sufficient in practice, because in most cases, an initial analysis is required first; not described in the ISO standards. This guideline thus deliberately takes a different approach.

On the basis of the practical experience gained in recent years, the introduction and implementation of an efficient system, complying also with ISO 50001, is therefore described in **18 successive steps aligned with practical requirements**. All of the requirements in the standard are taken into account, as is demonstrated by the references to the relevant sections of the standard, which are shown in the page margin.

For the introduction of a new EnMS, this guide therefore provides a clear and practical structure, which, from the very beginning, facilitates success in saving energy without having to form a bureaucratic superstructure first. The documentation is “automatically” created – in a very efficient and practical manner – when working through the introductory steps**.**

An orderly system, right from the beginning

Various specification documents (system descriptions, procedures, rules) and records (consumption data, analyses, planning) are created when setting up an energy management system. These documents should be systematically filed and stored from the start. They form the basis of an EnMS and will continuously provide support for analyses and planning.

To enable you to establish a well-ordered filing and structure from the very beginning, the most important documents and records that are created in the course of executing the steps are summarised below.

Stage I

- Declaration of intent by top management (1)
- Project plan (2)
- Specify/Determine the system boundaries (3)
- Initial energy, measuring and evaluation plan (4)
- Energy report (energy consumption with list of all energy consumers and measuring systems) (4)
- Inventory of legal requirements and regulations (4)
- 1st list of potential energy savings (5)
- Energy saving programme (targets, and measures) (5)
- Minutes of the 1st EnMS review of Top Management with their decisions(6)

Stage II

- Documentation of the EnMS (e.g. manual; process descriptions):
- Energy policy (7)
- Organisational structure (8)
- Document management specifications (9)
- Specification for designing energy-related tasks and activities, e.g. rules for procurement of materials and equipment (10)
- Rules for planning of infrastructure and processes, etc.(10)
- Training (plan) for employees (11)
- Definition of communication (12)
- Identification of improvement measures Improvement action plan (13)
- Annual energy planning (14)
- Energy, measuring and evaluation plan (14)
- Definition of key energy indicators (14)

Stage III

PLAN

- Updated energy saving programme (17)

DO

- Records from current energy controlling (15)

CHECK

- Internal energy audit, audit plan and report (16)

ACT

- Updated energy analysis (and, where necessary, energy report) (16)
- Minutes of energy reviews (18)

Figure 2: Resultant Documents and Records

Step-by-Step Introduction of an Energy Management System

Larger organisation projects are typically implemented in stages; after the completion of the stages, they are usually followed by milestones that allow the top management to intervene and make decisions.

When introducing an EnMS, three essential, autonomous stages should be planned:

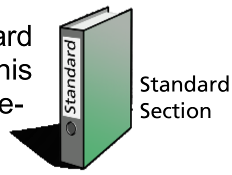
I. The acquisition of the current status, including the identification of initial energy saving measures (Steps 1-6)

II. Introduction of supplementary or new rules and regulations for managing an organisation (Steps 7-14)

III. The comprehensive operation of a management system based on a PDCA cycle for continuous improvement (Steps 15-18)

If you are striving to obtain quick certification, Stages I-III can be worked through rapidly, and some of the steps can be executed simultaneously.

Relevant steps or partial steps that implement provisions from the ISO 50001 standard (Section 4.1. - 4.7) are highlighted so that, in a parallel study of the standard and this guideline, you can see which requirement of the standard is currently being implemented or which standard specification is currently being worked on.



At the end of every stage, the top management has to decide whether the next stage is to be started, halted temporarily, or stopped entirely. These points are highlighted separately by milestone symbols which indicate that it is only possible to proceed after top management has been fully informed about the results so far and has decided how to proceed.

Stage I – From Project Idea to Evaluation of the Current Status – Identification of Potential Savings

The decision by the top management (ISO 50001) to implement an EnMS starts the process and communicates the decision to the entire company. The first milestone therefore occurs at the very beginning.

Once the top management of an organisation has made the decision, it is useful to prepare a project plan in which the participants, the schedule, and the goal and/or intermediate goals are defined. To define the scope of the project, the system boundaries must be determined as accurately as possible before tackling the first major task, the data acquisition. The final part of the first stage comprises an analysis of the results together with the top management and the decision on further action, which, if applicable, advances the process to the second stage.

1st Step: Top Management Decision, Appointment of a Project Manager

At the start, the top management of the organisation has to demonstrate a clear commitment to evaluate the current situation and provide the necessary resources to do so.

4.2.1-
4.2.-2

This particularly includes the appointment of an energy management representative, energy management officer or energy manager (ISO 50001), who has sufficient authority to collect and record all data and current statuses. He/she must have the required means (time, assistants, IT and, if needed, funds for measuring equipment, etc.) and appoint persons with sufficient expertise (e.g. energy management officers) to support him/her in implementing energy management tasks and activities (ISO 50001, see Step 8). If necessary, an "energy team" may already be established at this point, comprised of participants from the relevant departments who work under the supervision of the energy manager.

Where required, an initial "energy policy" can also be formulated now, which consists of the organisation's energy strategy. However, this is not yet required at this point, and is often not possible, since the basis for establishing this strategy will not be formed until the following steps. What is important here is a clear commitment to conducting an initial energy analysis, and the provision of the materials and human resources required for it.

2nd Step: Project Planning

Preparing a project plan will facilitate the implementation of the next steps, and helps to plan and coordinate activities and resources. The project plan can be used as a basis for determining the timeframe required or to be allocated for introducing an EnMS.

Experience shows that project planning leads to greater concentration on the goals to be achieved and setting deadlines ensures better planning ability for all participants. Figure 3 shows an example of a timeframe for the various project phases. The time periods will vary depending on the company's requirements and situation. In most cases, the basis here is the provision of resources. In real-life practice, an EnMS is generally implemented within 3 to 18 months. Our experience shows that it is ambitious, but feasible, to implement one in 6 months.

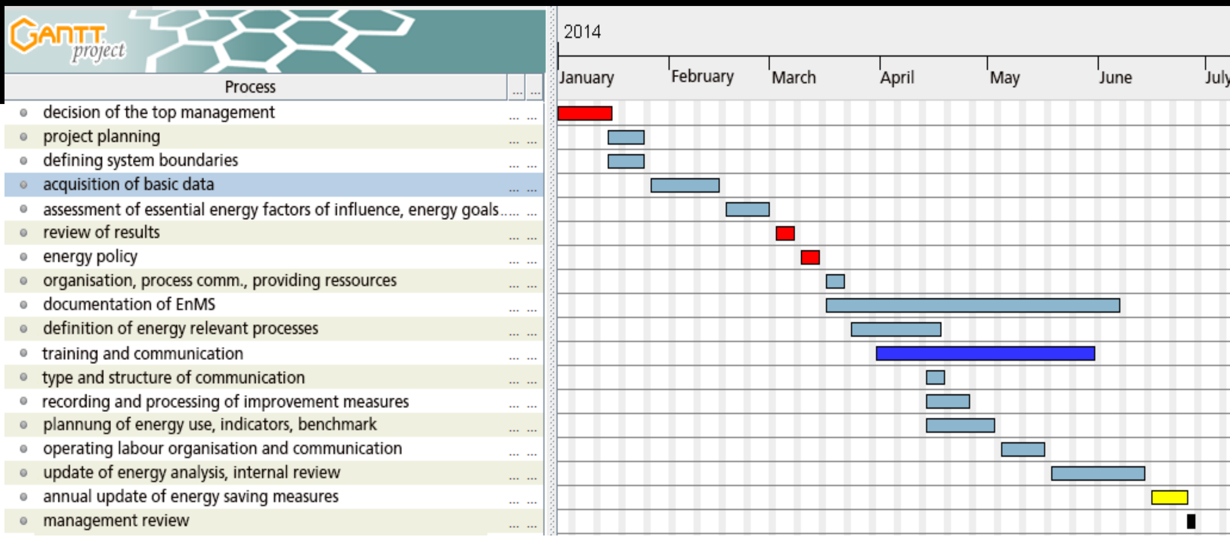


Figure 3: Sample Project Plan for an EnMS (created with GanttProject)

Minimum time required for implementing an EnMS:

Small companies (up to 50 employees), at one location

- With existing management system: approx. 2 to 4 months
- Without existing management system: approx. 3 to 6 months

Medium-sized companies (50-500 employees), at one location

- With existing management system: approx. 3 to 6 months
- Without existing management system: approx. 6 to 12 months

Large companies (500+ employees), at one location

- With existing management system: approx. 4 to 8 months
- Without existing management system: approx. 6 to 18 months

If the system is implemented at several locations, an additional 2-4 months should be scheduled (estimated time based on experience).

Table 1: General time required for implementing an EnMS (based on experience)

p for SMEs:

he tools already used by the company or those it is already familiar with should be utilised when preparing a plan.

For example, Microsoft Excel, Microsoft Project, or basic project management software, which is also available as freeware (Figure 3 was created using GanttProject freeware).

3rd Step: Establishing the System Boundaries

4.1 b)

In conjunction with the project planning, the scope of the analysis and/or of the subsequent implementation first has to be precisely defined. This system boundary essentially determines the extent and complexity of the EnMS. For instance, a high-voltage switchgear upstream of the factory's power grid connection, the supply or delivery transports, or the production of externally manufactured assemblies can be excluded or included based on their impact on the energy consumption and the potential to influence saving measures.

Determining the system boundaries is the EnMS management officer's first task in addition to preparing the project plan. It should allow the total energy use to be completely allocated to the energy consumers, both with respect to the energy components (electricity, gas, heat, etc.) as well as the entire amount of energy consumed (in kWh). It should be noted that energy can be converted in the system or leave it as diffuse "heat radiation" (see the first law of thermodynamics).

Note: What kind of "energy" are we dealing in an energy management context?

The direct use of energy, through:

- Combustion of coke/coal, gas, fuel, oil or alternative fuels
- Use of, e.g., diesel in the vehicle fleet or for internal transport
- Process gas with its chemical-caloric energy impact, (which, due to its pre-pressure, can have an additional energy impact)

The following also have to be included:

- Already processed forms of energy, such as electricity, steam, district heating, cooling or compressed air coming from outside the system boundaries
- Energy processed in-house within the system boundaries, such as electricity, steam, heat, cooling water or compressed air

To be considered has to be further energy released to the surroundings outside the system boundaries:

- E.g. as combustible CO gas
- As a product for a neighbour (e.g. steam, district heating or electricity)
- As a residual material to be used as energy (e.g. wood dust, chips, etc.)
- As waste heat in cooling water, radiation heat or diffuse as warm air.

Also important to the overall analysis is the possibly enormous physical energy content of supplied compressed gases such as nitrogen, oxygen, argon, acetylene or hydrogen – whether used for energy or not! Besides their physical energy content, process gases have a chemic one. The diversity of the industry necessitates an individual analysis in all cases.

The overall picture becomes more clear if the results are also represented graphically:

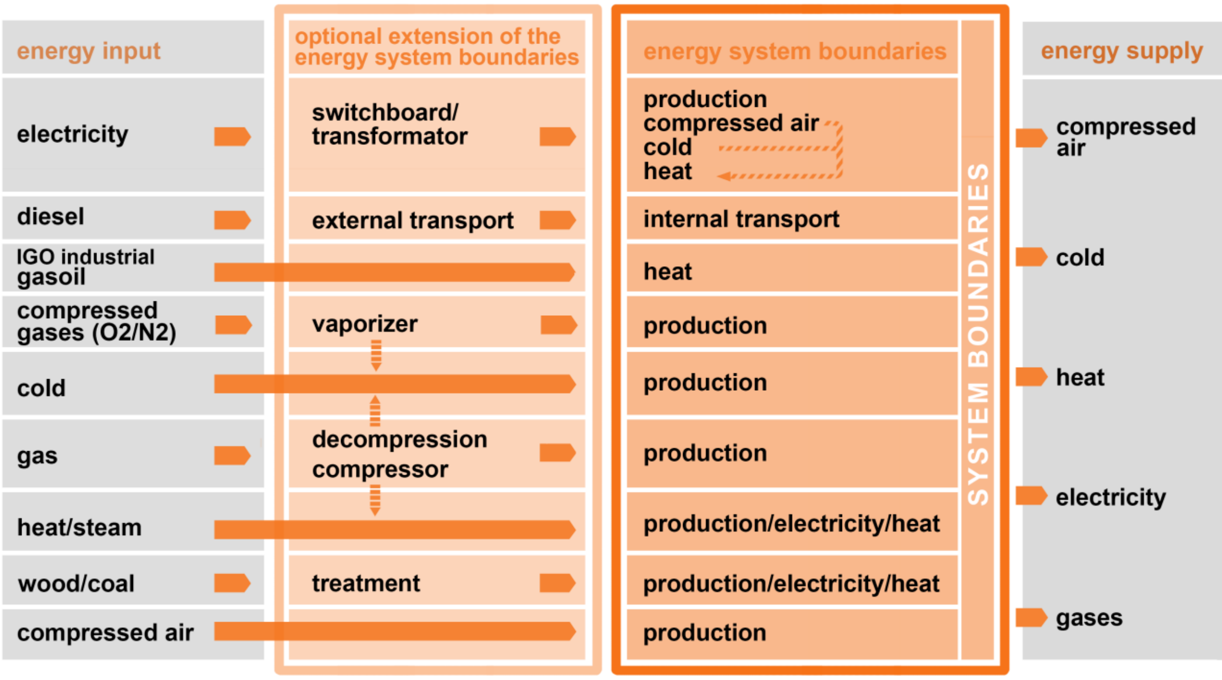


Figure 4: Determining the System Boundaries

Note: In addition to the boundaries of the EnMS, ISO 50001 also refers to its scope. Boundaries are location-related and refer to facilities, installations and energy flows. The scope of an EnMS can extend to a company headquarters with several locations, each with its own system boundaries and an overall energy balance for the entire company (e.g. including transports between the various locations). Restricting the scope to certain areas of the company or to individual activities, as is possible to do in other management systems, is hardly ever considered with regard to an EnMS, since it is almost impossible to delineate the energy flows.

4th Step: Acquisition of Basic Data

4.4.1
4.4.3
4.4.4.

The next step is the initial data acquisition, a systematic recording of the current status. This “energy baseline” is an essential foundation of the EnMS, since all subsequent decisions, targets and goals are based on it. It is the reference point for comparing the energy performance in the future. The energy baseline is always assessed for a defined reference period, usually a year, sub-divided into months, if necessary.

The most important component of the basic data acquisition is the energy analysis. This should include detailed data acquisition of energy input and energy consumption values and if possible, be based over several years in order to eliminate one-time, non-recurring effects. Furthermore, the energy analysis includes a comparison of the collected figures with selected benchmarks.

The initial data acquisition also includes an analysis of the existing energy organisation and if applicable, the comparison of the organisation with any other management systems (e.g. for QM or Env. Management). In addition, the cur-

Note:
For the subsequent evaluation and classification of the results, we recommended recording some influencing factors at the same time:

- medium- and long-term development trends of energy prices,
- foreseeable legal regulations,
- development of new procedures for saving energy,
- known and used indicators, and
- available benchmarks, etc.

rent activities and procedures have to be compared against all legal requirements and regulations related to energy use and consumption.

These detailed steps can be worked on in parallel in order to save time, since they hardly affect one another. In the final result, however, they must be summarised, e.g. in the form of an "energy report".

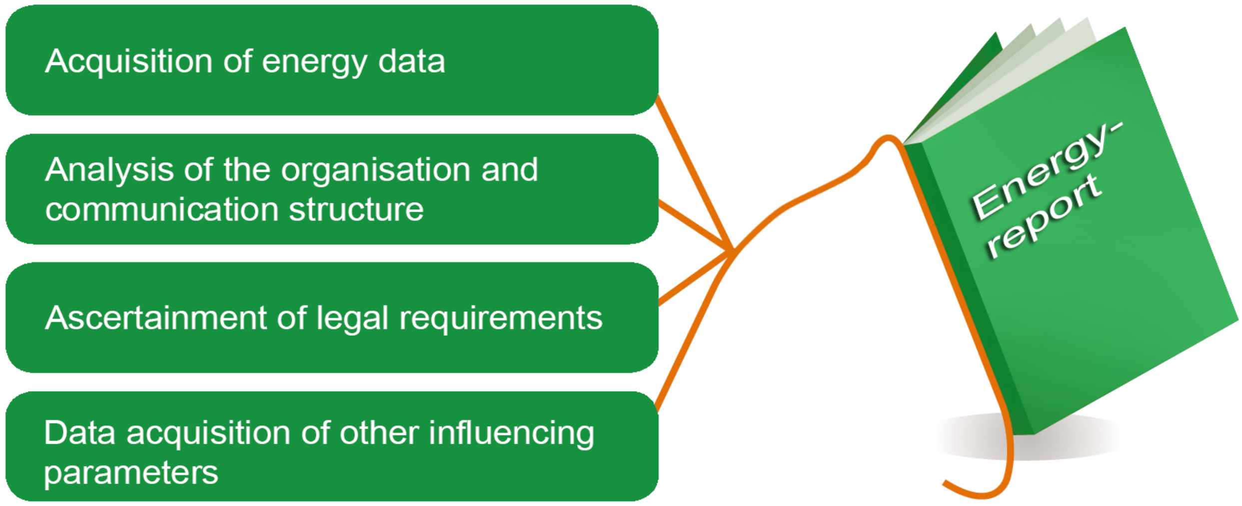


Figure 5: Components of Initial Energy Report

(1) Energy Analysis, Acquisition of Energy Data

At the start of an EnMS, it is essential to determine the current energy status (energy review). This comprehensive initial data acquisition is the basis for all subsequent planning and decisions. It is then extrapolated and updated systematically at regular (usually annual) intervals to ensure continuous improvement of the system (also see Step 16).

For the analysis and assessment, it is advisable to record all energy-relevant data on a period-based basis (annually) in two tables – one for energy use and one for energy consumption. Together, these two tables form the energy balance within the defined system boundaries.

a) Energy input

4.4.3 a)

The analysis begins with recording the energy used at the location (or if applicable, for the entire organisation). For those areas included in the defined system boundaries, the values for the used energy should be determined for at least the past three years. In order to pinpoint seasonal effects, we recommend including monthly data, if available. At the same time, relevant influencing factors, such as production output and activities, heated areas, outdoor temperatures, etc. should also be recorded and included, for the purpose of being able to establish initial energy performance indicators (EnPI). The result will be a basis for evaluating general influencing factors, which is the foundation for identifying potential improvements early on.

Energy use data is usually listed on invoices from providers or on receipts and is easy to obtain and record. Depending on the company's size, the data should be itemised as far as possible (categorised according to month, process, facility, machine, building, etc.), since that will already make it easier to identify potential savings. If you are interested, our website provides a tool that can be downloaded for free and will assist you with recording the energy sources utilised at your company and their consumption by various consumers (http://www.gut-cert.de/info-energiemanagement00.html).

Month	Electricity [kWh]	Gas [kWh]	Diesel [kWh]	Coal [kWh]	Other [kWh]	Total Energy [kWh]	Production [t]	Total Energy / t production
Jan.								
⋮								
Dec.								
∑ year								

Table 2: Sample Record of Monthly and Annual Energy input Data

4.4.3 a)

The energy input should be analysed for at least the last full year under review (energy baseline). Since the generation and/or consumption of energy causes different environmental impact (benchmark: CO_2 emission), it is also advisable to determine the direct CO_2 emissions[1] from the combustion processes as well as the “indirect” CO_2 emissions from generating power and heat, etc. Collecting the CO_2 data makes it possible to precisely gear energy saving measures towards reducing the environmental impact.

Energy used / Energy source	Quantity [MWh/ a]	Share of total quantity [%]	Costs [€/ MWh]	Share of total costs [%]	CO_2-Emissions [t]	Share of total CO_2 [%]	Measuring system/m Measuring location/ Accuracy

Table 3: Example of Annual Recording and Analysis of Utilised Energy Sources

b) Energy consumption

4.4.3 b)

In addition to the energy supply, the energy balance also includes the utilisation of energy. The consumer-related use of energy has to be broken down as well. Depending upon the organisation, complexity, and measurement differentiability, a consumer can be a single aggregate (motor / smelting furnace), a plant component (robotic machine / roller mill), an entire plant (production line / cold rolling mill), a process (heat treatment / mechanical machining), a group of consumers (hall lighting), or an entire consumption area (administration buildings). What is important is that the subdivision is structured in a way that allows "energy gluttons" to be identified. It should be designed in a way that allows it to be further and further subdivided in following years in line with the continuous improvement of the EnMS. (Note: An EnMS can already be certified if a rough categorisation of the consumers has been prepared in conjunction with the establishment of the initial balance. If the initial comparative values, targets and goals can be derived from it, and if the plan is to refine and further subdivide the measurements in the future, it is compliant with the system.)

In the table of consumers, the data should be collected for each plant, department or division – separately itemised for each of the different energy sources used by a consumer (electricity, compressed air, cold water, gas, etc.) – and recorded as a total sum. When establishing/calculating the balance for the individual energy sources (electricity use and consumption) and the total energy consumption, please ensure that any internally processed/converted energy (electricity for generating compressed air, gas for supplying heat, heating water, etc.) is not included twice. When entering the data, any transfer of energy beyond the system boundaries must be excluded and the company’s own self-generated energy (e.g. solar) has to be taken into account.

[1] The emission values are calculated based on the following formula: CO2 emission = Energy use [kWh]/[GJ] * Emission factor (for grid-bound energy, see the providers’ invoices or UNFCC standard values, for other forms of energy, see UNFCC standard values, etc.)

The data should be represented as quantities in kWh, costs, the CO2 emissions associated with the use of energy (direct and indirect), in each case as absolute values and as proportions, in order to facilitate detailed analyses.

Energy consumer				Energies consumed E1, E2,..- [kWh/€/ CO_2/%]				Waste heat [kWh] (temperature)	Measurement system/ Type	Accuracy
No.	Plant/ Facility/ Part	Year of construc-tion	Power input [kW] (Capacity)	E1	E2	E3	∑			
								Zellen Verbinden! WELCHE?		

Table 4: Example of Period-based (Annual) Recording of Energy Consumers

In the course of determining the energy balance, information is also obtained that describes specific details about the consumers and key general conditions. These details will subsequently be required for period-based comparisons (operating times, output parameters, heat dissipation, production figures, lighted or heated areas, etc.). When using an EnMS, further data and information will subsequently be added.

Therefore, we recommend using a database solution for recording the consumption data. Complex Excel tables with a worksheet structure (see, e.g., the GUTcert “Energy Data Recording Tool“) for different assessment levels of the same consumer have also proven useful and facilitate the subsequent creation of energy flow charts (Sankey diagram) as depicted in Fig. 6.

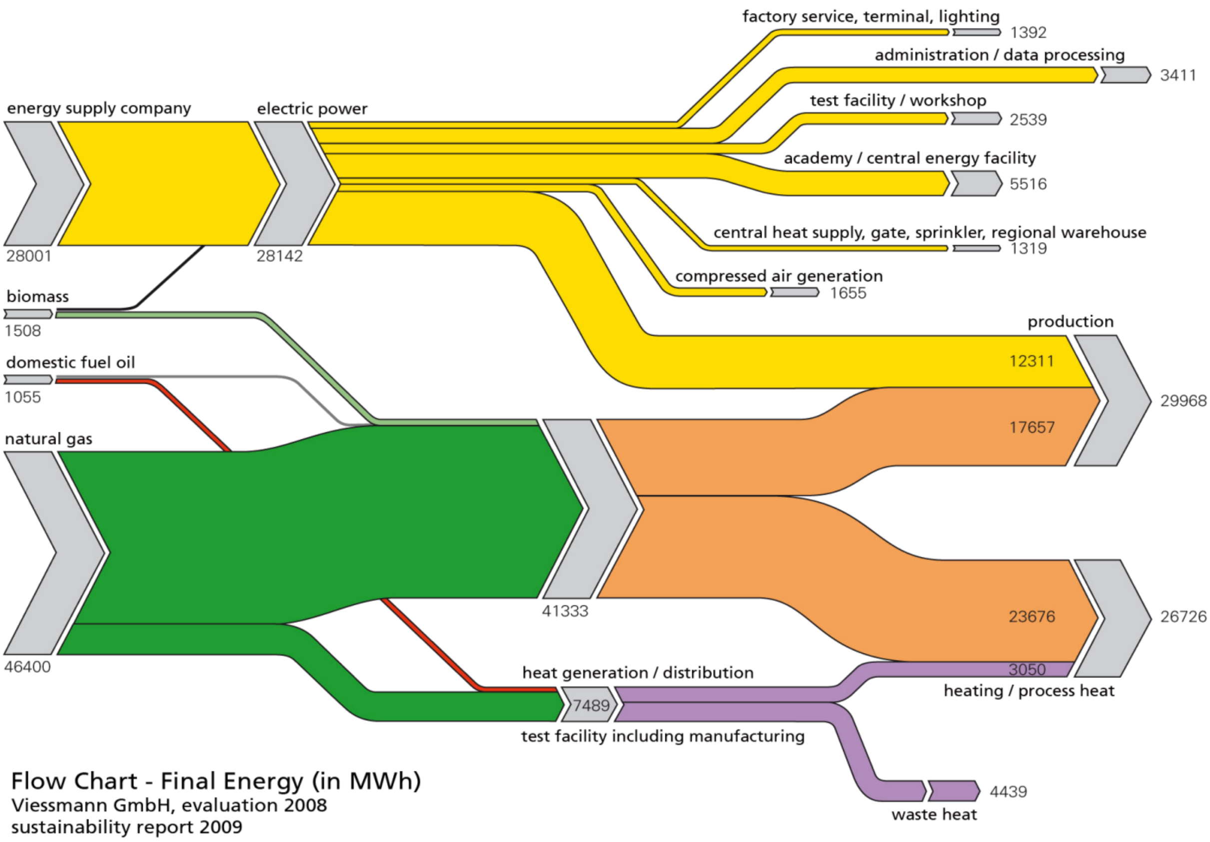


Figure 6: Example of an Energy Flow Chart

c) Measurement and Monitoring

4.4.1
4.6.1

Measuring equipment data and their accuracy should be recorded at the consumer level, in order to be able to detect any gaps or incorrect values. In general, the measuring accuracy should increase with the size of the consumer. When recording the total energy flow, i.e. the consumption not directly attributable to consumers, the deviation should initially be 5-10% maximum. This is the only way to ensure that the analyses provide the informational value needed for setting practical and feasible targets and goals.

In addition, an index of all measuring equipment is useful in this regard. It can be used to monitor whether measuring instruments subject to mandatory testing need to be inspected and, if necessary, recalibrated and/or recertified, identify measuring devices with incorrect measurements, and check whether the accuracy levels are sufficient for defining practical and feasible goals.

Measuring location	Consumer group	Measuring device number	Measuring principle	Reading principle	Last calibration	Accuracy
E-station	Workshop	1234567	Meter/electromagnet	Automatic data acquisition IT	None, in use since 2010	1.5 %
Boiler house	Heating oil	Unitop 3000	Direction finding/ level measurement	Monthly	April 2013	0.5 %

Table 5: Example of a Measuring Equipment Index

The acquisition of equipment/facility-related or department-related energy consumption data often requires extra effort (if measuring systems of sufficient quality are not installed everywhere and existing ones cannot be read out automatically). Frequently, as a first step, partial measurements of equipment and facilities need to be taken, e.g. using clamp-on ammeters or temporary gauges, and consumption, outputs, performance, operating times, etc. and have to be extrapolated.

Note: Energy, Measurement and Evaluation Plan:

Once the data starts being compiled and recorded, deficiencies and insufficiencies soon become apparent, since the existing measuring points and their recordings were not originally designed for the purposes of an EnMS:

- There is a lack of measuring devices that are able to record the data of certain consumers, e.g. cooling water, compressed air, gas or compressed gas, as such measurements were not previously required for the company operations.
- The measuring equipment is outdated, and not accurate enough for the EnMS, e.g. old metering orifices for steam or heat or electric meters up to >50 years old.
- Often, the obtainable values of the measuring task are not adequate and do not allow time-based recording, such as those that are essential for recording load curves or consumption peaks. New electronic meters can be used to measure and record not only continuous data, but active and reactive power as well.
- Especially in the case of larger companies, so much data and accompanying information accrues that cannot be evaluated without the aid of suitable IT programmes – the information for improvements that can be derived from the figures thus cannot even be identified.

As the data volume increases, knowledge and understanding of the measurement obligations and evaluation requirements increase as well. Therefore, all measurements should be systematically planned, performed and analysed.

In conjunction with the initial acquisition of all data, a measurement and evaluation plan (procedure for data acquisition) should therefore be prepared for energy management purposes.

p for SMEs:
hen evaluating meter data or installing new measuring equipment, the evaluation options offered by “virtual meters” should be considered. Often, combined superordinate measuring points (exclusion/addition) in combination with subordinate individual measurements allow the definition of further consumers or consumption areas and as a result, reduces the number of installed meters. In addition, the operation of independent equipment/single units in collectively metered areas yields precise consumption information or supports the recording of load profiles.

In addition, it is advisable to collect the power rating data of motors and/or the waste heat dissipated, in order to obtain information on potential optimisation measures. If available, information about load profiles of equipment and machinery should also be collected, provided there are already measuring options in place for that purpose. If that is not the case, but appears reasonable, it would already be a result from the first inventory, which should be reflected in a goal.

d) Energy report

4.4.3
4.4.4

We recommend summarising the acquired data, information and initial evaluations (energy report) together with the results of points 2 and 3 (see below). That will create a comprehensive information base (energy baseline for the EnMS) for a first review by the Top Management.

The aim of the energy report is to provide a format that enables a quick overview of the data and facts on the energy consumption and a comparison with the results of future energy analyses. The energy report is therefore the information medium for all participants involved in the EnMS. It can be distributed to stakeholders and interested parties, and also serves as a basis for analyses by external experts (e.g. energy audits pursuant to EN 16247). The summary should be updated and extrapolated annually (see Step 16).

The first energy report should, based on the data analysis, contain ideas for an initial energy saving programme, including targets, goals and concrete measures. If the “EnMS-Project” is further developed and continued after the implementation of Stage I, and the management structures are set up as part of Stage II, the energy report must be expanded with a section on planning (see Step 14).

(2) Recording the Organisational and Communication Structure

4.2.1
4.2.2
4.5.3

Almost all organisations already have established organisational rules, procedures and responsibilities for energy management; even if it only consists of the controlling department’s obligation to regularly compare energy invoices with the company’s own meter readings. Frequently, this involves designating persons who are put in charge of monitoring the energy consumption.

All existing organisational rules and procedures must be documented and recorded in order to be of use for subsequent energy management. Existing procedures are usually well-established and effective; they have already been in use for many years and should therefore be the basis for new rules and procedures.

The organisational analysis frequently shows that existing energy management activities are not coordinated, not part of an overall plan, and are not aligned with the strategic goals. Often, deficits in communication become apparent. A systematic organisational and communication analysis is thus also useful for deriving goals and measures to improve the organisational structure. The results should be a component of the energy report, in order to provide top management with comprehensive information.

p for SMEs:

arify:

- Who monitors and records what energy consumption (as routine or based on assignment)? In particular, consider memos in workshops, shift change logs and bookkeeping documents, which often contain energy data figures.
- Who receives the energy consumption figures, data and facts for checking and, where applicable, for evaluation? If nobody is clearly responsible for this, there is an immediate need for the company to take action – and not only with regard the EnMS.

(3) Ascertaining Legal Obligations and Additional Requirements (Compliance)

A component of any good company management and management system (QM, EM, security, safety, energy, etc.) is ensuring compliance with laws and regulations (as well as commitments that an organisation has undertaken). Checking to ensure that current company practice complies with energy consumption laws and commitments is essential when collecting the basic data.

4.4.2

For this purpose, all pertinent laws, municipal regulations, and commitments (e.g. relevant to the sector) that are applicable to the organisation must be compiled in an inventory of legal requirements and regulations. The inventory is created within the scope of the basic data acquisition, but should only contain those requirements and regulations that apply or could apply to the organisation; otherwise it is easy to lose the overview.

No.	Dept./ Area	Level	Law/Regulation/ Ordinance	Short n ame /Description (Link)	Applicable Requirement	Affected Process/ Facility/Equipment	Responsible for Implementation	Reviewed on: By:
1	Energy	Federal	German Energy Savings Ordinance	EnEV	Section 4 Requirements for Non-residential Buildings	Production Hall	Employee Mr. XY	Date; Employee

(Last updated on DD-MM-YYYY by Ms. Template)

Table 6: Example of Inventory of Legal Regulations and Requirements

p for SMEs:

hen preparing the inventory of legal regualtions and requirements, the federal and state energy agencies, trade associationd, or specialised lawyers who work in this rapidly growing legal field can be of help. Other companies that use energy management systems can also provide support and assistance if needed.

Compilations of legal requirements that are already categorised by subject and are always up-to-date can be obtained by purchasing inexpensive subscriptions via relevant Internet service providers etc.

The second task is to compare the legal requirements recorded in the inventory with the daily operations in the organisation. If uncertainties or questions arise, specialists should be consulted if needed (see the “Tip” text box).

4.6.2

Note: Compliance with Legal Requirements

Even if this initial data acquisition is not further developed into a management system with a continuous improvement cycle, a result of the initial data collection should be to specify who will be responsible for continuously updating the inventory of legal regulations and requirements and for verifying compliance within the organisation (compliance verification). Even if a formal management system is not set up, the established legal requirements and commitments rema in effect and are often subject to penalty.

[redacted] logue of measures derived from the basic data acquisition should be supplemented with measures to correct any non-conformities.

The results of this part of the basic data acquisition should also be a component of the first energy report, in order to complete the information basis.

5th Step: Evaluation of Energy Consumption, Significant Factors Influencing Energy Consumption, Initial Energy Goals, and Action Plan

4.4.6

In the course of collecting the basic data on the current energy status (figures, organisation, legalities), potentials for improvement already start to emerge. These need to be noted down and compiled into a list of potential energy savings and improvements. All potentials should be listed here, regardless of whether or not they can be implemented at the present time. For each point on this list, the following should be indicated as specifically as possible: savings goal, possible measures, associated costs, time requirements, potential project manager. From the potentials for improvement on this list, the first energy saving goals can be defined and summarised in an energy saving programme (ISO 50001: Energy Action Plan).

In addition, the ideas that emerged in the course of the initial data acquisition should be prioritised. The priority can be based, for example, on whether legal issues are affected (highest priority), whether a quick, cost-efficient implementation is possible, whether the saving volume is especially high, etc. To define the priorities, an assessment of the significant factors that influence the energy consumption should be conducted. If the basic data acquisition is further developed into a continuous EnMS, the assessment has to be updated annually.

Tips for SMEs:

Potential for improvements can be identified by asking the following questions throughout the course of the data acquisition process:

- How has the energy consumption changed over the past years; are there trends and can they be explained?
- What are the largest energy consumers, and did I expect that?
- Where might there be potentials that can be identified through further measurements (load profiles)?
- What variables (could) affect my energy consumption?
- What energy pricing structure do I have and is it appropriate for the production?
- Can alternative energy sources be used (gas instead of Oil, or heat from electricity)?
- Can renewable/regenerative or CO_2-neutral energies be used as alternatives?

Definition: Energy Aspects, Energy Review = Energy Influencing Factors

In ISO 14001, the term (environmental) “aspects” is used. Section 4.4.3, “Energy Review”, of ISO 50001 does not include this term, although it essentially expresses the same: determining the significant consumers and influencing factors through measurements. It is important to determine these, because in day-to-day business, companies focus on what is essential: efficiency and compliance. The determination of the major energy consumers and the factors influencing consumption makes it possible to define priorities for action and use resources and tools in a more purposeful manner.

sumer or a circumstance that has a major effect (positive or negative) on the consumption, e.g. climate conditions, maintenance intervals, break and shift regulations, capacity utilisation of equipment, energy prices, legal framework conditions, etc.). The systematic evaluation of these energy influencing factors (“energy aspects”) is an essential tool of the EnMS, as it filters out the facilities, equipment and circumstances that most strongly affect the energy consumption and thus should be the focus of the efforts and actions.

4.4.3

Identifying significant influencing factors

A list of the consumers that can be sorted according to consumption amount (ascending or descending) can be helpful for this purpose. The largest consumers have to be evaluated in greater detail. In addition to size, this includes indentifying which consumers have the most consistent and the most fluctuating consumption and where changes can be made quickly and with little effort. Furthermore, other factors that influence consumption must also be recorded (Table 7). These are evaluated using the criteria that are relevant for the organisation.

▶ Consumption level	▶ Legal compliance
▶ Extent of consumption fluctuation	▶ Extent of environmental impact
▶ Deviation from planned consumption	▶ Time to implementation
▶ Cost effectiveness	▶ Possibility to influence consumption
▶ Potential savings	▶ Deviation from benchmarks

Table 7: Typical Criteria for Evaluating Energy Influencing Factors

Systematically determining energy influencing factors

A variety of different procedures and methods can be used for this. They range from a simple evaluation resulting from the discussion among the energy team up to complex calculation models.

Criteria / Influencing Factor	Consumption	Consump. fluctuation	Planned consumption	Costs	Potential savings	Legal compliance	Environ. impact	Implementation	Dev. from benchmarks	Possibility to influence consumption
Consumer 1	1	3	2	2 (electricity)	1	No action needed	1	3	3	3
Consumer 2	3	None	3	2 (gas)	3	Action needed	3	2	1	2
Consumer x	2	2	1	3 (electricity)	2	2	2	1	2	3
Legal Requirements	1	1	2 Cleaning requirements	3	2	Action needed	2 (energy consumption)	3	1	1
Capacity Utilisation	3	3	3	3	2	None	2	2	3 (poor)	2
Maintenance	3	1	2	2	3	1	3	1	3	3
Shift System	2	2	2	2	1	No action needed	1 (caused by energy consumption)	1	2 (better system)	3
Annual Mean Temperature / Degree Days (daily temperature figures)	3	1	2	2	1	None	2	None	1	1

3= Strong influence, **2**=Medium influence, **1**= Little or no influence

Table 8: Example: Evaluating Significant Influencing Factors on Energy Consumption

[redacted]
points, or colours (strong, medium, none). Each field of the matrix is assessed. The energy influencing factors with the highest score or total are the most significant ones. Particularly important criteria, e.g. the compliance status, can be highlighted by using a weighting system.

If there are too many influencing factors and criteria, a two-step analysis can also be conducted. All consumers and factors are checked against a few key criteria (consumption/influence on consumption, compliance, potential savings) and the most significant consumers are subjected to an analysis across all criteria.

Note: Goals for Significant Influencing Factors

Factors that prove to have a significant influence on the energy consumption necessitate the formulation of energy saving goals. At minimum, goals must be defined for all significant factors; further goals can be subsequently added. Therefore, the three to four most important aspects should be identified, since only a limited number of goals can be pursued intensively and continuously at the same time.

Creating an action plan

Such a comprehensive evaluation provides a solid basis for creating an energy action plan. The action plan summarises all goals for saving energy and describes what measures will be used to implement them and how the degree of attainment will be measured. Goals must be as specific as possible. Goals such as "lowering the energy consumption for heat generation" or "modernising the lighting“ are strategic goals that belong to the energy policy or a superordinate energy strategy.

Operative goals and targets of the energy action plan must always be measurable – otherwise they are not real goals! "Goals" that are not measurable, i.e. whose implementation and attainment cannot be monitored or verified, are not true goals.

4.4.6

Note: Define S.M.A.R.T. goals!

Specific
Measurable
Acceptable
Realistic
Terminable

To be able to verify whether the goals are attained independently of production, seasonal fluctuations, etc., it is advisable to base them on a variable basis, for example, on the energy consumption per piece, per kg of product, per m², a "heating degree day", or the like. Within the scope of the action plan, ISO 50001 requires indicating how the goals (saving targets) will be measured and verified. After the potentials have been evaluated, the top management resolves the energy action plan in a (first) review.

When a systematic energy management system is first implemented, substantial energy savings can be achieved right from the start, often with simple measures and at low costs. In some cases, however, savings can only be realised with considerable capital expenditure, which means a high capital commitment with corresponding loss of liquidity. Before binding goals are decided on in the review, it is therefore important to not only specify the absolute investment amount, but, for larger sums and longer amortisation periods, to calculate the amortisation schedule dynamically as well. This makes it easier for management to make a decision, taking into account the current situation of the organisation.

Investment/ Measure	Investment [€]	Internal Interest Rate [%]	Technical use [a]	Savings [€/a]	Straight-line Amortisation [a]	Annuity Factor [1/a]	Dynamic Amortisation [a]
Project 1	120,000	12.0%	10.0	40,000	3.0	0.1769	3.94

Table 9: Sample Calculation of Dynamic (Annuity-based) Amortisation

[redacted]

[redacted]p for SMEs:
[redacted] simple sensitivity calculation can be performed, by calculating the dynamic (annuity-based) amortisation several times with different energy cost savings (due to price changes) and as well as with different interest rates. This facilitates the selection of the suitable time for implementing a reasonable, but maybe currently not economically feasible, goal.

[redacted] leads to positive results, since a capital investment in new production methods often makes more sense than other financial investments. This also applies in principle to investments in increased energy efficiency, and thus this calculation method is also suitable for such investments. However, the use of the method depends to a great extent on the company's liquidity. (This is also the basis for many contracting models.)

Energy costs also increase dynamically (price increase). "Sensitivity analyses" are recommended for this, which are used to determine the energy price at which an investment is reasonable. Moreover, energy consumption planning must be taken into account. Greater savings can have effects on the rates, which may promise additional discounts (connected wattage), but can also lead to cost increases (order thresholds).

The pursuit and progress of the goals should be regularly monitored already during Stage I, and the progress status documented (see the sample table for Step 13). Systematic monitoring in accordance with an established process (internal audit) is not necessary until a continuous improvement cycle has been initiated (see the description of Step 17 in Stage III).

Saving Goal	Measure(s)	Costs	CO_2 Saving	Amortisation [a]	Responsible Person/Dept.	Deadline
Electricity savings of 37,400 MWh	Optimise control unit and replace old transformers	€3,150	16,800 t/ a	< 2	Technical / Engineering Planning	05/20xx
Reduction of consumption by approx. 690 MWh	Reduce diesel consumption by 5% by utilising used grease	€0	185 t/ a	Immediate €64,000/ a	Production Manager	07/20xx
Reduction of electricity consumption by 74 MWh	Only allow pumps to run automatically	€0	48 t/ a	Immediate €6,500/ a	Technical / Engineering Planning	04/20xx
Reduction of electricity consumption by 1,350 kWh/light	Replace with more efficient light bulbs	€100/ light	878 kg/ light / a	€117/ bulb	Building Services Engineering	03/20xx
Reduction of electricity consumption by 50 MWh	Reduce compressed air by 1 bar	€0	31 t/ a	Immediate €6,150/ a	Technical / Engineering Planning	03/20xx
Reduction of electricity consumption by 350 MWh	Feed in electricity from hydropower plant	€100,000	200 t/ a	< 3 €35,000/ a	Technical / Engineering Planning	04/20xx
Reduction of electricity consumption by 1,000 MWh	Reduce compressed air grid losses caused by non- closing steam traps	€10,000	570 t/ a	< 0,2 €55,000/ a	Production Manager	11/20xx
Reduction of gas consumption by 300 MWh	Reduce drier capacity by 50%	€0	600 t/ a	Immediate €8,100/ a	Production Manager	05/20xx
Reduction of electricity consumption by 250 MWh	Install an energy control system for efficient operation of ovens and furnaces	€15,000	169 t/ a	< 1 €23,550/ a	Production Manager	06/20xx

Table 10: Example of Energy Saving Measures from Energy Programmes

Tip for SMEs:

Even during the first steps of establishing an energy management system, substantial potential savings arising from simple, inexpensive measures can be quickly identified:

- In many cases, the idle times of machinery and equipment can be reduced through organisational changes
- Personnel can be trained to switch off machinery and equipment during break times or to eliminate unnecessary consumption (regular training)
- Maintenance and cleaning of facilities, equipment and filters to reduce pressure losses
- Facilities, equipment and clothing can be cleaned using methods other than compressed air
- Utilisation of waste heat raising room temperatures or for cooling via adsorption chillers or of lower pressure stages in compressed air systems
- Measures such as recording load profiles and subsequent comparison with production processes frequently reveal potential energy savings. Often, energy providers for the delivery point will provide this data at no cost

6th Step: Review of Results and Commitment by Top Management

4.7

With the data acquired in the first step, an (initial) energy review is carried out by the top management and as possible all departments and individuals that have a significantly influence on the energy consumption. During the review, the results of the first basic data acquisition are presented, explained and discussed. After preparing a list of potential energy savings, conducting an initial evaluation of the significant energy factors that affect energy consumption, and the creation of an energy action plan, the top management has to make decisions with regard to the following:

- Verification of compliance with all relevant energy regulations or formulation of measures to ensure compliance with them in the future
- Determination/verification of the main factors influencing the energy consumption and energy costs; these are the basis for defining the energy targets and goals
- Confirmation and/or derivation of the energy targets and goals and energy action plan for the next period
- Formulation of an initial energy strategy (energy policy, guidelines, or the like) for the organisation
- Determination of a suitable organisational structure for working on the goals, collecting the data, regular communication, and, where appropriate, further development of the EnMS in the next stage (energy management officer, energy team, etc.)
- Decision on the further procedure (establish a more formal system structure and proceed to Stage II, or simply update the basic data annually and remain at Stage I for the present time)

At minimum, the results of this initial review should be published in a suitable form in order to inform the employees and more strongly integrate and motivate them. The comprehensive information should be used for the purpose of involving all employees in the efforts to save energy.

Stage II – Integration of the EnMS into the Company Processes

The first stage created the basis for establishing an EnMS. The self-assessment that was conducted already enables the identification and implementation of substantial saving measures. In some companies, that is enough. They can simply continue with the annual data acquisition and management review with updated targets and goals.

As a result of the savings that have been achieved, many companies will proceed to the next stage, which be used as a basis for setting up a compliant and ultimately certifiable management system under ISO 50001, in order to save even more energy and money.

If the latter is the case, it is time to proceed with Steps 7 to 14, in which essential management system structures are set up and the required resources, means and tools are allocated and provided.

The name of this stage makes it clear that an EnMS should not be established by introducing “unnatural” and unfamiliar structures and processes in an organisation. The better approach is to supplement the existing processes in the organisation and only introduce new processes where necessary. The following steps therefore describe the key elements that ensure the effectiveness of the EnMS in all areas of an organisation.

7th Step: Energy Policy

4.3

An energy strategy was already formulated at the start of the project and during the initial review. When establishing permanent EnMS structures, the creation of a comprehensive energy policy, based on the initial data acquisition, should be the foremost objective of the top management. As in other management systems, this specifies the general scope and strategic goals of the EnMS. The top management thus defines what priority energy management has in the company.

Therefore, it is important that top management does not only "rubber-stamp" and **sign** the energy policy, but rather directly participates in its preparation and formulation. This ensures that its expectations and desires with regard to the EnMS are recorded, and that all departments of the organisation subsequently provide and receive the required support.

If there is already a company policy and/or other management systems in place that require such a policy, the aim should be – in accordance with expectations formulated by the top management – to try to expand the existing policy with the energy-relevant aspects. The obligation to comply with laws and regulations and the principle of continuous improvement are also the basis of other management systems.

The minimum components of an EnMS policy are specified in the standard:

- Compliance with applicable laws and obligations is a prerequisite, without which no management system can continue to exist in the long run.
- The same applies to the principle of continuous improvement (PDCA cycle), which is the basis of all management systems and describes the process through which an organisation “learns”.
- Determining the energy baseline, on which the strategy, targets and goals are based, as shown in the previous steps, is also a basic prerequisite for an EnMS.
- For that purpose, the top management must provide the necessary resources and should emphasise this in the energy policy.
- The procurement of energy-efficient raw materials, facilities, machinery, equipment, products and services is essential to ensure that the EnMS is functional and effective.
- Energy efficiency should be a focal point when planning and configuring facilities, machinery and equipment, processes and buildings.

[redacted]

goals in the policy as well.

The energy policy must be confirmed or updated annually (for example in the review). Organisations which use an EnMS have to ensure that it is communicated to everyone involved. This also applies, e.g., to subcontractors (and service providers), to make sure that their employees also comply with the general rules on efficiency. The energy policy can be (but does not necessarily have to be) made known to the public (e.g. via the organisation's website).

p for SMEs:

hen preparing an energy policy, a meeting based on the metaplan principle is suitable:
The opinions, ideas, and wishes of the participants with respect to different aspects (continuous improvement, compliance, savings through environmental protection measures, etc.) are collected, summarised, and sorted by importance. The policy can be drafted later in a small group or by the officers. It is then decided on and approved by the top management.

8th Step: Organisation, Communication of Procedures, Provision of Resources

4.2.1
4.2.2

If the company analysis identified deficits and gaps in the fourth step, it is now important to define a systematic organisational structure for the EnMS. The top management has to appoint an energy management representative (EnMR) or energy manager (if necessary, directly from the top management). To provide support with administrative tasks in the day-to-day business, the energy manager should also appoint an individual energy officer, who undertakes the day-to-day tasks of the EnMS. Furthermore, an energy team should also be formed.

The energy management representative must have all the authorities needed to introduce, maintain, and monitor a functioning EnMS. In particular he needs to have the authority to approach the members of the top management, who support the EnMR in his work. He should have, or acquire, experience, qualifications and skills in energy relevant areas. The EnMR's role, tasks, and sphere of responsibility must be communicated to all employees, documented, and be integrated into the organisational structure / organisational chart.

From the onset, it is important to organise internal communication, i.e. the quick and efficient exchange of information about the energy status and new findings and ideas. Especially in larger organisations, along with designating the energy officers, it can also be useful to appoint an energy team or a similar committee that meets at least quarterly (four times a year would still be considered "regular" as defined by the standard). The team should monitor the current situation and implementation of goals and define further or supplementary measures. An energy team can support the top management and the energy management officer in all tasks associated with introducing and maintaining an EnMS and ensure implementation and communication in all areas of the organisation. The members of the energy team should therefore come from all areas and departments that are energy-relevant, to make sure that the entire range of knowledge regarding energy-intensive processes is represented. An efficiently working energy team is a very helpful catalyst for implementing an EnMS successfully and quickly and saving energy on an ongoing basis.

The following example illustrates a possible organisational structure for an energy management system:

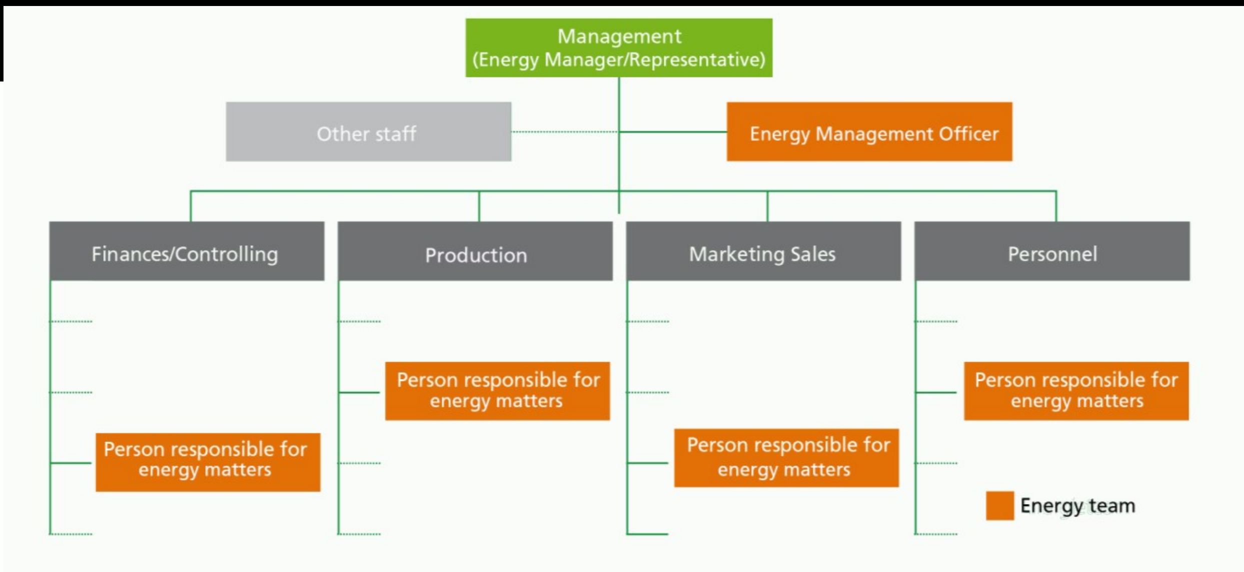


Figure 7: Example of an Organisational Structure for an Energy Management System

Different methods have proven suitable for mapping the tasks and authorities of the authorised officers and responsible persons in management systems. If a management system is already implemented, the responsibilities within the scope of an EnMS should be integrated into it and the same mapping method should be used.

Available roles:
R - responsible
A - assistance
I - information

	Energy officer	Energy team	Top management	Sales management	Production management
Data collection and monitoring	R	A I		A	A
Energy report	R	A I	I		
Energy management programme	A	I	R		
Evaluation	A	R	R		
Training and awareness	R A	A I	I	R	R
Purchase of energy efficient components	A	A I	I	R	
Technical improvement measures	A	A I	I	R	R
Energy input in production	A	A I	I		R

Table 11: Example of Responsibility Matrix

[redacted]

quality. Therefore, information about these aspects should already have been included in the energy programme. Moreover, in addition to the required time, the energy manager and energy officer also need tools, expertise, access to supporting functions in the organisation, and, if necessary, the option to bring in external support within the scope of the allotted budget.

p for SMEs: Required Resources

- **Time**: If an energy team is appointed, members must be provided with ample time resources (which is, e.g., underscored by the participation of top management)
- **Money:** The funds alloted to the persons in charge of the various goals should be budgeted. In addition, the officer should be given a fixed budget for discretionary purposes. The possibility of increasing these budgets from funds arising from immediate savings has a motivating effect!
- **Support functions:** The support from important functional areas (IT, maintenance, R&D, Controlling) should be specified in the task and functional descriptions. If an energy team is appointed, these functions in particular must be integrated
- **Personnel**: Informing and training personnel is essential to ensuring the active participation of employees, which can lead to considerable savings. As a support function, the HR department needs the necessary funds and resources for that purpose
- **Equipment/technology**: Not only are measuring instruments and equipment for data acquisition required, but skilled and qualified staff to operate, install and maintain them is essential as well
- **External consultants**: The officer or the responsible department should be allocated a budget for consultation or services

9th Step: Documentation of the EnMS, Management of Documents and Records

4.5.4
4.6.5

To ensure efficient use of the EnMS, it is important to define key organisational procedures. This not only applies to an organisation (organisational chart), but also to the execution of tasks and activities that are particularly energy-relevant (Step 10) as well as to the recording and implementation of improvement measures (Step 13). Energy-relevant tasks and activities include: continuous energy controlling (Step 15), the organisation of staff training (Step 11), and internal and, especially, external communication (Step 12). The procedures designated for these processes must be documented. Their design and contents are described below in the following steps. The (future annual) data acquisition, the recording of legal requirements, verification of compliance with them, and the subsequent evaluation of the significant factors influencing the energy consumption (Step 5) have already been addressed.

The execution of internal audits (Step 16), explained further below, the goal-setting process up to the creation and/or update of an energy programme (energy action plan) (Step 17), and the review by the top management (Step 18) are also to be documented as processes. Records presenting the key results of the processes (data, logs, measurements, etc.) must be prepared.

Note: Documents and Records

- Documents reflect the requirements in the EnMS, such as processes or methods.
- Records show the results or proof of activities performed.

Accordingly, for certain activities of a documented process, records on the current status are maintained (e.g. records concerning the results of an internal audit or management review).

ISO 50001 does not describe these concepts as clearly as other standards. Table 13 in the appendix shows which documents are required by ISO 50001, and which records and documentation, as a minimum, have to be prepared in order to demonstrate the functionality of the EnMS.

4.5.4

All management systems require the documentation and recording of core elements. This is for a good reason: Only that which is written down (documented) can be improved. If there are only verbal agreements, experience teaches us that different people, although they think that everybody follows the same procedures, often act very differently when it comes to implementing the agreement. Only a document provides a “target” with which an "actual value" can be compared. Therefore, documentation within the scope of management systems is not a "meaningless mandatory task", but rather a prerequisite for continuous improvement.

4.4.1

An example here is the description of the acquisition and preparation of the energy data (see “Note: Energy, Measuring and Evaluation Plan”). To be able to ensure the quality, reproducibility, and comparability of data, it is necessary to define how, how often, when, at which time intervals and in which quality, etc., the data should be collected. These details can also be a part of the introduction to the energy report, for example.

“Documentation” in the sense of a standard does not entail a “manual” with hundreds of pages that nobody will read later on. It can also consist of graphs, diagrams or combined text and graphic representations of the procedures and processes. Moreover, a paper (hardcopy) format is not required. Modern workflow software programmes offer a good alternative to purely text-based descriptions. In the "MS Office world", partial graphics and descriptions with links to compliance documents, forms, etc. can also be created. Programmes such as Microsoft Visio and PowerPoint, which also allow the insertion of links to other documents, are suitable for visual representations. Moreover, an IT solution lets all employees have access to the procedures and rules.

4.5.4.2
4.6.5

Step 9 should be implemented in parallel with other steps. At the beginning, however, the type and manner of documentation (text, workflow, combination, IT basis, paper basis, etc.) has to be specified and agreements on “document management” have to be drawn up. “Document management” refers to different aspects of clear and traceable labelling and versioning (e.g. numbers, revision statuses, responsibility for the contents and for reviewing them), as well as to specifications on archiving older versions and records. In terms of managing records, it should be ensured that they are legible, identifiable and can be traced back to the respective activity.

The scope of documentation depends on the type and size of the organisation as well as of the complexity of the processes. If a documentation system already exists on the basis of an environmental or quality management system, the EnMS-relevant documents should then be integrated into it, since the personnel are already familiar with the system. Over the course of time, the number of records and documents will increase. Therefore, a clear hierarchical structure should be established, to ensure that new procedures, rules and regulations can be integrated at any time and also linked to, so that the relevant departments and persons can easily find and access them.

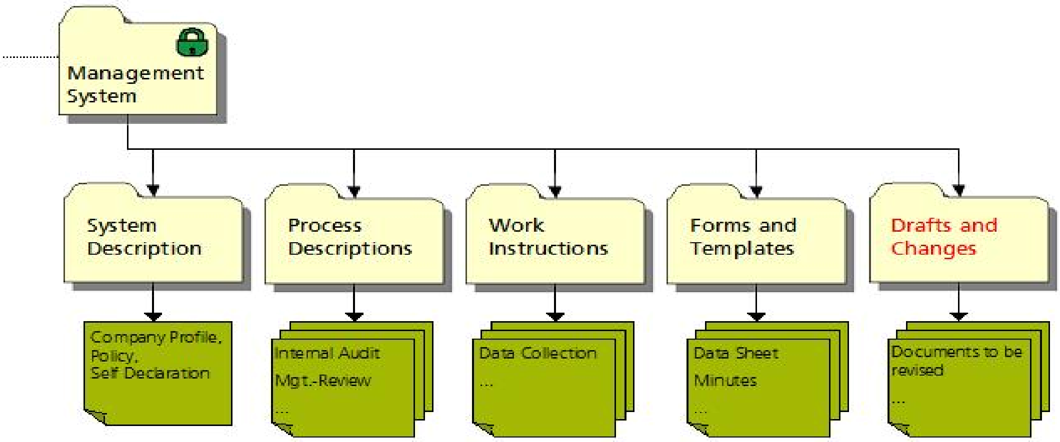


Figure 8: Example of a System Structure

Tip for SMEs:

To maintain an overview of all relevant EnMS documents, we recommend creating an overview (list) of all supporting and applicable documents of the EnMS (document name, responsible persons, revision/version dates and numbers). Changes can then be entered in this list, thereby ensuring a continuously up-to-date overview without the need for complicated structures.

10th Step: Design and Contents of Energy-Relevant Processes

In addition to identifying and determining organisational procedures and system-relevant processes, the activities that have a significant influence on energy consumption have to be described more precisely (heat cycles, plant operating modes, maintenance and repair work, procurement of energy-relevant raw materials, equipment and machinery, facility management, fleet operation, etc.). In particular, activities that (can) have a significant influence on energy consumption should be identified and documented in order to codify a "best practice" and be able to systematically improve the processes in the future on the basis of new experience. Operational control refers to planning, executing and running the activities and operations associated with significant energy influencing factors in a way that result in the lowest possible energy consumption with the highest possible efficiency.

4.5.5

Processes that have a major influence on energy consumption were already identified in the initial analysis of the energy-related factors. A detailed examination of all organisational procedures (if applicable, already documented in other management systems, such as QM) shows which processes should be described more precisely, at least in the first approach, and thus should be included in the next analysis of the energy influencing factors. As experience in using an EnMS increases, this section has to be supplemented accordingly.

Amongst others, the following processes have an ongoing effect on energy consumption and therefore should be regulated and described:

- Operational requirements and specifications on the **planning and installation** of structural equipment and facilities
- Description of the procedure for **designing** (planning) energy efficient processes, plants, systems and facilities
- **Development** of energy efficient products (services), processes and procedures
- **Selection** and procurement of energy-efficient usable raw materials, energy-efficient plants, machinery, equipment and services
- **Maintenance and servicing** of buildings, facilities, installations and equipment
- **Start-up, continuous operation, and/or shutdown** of major energy consumers (furnaces, air conditioning, compressed air)

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mented. Within the scope of the EnMS, managers, together with the energy management officer, are responsible for systematically searching the market for such opportunities (technologies, procedures, processes).

Design of energy-relevant processes

In particular, new facilities, installations and buildings have a significant and long-term influence on the energy consumption of an organisation. Therefore, they should essentially only be planned with a view towards energy efficiency and optimisation.

4.5.6

The same may apply to the energy consumption of services and products over their entire life cycle, which can be much higher than the consumption for the production . Consequently, research and development activities are especially energy-relevant processes that need to be clearly defined (even if ISO 50001 does not provide any further information on this).

Existing facilities, machinery and equipment and/or their use or mode of operation can be optimised, especially if the experience of the employees is utilised. For this purpose, systematic analysis programmes should be introduced and/or existing programmes supplemented (e.g. within the scope of TPM activities). It is important that all individuals working for the organisation and/or on its business premises be trained in the energy efficient processes relevant to their work, and be instructed to comply with them; if necessary, compliance should be monitored.

p for SMEs:

he procedures described will only be effective if they are not "theoretically" defined, but are nstead geared towards the “reality” of the organisation. In addition, the already established procedures should be examined once again from an energy efficiency viewpoint, together with everyone involved, and adjusted as needed. Under certain circumstances, procedures are already appropriate and only have to be documented for the first time in order to create a basis for improvements in the future and to ensure that they are always conducted“exactly” as specified.

Furthermore, at a minimum, the relevant employees must be instructed or trained on how they should proceed in the future. To achieve even greater acceptance, it should be pointed out during the training that suggestions for improving procedures and processes are always welcomed by the energy management officer.

Procurement of energy-relevant facilities, machinery, equipment, materials and services

In building or plant specifications, requirements concerning energy consumption should be compiled in a separate section. With regard to the procurement of machinery, for example, binding specifications on the consumption of, e.g. electricity, heat, gas, cooling energy or compressed air should be explicitly required for defined operating points. These should be incorporated as contractual components subject to penalties.

4.5.7

When considering offers, detailed consumption data can facilitate lifecycle cost comparisons, which, in addition to depreciation, take operating costs into account as well (concept of TCO = total cost of ownership). Often, more expensive machines and equipment with more efficient motors or buildings with better fittings prove to be much more cost-effective than “the cheapest deal” after a few years due to their lower operating or maintenance costs. Early on during the bidding and procurement process, it should be made clear to potential suppliers that the energy consumption of the facilities, machinery, equipment or services being offered is an essential part of the evaluation and contract award decision. The criteria for this evaluation should be defined prior to the bidding process and communicated to the suppliers.

11th Step: Raising Awareness, Training, Skills and Capabilities

4.5.2

Without personnel, a system does not work. No management system functions without the commitment of the employees and the consistent use of established procedures. This especially applies to an EnMS. All employees decide many times each day whether they should contribute to saving energy – whether they should turn off the light or the PC, shut down equipment during break times, switch off compressed air when it is not needed, etc.

Employees know their work environment well, and more than anyone, they are in the best position to offer suggestions on how energy can be saved, used more efficiently, or, for example, utilised at a lower temperature level. It is therefore important to influence the awareness of personnel and to change their behaviour in the medium term. Personnel cannot be "forced" to save energy. Internal refusal cannot be controlled or sanctioned, but it can sabotage any management system. If personnel are motivated, they will commit to keeping energy consumption low and contribute to making improvements.

Training topics related to an EnMS can come from general training requirements surveys, from comparisons with a training matrix, and from the experience of the energy management officer, who keeps abreast of developments in the organisation, in the industry, and on the market. The information and training of all personnel with regard to an EnMS is summarised in a training plan. The required training depends on the age and maturity of the system as well as the positions of the employees:

- The first information provided about the EnMS communicates the intentions of the top management to all employees on the basis of the energy policy and the initial goals, describes the system function, refers to information and communication options, and encourages participation. The focus is on how each and every employee can act in an energy-efficient manner.
- Information on energy savings topics (also in private households, as that increases the attention value) and on new efficient technologies should be continually offered to all employees in order to sustain motivation, demonstrate the personal advantages that can result from it, and thus promote and encourage further ideas on a broad basis.
- Depending on the prior qualifications of the employees, special training may be required if their work can have an effect on the energy consumption (e.g. by a facility).
- Energy management representatives, energy officers, and if applicable, the members of the energy team and/or all experts must independently keep themselves continuously informed and up-to-date on topics related to energy conservation and savings. Topics can be compiled and discussed in energy team meetings. Basic training in methods and processes for saving energy and in management systems is useful. If the energy officers, energy team members, and other persons involved are responsible for conducting the internal EnMS audits, they should be trained in audit techniques as well.
- The management should also be continuously trained and instructed on the current energy situation so that they can participate in defining strategic and operative goals and actively promote its implementation in all areas.
- Important topics (for example new procedures, new techniques, energy-efficient construction, etc.) should be brought up by the energy management officer, based on his/her market knowledge, if the specialised departments themselves do not proactively address such topics.
- With regard to the machinery, equipment and procedures relevant to them, employees of service providers or persons acting on their behalf must also be trained with respect to energy efficiency aspects, in order to promote their participation in the EnMS and their understanding of energy-related processes and motivate them to create new thoughts and act consciously.

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ciency need to be addressed in the training plan. With respect to energy topics, already existing system training programmes, e.g. on quality management, security, and especially environmental protection, can certainly be used. The path from idea to training and up to its implementation and feedback is planned during Step 8 and documented in Step 9 in accordance with the requirements.

Tip for SMEs:

Especially at the beginning, it is advisable to provide training in the form of workshops, which personnel encourages to participate in and thus have the opportunity to revise established processes and adapt the draft based on their knowledge.

The following can help raise employee awareness on a broad basis:

- Campaigns to promote the employee suggestion scheme for submitting energy-saving suggestions (results become part of the energy saving programme)
- Information on the amount, costs, and potential savings as regards energy consumption, where appropriate in comparison with other parameters such as wages or raw material costs
- Energy consumption barometers, “energy cockpits” and goal attainment information on notice boards, which provide employees with immediate feedback on the progress and success of ongoing activities

12th Step: Type and Structure of the Communication

4.5.3

In quality management, the customers are the focus of attention, in environmental management, it is the neighbours and interested public, and in health and safety, it is the personnel. For an energy management system, there is no specific “target group” for the communication. There are also many possible connections to different partners in EnMS, even if they are not as pronounced as in other management systems.

As explained above, the information and systematic inclusion of all employees is the decisive variable for the success of all efforts to save energy. Including all personnel greatly contributes to their active participation in the EnMS. This can be accomplished through the aforementioned measures for systematic training (Step 11) and the general continuous provision of information.

Once the energy policy is communicated, all participants are obliged to comply with the energy strategy and integrate it into their work. In addition, well-informed employees are more motivated to realise the goals. All commonly used means of communication, e.g. employee newsletters and magazines, intranet and Internet, e-mail as well as notice boards, and especially internal meetings and training sessions, are suitable contact media. The provision of ongoing information about the status of the efforts to save energy, the accomplishment of goals, and suggested goals from staff members keeps the attention level high and increases the employees’ willingness to make a personal contribution, for example, through their own ideas.

In addition to the staff, there are other groups that need to be or can be communicated with or communicated to:

Above all, the public (stakeholders), who can be informed about the energy policy (for example on the company’s website) in order to demonstrate the company’s commitment. It is often worthwhile to integrate the stakeholders. Their suggestions can improve the quality of projects, provide an early warning system for weak points in the concepts, or can contain further-reaching ideas. In ISO 50001, however, publishing the energy policy outside of the scope of the company today is not a requirement, but rather an option.

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energy.

- Given their extensive knowledge, energy consultants are usually interesting communication partners. Along with independent consultants and specialised engineering firms, this also includes energy agencies, which have been established in recent years.
- Customers are also an important target group in terms of communication, especially if the company manufactures products whose production is very energy-intensive (aluminium) or which consume energy when in operation (electrical appliances, motor vehicles). In this case, marketing often becomes a significant energy influencing factor and thus a process that must be described in detail according to Step 10, since the relevant customer requirements and wishes as well as the consumption behaviour must be included in the planning (even if ISO 50001 does not explicitly require this).
- The necessary communication with suppliers of facilities, equipment and materials was already described in Step 10 and the communication with service providers working on the organisation's premises or on its behalf is described in Step 11.
- The investors in an organisation as well as banks are also certainly interested in the energy saving activities, and especially in the associated cost reductions and preliminary investments. Nowadays, analysts as a main KPI assess the CO2 emissions of an organisation in relation to the added value that is essentially determined by the energy consumption as a major indicator.
- Often authorities are to be contacted, for example if tax credits are claimed or statutory compensation regulations and subsidies are utilised. Such contacts are also helpful or even required, for example when using renewable energy generation plants.

After identifying all of the communication channels that an organisation wants to or must use, specifications for each of these should be established (e.g. in a process description in accordance with Step 10, documented according to Step 9).

The following has to be specified for each communication channel: Who is the point of contact and internally responsible for this communication aspect? What information (at minimum) is to be shared or forwarded? When or how often should the information be shared or forwarded?

The top management has to decide whether (and, if yes, how) the EnMS commitment should be communicated to the outside. Should communication with the public extend beyond the energy policy, such communication has to be regulated in a traceable way when complying with ISO 50001. This is intended to ensure its seriousness and prevent only "success stories" from being communicated. The decision regarding communication with the public has to be documented (minutes of the decision meeting).

13th Step: Acquisition and Implementing Improvement Measures

4.6.4

Suggestions for improvement and the discovery of inadequacies and risks lead to new ideas for savings, revisions, and measures for preventing dissipation. These form the basis for continuous improvement in a management system. In addition to the savings goals, the corrective and preventive measures, as they are called in all standards, are the primary tools for making an organisation more efficient, better, and safer. For this purpose, standards often require drawing up a "corrective and preventive measures plan" (CPM). Here, we recommend calling this list an "improvement measures plan". That name makes its aim much clearer, removes its image as an "error list", and includes new and innovative ideas, which are often far more than just corrections of "deviations" or measures for "prevention".

Improvement measures originate from everything that happens in an organisation. Walkabouts of every kind, internal and external audits, suggestions from personnel, ideas or

[redacted]
The suggestions, possibilities and options for improvements that continuously come in should immediately be recorded, so that good ideas do not fall by the wayside.

In addition to general numbering, it is advisable to include the following columns in such a plan:

- "Cause/Problem/Improvement" (and, if applicable, "Goal"). This is often not considered important. However, it is essential as it records the reason for a deviation, a risk, or an idea for improvement. If measures are implemented, they can be successful without solving the actual problem. The "effectiveness analysis" (mandatory according to ISO 50001) then does not show that the problem may still exist despite the measures having been successfully implemented.
- In the "Measure(s)" column, several measures may be listed that can be taken to solve a problem or implement an idea; the responsible person or a team determines the measures.
- For ALL measures, the "Responsible Person" and "Deadline" columns then have to be filled in (as they are for goals in the energy programme), so that they can be planned and traced (see the note on S.M.A.R.T.).
- Efficient monitoring of the status of the measures is important. The graphic representation in the example has proven useful, and it can be supplemented by traffic light colours in the background (green/yellow/red) in order to indicate whether measures are on schedule, slightly off schedule or way off schedule.
- Without the "Comments" column, nothing works right at all, as everyone knows.
- Columns for the department name, type of measurement, etc. can also be helpful. This plan is then suitable for other systems as well. In the ideal case, the organisation can utilise one plan for its entire management, which can be sorted and easily managed through internal codes and designations.

No./ Source	Cause/Problem/Improvement	Measure(s)	Responsible Department / Person	Deadline	Status	Comments
1 Int. Audit	Shutdown the machines during break times	Check where possible, while safeguarding quality	Technical Engineering	09/201x		Checks can only be done on step-by-step basis
2 Ext. Audit	Will 2 of 3 drives suffice?	Check and if feasible, put one motor in reserve	Technical Engineering	05/201x		Equipment is currently only operated with 2 motors
3 Int. Audit	Switch off lights in outside areas at night for 5 hrs	Separate outside lighting from inside lighting	Electrical maintenance	01/201x+1		Switch cabinets are being installed
4 Walk-about	Compressed air losses on the joining machine	Sealing and follow-up inspection at the weekend	Maintenance	04/201x		Shutdown took place, sealing confirmed

Planning started/documented
Implementation started
Implementation in progress
Implementation completed
Effectiveness checked

Table 12: Example of Improvement Measures Plan (own illustration)

Tip for SMEs:

To be able to manage the goals and improvement measures effectively, they are simply entered in a sortable Excel spreadsheet. (Access databases have also been proven to be effective for managing many measures, in particular, additional variables can be easily recorded, such as the department concerned, first entry date, history in the case of postponements, etc.)

The spreadsheet is subdivided into "discretionary measures" (goals and new ideas) and "mandatory measures" (problems, preventive measures). Along with the name of the plan, that makes it clear to all personnel that this is not a list of "errors", but rather a tool for improvements. Often new goals arise from the ideas. The better and more efficiently a management system is run, the larger the proportion of the "discretionary measures" becomes.

14th Step: Energy Consumption Planning, Energy Indicators, Benchmarking

4.4.1
4.4.4

Successful energy savings and achievement of the goals are often difficult to verify due to production fluctuations, model changes, or organisational changes. Therefore, an “energy baseline“ has to be determined at the beginning. This was already done in the 4th step, and significant factors influencing the energy consumption were also recorded. With the aid of indicators (energy consumption per time unit, etc.), this data may be compared over various periods and changes can be identified.

Often only the (horizontal) comparison across various years is possible or desired, in addition to the (vertical) comparison across different facilities. In order to facilitate these comparisons, annual data (in the vertical comparison plant data) are often subject to further standardisation. Examples of such standardisations are:

- Energy consumption of an organisation in relation to created added value [kWh/€ added value]
- Energy consumption per manufactured part (light bulb, can, etc.) and year
- Energy consumption per tonne of melted iron or saleable iron (energy goals can be environmental and quality goals!)
- Heating requirement for the year per m², standardised to the heating degree days in the year
- Energy consumption of a motor vehicle over 100 km at the same speed, etc.

These indicators describe different circumstances (operating indicator, process indicator, building indicator, product indicator). Often this heterogeneity is not taken into account and thus "apples are compared with pears”.

4.4.5

These specific energy performance indicators (EnPI) are established as the basis for energy consumption planning, for monitoring the progress in increasing effectiveness, and for monitoring consumption. As use and consumption of energy changes, the EnPI must be continuously further developed and adapted. Given the importance of the EnPI in terms of energy consumption planning and future progress monitoring, a systematic methodology for establishing and adapting them should be established and documented (see Step 8).

Good indicators represent baselines, and enable the planning and monitoring of efficiency goals as well as energy use and consumption planning. Production expectations for future periods often fluctuate, but can be estimated and forecast using suitable indicators. An extrapolation based on indicators allows a company to plan the energy consumption of individual machines, facilities or even the entire organisation.

A prerequisite here is that energy-related indicators for essential machines, facilities, , processes and procedures have to be determined and regularly monitored (at least annually).

Energy-related indicators	
Specific energy consumption	*total energy consumption / production quantity* *kWh / production unit*
Percentage of energy source	*consumption per energy source / total energy consumption* [%]
CO_2 sensitivity/CO_2 efficiency	*energy-related CO_2 emissions / production output* [kg CO_2/product]
Share of heat recovery	*energy from heat recovery / total energy consumption* [%]
Operating energy indicators	
Energy unit costs	*total energy costs per product / total energy per product* *€ / [kWh]*
Energy sensitivity/energy efficiency	*added value in € / energy consumption in kWh* *[€ / kWh]*
Energy share in turnover	*energy costs in € / turnover in €* [%]

Table 13: Examples of Energy Indicators

Annual energy plans should be prepared using indicators and including the goals, similar to the annual financial planning. This helps the company purchase energy based on demand and in a cost-optimised manner, since there are often better purchase terms for advance purchases than on spot markets. Furthermore, comparisons of current figures with planned data can pinpoint "outliers" and thus identify malfunctions or unnecessary consumption. Energy performance indicators can also be used for internal and external benchmarking. At the same time, they allow the sensitivity of the organisation or the product to be estimated in terms of energy cost fluctuations.

During the acquisition and recording of the energy data in Step 5, the first set of comparative figures are often already established "intuitively“, in order to compare energy data over different time periods (horizontal) or different facilities, locations and sectors (vertical). Regardless of whether facilities of the same type, facilities with the same product, or similar locations or similar organisations are compared, differences are (almost) always found. The value of the benchmarking process lies in these differences provided their causes are analysed.

This analysis is THE source for findings, particularly in energy management.

- Why do we consume more in spring than in autumn?
- Why does energy consumption increase when production remains constant?
- Why do two identically constructed machines consume different amounts of energy for the same production output?

The surprise about the differences immediately leads to the question of why some things and measures that work for one facility/machine or a certain time period do not work for other facilities/machines or other time periods. The answers results in findings that facilitate further optimisation and better energy planning.

Stage III – Starting a Continuous Improvement System Based on an Actual PDCA Cycle

The systematic data acquisition carried out in Stage I is intended to help you determine whether there is "something to be gained" with regard to the energy supply and the main energy consumers. It increased interest in progressing to the second stage, during which a more systematic energy organisation formed the basis for leveraging additional saving options. Defined processes were established for particularly energy-relevant activities and operations, a systematic improvement management process was set up, and the first energy indicators were determined. At the completion of Stage II, all of the energy-relevant processes and elements of an EnMS have thus been introduced and implemented. The top management can now decide how to proceed.

Will the top management decide to:

- ... return to Stage I, because the expense, benefits, and possibilities associated with a more systematic approach are not adequately balanced,
- ... have the rules established in Stage II simplified and require new documentation, or
- ... drive forward the savings achieved from the prior work and efforts and put a complete EnMS into effect, which means integrating new targets, goals and system adjustments into a continuous improvement process in the future?

If the top management resolves to make the documentation of the procedures, processes and their workflows (the "EnMS manual") binding, then the company has reached the third stage of energy management: the start of an actual PDCA cycle and implementation of a complete EnMS in accordance with ISO 50001.

The now implemented continuous cycle of improvement can be aligned with the calendar year or business year, but should not comprise more than 12 months. As specified in the procedural schedule, the defined goals are regularly monitored, information and experiences are exchanged with all departments and the top management, the energy team conducts its meetings, personnel are trained, etc. at regular intervals.

Once a year, all data and facts (the energy report) are updated and an internal energy audit is conducted (see Step 16). In a review with the top management, a decision is then made, on the basis of the results of the previous year, with regard to the future strategy and the goals to be achieved, before the routine processes for implementing the goals and improvements continue again.

Once this entry into the EnMS is completed and the first internal audit cycle has begun, there is nothing more standing in the way of an external audit and certification under ISO 50001!

15th Step: Using the Organisation and Communication (Do)

Once the comprehensive rules for implementing an EnMS have been established during the steps of the previous stage, it is now time to put them into practice in day-to-day operations.

Regular monitoring of the targets, goals and improvement measures is vital. This can be done, e.g., through regular (at least quarterly is considered "regular") meetings of an energy team, during which information from all departments is shared (see Step 12).

[redacted]

4.5.2

especially energy-relevant and will use them to achieve maximum savings. The energy management representatives and officer will collect suggestions for their work by attending specialised seminars and presentations and communicate them internally.

4.4.3
4.4.4
4.4.5

Now, if it has not already been initiated, systematic energy controlling can begin throughout the year. Supported by historic data from the energy report (the first energy consumption analysis) and in conjunction with the current data and indicators, this allows the responsible persons to supervise, monitor and control the effectiveness of the EnMS based on the consumption figures. If "deviations" from the planned goal or new consumption details are detected, they then form the basis for the further continuous improvement of the energy consumption planning, for indicators, or for defining new energy goals. Furthermore, campaigns encouraging the participation of all personnel give rise to energy-relevant suggestions, which can be added to the list of improvement measures.

Step 15 is not a work package that has to be ticked off, but rather the start of an ongoing process that is continuously implemented, revised, improved, and supplemented by all participants.

16th Step: Updating the Energy Analysis, Internal Energy Audits (Check)

The energy analysis is the first part of the self-assessment (check) in the PDCA cycle, and must be conducted at least once a year. The ongoing energy controlling does not replace the detailed acquisition of all relevant data and facts (which is done at least annually) and the updating of (external) information (energy price trends, upcoming legal regulations, new (energy) efficient procedures and methods, current indicators from benchmarking, etc.). If the energy analysis were summarised as an energy report, it has to be extrapolated with the current values after the year under review has ended (see Step 4).

The updated energy analysis serves both as a basis for revising the energy consumption planning for next period and as a basis for the internal audit. During the review, it is used by the top management for the purpose of monitoring the success and effectiveness of the EnMS.

4.6.2
4.6.3

The second part is the internal audit of all relevant departments. The internal audit is one of the core elements of any management system. The current situation with respect to the energy-related equipment and costs should be recorded with the participation of as many departments and employees as possible. The procedure for this should therefore be planned and documented (see Step 8). The internal audit plan must take into account the relevance of the respective departments as concerns the energy consumption. Within a period of three years, every department that has an effect on the energy consumption or is associated with it must be audited at least once. Therefore, it is useful to include energy-intensive facilities, equipment and installations, especially those used to convert energy into other energy forms (electricity, heat or compressed air generation) annually in the internal audit. Departments, facilities and installation with a low energy consumption can optionally be included only once in three years, if applicable.

Internal audits can be conducted throughout the entire year (especially in large organisations). Often, they take place within a certain time frame in order to determine (as a supplement to the energy analysis) the current status of the energy situation and energy management system prior to the review. These will be evaluated in the review. The results of this evaluation serve as a basis for further planning.

[redacted]

be able to use the information as a basis, e.g. for clarifying the reason for changes. After the internal audit has been completed, the energy analysis (energy report) needs to be corrected, revised or supplemented based on the current results.

Furthermore, prior to each visit, the auditors should be made aware of any pending improvement measures planned for the department, facility or equipment, in order to check and verify their status. In management systems, internal audits usually pursue four goals:

- **System audit**: Verification that standard specifications that have to complied with are integrated in the management system (importance decreases substantially as the age of the management system increases).
- **Performance audit**: Verification of the implementation of internally defined processes and workflows and the pursuit of goals, auditing of processes for quality assurance of data acquisition, determining the causes of deviations and determining the need for correcting issues related to the users or system (if improvement is required).
- **Compliance audit**: Verification of compliance with applicable legal regulations and commitments. (This audit may be carried out in parallel with the system and functional audit, although the procedure and results have to be described separately in the audit report).
- **Continuous improvement**: Identification of potential savings culled from meetings and suggestions submitted by employees, from on-site inspections, and from the joint analysis of the current data and facts.

An internal energy audit conducted by energy specialists offers the opportunity for more in-depth findings based on the preliminary information. Considerations and discussions with personnel can give rise to new or supplementary suggestions for potential energy savings.

If a management system (QM, EM, OHSAS) that provides for internal audits is already in place, the energy audit can be part of a comprehensive, integrated internal audit that also includes environmental or quality management, for example. As with other management systems, the energy auditors should be knowledgeable about the relevant standards and about energy distribution methods and energy usage. However, they also have to be independent from the departments being audited, in order to allow a "view from outside". If required, external energy experts can also be included in the audit.

An organisation rarely has the opportunity to examine a subject as comprehensively as an audit team does. The results of the energy audits are thus an essential information basis for the review. Therefore, the lead auditor should prepare a summary of the results. The audit report should also include a list of potential improvements that are subsequently integrated into the improvement measures plan.

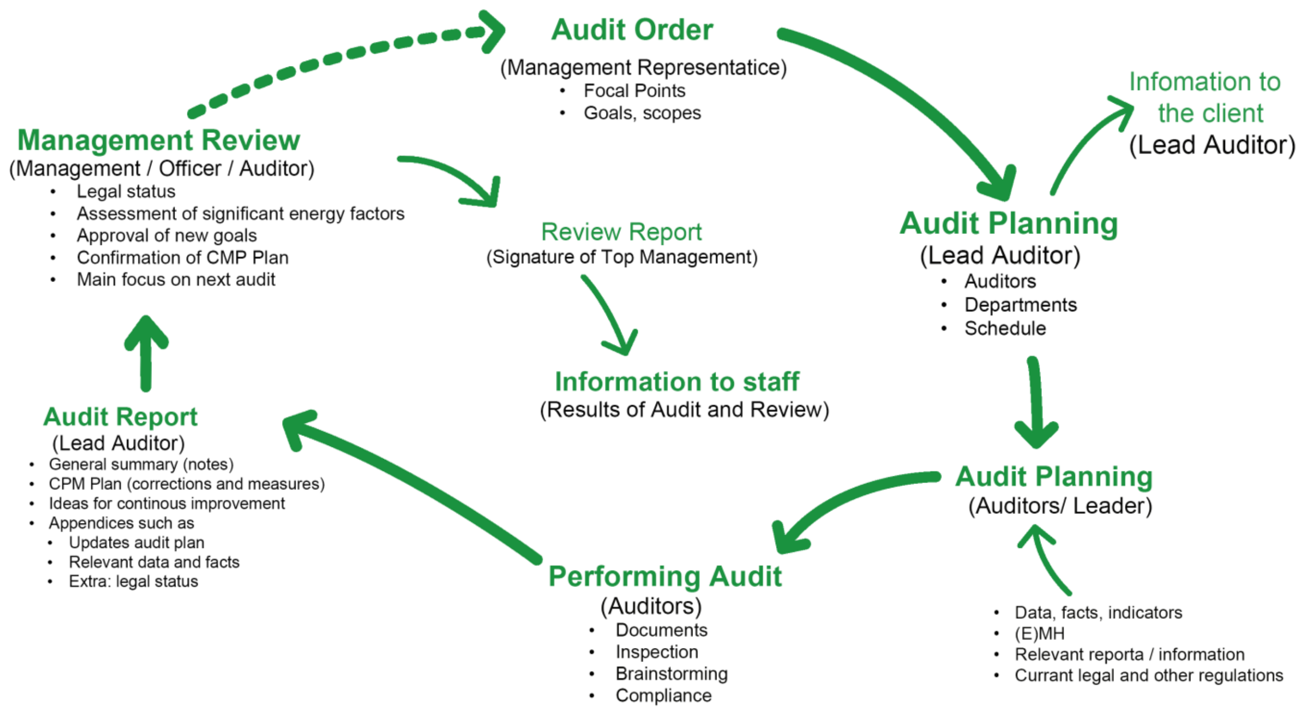
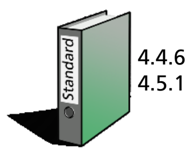


Figure 9: Flow Chart for an Internal Audit

Tip for SMEs:

The audit team should include a person from the company who is familiar with the management rules set forth by the management and who concentrates on that aspect during the audit, as well as an external expert, e.g. an energy consultant (there are often government subsidies available to defer the cost of such consultants). This approach will help identify further potentials for savings during the internal energy audit.

17th Step: Annual Update of the Action Plan (Plan I)



An energy action plan was set up based on the results of the first stage and subsequently approved. The implementation of the plan is regularly reviewed in internal meetings. Updating the figures, data and facts, or detailed analyses such as load profiles frequently gives rise to further options to save energy. These complement the action plan throughout the year as well. If they are substantiated in the course of preparing for the review, they can be added to the list of goals that is created at that time.

Over the course of the year, suggestions for improvement come from personnel, and further potential energy efficiency measures are identified in connection with the updated energy analysis. In addition to any required corrections and adjustments, the internal audit should, in particular, identify and record new ideas for potential energy savings. This is a systematic approach to developing a proposal for an updated energy saving programme (with new and updated goals), which is presented in the review, and after being discussed and if necessary, supplemented, is resolved as binding by the top management.

Note: Creating an Energy Saving Programme

It becomes clear that the PDCA cycle is not to be seen as a rigid sequence of system modules, but rather consists of elements that are sometimes processed simultaneously and interact in the improvement cycle. This is exemplified by the process of creating an energy saving programme (to be described and defined in Step 8).

18th Step: Management Review (Act up to Plan II)

4.7
4.4.5
4.4.6

The EnMS must be reviewed at regular intervals by the top management and evaluated for its effectiveness and appropriateness. Right from the outset, the management committed to an energy policy of continuous improvement and the systematic implementation of the PDCA cycle. The review always represents the end of the old cycle and simultaneously the starting point of the next cycle. After the first cycle has been completed, it always combines the important "Act" and "Plan" elements of the improvement cycle. All persons entrusted with key energy-relevant tasks should take part in the review.

A logical agenda for the review can be derived from a hierarchy of the system elements. It furthermore results from analysing and assessing the strategic EnMS elements, starting with the energy policy.

- At the start of the review, the EnMS framework is reviewed and assessed for up-to-datedness based on the energy policy and the compliance status. If necessary, the policy needs to be adapted (decision (D)), and/or immediate measures for establishing legal compliance must be taken (D). (Act)
- Against the background of these decisions, and in connection with the current energy analysis as well as the results of the energy audits and existing goals, the significant energy factors have to be updated and, if applicable, adapted or confirmed (D). In addition, the energy performance indicators (EnPI) that are the basis of the evaluation have to be revised, if applicable. The significant energy influencing factors form the foundation for updating the energy strategy (D). (Act)
- Potential energy saving goals and a new energy saving programme (D) can then finally be decided on (D) (Plan). The energy goals now form the basis of an updated energy use plan (D). (Plan)
- The continuous improvement system also includes the improvement measures (corrective and preventive measures) pursued over the entire year. Their status should also be discussed and the confirmation of the on-schedule implementation should be one of the resolutions made during the review (D). (Act)

For the discussion and evaluation of the status of the EnMS, the participants require information (which should be provided in advance for preparation purposes). This includes:

- The valid energy policy
- The minutes of the last review of the top management
- The internal audit report
- The report on the compliance audit
- The current energy consumption analysis (energy report)
- The current energy (performance) indicators
- If applicable, a supplementary report by the energy manager/energy management officer
- The goal attainment status
- The current version of the improvement measures plan
- The existing energy use planning

The procedure for the review is similar in principle to other management systems and, like the audit, can be integrated into the review on other standards, such as environmental management or quality management standards.

The incoming data and resolutions made during the energy review form the basis for the new cycle of the continuous improvement of energy efficiency that now starts.

Welcome to Systematic Energy Management!

All of the steps for managing the efficient use of energy have now been completed. Decisions on how to proceed further have been taken several times on the basis of the “distance covered” and the success achieved. In particular, the implementation of Stages II and III resulted in a systematic structure which initiated a cycle of continuous improvement.

Now you can decide:

Do you want to implement an ongoing management system, continuously review it, and explore input and ideas from outside? Then nothing is standing in your way. Your established energy management system is now "ripe" for external certification according to ISO 50001.

You have now collected enough material to, for example, make a first attempt to determine your corporate carbon footprint (CCF), since your energy consumption substantially contributes to it.

If we have sparked your interest with this guideline for best practice, please do not hesitate to contact us, we will be glad to make you an offer tailored to your requirements.

The GUTcert auditors wish you every success, especially in saving energy and money and improving your environmental performance!

Yours faithfully,

The GUTcert Energy Team

Appendix I – Documentation / Records

The ISO 50001 standard requires mandatory documents and records for certain steps. The following overview lists the minimum documents that have to be completed and available in order to facilitate successful certification.

Documents of the EnMS	Records on/about
Documentation of the EnMS **4.1 a/4.5.4.1**	Appointment of an energy manager and energy team **4.2.1 b/(4.2.2)**
Scope of application and system boundaries **4.1 b**	Results of the energy review **4.4.3**
Energy policy **(4.2.1.a)/4.3 g**	Current energy baseline **4.4.4**
Procedure for an energy planning process and its implementation **4.4.1**	Training requirements/training plan for employees and anyone working on behalf of the organisation with regard to energy requirements **4.5.2**
Methodology and criteria for the energy review **4.4.3**	Results of the design and configuration of buildings, facilities, equipment and processes **4.5.6**
Methodology for determining and updating the EnPI **4.4.5**	Results of the monitoring and measurement of the main characteristics of their operation and activities with an influence on their energy performance Calibration and other measures to verify reproducibility and accuracy of the measurements Results of the analysis of the major deviations in the energy-related performance **4.6.1**
Strategic and operative energy targets and goals with action plans for pursuing them **4.4.6**	Results of the compliance evaluations **4.6.2**
Decision as to whether the energy policy or the EnMs should be communicated externally **4.5.3**	Results of the internal audit **4.6.3**
Define energy purchasing specifications **4.5.7**	Corrective and preventive measures (plan) **4.6.4e**
Energy measurement plan **4.6.1**	Elements necessary to verify **4.6.5** 1) Conformity of the EnMS with the standard 2) Results of the energy-related performance
Audit plan **4.6.3**	Results for the management review **4.7.1**

Table 14: Documentation Required Pursuant to ISO 50001

Appendix II – Further information / Assistance

- Small and medium-sized enterprises (SME) as defined by the EU
  http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_de.html
- Deutsche Akkreditierungsstelle (DakkS – Germany's National Accreditation Body)
  http://www.dakks.de/

Additional guidelines/checklists

- Lackner, Mag. Petra; Holanek, Nicole (2007): Handbuch Schritt für Schritt Anleitung für die Implementierung von Energiemanagement (Manual of Step-by-Step Instructions for the Implementation of Energy Management). Österreichische Energieagentur (Austrian Energy Agency), Vienna:
  http://www.energymanagement.at/fileadmin/elearning/Tools_Startaktivitaeten/Energiemanagement_Handbuch_ka_eeb.pdf
- Tools, checklists, templates and models for energy policies, etc. from the Österreichische Energieagentur (Austrian Energy Agency):
  http://www.energymanagement.at/Downloads.24.0.html
- Walter Kahlenborn, Sibylle Kabisch, Johanna Klein, Ina Richter, Silas Schürmann (2012): Energiemanagementsysteme in der Praxis – ISO 50001: Leitfaden für Unternehmen und Organisationen (Energy Management Systems in Practice – ISO 50001: Guidelines for Companies and Organisations), BMU/UBA, Berlin
- http://www.umweltbundesamt.de/uba-info-medien/3959.html

mod.EEM – "Modulares Energie-Effizienz-Modell"- Energiemanagement in Unternehmen, kosten senken mit System ("Modular Energy Efficiency Model" – Energy Management in Companies, Systematically Reduce Costs)
http://www.modeem.de/

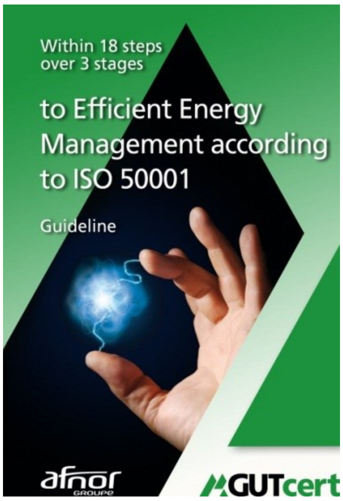
Energy Flow Diagrams – Useful Links to Software Tools

- SankeyVis software for creating animated Sankey diagrams
  http://www.sankeyvis.de/
- S. Draw software for Windows
  http://www.sdraw.com/
- Sankey Helper freeware for creating Sankey diagrams in MS Excel
  http://www.doka.ch/sankey.htm
- Sankey Editor software for creating (animated) Sankey diagrams
  http://www.sankeyeditor.net/
  http://www.umberto.de/

Better: GUTcert Tool for making a first Energy balance

http://www.gut-cert.de/info-energiemanagement00.html

EnMS Guideline – EnMS Guideline Goes International



English

French

Russian

Mandarin

Bulgarian

Polish and Spanish translations of our guideline are in the planning stage.