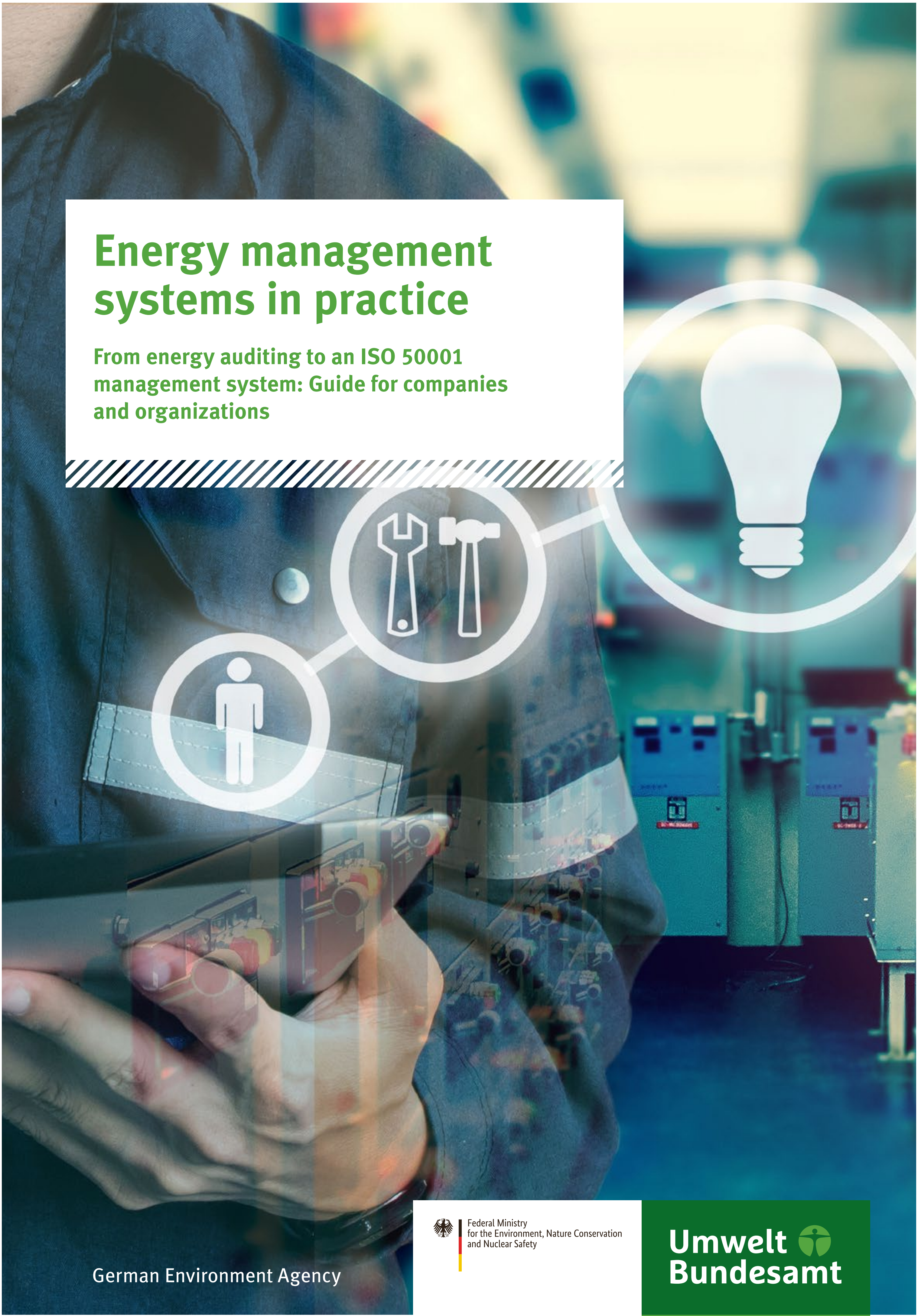
Energy management systems in practice

From energy auditing to an ISO 50001 management system: Guide for companies and organizations



German Environment Agency

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

Umwelt
Bundesamt

Imprint

Editor:
German Environment Agency (UBA)
Federal Ministry for the Environment, Nature Conservation
and Nuclear Saferty
P. O. Box 14 06
DE-06813 Dessau-Roßlau
Tel: +49 340-2103-0
buergerservice@uba.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt
/umweltbundesamt
/umweltbundesamt

Authors:
Anton Barckhausen, Juliane Becker, Peter Malodobry
(adelphi)
Nathanael Harfst, Ulrich Nissen (Chair of Controlling and
Energy Management, Niederrhein University of Applied
Sciences)

Edited by:
Christoph Töpfer, Section I 1.4 “Economic and social
environmental issues, sustainable consumption”

Design:
le-tex publishing services GmbH

www.umweltbundesamt.de/publikationen

Photo credits:
Titel: Shutterstock/ViblyPhoto
Page 6: Photostudio D29 Berlin

Status: March 2020

ISSN 2363-832X [Online]

Energy management systems in practice

From energy auditing to an ISO 50001 management system: Guide for companies and organizations

Contents

Foreword

The impacts of climate change are already visible today. We have to act now to keep global warming and its effects manageable. Germany wants to be greenhouse gas neutral by 2050. By 2030, greenhouse gas emissions are expected to decrease by 55 per cent compared with 1990 levels. Achieving the ambitious objectives requires widespread effort, from politics and business to citizens.

Companies can make a significant contribution to climate protection through systematic and long-term energy management by using energy more efficiently on the one hand and reducing their energy consumption on the other. If operational energy management is seen as a gateway to climate and environmental management, the potential is even greater, for example through switching to renewable energies or the consideration of non-energy-related greenhouse gas emissions. This not only benefits the climate and the environment, but also businesses, as there are often considerable cost savings.

Since its publication in 2011, ISO 50001 became the most important international standard for energy management systems. There are now more than 18,000 organizations certified worldwide, one third of them in Germany. Due to the recent amendment to the standard, the energy management systems of these organizations need to be adapted to the new requirements by 2021. Additionally, in Europe large companies are obliged to conduct an energy audit on a regular basis. These companies are faced with the question of whether to introduce an energy management system instead of an energy audit.

This guide is intended to provide assistance to both groups: Through concrete recommendations and a large number of practical examples from organizations in different sectors, it will show how an energy management system can be set up on the basis of an energy audit. The guide also contains approaches and practical tips to identify, evaluate and leverage efficiency potentials and to realize associated cost savings. In help boxes, the additional steps required to build a comprehensive environmental management system in accordance with the European Eco-Management and Audit Scheme (EMAS) are outlined.

With this guide, the German Environment Agency together with the German Ministry for the Environment, Nature Conservation and Nuclear Safety seek to encourage companies to systematically examine their energy consumption and the associated environmental impacts and to take ambitious measures for environmental and climate protection. If it were possible to attract significantly more companies for energy and environmental management, a major step towards climate protection and greenhouse gas neutrality would be taken. At the same time, the achievable cost savings would strengthen the competitiveness of these companies.

Navigation

A navigation system has been developed for this guide to help you identify important information. The following symbols highlight helpful practical examples, hints and tips. Additional information is provided in the course of the text in the form of boxes. A presentation of the companies from the practical examples can be found in the annex at the end of the document.

Practical example and experience reports

Practical tips from certification

Further information, literature and standards

Additional requirements to get to EMAS

You will also see the following icons as **navigation aids** at corresponding passages on the page margin:

QR codes

Further information can be called up using QR codes attached to the respective text passages. Texts that refer to these QR codes are colored red. Readers are offered the option of a second screen on a smartphone or tablet. In addition to external sources of information, the code can also be used to directly call up additional chapters developed for this guide:

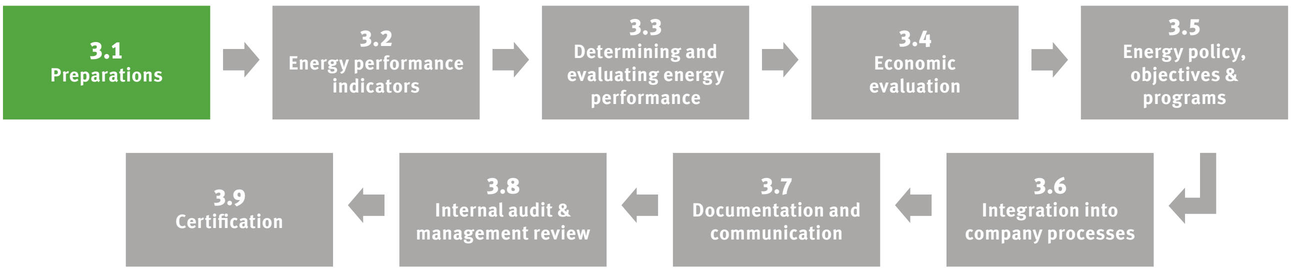
- The energy management checklist
- Payback period as a benchmark for energy efficiency actions
- Exemplary calculation of the net present value of an energy efficiency action
- Advantages of the “High Level Structure” in relation to the implementation and operation of an energy management system according to ISO 50001

High Level Structure
In its revision in 2018, the ISO 50001 standard was aligned to a binding structure for all management systems – the so-called “High Level Structure” (HLS). It simplifies the integration of several management systems into one superordinate structure, i. e. an integrated management system. The HLS symbol indicates the corresponding HLS clause in the guide.

New features in the revision of the ISO 50001
In addition to the adoption of HLS, further changes to the standard were made with the implementation of ISO 50001:2018. This icon shows you that a requirement has been in effect since the 2018 version.

Energy audit according to EN 16247-1
The energy audit according to EN 16247-1 already covers some key components of an EnMS according to ISO 50001. Wherever you see this icon, you can rely on the experience and results of the energy audit.

Navigation in chapter 3: Implementation of an energy management system



A figure at the beginning of each subchapter shows which step in the process of implementing an EnMS is being handled. The current subchapter is highlighted in green.

1. Introduction

To the guide

In June 2012, the Federal Ministry for the Environment and the German Environment Agency (UBA) published the guide “Energy management systems in practice – ISO 50001: A guide for companies and organisations”. The new version available here is updated in the course of the revision of the ISO 50001 which was fundamentally revised in 2018.

In contrast to the first version, the readers are no longer guided based on the structure of the ISO 50001 standard, **but are led chronologically from conducting an energy audit to the implementation of energy management to the implementation of actions and the certification of the management system**. The guide contains numerous recommendations, some of which go beyond the requirements of the standard, but are nevertheless helpful in achieving a high degree of effectiveness and an alignment of the EnMS for the companies success.

Target group

Basically, this guide can be used by all organizations. However, it is specifically tailored to private enterprises. The word “company” is used in the guide for reasons of legibility. Organizations such as municipalities, churches, associations and unions are in principle also included. **In particular, this guide offers assistance to those companies and organizations that are faced with the decision to introduce a certified EnMS or an environmental management system (EMS) over an energy audit, which is mandatory in the European Union.** Of course, the guide is also suitable for companies and organizations without a previous energy audit who would like to go directly for an energy management system. For both groups, the implementation of the so-called **“test run”** is useful for examining the economic benefits, which the implementation of an EnMS can entail (see subchapter 2.1).

Chapter 2 is especially aimed at **top management**. There is an **overview** of how an EnMS can be aligned with company success. **Chapter 3** essentially addresses the **persons responsible for the operative implementation of an EnMS** (e. g. technical specialists) and describes all necessary steps for implementation of an EnMS in more detail.

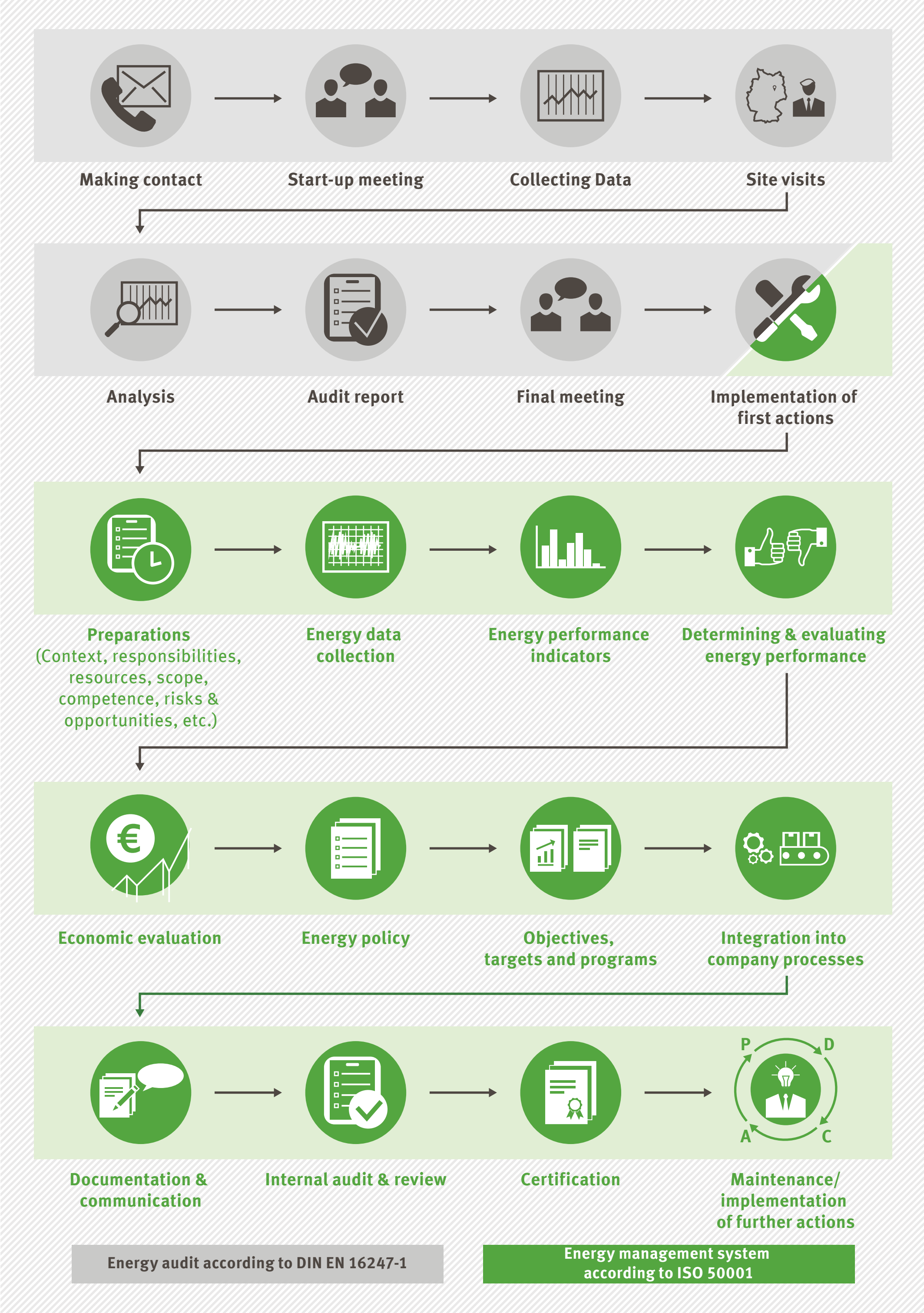
The energy audit according to EN 16247-1 as a starting point

The energy audit according to EN 16247-1 covers the key components of an EnMS according to ISO 50001. Information from the audit report and the final meeting with the auditor provide a suitable basis for setting up an EnMS. Based on data collection and analysis, you create a plan for collecting energy data. Proposals for building up the data collection should be included in the audit report[1]. When assessing energy data and other documentation, experience gained through the energy audit is typically valuable. With regard to legal requirements, you already have information after an energy audit needed to quickly and systematically review the applicable requirements. In addition, initial ideas for improvement actions should have been identified, evaluated and documented in the audit. Lessons learned can also be used to develop objectives and related programs of your management system. The following figure shows the individual process steps of an audit (gray) which leads to the chronological procedure for setting up and operating an EnMS according to ISO 50001 (green) (Figure 1.1).

1 According to EN 16247-1, the energy audit report contains measurement and verification procedures to be used for estimating the savings after the implementation of the recommended options.

Figure 1.1

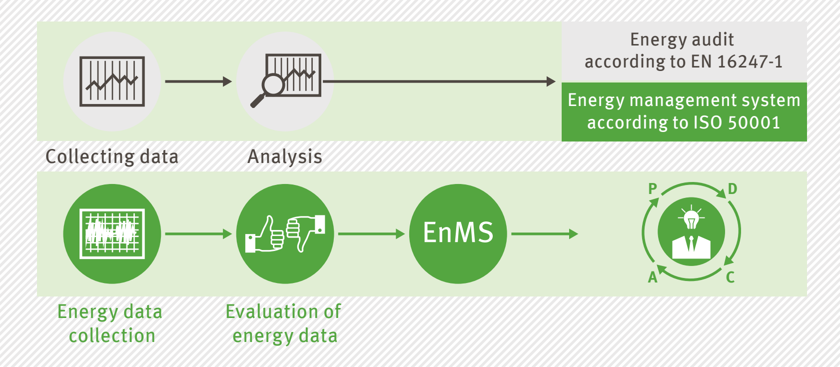
The energy audit according to EN 16247-1 as a basis for an EnMS according to ISO 50001



Source: own illustration

Figure 1.2

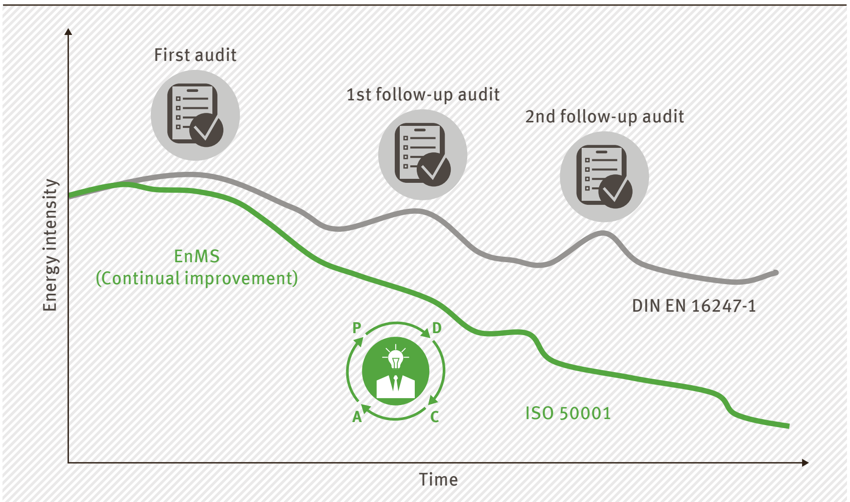
Coverage of energy data collection, processing and analysis in the energy audit as a basis for the EnMS



Source: own illustration

Figure 1.3

Comparison of energy intensity over time between an energy audit and an EnMS



Source: own illustration

The energy audit and EnMS are comparable, especially when it comes to energy data collection, processing and analysis, meaning that in these points, large parts of the work for the EnMS can be covered after an energy audit (Figure 1.2).

In contrast to an energy audit, in which energy demands are checked and actions are developed only at fixed intervals, an EnMS results in **continual improvement** as shown in Figure 1.3.

The different terms relating to energy encountered during implementation of an EnMS

- **Energy consumption** describes the energy actually used.
- **Energy efficiency** is relative and describes a quantitative performance or yield (e. g. number of goods produced, services, turnover, useful energy) per energy used. An increase in energy efficiency does not automatically lead to reduced absolute energy consumption.
- **Energy intensity** is the inverse of energy efficiency.
- **Energy use** refers to the concrete application of energy, e. g. for lighting, compressed air, heating and cooling.
- **Energy performance** according to ISO 50001 describes measurable results in terms of energy efficiency, energy use and energy consumption. This guide discusses standard requirements for energy performance.

Management systems and standards

When used properly, **management systems** make an essential contribution to the further development, consolidation and continual improvement of the processes within a company. They provide assistance to organizations, especially with regard to achieving company objectives. Organizational actions such as the definition of responsibilities, operating procedures, objectives and control systems form the basis. Responsibilities are defined in action plans ("who does what by when?") and the system is inspected independently through internal audits. The dynamic model of the "Plan-Do-Check-Act" cycle provides the framework.

Standardization serves as a guideline to ensure effective energy management. Since 2013, management system standards need to have consistent structures and content. Specifications exist with regard to

- The basic structure (High Level Structure, HLS),
- Uniform basic texts, and
- Common terms and basic definitions to be applied to all ISO management system standards.

High Level Structure – what does that mean?

The application of the HLS in all available management system standards should ultimately lead to a "standardization of standards". The objective is to ensure a high degree of compatibility between different management system standards.

With the new version of ISO 50001:2018 published on 23 November 2018, this standard now also follows the same structure as other management system standards, e. g. ISO 9001 (quality management) or ISO 14001 (environmental management) as well as the European Eco-Management and Audit Scheme (EMAS).

The harmonization results in many advantages with regard to the development and operation of an EnMS in accordance with ISO 50001. These are to be expected in particular in those organizations that have already established and maintained another standardized management system and that can build an integrated management system. An already existing quality management system, environmental management system (EMS) or occupational safety management system (according to ISO 45001) could serve as a basis for such an integrated system. The specific advantages as well as an overview of the HLS-relevant clauses within ISO 50001 can be retrieved in an annex that is accessible via the QR code in the margin.

The relationship between energy and environmental management

Organizations that operate an EMS systematically address the impact of their activities, products and services on the environment. The most widely used environmental management systems are the international environmental management standard ISO 14001 and EMAS, which is based on the European Regulation (EC) No 1221/2009. EMAS includes ISO 14001 but places higher requirements on the participating organizations. It is considered the world's most ambitious environmental management framework.

The management of energy use and consumption is a central component of environmental management. In addition to energy, environmental management systems also deal with other environmental aspects such as material and water consumption, emissions, waste or land use, provided that they are significant for the respective company. Environmental and energy management can therefore be meaningfully complemented and implemented in an integrated management system.

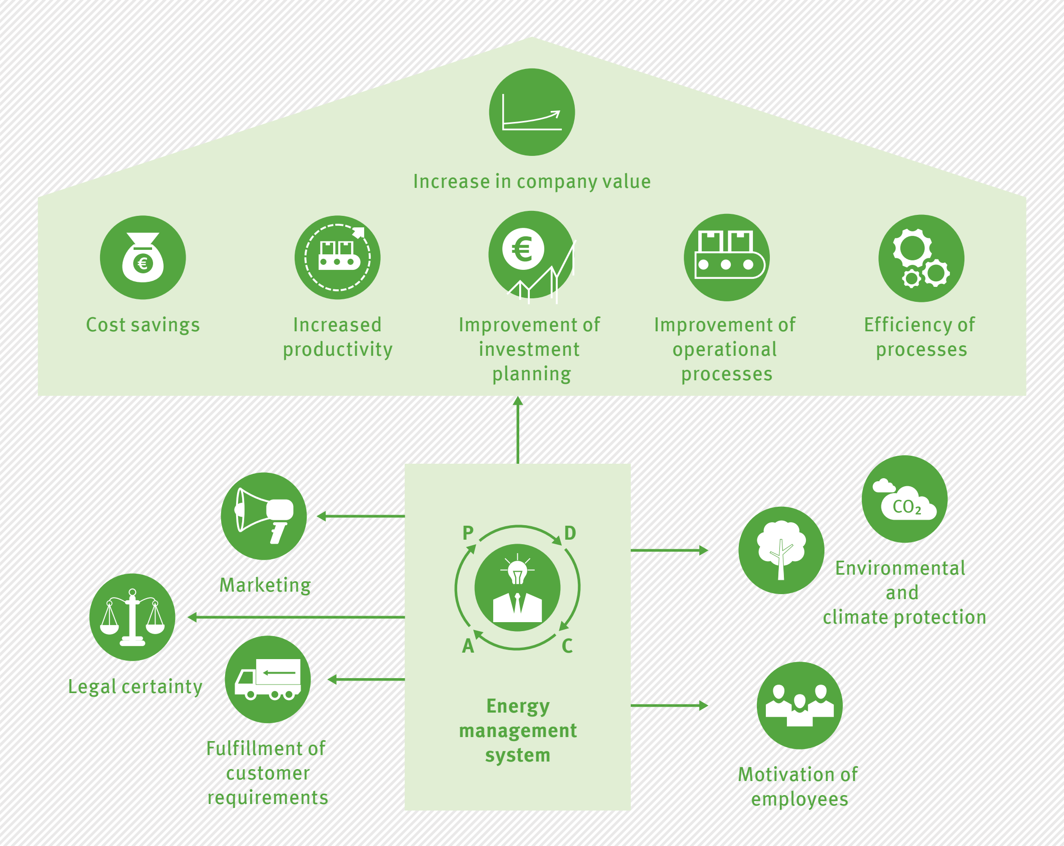
If you have decided to address your environmental impacts on other levels and to integrate the topics of climate, resource and environmental protection holistically in your organization, the EMAS boxes in this guide provide assistance on what you have to consider to successfully implement an EMS.

2. Recommendations for top management

The implementation of an EnMS is primarily aimed at systematically and continuously improving energy efficiency and, as a result, minimizing greenhouse gas emissions in addition to energy costs. As positive side effects, other benefits also arise on a regular basis (Figure 2.1).

Figure 2.1

The top arguments for an EnMS at a glance



Source: own illustration

Used properly, an EnMS can systematically increase the value of a business. This chapter outlines how this can succeed.

ALBA Group
the recycling company

"During the implementation of the EnMS in accordance with ISO 50001, we not only meet the requirements of the German Act on Energy Services, but also receive numerous other benefits, in particular significant cost savings, ensuring a demand-based energy supply and increasing productivity by making energy consumption and energy flows transparent. In addition, the certification opens up options for funding and further legal relief." *Olaf Siegel, Head of Energy Management, ALBA Management GmbH*

ZEPPELIN®
WE CREATE SOLUTIONS

"As a foundation company, we are particularly committed to the idea of sustainability and have therefore opted for the EnMS. In addition, for our company, conducting energy audits would have been associated with a significantly higher financial and organizational effort compared with the implementation of an EnMS, since we have about 130 locations in Germany. The ISO 50001 permits matrix certifications in which all locations work under one EnMS and only selected locations are checked in a sampling procedure." *Mr. Jürgen Untheim, Head of QM, Occupational Safety and Environmental Protection, Zeppelin GmbH*

2.1 Aligning energy management with company success

Aligning energy management to corporate success means understanding an EnMS as an instrument for the systematic and long-term exploitation of energy cost reduction potential. The recommendations listed in Figure 2.2 help to ensure this.

Figure 2.2

Characteristics of energy management geared to company success

Aligning energy management with company success

- Focus on the essentials.
- Self-regulation by establishing control loops.
- Bottom-up definition of energy targets and motivational incentives for those affected.
- Integration into existing control structures.
- Definition of efficiency actions with a focus on net operational success.
- Decision-oriented. Creation of suitable framework conditions before the implementation of an EnMS.

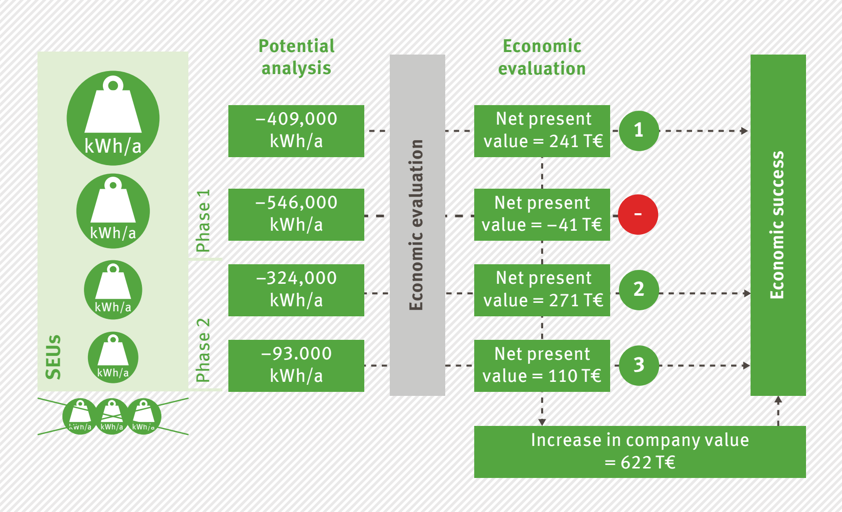
Source: own illustration

Recommendation 1: Align your energy management to the essentials.

Energy management geared towards the “essentials” focuses on operating processes that have the highest energy consumption and therefore could also entail the highest savings potential. This can be ensured by identifying significant energy users (SEUs) (for more information see subchapter 3.2).

Figure 2.3

Success-oriented exploitation of efficiency potentials with example calculation



Source: own illustration

It is often appropriate to address SEUs in several phases. This allows one to generate quick results, which can in turn trigger motivational impulses. First, take a closer look at the most important of the SEUs (two, possibly three processes) (phase 1 in Figure 2.3). Only for these should,

- Energy performance indicators be derived[2]
- Indicator owners be defined (these are persons who take responsibility for the respective SEU)
- Ideas for reducing energy consumption be developed
- Proposed actions be evaluated
- Approvals be obtained and
- Objective and target values be set.

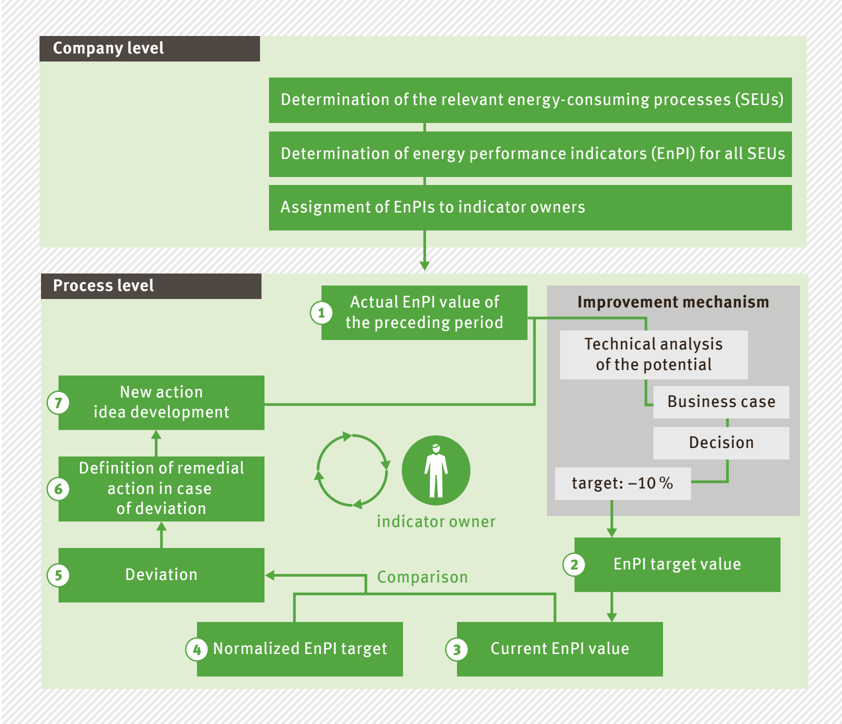
Only when these SEUs have been processed, the next phase should be started (phase 2 in Figure 2.3).

In this way, results can be produced, decisions made, and experiences gained faster than by trying to tackle all SEUs at once.

2 A detailed description of how to develop energy performance indicators can be found in subchapter 3.2.

Figure 2.4

Mechanism for the systematic control of energy consumption and costs



Source: own illustration

Recommendation 2: Establish control loops for energy consumption and energy costs.

Success-oriented energy management should be carried out for all SEUs according to an individual plan and in closed control loops by,

- Determining energy performance indicators (EnPIs) and assigning them to responsible persons – so-called indicator owners
- Regularly developing ideas and defining actions for saving energy and improving energy efficiency
- Defining challenging yet achievable objectives and targets and, as a result, defining target values for EnPIs involving indicator owners
- Implementing the previously evaluated and selected efficiency improvement actions, regularly reviewing the achievement of objectives and targets through deviation analyses
- And, in case of deviations, taking corrective action

Figure 2.4 clarifies the connections. Subchapter 3.2 goes into detail.

Recommendation 3: Establish bottom-up energy savings targets and establish motivational incentives for those affected.

The improvement mechanism in Figure 2.4 may clarify that defined energy savings targets are important for the effectiveness of an EnMS and thus the extent to which energy efficiency potentials can be exploited. Targets should be demanding, but also achievable. The achievability of targets results from an estimation of what is possible. This requries detailed process-related considerations, which are purposefully performed by the indicator owners (e. g. those responsible for specific processes). For this reason, a bottom-up definition of operative EnPI targets is in this case preferable to a top-down approach where management sets the targets. It may also be useful to merge bottom-up with top-down into a counter-current process. This means that defined bottom-up targets are aligned with strategically higher-level top-down objectives.

Appropriate incentives should be developed to encourage employees – especially indicator owners – to develop ideas for reducing energy consumption, to set ambitious targets and to implement them. For example, financial participation of the person concerned or the idea provider in the success of energy efficiency[3] or an increase of the department budget in which the actions are implemented may bring about a "win-win" situation.

Recommendation 4: Integrate the EnMS into existing control structures.

The energy management should not be established as an expensive stand-alone solution. Instead, integrate it into existing processes in order to minimize effort and generate the greatest possible benefit. For example, it makes sense to integrate the EnMS into a possibly already existing controlling system.

Recommendation 5: Define energy efficiency actions with a focus on net operational success.

With regard to required investments, focusing on company success requires the implementation of those energy efficiency actions expected to generate a net operational success, i. e. if the return is greater than the investment. As will be shown later in subchapter 3.6, the net present value method may serve as an evaluation tool when assessing the appropriateness of energy-oriented investments. With a complete record of all relevant factors of an energy efficiency action, it helps to determine the increase of the company value and contributes to clear decision proposals. The use of the payback period method is not recommended because it has systematic weaknesses that are particularly relevant

3 E. g. x% of the energy cost reduction of the first year after implementation of the action

when evaluating energy efficiency investments. This is discussed in more detail in an annex, which can be accessed via the following QR code.

Recommendation 6: Make your EnMS decision-oriented.

Ideas for reducing energy costs and idea evaluations should be prepared in a way that results in decision proposals. In order to make rapid progress in setting up an EnMS and to prevent frustration – for example, by a late rejection of detailed efficiency improvement ideas – the following basic conditions should be met:

a) At an early stage, define **how energy-saving and efficiency improvement ideas should be evaluated economically** (determination of the evaluation procedure). A requirement for this is not described by the ISO 50001, meaning company-specific clarification is necessary.

b) **Establish appropriate processes to implement improvement actions**. Many companies have procedures or other processes in place to manage a variety of issues. These should be examined to see whether they allow for or may prevent the implementation of energy efficiency actions. The aim is to find out which people are usually involved in such decision-making processes, which procedures, forms, instructions, etc. are relevant for the implementation of energy management actions and which could possibly be in (partial) conflict with these energy management actions or the previously established evaluation method.
It is important that all affected parties ultimately pull together and that there are no barriers to implementation. The result can be an individual procedure that determines as precisely as possible which formal steps have to be taken and which persons need to be consulted in order to implement a positively evaluated efficiency improvement idea. An impression of what a formal notation could look like is shown in Figure 2.5. Note, however, that such instructions are highly company-specific and Figure 2.5 is just one example.

Figure 2.5

Example of a directive on the implementation of efficiency improvement ideas

Directive on the Implementation of Efficiency Improvement Ideas of XYZ GmbH

“Following the identification of a significant energy cost reduction potential (assumed Net Present Value › € xxx,xxx, investment volume › € xxx,xxx) ...

1. The energy management department assesses the proposal on the basis of the internal evaluation guidelines “xxx” (reference person: xxx).
2. The relevant adjustment parameters of the evaluation procedure are provided by ... (department & person).
3. The evaluation results are presented to ... (department & person) ....
4. Provided the evaluation of the proposal makes it clear that the proposal is feasible and beneficial, an assessment of the financing department should be done no later than ... days after presentation. Responsibility for this falls to ... (department & person).
5. The provisional approval decision (by [3]) should be made no later than ... days after submission of the financing proposal, provided there are no outstanding questions (otherwise ... days after the last clarification). A refusal must be justified.
6. If the proposal is accepted and the financing has been clarified, the proposer initiates the implementation by drawing up a detailed project plan with cost and time information and specification of a project manager.
7. If the project plan makes it clear that no significant (... %) deviation exists between the originally assumed costs for the returns and the project plan costs, the project should be approved and subsequently initiated, otherwise a new project evaluation should be carried out.
8. One year after completion of the project, the project manager presents an overview of the project outcomes ... (department & person) and compares those outcomes with the information from the proposal.”

Source: own illustration

In addition to a variety of benefits and opportunities, the implementation of an EnMS can also entail risks. There is a risk that the EnMS will be understood as a mere documentation task or will establish a parallel structure in addition to the actual business processes. An official commitment of the top management, who at the same time serve as a role model, can help to make the EnMS an important part of the corporate strategy and to convincingly motivate employees to participate.

As top management, you are responsible for finding suitable staff and providing sufficient resources for the implementation and maintenance of an EnMS. The tasks and activities associated with the EnMS should be a high priority so that they do not “fall by the wayside”. You should not underestimate internal resistance which can result, for example, in the change of responsibilities or the transfer of responsibilities. Nevertheless, clear responsibilities are indispensable for the success of the EnMS. You should also create special incentives. For example, you can introduce rewards such as idea pricing, or pass on some of the saved costs to your employees in the form of training or company events.

2.2 Test run – Can an energy management system pay off for us?

From the point of view of top management, the following question often arises before the possible implementation of an EnMS: "Do the benefits generated by the establishment of such a system exceed the effort involved in setting up and operating it?" Or in other words: "Is this worthwhile?" Of course, these questions cannot be answered precisely in advance. However, a so-called "test run" can provide valuable information.

Figure 2.6

Sequence in the "EnMS test run"

EnMS test run

- **Step 1:** Declaration of intent
- **Step 2:** Evaluation approach
- **Step 3:** Implementation approach
- **Step 4:** Selection of three suitable test processes
- **Step 5:** Improvement ideas
- **Step 6:** Determination of impacts (kWh/a, kW, €, €/a)
- **Step 7:** Economic evaluation
- **Step 8:** Decision and implementation

Source: own illustration

Idea of a test run

As part of a "test run", two or three promising energy efficiency projects are delineated, analyzed for their potential for reducing energy consumption, evaluated economically and accompanied up to the time of implementation. In the course of the test run, possible barriers to implementation should be eliminated and the value of the energy efficiency actions for the company identified and clarified. If overviews of possible improvement actions and suitable evaluations have been compiled via an energy audit, they should be used as the basis of the test run.

On the one hand, the test run will provide you with information about the possible minimum benefit of the implementation of an EnMS in your company. On the other hand, during implementation, the course is already set for a success-oriented EnMS (see previous subchapter). In addition, you benefit as quickly as possible from the savings that result from the actions implemented.

Execution of a test run

The test run consists of eight steps (Figure 2.6). At the start (**step 1**), a letter of intent from top management is required, i. e. a clear statement that the implementation of the test run will be fully supported in terms of staff and finances. Then (**in step 2**), it should be determined by which method possible energy efficiency improvement ideas should be economically evaluated. We recommend a complete net present value calculation that includes all relevant parameters[4].

After that, it would be necessary to clarify which persons in the company are involved and which processes should be taken into account in order to ensure the implementation of the positively assessed improvement ideas at a later time. Here, practice often reveals barriers to the implementation of actions. Such barriers should be uncovered and eliminated. It has proved helpful to draw up and define processes from the assessed idea to the final decision and implementation of energy actions (see, for example, Figure 2.5) (**step 3**). In **step 4**, there are two or three suitable operational processes to select from that have comparatively high energy consumption and for which ideas for reducing energy consumption already exist (for example from the report of an energy audit in accordance with EN 16247-1) or can be developed relatively easily. For those processes, cost estimates and the reduction potentials for energy consumption should also be identifiable with little effort. Then, ideas for improvement will be developed or taken over from the audit report (**step 5**) and the impact of the ideas (measured in kWh per year or kW) and the cost of implementing each idea (in € or € per year) will be estimated (**step 6**). Afterwards, the ideas are to be evaluated according to

4 The procedure of the economic evaluation on the basis of the specified procedure should be standardized and declared in-house – i. e. after the possible implementation of an ISO 50001 system – in order to be universally valid.

Figure 2.7

Example of an EnMS test run

Step					
1	**Declaration of intent from the top management**	"The top management of Example GmbH supports the implementation of an 'EnMS test run'. It provides the financial and human resources necessary for the identification of possible actions and their economic evaluation. If profitability is established, the top management guarantees that the approval decision will be made swiftly and implementation will be initiated."			
2	**Evaluation approach**	"The economic evaluation of potential savings actions takes place on the basis of the net present value of a particular project. This will be determined and interpreted according to the internal 'XY guidelines'."			
3	**Execution approach**	"See 'WZ guidelines' for the implementation of energy efficiency improvements."			
	4	5	6	7	8
Actions	**Selection of actions**	**Improvement ideas**	**Determination of impacts**	**Economic evaluation – Net Present Value**	**Decision and implementation**
A	Compressed air	New compressed air station (action 4 from the 2015 audit)	Reduction of electricity by 50,000 kWh/a At 0.18 €/kWh over 18 years Investment: € 50,000	€ 97,978	Implementation approved
B	Heat provision	Integration of a combined heat and power module	Still to be evaluated	Still to be evaluated	Still to be evaluated
C	Lighting	Replacement of the lighting in hall 3 (action 2 from the 2015 audit)	Still to be evaluated	Still to be evaluated	Still to be evaluated
D	…	…	…	…	…
Net benefit				**€ 97,978**	

Source: own illustration

the previously defined procedure (**step 7**). Finally, the respective decision is made, possibly required aggregates procured and the the action implemented (**step 8**).

The outlined procedure is illustrated in Figure 2.7 with an example. It describes the core of operational energy management in accordance with ISO 50001. If the test runs reveals that economic energy efficiency actions exist to a relevant extent, the implementation of an EnMS according to ISO 50001 should be considered to:

- Perpetuate the process and uncover and raise further and lasting efficiency potentials
- Secure the impact of efficiency actions through the use EnPIs and assignment to key performance indicator ownership[5]

5 See subchapter 3.2.

- Highlight the importance of energy efficiency within the company and to suppliers in order to promote energy efficient behavior and procurement
- Officially confirm the efficient use of energy as a resource with a certificate (for example, with customers)

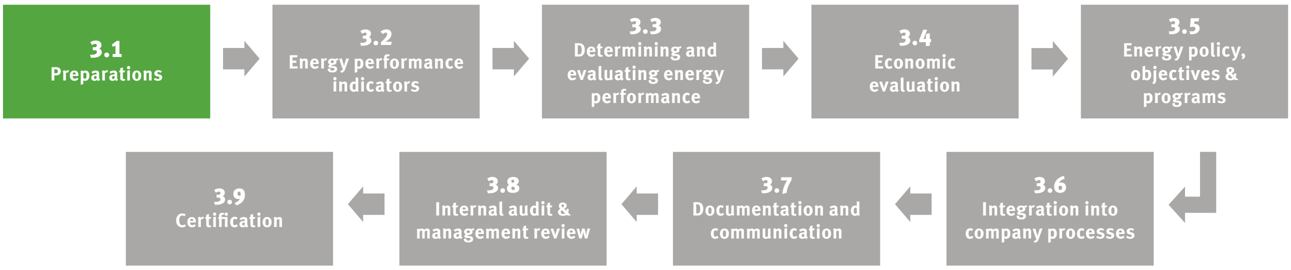
A positive test run can be considered a suitable preparation for implementing ISO 50001. It lays the foundation for swift implementation of the ISO standard.

3. Implementation of an energy management system

This chapter explains the implementation of an EnMS according to ISO 50001 in chronological order. The order of the subchapters is not fixed. It may be possible that you have already done preparatory work in certain areas, e. g. by using other management systems. Should certification be sought after the implementation of the EnMS in accordance with ISO 50001, it is important that all the requirements of the standard are met. So that you can match the subchapters of this guideline to the respective clauses of ISO 50001, you will find HLS symbols in the margin and a correspondence table in the annex.

While an energy audit in accordance with EN 16247-1 is rather a snapshot with a focus on individual actions, systematic energy management aims to affect continual energy performance improvement. This is achieved through continual improvement of processes and is often described as a control loop with the phases “Plan, Do, Check, Act” in which the results of one run create the basis for the next.

3.1 Preparations

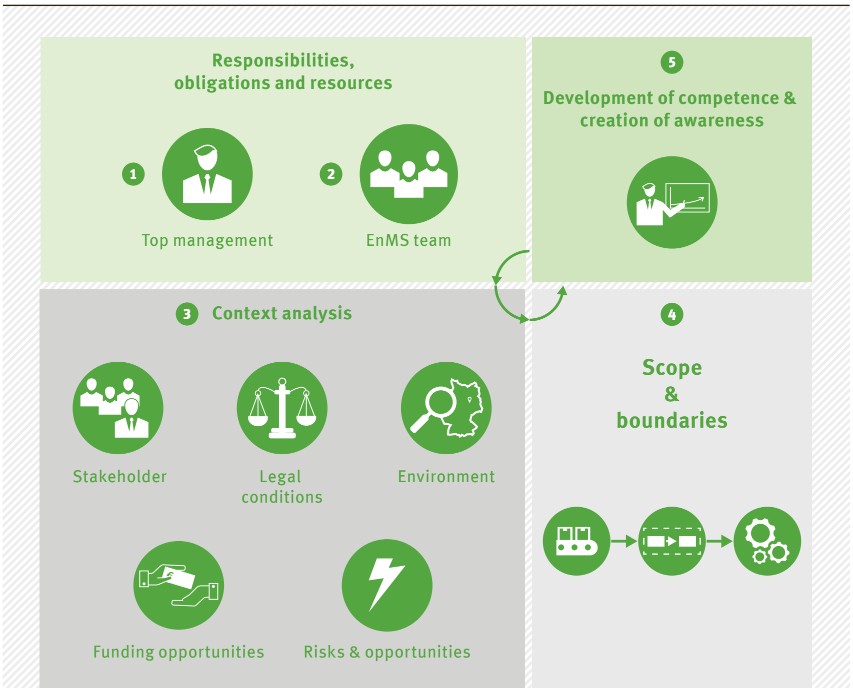


After convincing top management of the implementation of an EnMS, it is time to take the first preparatory steps that are already standard requirements (Figure 3.1). In the preparatory phase, decisive foundations are laid for the success of the EnMS, which later only have to be checked for up-to-dateness and adapted if necessary.

For the long-term success of an EnMS, the motivation of the workforce and the integration of the EnMS into the daily processes of the organization are imperative. An EnMS according to ISO 50001 **involves all levels and functions of an organization** beginning with the top management level, which has primary responsibility for the success of the EnMS. The number of persons involved and the extent of involvement is often greater than with an energy audit according to EN 16247-1.

Figure 3.1

Preparatory steps in the context of the implementation of an EnMS



Source: own illustration

5. Leadership

Step 1: Know the requirements for top management[6]

In particular, according to clause 5.1 of ISO 50001:2018, management must ensure that:

- An energy policy and the scope and boundaries of the EnMS are defined
- The EnMS is integrated into the company strategy
- Objectives and targets are set and action plans implemented
- Sufficient resources are available for the introduction, implementation, maintenance and enhancement of the EnMS (staff, specific skills, technical and financial resources)
- The EnMS achieves its intended outcome(s)
- An energy management team with defined responsibilities and authorities for the realization of the EnMS is formed
- Appropriate EnPIs are defined and energetically-relevant changes are identified and addressed

The communication of the importance of the EnMS is also the responsibility of top management. It should actively support the EnMS team in its work, as well as other individuals, including other relevant leaders to help energy performance improvement. Top management is responsible for promoting continual improvement of the EnMS itself and energy performance and checking it at fixed intervals (see subchapter 3.8).

Make sure that the involvement of top management is guaranteed and the resulting obligations for internal communication to the EnMS, for setting objectives and targets and for EnPI determination, are met. Also make sure that the long-term planning of the company refers to energy performance.

It also makes sense at the very beginning to coordinate the planning of implementation, including schedule and resource requirements, with top management.

6 The ISO 50001: 2018 uses the term from the HLS “top management”.

Step 2: Forming the energy management team

An important planning step is the formation of an EnMS team. It is recommendable to assign tasks to several participants so that the entire company can be involved. In order to perform its duties, the EnMS team needs sufficient expertise, competence, and motivation as well as the full support of top management. Although no energy management representative is required since ISO 50001:2018, it is advisable to nominate a responsible person as a contact for compliance with the requirements of the standard and to coordinate the energy management team.

NEW in ISO

EMAS explicitly requires the appointment of one or more environmental management representatives who will take over overall coordination. The tasks include:

- Implementation, maintenance, development, centralized steering and monitoring of the environmental management system
- Contact person for top management and employees
- Involvement of staff and strengthening of environmental awareness
- Preparation of reports

When selecting a team, not only expertise, but also motivation is crucial. Search the workforce for people with energy competence from the different operating areas for the EnMS team. Communicate participation in the EnMS team as a positive development of their job ("job enrichment"). External experts can support and motivate the team through their experience and an independent view of company operations.

Although you are free to choose the members of the EnMS team, it is crucial that people responsible for energy-related processes are appointed to the team. It is also advisable to include employees from controlling or purchasing in the EnMS team. It also makes sense to bring a representative of top management into the team.

ALBA Group
the recycling company

The **ALBA energy management team** has been in business since 2014 and has since been responsible for the areas of energy procurement, EnMS and energy efficiency in the ALBA Group. The originally in-group energy management team now also supports external customers with its interdisciplinary competence.

When it comes to implementation, among the key people in the team are members of management as well as the department heads from Purchasing, Communication and Technical Facility Management. This created the necessary acceptance among the employees of the ALBA Group.

The team successfully introduced an ISO 50001 certified energy management system to the group of companies and continues to maintain it within its 60 companies and 260 locations. The EnMS team is itself part of the subsidiary ALBA Management GmbH. As part of energy management consultations, the experts conduct consumption analyses, identify potential savings and implement energy optimization together with those responsible for a location.

:DÜSSELDORF
Bädergesellschaft

The **energy team of Bädergesellschaft Düsseldorf** consists of the energy management representative, a representative of the top management, a representative of the commercial team, a representative of the technical department as well as two representatives of the pool operations. The team was and is significantly involved in the implementation and support of the EnMS. The table gives an overview:

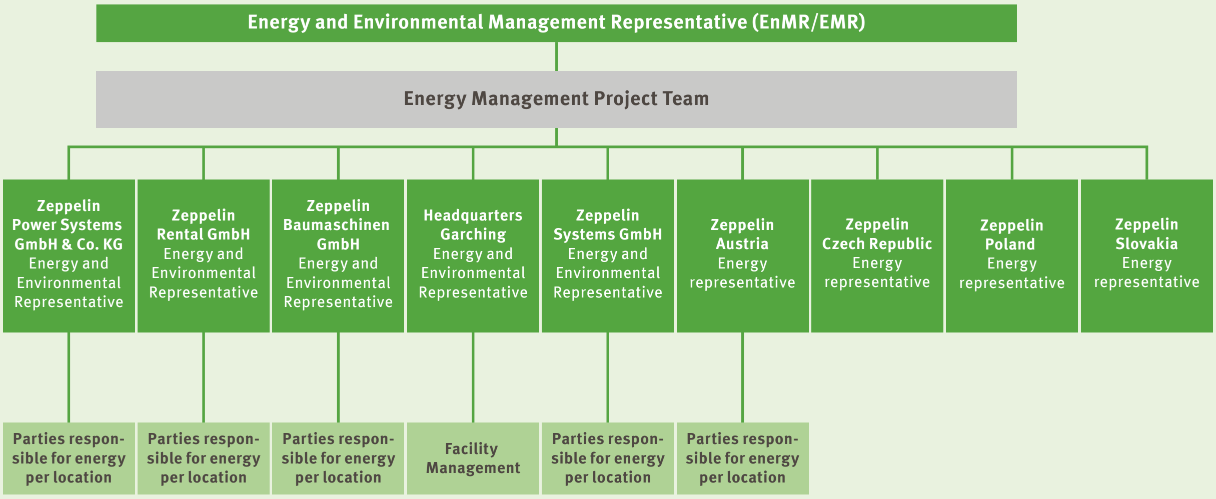
Name	Position in the company	Position in the team
Recep D.	Employee of Energy Controlling and IT System Administrator	Energy Management Representative
Sarah S.	Employee of Energy Controlling	Representative of the Commercial Department
Katharina V.	Assistant to the Management	Representative of the Management
Manfred Z.	Deputy Head of Maintenance	Representative of the Technical Department
Harald J.	Operations Manager	Representative of the Spa Operations
Mirco F.	Head Swimming Supervisor	Representative of the Spa Operations

ZEPPELIN
WE CREATE SOLUTIONS

The energy and environmental management system at Zeppelin GmbH is coordinated, controlled and continuously developed throughout the Group (holding) by the energy and environmental management representative. For each of the subsidiaries in Germany, Austria, the Czech Republic, Poland and Slovakia, one energy representative has been appointed to implement the Group specifications, taking into account the company-specific activities, and report the development back to the Group and the respective company and the associated locations. A clear structure and the definition of responsibilities ensure that the energy and environmental management system is implemented throughout the Group and at all locations.

Organization chart

Energy and environmental management system ISO 50001/ISO 14001



The tasks of an EnMS team consist of setting up and maintaining the EnMS. This includes[7]:

- Definition of criteria and methods for the EnMS and its monitoring to function effectively
- Implementation of action plans
- Responsibility for the reports on the performance and results of the system to top management
- Ensuring compliance with standard requirements

In addition to the mandatory requirements outlined in the standard, the team can also contribute to the success of the EnMS with the following activities:

- Development of effective organizational structures for integrating the EnMS into the company organization

7 According to EN ISO 50001:2018, clause 5.3

- Establishment and maintenance of an energy information system for internal communication
- Comprehensive data collection and analysis as well as development and energy efficiency actions to support the implementation of the action plans
- Internal consulting on the purchase and sale of energy and the acquisition of energy-related products, facilities and services
- Contact point for employees and the public for questions regarding energy in the company

Because energy efficiency touches almost every aspect of your business, it is essential that the EnMS team works with people from all concerned departments. Top management should be involved at least once a year. To maintain the EnMS team's ability to act, it is best that it has its own budget and can use a fixed portion of the savings for further action.

HLS

4. Context of the organization

NEW in ISO

Step 3: Understand the context in which your company operates, including risks and opportunities as well as the needs and expectations of interested parties

First, you should get acquainted with the context of your organization, determine internal and external issues, relevant for energy consumption and the EnMS, and establish existing connections. Internal issues include, for example, the general company strategy, processes and budget requirements and other criteria for making investment decisions. The development of energy costs, technologies and legislation in the field of energy or greenhouse gas reduction, for example, represent external issues. Furthermore, aspects of energy security or the potential use of nearby energy can be external issues relevant for your EnMS.

All of these influences put your EnMS into context. The standard requires you to analyze the context to be able to identify factors that affect energy performance. With this, the EnMS supports your company in identifying strategic challenges and reacting to them.

If an energy audit was carried out in accordance with EN 16247-1, you have already dealt with the energetic interrelations in your company and the context should have been briefly described at the beginning of the audit report. While this is not comprehensive enough for understanding the context as required in ISO 50001:2018, it can be a starting point.

Identify all relevant interested and affected parties (stakeholders) and consider their relevant requirements. In the standard, the identification of the context and the needs of the stakeholders purposely come one after the other. This is because the identification of stakeholders is seen as complementary or corrective to the understanding of your organization's context. In addition to your own employees, stakeholders can also include suppliers, customers, authorities or residents. You should identify those with the greatest impact on energy performance and identify their expectations. Consider internal and external issues when doing so. The latter could, for example, include industry-specific objectives and agreements and the development of energy costs, while internal issues could include operational risks, personnel policy, or business objectives.

NEW in ISO

An important aspect of context analysis is the identification of relevant legislation as well as the examination and assessment of compliance with it. If available, you can refer to the report of the energy audit for relevant regulations. In addition, this could also contain initial information about possible **grants and subsidies**.

The condition for participation in EMAS is proof that all relevant environmental legislation is complied with. In addition to the relevant legislation in the field of energy, environmental management focuses on European, federal and state laws, ordinances and technical regulations in the areas of immission control, water and wastewater, waste, nature conservation, chemicals and hazardous substances, fire protection and occupational safety.

Compliance with the legislation is checked and confirmed by the environmental verifiers. The responsible environmental authorities are also involved before the EMAS registration of an organization.

Identify risks and opportunities and decide how to deal with them to be prepared for any negative events. In addition to your own needs and obligations, you also incorporate the needs and expectations of stakeholders. A risk is defined by the consequence of an event and its likelihood of occurrence and represents a deviation from your expectations, which can be both positive and negative. Potential risks may occur within the EnMS, such as high implementation costs, lack of acceptance or inefficient investments in energy efficiency actions, or may occur externally, such as market risks or the uncertainty of a forthcoming legislative change. Risks can also be related to climate change, such as energy supply constraints from low water. Do not forget to analyze the opportunities[8]. If you have performed an energy audit in accordance with EN 16247-1, the information from the audit report and from the final discussion can provide further starting points for assessing risks

8 Possible opportunities that arise from the implementation of an EnMS can be found in Figure 2.1 in subchapter 2.1.

and opportunities. As your EnMS progresses, also consider the results of the energy review (see subchapter 3.3) as part of the "Plan Do Check Act" (PDCA) cycle and adapt risks and opportunities to new findings. You also have to plan actions for dealing with risks and opportunities in order to be able to react to such events with as much control as possible. For example, the risk of not meeting all legal requirements or failing to meet further obligations, such as industry-specific agreements, could be met with the systematic identification, analysis and evaluation of these requirements. For this purpose, for example, so-called legal registers, in which all laws, ordinances and other obligations relevant to the organization are stored, are helpful.

NEW in ISO

Since stakeholders can also indirectly influence energy performance, it is essential to identify and analyze all interested groups. In particular, the internal stakeholders must be taken into account to ensure complete coverage (e. g. top management, controlling, personnel department, etc.). The relationships between context and stakeholders should be seen as complementary elements. The following questions should be asked:

- Which topics of the context are relevant for us and where should we act?
- Which stakeholder requirements are relevant and should be considered?
- Which organizational units and business processes are relevant to the EnMS and should be looked at in more depth?

If the process is handled systematically, significant opportunities and risks should become visible. This can be supported by a strengths, weaknesses, opportunities, threats (SWOT) analysis or the like. Such a process usually also serves as the basis for developing a new strategy or adapting or correcting an existing strategy.

Step 4: **Define the scope and boundaries of the EnMS from the analysis of the context**

The scope determines the coverage, informative value and complexity of your EnMS. Depending on whether you have direct control over or can at least influence the energy consumption of certain areas, you should arrange the respective areas within or outside the accounting boundaries of the EnMS. Depending on the area of influence, the supply or delivery traffic may, for example, be within or outside the boundaries of the EnMS. If you for instance transfer energy to a neighboring company beyond your accounting boundary, it is advisable to look at these energy flows. The same applies for waste heat which is, for example, released via air or cooling water.

Define the boundaries of the scope based on factual reasons. In no case should you exempt substantial energy consumption that is in your sphere of influence from the EnMS scope. For example, if you do not include all major processes, you may not optimally design energy efficiency actions, which may result in unwanted energy increases in processes outside of boundaries without receiving feedback from your EnMS. In addition, the credibility of your EnMS may suffer from a too narrow scope.

If you have already carried out an energy audit, you can orient yourself to the scope of the audit, but you should question it again with a critical eye. It is advisable to put the scope to the test every year – hand in hand with the context and stakeholder analysis.

Step 5: Ensure the necessary development of competence and creation of awareness

Once you have decided who takes on which task, it is necessary to find out if all affected employees have the knowledge and skills to perform their energy management tasks. This applies both to the energy management team and to all other relevant persons. The training requirements can be determined, among other things, from an analysis of the past and future activities of the respective persons, requirements for the operation of machines and systems or in the context of employee appraisals. It is advisable to set up a training plan and follow up with it.

On the one hand, suitable training actions lead to the development of appropriate and necessary knowledge in the company, and on the other hand, the individual employees become aware of the importance of energy management. Depending on the needs identified, it may be useful to train employees for this task. This is particularly advisable for departments whose staff is not technically trained, but who nevertheless contribute significantly to energy consumption.

Sensitization and raising awareness are important prerequisites for the success of energy management in your company. Employees can be sensitized through a number of different actions. Suitable are, e. g., information campaigns, flyers, info screens, articles in company newspapers, the intranet or internal meetings.

In any case, it is important to motivate your entire staff to participate actively. Give tips on how to easily save energy at work or at home, and communicate success stories that include both environmental and cost aspects. It is also important that top management leads by example. Simple behavioral changes are much easier to adopt if the leadership also gets involved and communicates these.

Ideally, energy management training and awareness are not limited to your own company, but will also involve suppliers. You could make it clear that all who work on behalf of your company are expected to also have the necessary knowledge to implement successful energy or environmental management.

ALBA Group
the recycling company

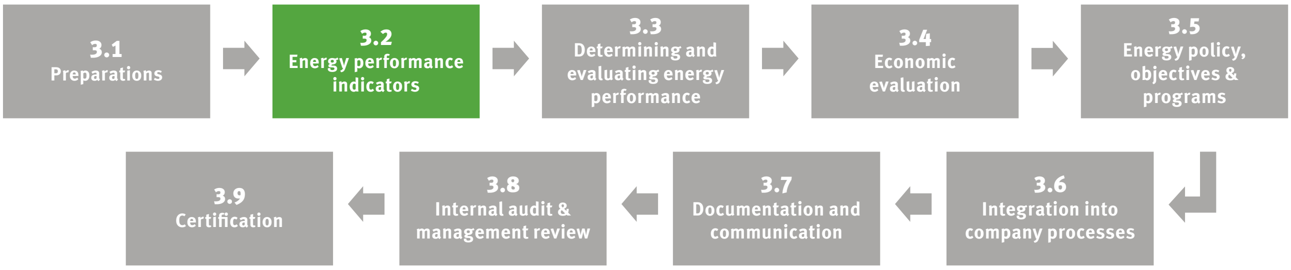
Building up, passing on and networking competence

At the ALBA Group, a multi-level training concept has proved successful that is aimed at those employees involved in energy management. It was created according to their tasks and requirements. An example are seminars on the topics of "energy performance indicator creation" and "influencing factors". Anyone who attended the seminar will pass on newly acquired knowledge to the energy representatives of the regions as part of "in-house" training.

In addition to the training sessions, the energy management team of the ALBA Group regularly visits the companies on-site. There, the team discusses with the respective energy representatives and technical specialists how the operating modes of the installations can be optimized.

In order to keep up to date, the members of the team also maintain contact with other professionals, e. g. the chamber of commerce in Berlin and with the energy representative of the federal state of Berlin. This intensive dialog enables the continuous development of energetic actions.

3.2 Building a system of energy performance indicators (EnPIs)



EnPIs play a key role in systematically reducing energy costs and continual energy performance improvement. They act as indicators that represent past, desired and actual energy consumption. This allows for controlling to demonstrate improvements and, in case of deviations, the need for corrective actions.

Data collection, measurement and analysis of energy use is already an integral part of the energy audit according to EN 16247-1[10]. If you have done an energy audit, you should already have a comprehensive database for developing EnPIs:

- General operating performance indicators
- Characteristic features of the location and of the building(s) (e. g. building energy certificate, type plates)
- List of energy-consuming systems, processes and equipment (e. g. system register, process or system images, operating hours)
- Historical consumption data and information on internal energy production (e. g. bills, regenerative energy sources, already implemented actions)
- Design, operation and maintenance documents of energy consuming systems
- Special features or operational abnormalities
- Relevant information for economic analyses (e. g. savings potential in kWh/a and €/a, cost estimates for actions, budget limits for energy efficiency actions, etc.).

The basis for the formation of EnPIs is the so-called "energy review" (ISO 50001:2018, clause 6.3). This is a systematic identification and analysis of energy use including the measurement of consumption values and the values of all relevant factors. The energy review aims at identifying the main consumers (SEUs) and revealing potentials. Based

HLS

6. Planning

9 According to EN 16247-1, clause 5.5 the analysis includes a breakdown of energy consumption on the consumption and supply side, the energy flows and energy balance of the audited object as well as the pattern of energy demand over time.

on this, EnPIs for monitoring and measurement are to be developed and used for the identified main consumers. This will be discussed in detail below.

An energy data collection serves as the basis for the energy review and the derivation of suitable EnPIs. The higher the consumption of areas and installations, the more accurate the measurement and the higher the level of detail of the measurement concept should be.

Based on a practical example, the following explanations illustrate how a system of energy performance indicators can be developed step-by-step and then controlled (Figure 3.2).

Control objects are energy-consuming installations and processes whose energy use is to be optimized. When choosing the installations and processes, you may want to follow the results of the energy audit.

Figure 3.2

Steps for building a system of EnPIs

- **Step 1:** Capture all processes that use energy
- **Step 2:** Defining SEUs, establishing responsibilities (indicator ownership)
- **Step 3:** Determining possible influencing factors
- **Step 4:** Checking whether the possible influencing factors are also "relevant variables", determining the respective energy consumption functions (ECF) and further development into EnPIs
- **Step 5:** Developing, evaluating and possibly approving improvement actions, defining EnPI target values and implementing deadlines
- **Step 6:** Conducting deviation analyses after normalization
- **Step 7:** Responding to any deviations, setting new targets, determining "energy performance"

Source: own illustration

Step 1: Capture all processes that use energy.

NEW in ISO

It is useful at the beginning to create a list of all processes that use energy that includes the following information (step 1 in Figure 3.3):

- Designation,
- Energy sources used,
- Annual energy consumption and
- Annual energy costs.

Small consumers can be grouped together as a common control object or not be considered.

If it is difficult to quantify the energy consumption of a reference period due to a lack of available measurement data, energy consumption could be estimated on the basis of the type plate information of the respective process plants and taking into account the recorded running hours (productive hours of a system per year) and converted into energy costs.

Step 2: Set boundaries for the SEUs and define responsibilities.

Once energy consumers and energy consumer groups are included in the list, it is recommendable to order them by annual energy consumption. To determine the SEUs, use a fixed criterion such as:

- All processes that cause cumulative x% of energy consumption or energy costs or
- All processes with an energy consumption share of more than x%

are to be regarded as SEUs. According to ISO 50001, the determination of criteria is your own obligation.

To produce a great effect as quickly as possible, **ISO 50006** and **ISO 50001** suggest concentrating the control on processes with a high consumption reduction potential. These are presumed to primarily be the SEUs. Clause 4.2.6 of ISO 50006 provides practical information on energy data collection.

EnPIs should be defined for all SEUs. EnPIs are calculation rules that serve to determine normalized indicator values (more on "normalization" later) with reference to the past (baseline values) or to the future (target values). They can be compared with actual values to show deviations.

The comparisons are necessary to visualize changes, creating pressure to achieve target values and bring about improvements. In addition, it makes sense for persons who can exercise the greatest influence on the energy consumption of SEUs to be assigned with the responsibility for the indicator values. These individuals should therefore be referred to as “indicator owners”. Since EnPIs – as explained – usually refer to SEU processes, in many cases it makes sense to transfer this “indicator ownership” to already existing process owners (machine operators, foremen, masters, cost centre management in production, etc.). It is important that you assign each EnPI to only one person so that clear responsibility is ensured.

Step 3: Determine the possible “relevant variables”.

Once you have established indicator owners, consider for all SEUs what factors could affect their energy use. Also keep these potential influencing factors in the list.

Figure 3.3

Recording of all processes that use energy (step 1), demarcation of the SEU, definition of the indicator owner and clarification of possible influencing factors (steps 2 and 3)

Step 1				
System	Energy carrier	Reference period	Annual energy input Reference period [kWh]	Annual energy costs Reference period [€]
Process 4712	Electrical current	2017	3,237,137 kWh	€ 453,199
…	…			
Total: › 80 %				

Step 2			Step 3
Priority	Category (SEU vs. non-SEU)	Responsible person (→ EnPI owner)	Possible relevant variables
1	SEU	Uwe Maier	· Production volume · Outside temperature
2	SEU	…	
…	…	…	
10	Non-SEU		
	…		

Source: own illustration

For EMAS, both **direct and indirect environmental aspects** are assessed. In addition to the field of energy efficiency, **core indicators** must be defined in further **key environmental areas:** Material, water, waste, biodiversity, emissions. Examples of environmental indicators are annual total air emissions (SO_2, NO_X etc.) as well as the total annual amount of (hazardous) waste.

Step 4: Identify the "relevant variables" and determine the energy consumption function

Next, you have to test whether the possible influencing factors are so-called "relevant variables", so to what extent there is a connection between them and energy consumption. For this purpose, you collect information about the possible influencing factors (e. g. production volume and temperature) for the energy consumption data (from step 1) and evaluate it. Table 1 shows an exemplary overview that can serve as a basis for further analysis.

Table 1

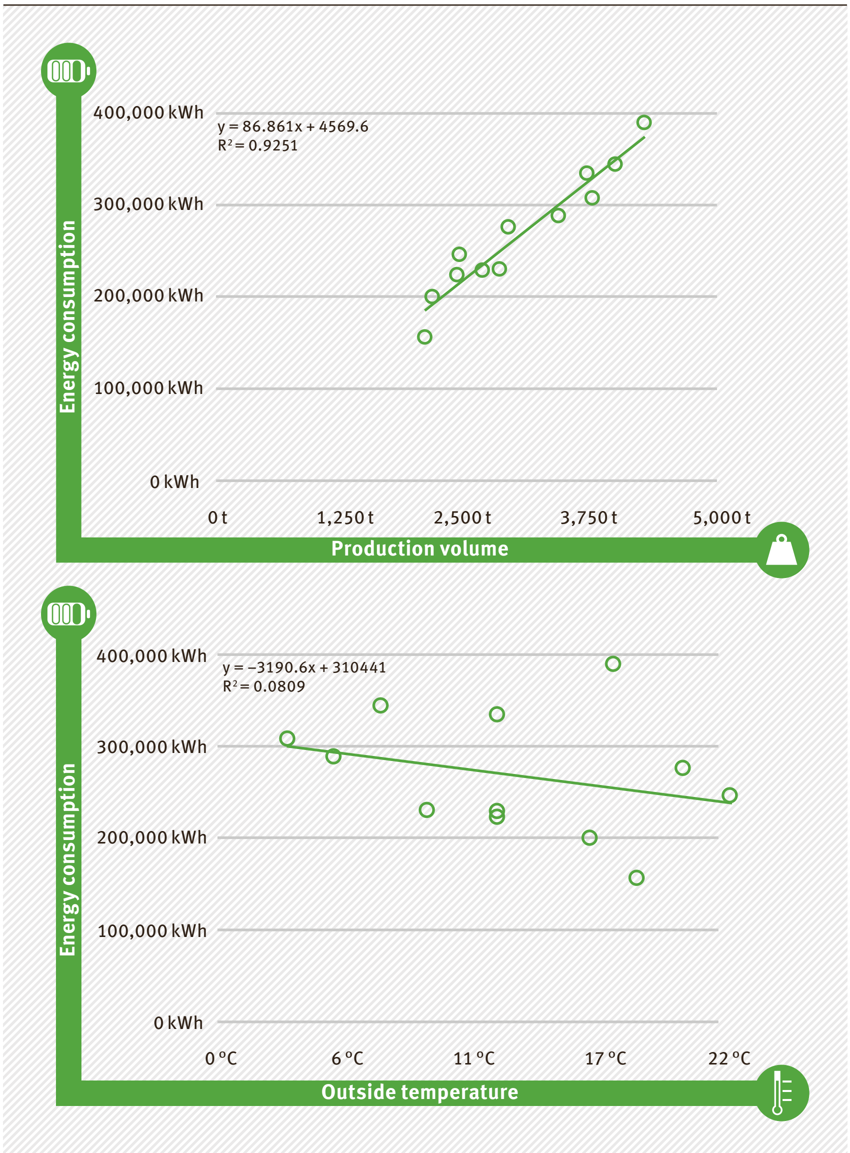
Example of a data table for determining the relationships between influencing factors and energy consumption

Month	Consumption of electric energy [kWh]	Possible "relevant variables"	
		Production volume [t]	∅ Outside temperature [°C]
January	308,546	3,757	3
February	289,457	3,420	5
March	345,789	3,981	7
April	224,545	2,411	12
May	335,778	3,701	12
June	156,788	2,092	18
July	246,789	2,434	22
August	276,888	2,918	20
September	200,456	2,161	16
October	391,345	4,275	17
November	229,757	2,660	12
December	230,999	2,827	9
Total	**3,237,137**	**36,637**	

Source: own illustration

Figure 3.4

Result of the regression analysis to clarify the relationship between production volume (top), outside temperature (bottom) and energy consumption



Source: own illustration

Then, you will test the correlation of this data with the help of a regression analysis. First of all, compare the energy consumption with individual influencing variables in a simple XY diagram. This often makes it clear whether or how strongly energy use correlates with the influencing variable. Figure 3.4 shows the results for a regression analysis between energy consumption and production volume (top) and outside temperature (bottom), which was carried out using spreadsheet software.

In the present case, when looking at the two figures, the graphics show that the production volume has a clear correlation to energy consumption, since all real measured values are close to the trend line. How well the trend line explains the relationship between energy consumption and influencing variable is also determined by the coefficient of determination (R^2). A coefficient of determination of "1" represents a perfect relationship, while one of "0" no correlation. The production amount has a relatively high coefficient of determination of "0.93", while the temperature with an R^2 of about "0.08" has a much weaker explanation of energy consumption. It therefore makes sense to regard the production volume as a "relevant variable" and to exclude the temperature. However, in the case of several influencing factors, those with a low R^2 can generally be considered relevant variables when examined individually. If the energy consumption can be traced back to several (measurable) influencing factors, then it can only be adequately explained if their influence is simultaneously determined in the context of a "multiple regression analysis" by the "corrected coefficient of determination R_{corr}^2".

In such models, the individual variables then explain only a part of the change. It therefore may well happen that the consideration of a supposedly weak factor in the simultaneous consideration can increase the corrected coefficient of determination R_{corr}^2 and thus be considered a relevant variable (this is more relevant for multiple analyses). The representation of individual correlations with the aid of XY diagrams as above thus provides only a first assessment for evaluation of the relevance of variables. Overall, however, it can be assumed that the variable with the highest R^2 most affects energy consumption.

When deciding whether an influencing factor should be considered a relevant variable, not only its effect on the "corrected coefficient of determination R_{corr}^2" plays a role, but so does the effort to continuously capture and provide the appropriate data for each variable. Should an influencing factor provide only a very small part for the explanation of the energy consumption (small increase of the R_{corr}^2 value) but nevertheless entail a significant collection effort, it may well be justified not to provide for it as a "relevant variable" (proportionality principle). In the present example, this is assumed for the temperature and therefore only the production volume is declared as a "relevant variable" and consequently taken into account in the EnPI determination.

An energy consumption function (ECF) – which then represents the EnPI – can usually be taken directly from the regression result determined by computer software. It gives the energy consumption as a function of its influencing variables using a mathematical function and thus allows energy consumption to be estimated on the basis of predicted variable values. Furthermore, an ECF allows for normalization, creating the basis for fair comparisons between periods or target and actual values. In our example, the ECF and the derived EnPI are:

$$EnPI(month)_{4712} = 86.861\,\tfrac{kWh}{t} \times production\ volume[t] + 4{,}569\,kWh$$

The EnPI shown here refers to months due to the given data situation (evaluation of monthly data) and the fact that a base load is present.

It should be noted that an EnPI can also be represented as a quotient (energy consumption in the numerator and value of the relevant variables in the denominator). However, as the parenthetical expression clarifies, this is only possible if only one relevant variable and, in addition, no base load is available. Since these basic conditions are often not met and, moreover, an aggregation of several EnPIs into higher-level EnPIs (such as an EnPI of an entire factory building) is usually not possible for quotients, their presentation has been omitted from this subchapter.

Step 5: Develop and evaluate actions for improvement.

The definition of the exemplary EnPI is now complete (step 4). This is followed by the development, evaluation and possible approval of actions for improvement, the derivation and evaluation of EnPI values and the definition of implementation deadlines (cf. step 5, 5). Following this, the other SEUs should be processed accordingly.

Figure 3.5

Process analysis for the development, evaluation and possible approval of actions for improvement as well as the definition of EnPI target values and implementation deadlines

Step 1 … 3		Step 4		Step 5				
System	Energy source	…	EnPI (= energy consumption function)	Improvement action	Net Present Value	Ok?	Target value	Deadline
		…						
Process 4712	Electricity	…	$EnPI(month)_{4712} = 86.861 \frac{kWh}{t} \times production\ volume\,[t] + 4{,}569\ kWh$	XYZ	€ 324,500	✓	−10 %	12/19
…	…	…	…	…	€ 195,700	✓	−5 %	…
…	…	…	…	…	€ 178,000	✓	…	…
…	…	…	…	…	…		…	…
			Increase in value:	€ 1,287,000				

Process analysis

- Development of improvement ideas
- Evaluation
- Approval
- Setting of targets
- Implementation

Source: own illustration

You must be able to explain irregularities. It is therefore necessary to collect data on the relevant variables and static factors, in addition to energy consumption and energy usages. In order to maintain clarity, it makes sense to consider the entire company as well as individual areas (e. g. installations, locations, facilities), systems and processes, but to always set system boundaries and operating conditions for this consideration. In addition, staff who have a significant impact on energy use must be known for each of the key areas (SEU).

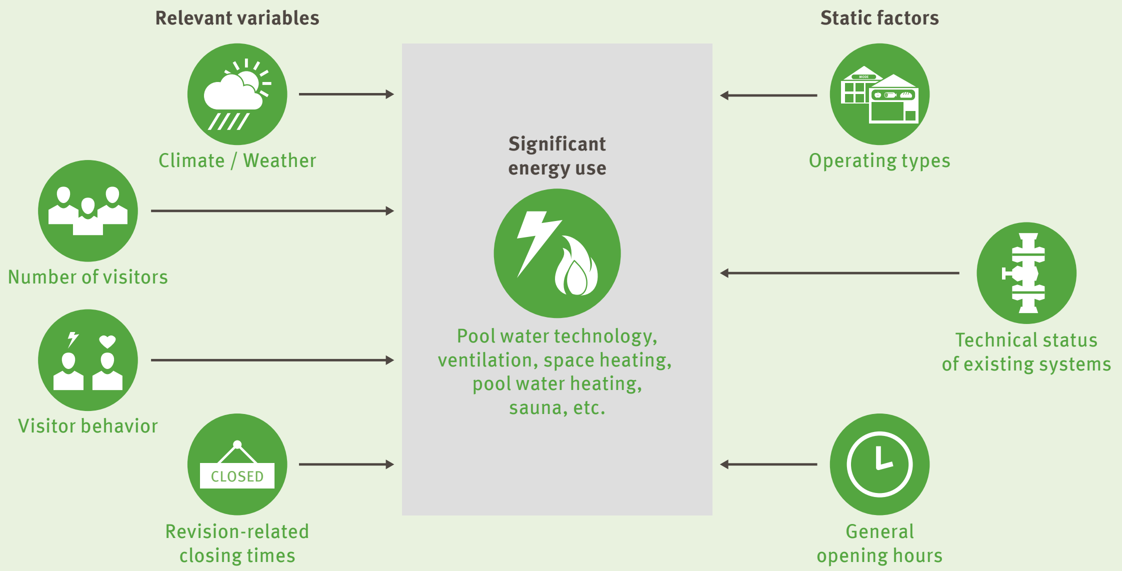
:DÜSSELDORF
Bädergesellschaft

Relevant variables and static factors that significantly affect energy use

Various influencing factors have different effects on the energy consumption of certain areas. This makes it difficult to compare the pool operations to each other, both on a national level and to compare different years of operation.

Therefore, for each of the SEUs, **relevant variables** and operating characteristics are included to enable a comprehensive evaluation of the data. For example, school classes shower for shorter times than senior groups. A higher pool volume in the outdoor pool in warm, sunny weather requires more displacement water, which must be returned to the pool heated. However, the pool heats up due to solar radiation.

Later – when structural changes have occurred – the collected data also includes **static factors**. While relevant variables are subject to routine or irregular changes, static factors are not. The types of operation, for example, can be regarded as static factors: Indoor swimming pools with and without a sauna, outdoor pools, recreational pools or combination pools have different energy consumption. In addition to direct influences, such as differently heated basins, there are also indirect influences, such as different amounts of evaporating water in different types of pools. Technically, modern systems with energy-efficient control and ventilation technology and high heat recovery also require less heat. The efficiency and controllability of pumps have a strong impact on power consumption.



Defining appropriate EnPIs can be challenging if several factors together affect energy consumption. In such cases, narrowing down the SEUs so as to break the EnPI down into smaller units with possibly a small number of influencing factors is recommended.

Think about actions for improvement and set target values. The continual improvement of “energy performance” should be achieved by reducing the – normalized – energy consumption of all relevant processes. For this purpose, suitable actions must be identified, evaluated and implemented. By comparing a historical reference value – the so-called “energy baseline” (EnB) – with an actual value you can examine the development. In addition, to achieve reasonable improvement, consider targets and, subsequently, target EnPI values at the operational level. More about setting objectives and targets can be found in subchapter 3.5.

In the above example, a baseline value of around 3,237 MWh (with reference to the year 2017) was calculated. This baseline value is now the foundation for developing ideas for actions for improvement. For this purpose, the process under consideration must be questioned critically in terms of energy by the indicator owner in cooperation with other capable colleagues. Idea development is more productive the more detailed the EnPI structure of a particular process is. The result should be a presentation of specific actions, an overview of the necessary steps for implementation and necessary acquisitions/activities as well as the expected energy-related impact (ideally measured in kWh energy savings per year). From the determined savings effect, the objective value for the EnPI results in 324 MWh/year in the example, so about 10 %.

Step 6: Analyze deviations after normalization.

Deviation analyses could reasonably fall under the responsibility of the controlling department because such activities are part of its usual work. Nevertheless, it is conceivable and possibly also appropriate to assign this task to the energy management department.

First, for each SEU list the developed EnPI, the reference periods, the measured baseline value, the current values of the relevant variables as well as the predefined objective value (see example of Table 2). As soon as actual values of the reporting period are available, preparation of the deviation analysis can begin.

Table 2

Example of a deviation analysis after normalization

System/Process: 4712_electricity $EnPI(month)_{4712} = 86.861\frac{kWh}{t} \times production\ volume[t] + 4{,}569kWh$						indicator owner: Uwe Maier		
Reporting period:	1-12/2018	**Baseline period:**		1-12/2017		**Target value for 12-31-2019:**		−10 %
Energy price:	0.19 €/kWh	**CO_2 load of electricity:**		0.61 t/MWh				
Relevant variables	**Baseline values (measured)**	**Current values (measured)**	**Normalized baseline values (calculated)**	**Baseline deviations (“energy performance”)** Absolute	%	**Normalized target values (calculated)**	**Target deviations** Abso-lute	%
Production volume [t]	36,637	31,000						
ENPI values	**3,237 MWh**	**2,509 MWh**	**2,748 MWh**	**−239 MWh**		**2,473 MWh**	**36 MWh**	
Monetized EnPI values	**€ 615,030**	**€ 476,710**	**€ 522,029**	**€−45,319**	**−8.7 %**	**€ 469,826**	**€ 6,884**	**1.3 %**
CO_2 change				**−145 t**			**22 t**	

Source: own illustration

To perform a deviation analysis, so-called **normalizations** are necessary. This allows you to compare the energy performance of a process **under equivalent conditions**. The comparison refers either to performance at different time periods (past vs. present) or actual performance is compared with a target performance. If, from the reference period up to the reporting period, the framework conditions that are relevant for the energy consumption have changed, then this becomes visible in the values of the “relevant variables”. These values are now transferred to the EnPI function (note: here, the base consumption must be multiplied by 12 [months], which refers to the EnPI for months) and thus lead to normalized EnPI values. The result of normalization are therefore EnPI values, which would have been determined with the framework conditions of the reference period. The normalized baseline value in our example results from applying the EnPI with the values of the relevant variables in the reporting period, and is 2,748 MWh (Table 2).

NEW in ISO

If you compare this value with the measured actual energy consumption, the example shows an efficiency improvement of about 239 MWh, a cost reduction of 45,319 € and a CO_2 reduction of 145 t. The extent to which the set objective has been achieved, on the other hand, results from the comparison of the actual value with the normalized objective value. The latter can be determined by multiplying the normalized baseline value by “1 minus the objective value”, in this case about 2,473 MWh. In the example, an efficiency improvement (by 8.7 %) is achieved (improvement of the energy performance), but the set objective is missed by 1.3 %. The efficiency improvement relates to the normalized baseline values in Table 2. For climate protection, however, the absolute savings in greenhouse gases without normalization are particularly important.

Calculation of greenhouse gas emissions

Depending on the energy source, energy consumption causes different greenhouse gas emissions. Using emission factors for e. g. electricity, oil and gas, you can calculate energy consumption in emissions of CO_2 equivalents, which are used to unify the different effect of other greenhouse gases besides CO_2. The reduction results from the multiplication of the amount of energy saved and the specific emission factor for the energy source.

Germany-specific emission factors can be found in the UBA publication **"CO2 Emission Factors for Fossil Fuels",** https://www.umweltbundesamt.de/publikationen/co2-emission-factors-for-fossil-fuels (available via QR code in the margin).

It often happens that organizations determine EnPI on a high level. These, however, can often not be normalized due to the variety of influences on energy consumption. In such a case, consideration should be given to setting new, lower level and therefore normalizable EnPIs.

Step 7: Respond to deviations and set new target values

In case of deviations, a cause analysis is crucial for the effectiveness of a control system. Only the clarification of the causes of deviations makes it possible to derive remedial actions (options for action) which are intended to prevent corresponding deviations in the future or to achieve targets and objectives retrospectively. At this point, the role of the indicator owners is again visible, namely to contribute significantly to the clarification of causes of deviation.

Once you have achieved your targets, you will need to consider whether you can set new energy targets based on the new EnB. This may be particularly useful if, in the meantime, new ideas for efficiency have been developed, or if rising energy prices have made previously uneconomic efficiency actions economically viable.

Defining the targets and thus the normalized target values play a decisive role in the control process just described. In this context, you will examine to what extent an improvement in energy efficiency is possible. The level should be challenging but achievable in order to maximize impact and avoid frustration. Furthermore, appropriate scheduling of the achievement of objectives is important (see also subchapter 3.5).

If it later turns out that influencing factors have been overlooked in the determination of EnPIs or were initially disregarded due to a lack of data, make appropriate adjustments or corrections. Also do this if framework conditions and, consequently, “static factors” have changed. As already mentioned, “static factors” are influencing factors which, in contrast to the relevant variables, do not routinely change but also have a significant influence on the energy consumption, e. g. the product type. Such an adaptation will also subject your EnPIs to continual improvement as part of the EnMS.

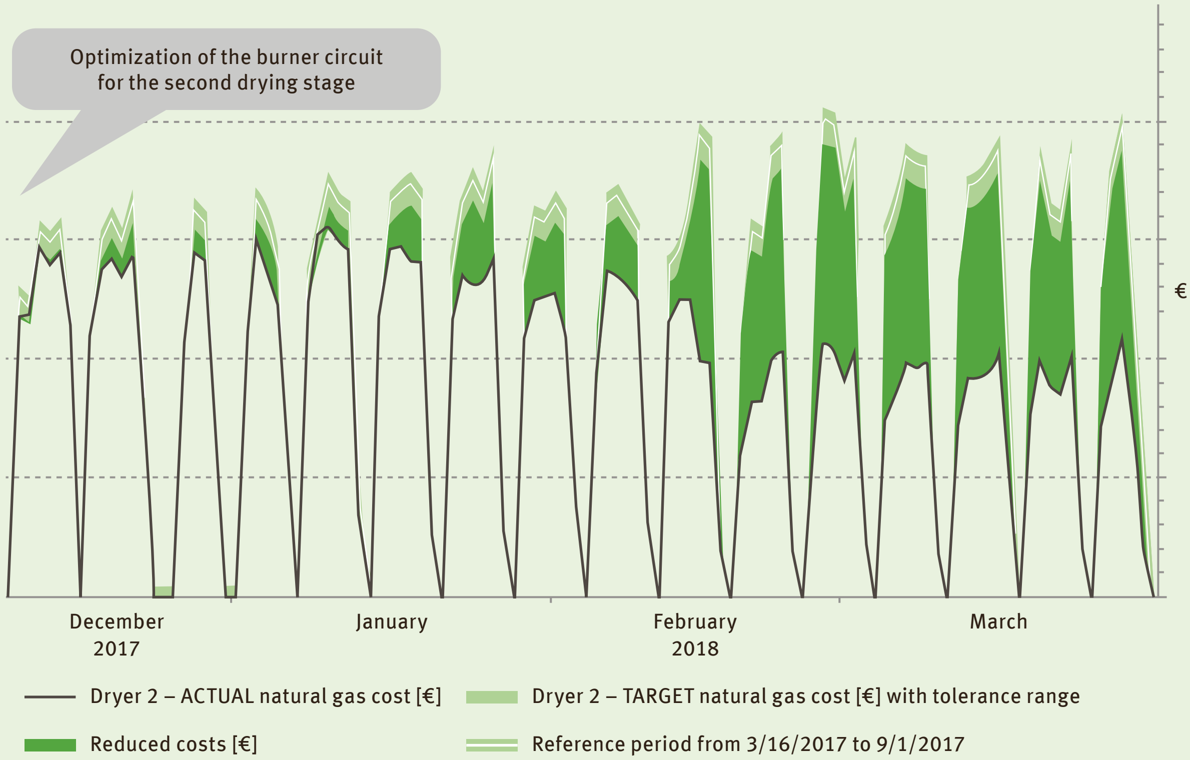
ISO 50006 contains general principles and practical guidelines for setting EnPIs at various levels as well as for determining the current EnPI values, the initial EnBs (past) and energy performance targets (future).

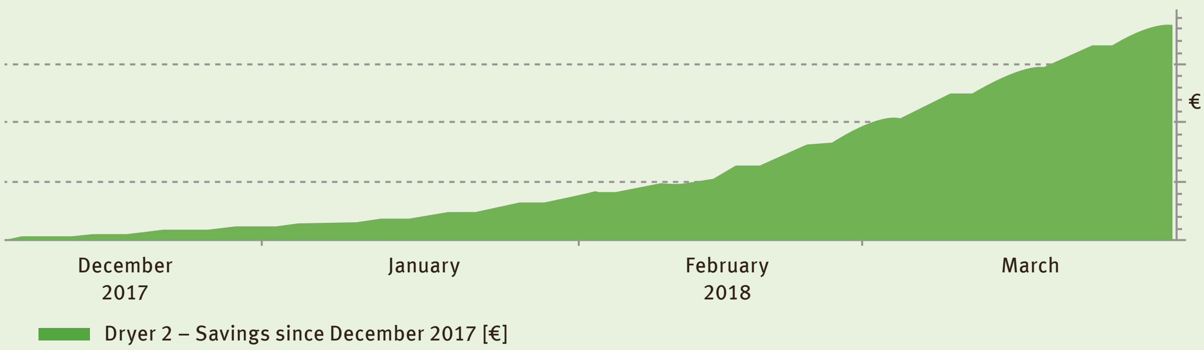
Another focus of the standard is the identification and investigation of influencing factors and their interactions. In addition, practical guidance on normalization is provided to compare performance between different time periods under equivalent conditions using mathematical techniques.

Monitoring energy savings

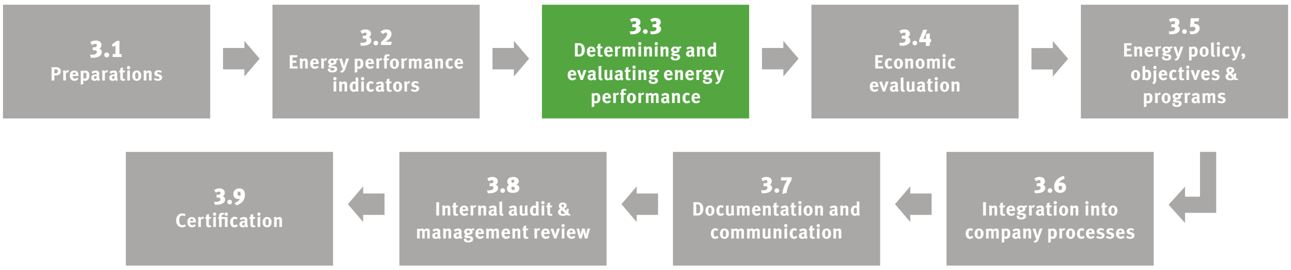
City Clean is constantly working to identify and implement ways to increase energy efficiency. The burner circuit has thus been optimized in a drying plant. Key performance indicator-based energy efficiency monitoring enables the savings to be precisely reproduced and documented.

City Clean uses professional software for monitoring energy efficiency. Prior to the implementation of actions, statistics functions were used to analyze how the gas consumption of the drying devices depended on the amount of dried mats and the types of mats. This relationship marks the baseline. This means that City Clean can precisely track the savings made at each operating time: Over 40 % in peak load periods. The following figure shows a screenshot from the EnEffCo® energy efficiency monitoring software (Source: City Clean).





3.3 Determining and evaluating energy performance



The **determination of energy performance** serves to set a focus within the EnMS, to initiate actions for improvement, to check objective and target achievement and to prove that improvements have been made – for example to the certifier.

HLS

6. Planning
9. Evaluation of performance

NEW in ISO

The **energy data collection plan** provides the basis for determining energy performance. In this plan, you should define all data required for monitoring the key characteristics of the activities that affect energy performance. Data collected or measured must include at least:

- Relevant variables;
- Energy consumption of SEUs and of your company;
- Internal criteria affecting energy consumption of SEUs, such as certain operating modes of installations and equipment or predetermined time frames;
- Data specified in action plans;
- and static factors, if existent.

In addition, you must specify in what form and at what intervals the data is collected and kept. This makes it possible to compare the expected energy consumption with the actual consumption at a fixed interval and to evaluate it.

The **proof of improvement in energy performance** is basically done by comparing the actual values of the EnPIs with the normalized EnB. An EnPI system, as described in the previous subchapter, is able to meet such demands. It enables the determination of energy performance and the deviation from the respective baseline and target values for each SEU and thus the change in performance. It also determines the cost (deviations), providing the indicator owner with a cost control function. If the EnPIs are derived from ECFs, their values can usually be added up, since they regularly have the same unit (about MWh/a), so that the change in the energy performance and possible energy cost savings can be easily determined for an entire company, as illustrated in Table 3.

Table 3

Exemplary summation of energy performance improvement at company level

Facility	Annual data			
	Energy consumption	Energy source	Costs	CO_2 emissions
Entire factory	**–871 MWh**		**€–76,030**	**–256 t**
Process 4711	–734 MWh	Gas	€–36,700	–132 t
Process 4712	–239 MWh	Electricity	€–45,319	–145 t
Process 4713	95 MWh	Gas	€4,750	17 t
...	...	...	...	

Source: own illustration

Please note that during the implementation phase of the EnMS, the time required to collect the data for the first time can be higher and therefore more resources have to be planned.

The **ISO 50015** contains **general principles and guidelines for the measurement and verification (M&V) of the energy performance of organizations.** The standard guides the creation of individual measurement concepts for the verification of implemented actions. ISO 50015 defines six steps to implement an M&V plan:

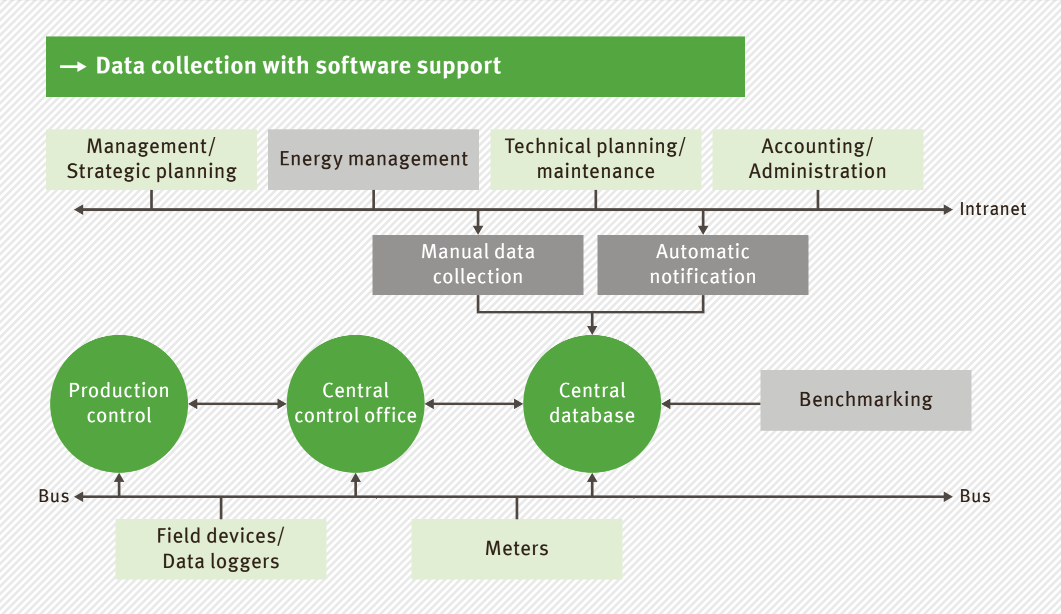
1. Data collection with EnPIs or other indicators
2. Review of actions for energy performance improvement, including unimplemented or divergent actions and justifications
3. Observation of unforeseen changes or non-routine adjustments
4. M&V analysis of the improvement of the energy performance based on the data collection relating to the baseline (creation and adjustment of the baseline are also described in the standard)
5. M&V reporting
6. Check if the M&V process has to be repeated

If energy targets are missed and no measurable improvements in energy performance have been achieved, you should immediately initiate and implement appropriate corrective action.

Use software as support. Figure 3.6 illustrates a possible structure for collecting data with software support. If you already have a computer-aided infrastructure for regulating and monitoring system technology, it is particularly worthwhile to look for suitable IT-based solutions.

Figure 3.6

Data collection with software support



Source: own illustration acc. to perpendo 2005

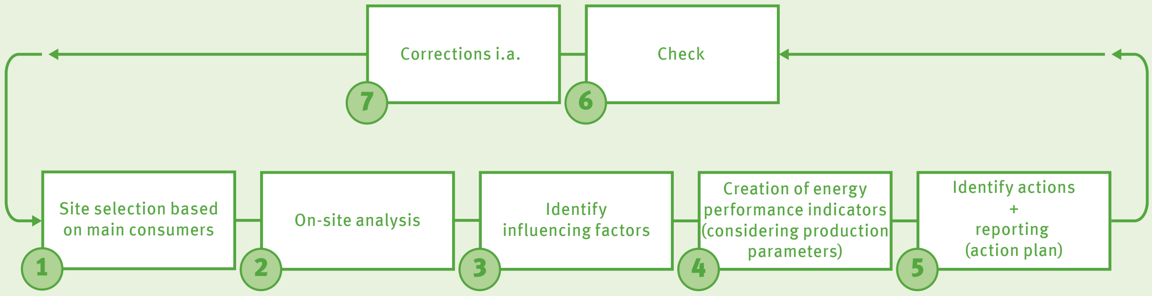
ALBA Group
the recycling company

Concerning measurements, the energy management team focuses on two crucial aspects: The **structure of the measurement networks** and the **visualization of the data**. They record the values in an energy controlling system to assess the status quo of consumption and its development. Based on this, the energy management team can derive specific recommendations for action.

As a first step, ALBA professionals create a concept for the measurements and define the points of consumption where they measure. Quality is more important than quantity. The decisive factor is that important influencing factors, such as production or even weather data, are taken into account. In the next step, assumptions can be replaced by real data.

When selecting the measuring technology, energy management experts at ALBA make sure to use open and common interfaces such as ModBus, MBUS and Impuls. Short communication paths are also an important factor. **Visualization, alarms** and **reporting** are done by the **energy controlling software**. Data is usually transferred automatically from other upstream systems.

© Pictures/Graphics: ALBA Management GmbH



The energy flow in the company can be represented in the form of tables with inputs (electricity, gas, etc.) and uses (areas, machines, production facilities, departments, floors, etc.). Furthermore, the processing of raw data by visualization has proved useful, e. g. in an energy flow diagram (Sankey diagram). If basic energy flows in your company have already been prepared as part of the energy audit in accordance with EN 16247-1, you can apply them if they are detailed enough or use them as a basis for further analyses.

Examples of software for creating Sankey charts:

- e!Sankey, https://www.ifu.com/en/e-sankey/
- STAN (freeware), http://www.stan2web.net/
- Sankey Helper (freeware), http://www.doka.ch/sankey.htm
- S.DRAW, http://www.sdraw.com/
- SankeyBuilder (online), https://sankeybuilder.com/

:DÜSSELDORF
Bädergesellschaft

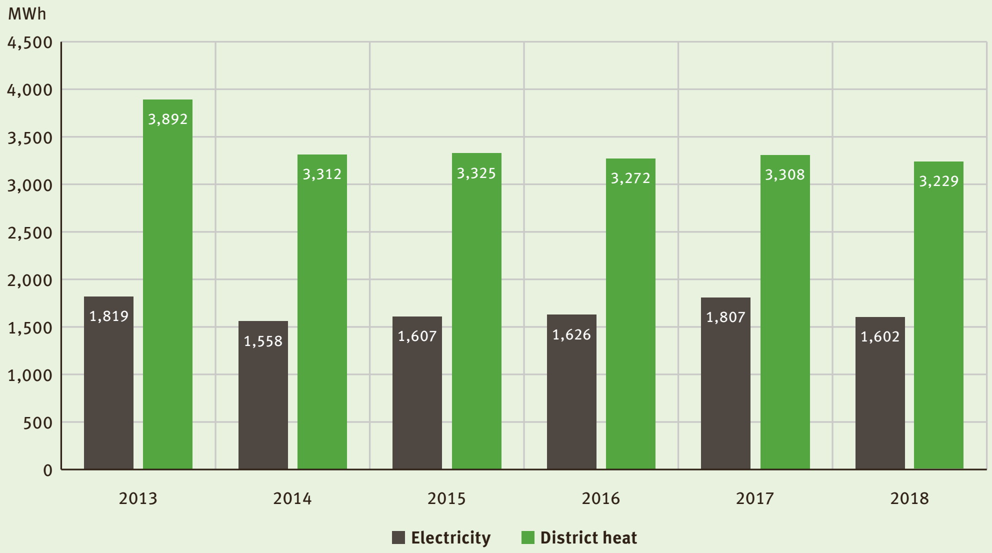
Software-controlled operating data collection

The pool company uses an existing quality assurance system consisting of an app and a cloud-based web application for simple and efficient data and information exchange in the individual pool operations. Due to the individually coordinated user interface, tasks and processes can be executed, saved and controlled. Tablets are used to record operating data and meter readings, manage tasks and coordinate maintenance and service appointments. Energy meters or systems can be easily scanned and the meter reading can be entered into the individualized form created in advance. In addition, an error message appears as soon as the consumption exceeds or falls below a defined threshold.

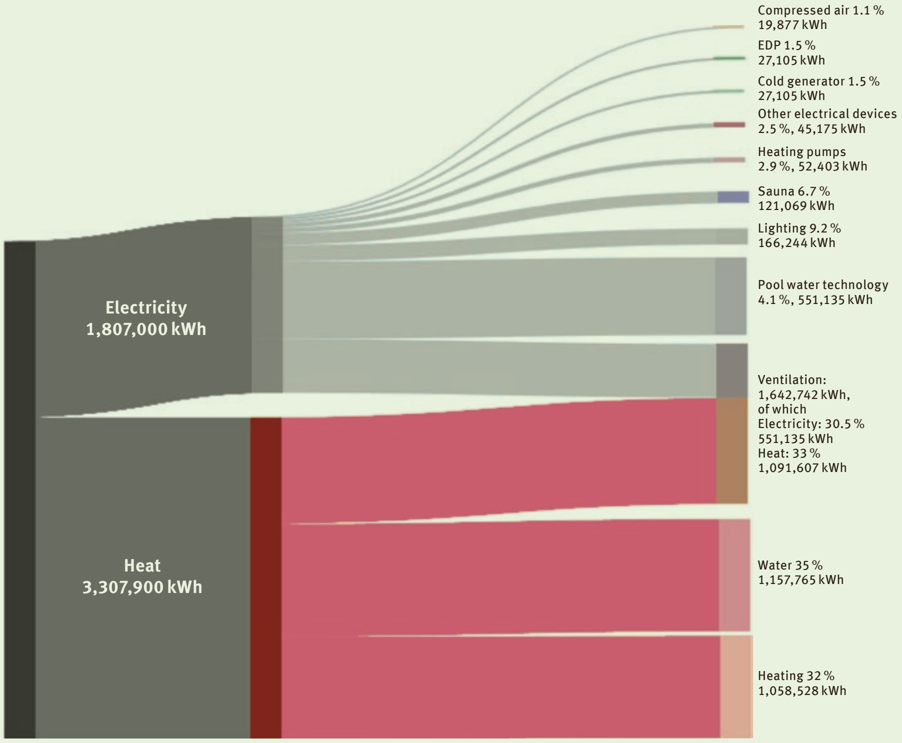
The energy monitoring system can use the web application to access, evaluate and analyze the data. Recurring tasks and maintenance work are created as a to-do list and can be supplemented with information texts or graphics, if applicable. The digital documentation of the operating data shortens communication paths and optimizes times as well as the monitoring of the operating procedures.

:DÜSSELDORF
Bädergesellschaft

Development of electricity and district heat consumption at the swimming pool "Düsselstrand" 2013–2018

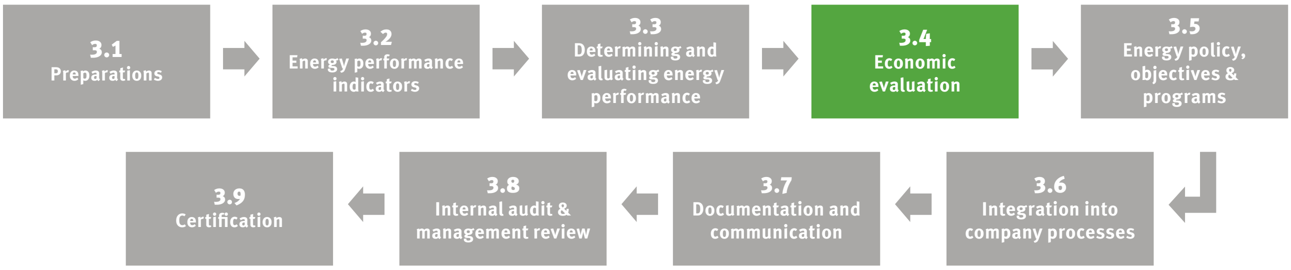


Energy flow in the company



Percentages refer to electricity or heat consumption (not total energy consumption)

3.4 Economic evaluation of energy efficiency actions



The implementation of energy efficiency actions is often associated with investment. Companies regularly require economic feasibility studies for their approval. In practice, there are often communication problems between persons who develop or propose ideas for action and mostly come from technical areas and those who have to decide on implementation and are more likely to be part of the commercial management of an organization.

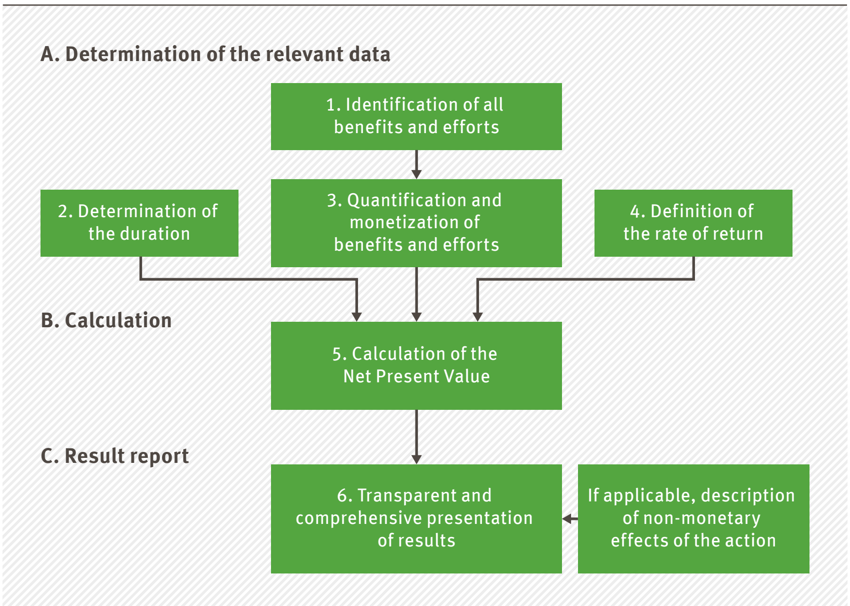
As a result, proposals for energy efficiency actions often focus on investment spending, but not on the overall financial benefit evaluated for the project. This often leads to the rejection of actions, although these could make valuable contributions to the company's success. In addition to the resulting economic disadvantage for companies, such reactions are often followed by frustration among those whose commitment to the development of efficiency ideas is not appreciated.

In order to make the best possible use of potential savings in companies, you should ensure that economic evaluations of actions are carried out in a transparent and complete manner so that they provide a clear basis for decision-making.

In the following, the essential elements of a complete and transparent economic evaluation of energy efficiency actions are briefly explained and illustrated using practical examples. The assessment is divided into three phases (A, B and C) with a total of six steps (Figure 3.7). The individual steps are illustrated by an example (replacement of five pumps in a return cooling system).

Figure 3.7

Procedure for the transparent determination of economic energy efficiency actions



Source: own illustration

A. Determination of relevant data

Step 1: Identify all the benefits and efforts that result from deciding on a possible action to improve energy efficiency.

In the beginning, all the benefits and efforts that result from an action must be described qualitatively. “Efforts” refers to all burdens (including non-monetary ones) that an efficiency action induces, including costs as well as land use, optical degradation, noise generation, etc. This identification process requires thinking beyond obvious financial effects so that all effects are taken into account in the decision to invest.

These also include non-quantifiable or difficult-to-quantify effects such as improved occupational safety, noise reduction, cleaner air, less pollution, less greenhouse gas emissions, etc. All the impacts of the investment decision should be recorded and can be later included in the evaluation report and serve as an additional basis for decision-making.

Step 2: Determine the duration of the action.

For the evaluation, you have to determine how long the respective action will take effect. The estimation of the duration “T” must be carried out carefully, since imprecise or unrealistic data can lead to considerable inaccuracies in results and, as a consequence, to erroneous decisions. The following questions can help to determine the duration of an investment:

- How long can monetized benefits and efforts be expected from the investment?
- Will there be relevant cash flows at the end of the lifetime (disposal, repowering, dismantling, etc.) and if so, when can they be expected?

For the example of a pump replacement, a duration of the action of 15 years is assumed.

Step 3: Quantify and monetize the benefits and efforts.

In the third step, all effects collected in step 1 are quantified and monetized, if possible. Estimation of the expected energy savings (e. g. in kWh/a) should be based on sound technical calculations. If this is not possible, reasoned estimates must be made.

If monetized benefits and efforts are available, they should, if possible, be converted into cash flows. For each cash flow, you should specify:

- Whether it is a **regular** or **unique** cash flow,
- **When** the payments will occur (time), and
- **How high** the expected price change for each cash flow is over the life of the investment (relevant, in particular, when setting specific energy prices).

Table 4 shows an overview of the benefits and efforts in our pump example.

As energy price increases in recent years have deviated significantly from other cost factors such as human resources, materials, etc., the estimation of the expected price changes of the different cash flows for energy-related investments has a special role to play. In order to adequately account for the effects of differing price increases, you should calculate with several specific price increase rates. Considering at least two is recommended; an **energy price increase rate** and a **price increase rate for non-energy-related cash flows/others.**

Table 4

Exemplary overview and specification of qualitative, quantitative and monetary effects

Effects of the efficiency action	Scope	Can be monetized?	Value per unit	Total value in Euro per year [€/a]	Single or regular payment	Time of payment	Price change rate
Benefits							
Annual energy saving (electricity)	150,000 kWh	Yes	0.18 €/kWh	0	Regularly	Annually	+3 %/a
Reduced maintenance and repair costs	5 hours less every 2 years	Yes	50 €/h	250 €/a	Regularly	Every 2 years	+2 %/a
Scrap value of the old pumps	5 pumps	Yes	300 €/pc.	1,500 €/a	One-time	Period 0	–
Reduction of the volume	Reduction of 90 → 65 dBA	No	–	–	Regularly	Annually	–
Increase in production safety	Not quantifiable	No	–	–	Regularly	Annually	–
Efforts							
Investment expenditure for the new pumps	5 pumps	Yes	10,000 €	50,000 €/a	One-time	Period 0	–
Planning costs	100h	Yes	50 €/h	5,000 €/a	One-time	Period 0	–
Production downtime during installation	15 hours for the replacement of the pumps	Partially	200 €/h	3,000 €/a	One-time	Period 0	–

Source: own illustration

Determination of environmental costs

With **ISO 14008** and **ISO 14007**, standards are set for the monetary evaluation of environmental impacts at the international level. ISO 14008 presents various methods of monetary valuation and formulates recommendations on how to conduct monetary evaluation studies. ISO 14007 builds on this and provides guidance on how an organization can determine its environmental costs and benefits.

The German Environment Agency provides practically applicable cost rates of greenhouse gas emissions and other environmental impacts with the **"Methodological Convention 3.0 for the Assessment of Enviromental Costs – Cost Rates"**. On the basis of the cost rates, it can be shown what benefit environmental protection offers and what costs arise from neglecting environmental protection. You can access the method convention of the German Environment Agency via the QR code or the following link: https://www.umweltbundesamt.de/publikationen/methodological-convention-30-for-the-assessment-of

Table 5

Determination of net present value; Example: Replacement of cooling pumps

Calculation interest rate “i”	7.0 %					
“Energy” price increase rate	3 %					
“Other” price increase rate	2 %					
Current specific energy price	0.18 €/kWh					
CO_2 emission factor electricity	0.486 kg/kWh					
Cash flows	**Basic values**	**End of period t**				
		0	**1**	**2**	**...**	**15**
Payouts						
Investment expenditure for the new pumps	€ 60,000	– € 60,000				
Planning costs	€ 5,000	– € 5,000				
Production downtime during installation	€ 3,000	– € 3,000				
Inpayments						
Annual energy saving (electricity)	150,000 kWh		€ 27,810	€ 28,644	...	€ 42,065
Reduced maintenance and repair costs	€ 250			€ 260	...	
Scrap value of the old pumps	€ 1,500	€ 1,500			...	
Results						
Total		€–66,500	€ 27,810	€ 28,904	...	€ 42,065
Present values		€–66,500	€ 26,000	€ 25,265	...	€ 15,332
CO_2 savings per year			72,900 kg	72,900 kg	...	72,900 kg
CO_2 savings total		**1,093,500 kg**				
Net Present Value of the investment		**€ 238,202**				

Note: The formulas used to calculate the values in each cell of Table 5 can be found in the separate document “Exemplary calculation of the net present value of an energy efficiency action” accesible through the QR Code.

Source: own illustration

Step 4: Define the calculation interest rate.

With a view to the upcoming economic evaluation, a interest rate “i” must now be defined. The interest rate is used to integrate the time value of the money into the calculation. It represents the interest payment expected from an investment. The determination of the underlying corporate and partially even project-specific interest rates is not trivial in practice. It should therefore be carried out by persons familiar with it, e. g. from an existing controlling or finance department. An arbitrary setting of the interest rate can have a significant effect on the calculation result. The following rule of thumb applies: For investments financed by equity, the interest rate of the best alternative means of use of the investment funds can be the basis; for debt-financed actions, the interest rate on debt capital. For this example, a calculation interest rate of 7 % is assumed.

B. Calculation

Step 5: Calculate the net present value.

To determine the net present value of the actions, first enter all monetizable benefits and efforts (cash flows) for each period in a calculation table (white cells in Table 5), taking into account the determined price change rates (energy and others).

Once this is done, add up the payments on a per-period basis, discount the annual sum to time zero (date of implementation of the action) and then combine the discounted annual sums. The result is the net present value, which at the same time expresses a potential increase in company value because it has been calculated in the same way as a company value (according to the so-called "discounted cash flow method").

Mathematically, the net present value (NPV) of an investment project can be represented as follows:

$$NPV = \mathrm{CF}_0 + \frac{\mathrm{CF}_1}{(1+i)} + \frac{\mathrm{CF}_2}{(1+i)^2} + \dots + \frac{\mathrm{CF}_T}{(1+i)^T} = \sum_{t=0}^{T} = \frac{\mathrm{CF}_t}{(1+i)^t}$$

Whereby CF_t describes the cash flows at time t, i describes the discount rate and T describes the duration of the action.

For the interpretation of net present value, it is important to understand its statement. In the case of an equity-financed investment, it represents the value of the returns that exceed the underlying alternative investment. In the case of debt-financed investments, the net present value is to be understood as a surplus after payment of the capital costs (interest and repayment of the loan).

A net present value of "0" of an equity-financed investment, for example, means that returns are generated that not only cover the initial payment plus additional running costs (= sum of payments), but also generate a surplus that results in a return on the investment that corresponds to the calculated interest and thus the best alternative. Each net present value "> 0" indicates that the given investment generates added value, as it surpasses the best alternative and is thus more advantageous.

In addition to the calculation of the net present value, it makes sense to integrate the savings of CO_2 emissions resulting from the energy efficiency action into the calculation table. This additionally helps to demonstrate the benefit of the action (see Table 5). The savings can be presented on a per-period basis and over the entire lifetime of the action.

C. Result report

Step 6: Display the result in a transparent and comprehensive way.

The evaluation report should include the following:

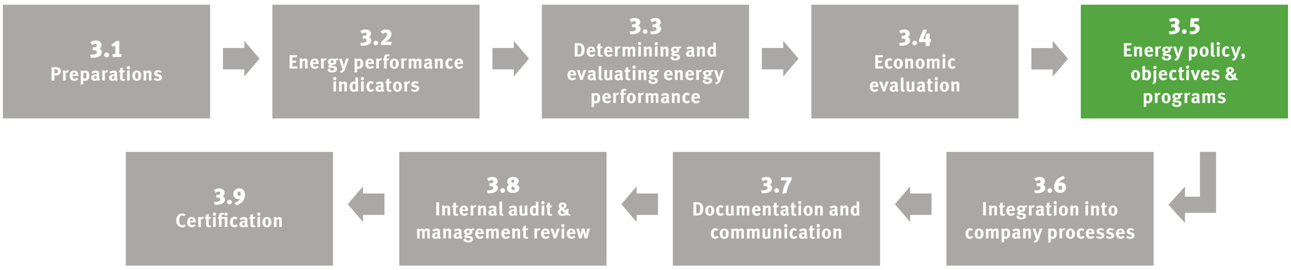
a) An **overview** on the qualitative description, quantification and monetization of all identified benefits and efforts including the expected price fluctuations in accordance with Table 4

b) The **calculation table** including a transparent presentation of the parameter settings (interest rate, duration of action, price increase rates) and the description of non-monetizable effects and their impact on the project

c) A **concrete proposal for a decision** based on the net present value and non-monetizable impact assessment.

Pass the entire report on to the person or group of people who has to make the decision for or against the project as an **editable spreadsheet file** to ensure the traceability of the calculation and to increase confidence in the results.

3.5 Energy policy, objectives & programs



5. Leadership

Step 1: Establish your energy policy.

The energy policy is a documented statement in which the management expresses the overarching objectives of the EnMS. It is indispensable for a functioning EnMS according to ISO 50001 and has to be formulated in line with your organizational context. The energy policy sets out your company's energy-related guidelines, principles of action and long-term objectives. It serves as a yardstick to measure the effectiveness of the energy management system.

According to ISO 50001, the declaration of a company energy policy must include the following:

- The **committment of top management for the continual improvement of energy performance** of your company and the careful use of energy
- An **obligation to comply with relevant legal requirements** and additional requirements with regards to energy use (e. g. voluntary energy agreements of business organizations or the parent organization)
- The **obligation of management to provide information as well as all resources** necessary to achieve objectives and energy targets, and a framework to define and review them
- Commitment to the **procurement of energy-efficient products and services** as well as actions related to an energy-conscious design of installations or processes

tba
Technisches Gebäudemanagement

UEG energy policy

UKT Energiegesellschaft mbH (UEG) is active in the market as an energy supplier to ensure the energy supply of their customers at the best possible conditions

Energy efficiency

In order to ensure and increase energy efficiency, i.e. the ratio between use and consumption, the market is constantly monitored and consumption figures are collected promptly and continuously. Measures to increase efficiency are derived and customer concepts are implemented with the UEG as a strategic partner.

Customer focus

Attention is paid to energy-related performance even during planning and procurement. Concepts for improvement are constantly being examined with partners and customers.

Continuous improvement

All activities of UEG are geared towards efficient use of resources, including the purchase of products and services. By constantly improving energy conversion, the energy performance is improved and economic success ensured.

Competence/ Communication

Our employees are qualified to accomplish our goals due to their experience and education. If necessary, further training is carried out. Communicating the knowledge of UEG is our expertise.

Resources/Energy Targets

Information on use, consumption and energy efficiency as well as the provision of appropriate resources is reviewed annually and adjusted as needed.

Energy targets are set annually as the top priority and implementation is monitored.

Legal requirements/Compliance

All requirements applicable to the UEG are centrally monitored and upheld. If there are changes, a check is done to determine if there is a need for action. If necessary, measures are taken and controlled.

The energy policy sets the framework and strategic direction for your company in terms of the EnMS. It includes energy efficiency commitments, and highlights the importance of the EnMS in your organization. If the policy is simply established by listing all requirements of the standard and without involvement of the employees or even management, it will not serve its purpose of being a “common theme” for energy management. It should therefore be prepared by involving the entire organization and in line with the corporate culture.

If your organization already has other policies, like an **environmental or quality policy or a general corporate policy**, you can integrate your energy policy into these.

Check your energy policy on a regular basis and adapt it to changed conditions if necessary. After preparation and implementation, your energy policy must be available to all people who work directly for your company. ISO 50001 does not necessarily require that energy policy be made available to the public. For a positive external presentation, however, this seems reasonable. If you choose not to publish it, you should document your reasons for doing so. When formulating your energy policy, make sure that it is easily understood both inside and outside the company.

EMAS

The **environmental policy** required in EMAS contains obligations that go beyond energy use and aim to protect the environment as a whole, including the prevention of environmental damage. It must be accessible to the public, in contrast to the energy policy. The EMAS environmental policy will be published as part of the environmental statement.

Step 2: Set objectives and energy targets.

HLS

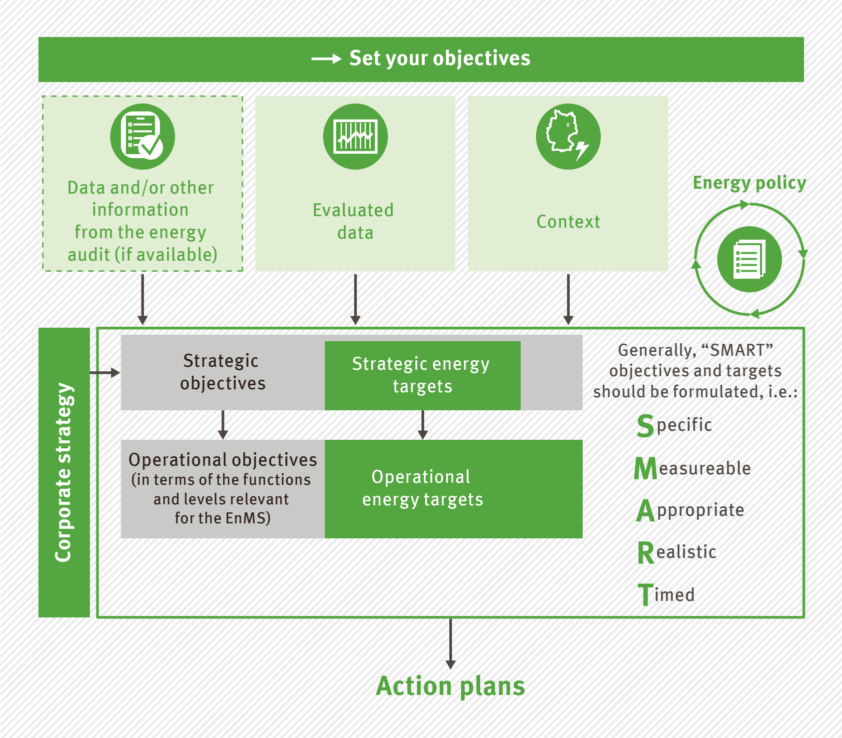
6. Planning

ISO 50001:2018 differentiates between **objectives** and **energy targets**. Objectives are more general and less area- or process-related. They also relate the improvement of the management system itself. For example, extending the EnPI system from 10 to 15 SEUs by the next internal audit would be an objective. In contrast, energy targets specifically relate to the improvement of energy performance.

You should set general **objectives** for business units that are relevant to the EnMS. They are based on your energy policy, i. e. the guidelines and principles of action of your company regarding energy consumption. Objectives can also affect the process organization and thus the effectiveness of the EnMS. **Energy targets** are derived from these overarching, longer-term objectives. They can result from the examinations of the SEUs as part of the definition of EnPIs and the development of actions for improvements (see also subchapter 3.2).

Figure 3.8

Derivation and setting of objectives and energy targets



Source: own illustration

For setting objectives and energy targets, you can use already evaluated data, the results of the context analysis and – if available – information and data from the energy audit according to EN 16247-1 (Figure 3.8). During the introduction and regular review of the objectives and energy targets, the legal and other requirements[10] as well as the opportunities identified for optimizing energy efficiency and energy consumption must be taken into account. If possible, objectives and energy targets should **be measurable**. You should set ambitious, yet **realistic** objectives and energy targets so that they can be implemented in the desired time.

Define energy targets using **EnPIs** to be able to consider influencing factors such as an increase in production volume. The **EnB** of processes can be used as a foundation for setting the target since they relate to a period for comparison. Energy targets at the process level should only be set after an assessment of the required (investment) actions. It makes sense for the energy targets to be determined by the indicator owners themselves. This requires an incentive system that motivates the indicator owner to set challenging targets and to achieve comprehensive improvements. It also requires extensive knowledge and experience in terms of the origin of energy consumption [kWh] and energy loads [kW]. In addition, the ability to develop ideas that reduce consumption and costs is also necessary.

10 Other requirements may be: Business arrangements, voluntary principles or energy agreements, agreements with other stakeholders, network restrictions for the electricity or gas supply, etc.

Ideas can be developed during brainstorming sessions under the leadership of the indicator owner. In a next step, the results of such meetings can be supplemented by an estimation on the energy consumption as well as the effort required to implement the actions.

Be sure to choose an appropriate time frame for the achievement and evaluation of the energy target. It is advisable to set an entire year as a period in order to include seasonal fluctuations. Setting concrete target values should take place before a business period. Afterwards, all actual values of the EnPIs can be regularly compared with the normalized target values and deviation analysis can be carried out – for instance on a monthly basis.

With an EnMS, you have a suitable instrument at hand for reducing the CO_2 emissions of your company. It therefore makes sense to set greenhouse gas mitigation targets in addition to energy targets. For effective climate protection, energy efficiency improvements should exceed production increases. This also ensures that greenhouse gas emissions are reduced in total.

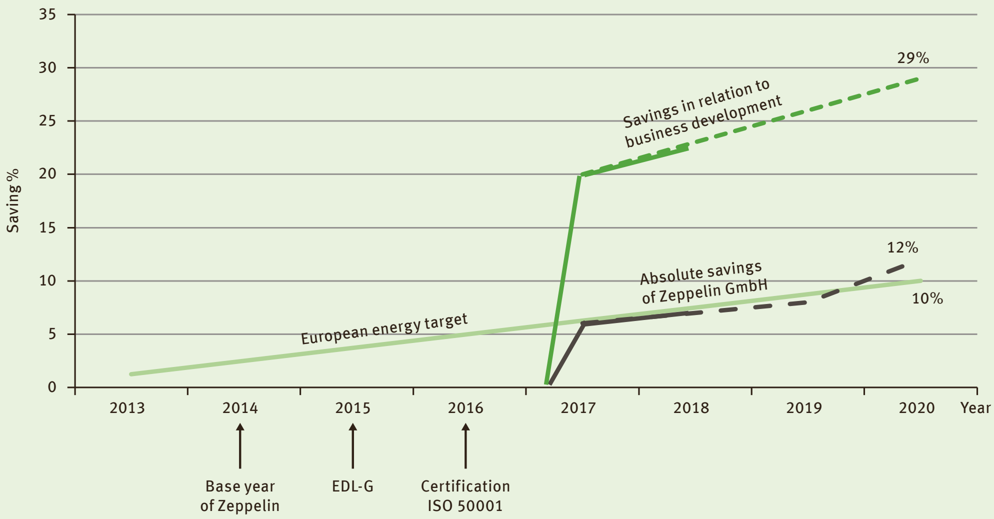
In the Paris Agreement, the signatory states have defined the limit on global warming to significantly under 2 °C. The so-called **science-based targets** are a methodological approach to a **climate goal** for companies. The approach was developed jointly by CDP, the United Nations Global Compact, the World Resources Institute, and the World Wide Fund for Nature. You can use the science-based targets to define a CO2 reduction path for your company compatible with the Paris Agreement. The Excel tool for the science-based climate target can be found at: https://sciencebasedtargets.org/sbti-tool/.

Savings of approx. 6.2 % energy correspond to savings of approx. € 600,000 by 2017

Based on the savings achieved by 2017, it is very likely that Zeppelin GmbH can achieve its objective of reducing energy consumption by 10 % depending on business development by 2020, both in terms of the EnPIs used and the cost-saving actions implemented. The saving shown in the graph refers to the energy saving actions actually implemented. By the year 2017, 6.2 % of the energy consumption related to the base year 2014 could be saved.

In this way, Zeppelin GmbH is making its contribution to achieving the energy targets of the European Union.

Realized savings for Zeppelin GmbH



If you have already carried out an energy audit in accordance with EN 16247-1, potentials, ideas and suggestions for potential actions (including an economic evaluation) should already have been developed. There should also be plans for the implementation of actions and possible interactions between actions. In the best case scenario, you have already derived objectives and targets for the coming years from the audit report that you can now use for your EnMS.

If there is no predefined **implementation period**, self-imposed or agreed objectives and targets are often not achieved satisfactorily. Without scheduling, actions to achieve the objectives are more easily deferred and given only low priority.

If you set **ambitious objectives and targets**, they may not be fully achieved. However, this does not mean that the management system itself is not effective or that you have to distance yourself from the ambitious objective or target. Achieving objectives and targets can also be gradual. They are then pursued in the spirit of continual improvement.

Step 3: Derive programs from objectives and energy targets.

In implementation programs or **action plans,** you define the actions for achieving the objectives and targets. The plans also include how actions are integrated into the internal company processes. Responsibilities must be defined for each target and the associated set of actions (normally assigned to the indicator owner). Deadlines must be set and resources provided for implementation. In addition, it should be shown how you will later check whether the objectives and targets and the associated improvements in energy use and consumption have been achieved and which methods have been used. At best, action plans also include the economic evaluation for each action.

Environmental objectives and targets, together with concrete actions are integrated in an environmental program. In contrast to the action plans in ISO 50001, key information from the environmental program is introduced in the EMAS environmental statement and must therefore be published.

Technisches Gebäudemanagement

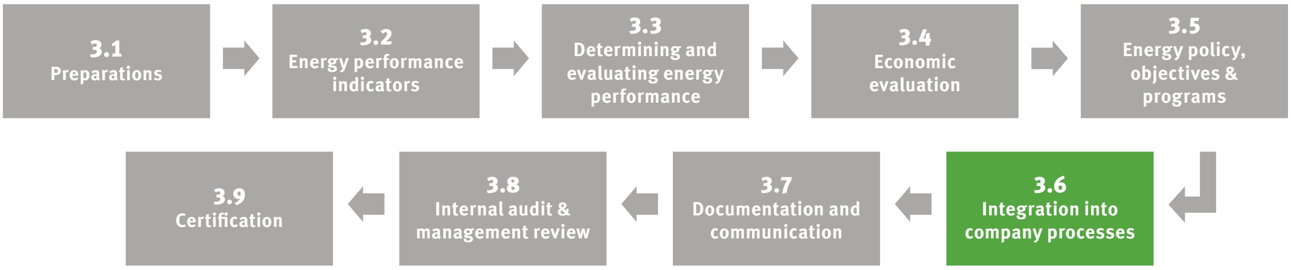
Objectives

1. For the University Hospital Tübingen, self-generation of 3 % is to be achieved by 2023
2. For the University Hospital Tübingen, self-generation should reach a coverage of 100 % by the year 2050
3. New customer acquisition (e. g. for the supply of electricity)

Energy targets 2019

1. **Saving of electricity consumption (general) by 1.0 % in the area of lighting**
   Actions: No. 323 → Responsible: Armin B.
2. **Saving power consumption by 5.0 % in compressed air**
   Actions: No. 324 → Responsible: Thomas G.
3. **Saving power consumption by 1.5 % in ventilation**
   Actions: No. 325 → Responsible: Armin B.
4. **Saving electricity consumption by 2.0 % in the area of refrigeration**
   Actions: No. 326 → Responsible: Armin B.
5. **Saving electricity consumption by 5.0 % in the area of heating**
   Actions: No. 327 → Responsible: Thomas G.
6. **Reduce the proportion of general electricity to 65.0 %**
   Actions: No. 328 → Responsible: Johannes B.
7. **New edition of the "Clever Minds" campaign**
   Actions: No. 329 → Responsible: Armin B.
8. **Increase in internal power generation by 0.1 % (of total power)**
   Actions: No. 330 → Responsible: Armin B.

3.6 Integration into company processes



HLS

8. Operation

Integrate the EnMS into the process landscape of your company. This involves operation, maintenance, and how to deal with deviations or non-compliance with standard requirements alongside procurement and design.

NEW in ISO

The introduction of employees into the world of management system standards, that is often foreign to them, is important. Maybe a lot has already been achieved in terms of energy efficiency, but it still has to be “translated” into statements that are in conformity with ISO 50001 requirements. Even after the processes of the EnMS have been developed, continuous efforts are required to implement them in the daily work routine.

NEW in ISO

Ensure energy-conscious operation. As part of your EnMS, you should consider all in-house, but sometimes also external, processes that are directly related to your company energy consumption.

On the one hand, this includes the planning of processes and procedures, the maintenance of installations, facilities and buildings, purchasing, procurement and the energy consumption of all assets used in your company. You should examine all processes to determine how much can be saved, for example, by shutting down machines while they are not in use, or by changing processes and operations.

Establish the operational criteria for effective operation and maintenance of key energy use areas, including installations, processes and facilities. Documented procedures and operating instructions, as well as e.g. automatic control and monitoring or operation by trained persons, can ensure energy-conscious operation.

To make sure that maintenance and service takes place on a regular basis and meets its intention, you should:

- **Create operating and maintenance plans** for machinery, equipment and installations

- **Describe maintenance intervals** for relevant equipment – this includes the type of maintenance
- Identify the departments and personnel responsible for the operation and the **maintenance of equipment**
- **Provide schedules** for the review of the relevant equipment and the description of how the maintenance is to be carried out.

ALBA Group
the recycling company

Save costs by detecting leaks

Compressed air is an energy carrier that offers an almost unlimited range of applications, which is why it is also used by the ALBA Group.

The weak points in the compressed air network, such as high energy losses and the susceptibility to leaks, must be minimized by efficient energy management. ISO 50001 prescribes process controls to ensure the efficient operation of installations and thereby counteract deviations from the expected energy performance.

At the ALBA Group, this is done for the compressed air network with the regular, systematic location of leaks. From the source of compressed air production to the individual application areas, the entire network is inspected. The most modern ultrasonic measuring devices are used for this purpose. They convert the turbulence caused by a leak in the compressed air network into optical and acoustic signals. This allows the technical staff to accurately identify and fix leaks. Regular maintenance with appropriate technology can save about 30 percent of the energy consumed. This significantly reduces operating costs.

©: ALBA Management GmbH

Make sure the design is energy-conscious. If you are looking for energy-efficient alternatives, low-energy standards or alternative energy sources – especially renewable sources – when installing, renewing or retrofitting production facilities, installations, buildings, new production lines or other installations, you can save energy and costs while contributing to climate and environmental protection. Typically, the benefits of energy efficient equipment exceed the costs of the initial investment when considering its entire lifetime (see subchapter 3.4). Consider energy efficiency when designing installations and sites. This allows you to achieve abrupt energy savings while avoiding long-term lock-in effects, such as those caused by oversized equipment or inefficient technologies based on fossil fuels.

In the context of energy-conscious design, ensure that:

- A detailed **analysis of energy demand and energy sources** is carried out in the very first phase of design and development projects
- In all relevant stages of design and development (offers, initial detailed design, final design, choice of equipment, delivery, commissioning, etc.), an assessment of energy and operating costs over the expected lifetime is carried out
- The tasks of the responsible persons regarding the energy-conscious design are **clearly defined**

:DÜSSELDORF
Bädergesellschaft

Renewal of pool water technology using the example of the Lörick swimming pool

In the Lörick swimming pool, the pool water treatment technology was operated inefficiently because the design of the existing pool circuits, the hydraulics and the filter system were no longer the best available technology. For this reason, the pool water technology was revised with a focus on energy-efficient renovation in 2018, when the entire pool water treatment system was renewed or adapted.

In this process, the filter surface was adapted to the requirements of German swimming pool sanitation standard DIN 19643. Additionally the entire filter technology was shifted to about 4 m above the water level of the pool for flood protection. The raw water now flows freely through the filters due to geodetic water pressure. Monitored and controlled by a flow meter, the filtrate volume flows are controlled by an electrically driven flap in each filter. This eliminates the operation of ten filtrate pumps. The number of raw water pumps was also reduced from four to three pumps.

In addition, after the conversion, it is now also possible to control the operating states in relation to the number of visitors (weak, normal and high). This allows one to adjust the intervals between filter rinsing accordingly. Since the energy-efficiency renovation, the circulation is switched to partial load operation and the flow rate is reduced at nighttime or during bad weather periods.

By adapting and optimizing the dosing of operating materials, the amount of chemicals is not only reduced, but also more efficient in terms of consumption.

The lack of consideration of alternative approaches or the use of standardized solutions that are not tailored to the specific processes are potential weak points in the design. Also note that installations are often utilized only with partial or variable loads, which results in lower energy efficiency than with optimal and higher loads. The use and operation of existing equipment can usually be improved effectively with the experience of the responsible employees.

ZEPPELIN
WE CREATE SOLUTIONS

Replacement of obsolete energy installations (heating installations, air conditioners, etc.)

Air conditioners are a great way to keep cool in the office. However, the devices usually consume a lot of energy and are not necessarily efficient. In order to find a good solution, Zeppelin is working together with an engineering office since the beginning of 2018 to measure demand at individual Zeppelin sites in Germany. In particular, the design and orientation of the buildings and building materials used are considered in order to find a suitable cooling system for each branch. It is planned to transfer the findings to other countries taking into account local specificities. The long-term objective: Reduce energy costs and increase the energy efficiency of buildings.

Make energy efficiency an evaluation criterion in your procurement processes. Procuring energy-efficient machinery, facilities, raw materials and services can save a lot of energy. Integrate energy efficiency and energy consumption as additional criteria in your procurement process. To this end, setting guidelines for energy-conscious procurement is recommended. Define criteria and calculation methods for economic efficiency (see subchapter 3.4).

As a general rule, you should set criteria for energetically significant purchases that allow you to evaluate their energy performance over the lifetime. Possible criteria would be:

- The energy costs over the entire useful life
- Expected effects on the overall energy efficiency of the system
- The performance at partial load and fluctuating load cycles

It is also necessary to set criteria for the procurement of energy, which may include, for example, greenhouse gas emissions, general environmental effects or the stability of prices for the respective energy source. In terms of climate protection, it pays off to switch to renewable energy sources in particular or to generate the energy on-site instead of purchasing from the energy utilities.

Employees making procurement decisions should be aware of the criteria. Typically, markings and labels (e. g. EU energy label, the German "blue angel", EU ecolabel) are awarded also according to energy-related criteria and can therefore assist you in purchasing. Consider energy efficiency when selecting your suppliers and consultants. Inform your suppliers about the fact that energy is an important criterion of your procurement policy.

Taking a life cycle perspective of products and services is an explicit requirement of EMAS and ISO 14001. While in ISO 50001, the assessment of energy performance of procurement only ranges from commissioning, operation, maintenance and repair to decommissioning, EMAS requires a consideration of significant environmental impacts that do not occur only on the site itself, but also in the supply chain, during use and disposal. This allows one to identify energy and material-intensive production phases and can support the organisation in an environmentally-friendly procurement.

HLS

10. Improvement

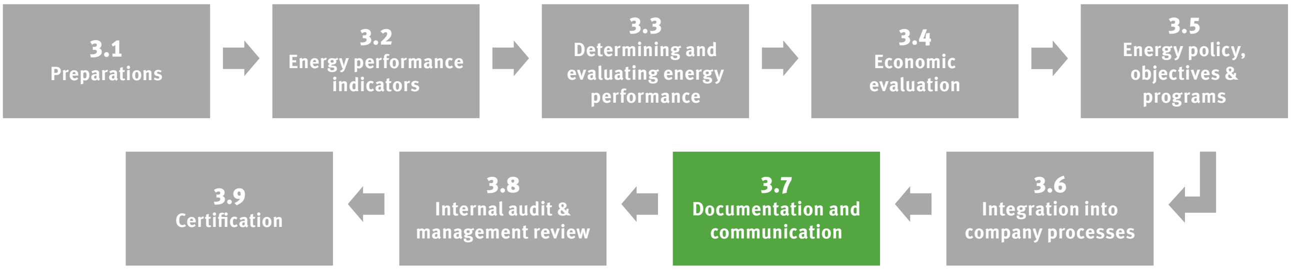
Perpetuate the management cycle to continually improve the EnMS and your company's energy performance. The **PDCA cycle** allows you to constantly re-evaluate and optimize the energy consumption and energy efficiency of your company. In contrast to selective actions (ad-hoc energy management), the continuous use of this process can often reduce the energy-related costs in the company. Corrective action can ensure continual improvement. If it is identified that the EnMS is not in line with the set objectives and targets, immediate action must be taken for monitoring of the system and correcting it. In some cases, it may be necessary to fundamentally change the EnMS.

After the implementation phase of the EnMS, employees may find it difficult to pursue the topic continuously and with priority. It is therefore important that the topic of the EnMS is emphasized by the energy management team and top management on a long-term and continuous basis.

ISO 50006 explains how EnPIs and EnBs can be revised and adapted.

EMAS as well as ISO 14001 and ISO 9001 are based on the PDCA. The different management systems can be easily combined. This allows a company to adapt an existing management system to implement an EnMS in accordance with ISO 50001 or to implement an EMS based on the EnMS. Once a management system is in place, the process of continual improvement as well as all formal and structural requirements are already established in your company.

3.7 Documentation and communication



HLS

7. Support

In an EnMS, **documentation** plays an important role to be able to verify that processes and actions have been carried out as planned. A systematic improvement process can only be initiated and its success proven, if you have established good documentation. Appropriate documentation also helps you to standardize processes and anchor processes of the EnMS in your company. The following **documented information** must be available in accordance with ISO 50001:2018:

- ☐ EnMS scope
- ☐ Energy policy
- ☐ Objectives and energy targets
- ☐ Action plans
- ☐ Methods and criteria for energy review
- ☐ Results of the energy review
- ☐ Methods for determining and updating the EnPIs
- ☐ EnPI values, EnBs and relevant variables
- ☐ Plan for energy data collection and collected data
- ☐ Information on the reproducibility and accuracy of the measuring instruments used
- ☐ Evidence of the competence of employees
- ☐ Design activities related to energy performance
- ☐ Information on significant deviations in energy performance, including response to these deviations
- ☐ Results of monitoring and measurement
- ☐ Results for assessing compliance with legal requirements and actions taken
- ☐ Evidence of the audit program
- ☐ Results of the management review
- ☐ Deviations from standard requirements (nonconformities) and results of corrective action

This information must be **legible**, **identifiable** and **accessible** and it must be possible to assign it **directly to the relevant processes, activities or persons**.

If you have carried out an energy audit in accordance with EN 16247-1, you should have an audit report that you can use to obtain the following initial information for your documentation:

- Documentation of the energy audit
- Accounting of the consumption values
- A list of actions to increase energy efficiency
- Savings potential and economic evaluation of the proposed actions
- Funding opportunities

What should suitable documentation look like? For documented information to be accessible quickly, it should be organized according to a defined system. To ensure traceable data management, it can be useful to record the periods and areas of the examination and the type of data sources. Clear documents will help you to implement the EnMS more easily. In addition, documented information that is up-to-date makes it easier for you to verify and measure the effectiveness of your EnMS. **Key questions for the documentation system** are:

- What is the object of the documented information?
- Which area of the company is affected?
- Which activities should be documented?
- For whom is the documentation intended, and who has to work with it?

An energy management manual is a useful tool for generating a clear, general EnMS documentation and for establishing the connections between the EnMS and other activities and processes in your company. Such a manual contains process descriptions and work instructions. References to other, more detailed documented information may also be included.

Control documented information. The documents must be regularly checked for up-to-dateness and correctness. It should also be ensured that the documents are protected against damage, loss or destruction. In case you have already implemented a documentation system in your company, you should consider also using it for the EnMS.

The management of documented information is necessary in order to carry out updates in a controlled manner and to ensure a targeted distribution of content. Also include external documents required for planning and operation of the EnMS in the document control system. The documents can be maintained both electronically and in paper form. The valid version of a document must be available where it is intended to be used. However, it may also be necessary to archive outdated documents, e. g. because of legal requirements. Make sure that these documents are clearly separated from the current versions, and thus ensure that outdated and/or obsolete documents cannot be used by accident. Make arrangements for reviewing, archiving and labeling (e. g. numbers, responsibilities for content, area of operation, field of activity) so that documented information is identifiable and traceable.[11]

It make sense to assist **the control of documented information** using suitable **software such as document management systems**, as it provides quick access to relevant data and information and simplifies the approval and assignment of documents. For example, the following software packages are available:

- roXtra, https://www.rossmanith.com/
- qmBase document management, https://www.qmbase.com/en/document-management/
- sycat IMS Portal, https://www.sycat.com/sycat-ims-portal.html
- eQMS, https://eqms.de/index.htm

Communicate your EnMS, its objectives, achievements and responsibilities internally. Internal communication in accordance with ISO 50001 is closely linked to the sensitization of personnel for the implementation of the EnMS as well as an important prerequisite for successful implementation. Especially in the initial phase, regular communication of the actions to be implemented is of great importance in order to achieve positive behavioral orientation among all those involved. It is also important to regularly communicate the most important aspects of the EnMS. Integrate the results of measurements and EnPIs collected for energy management into your internal controlling – for example in the monthly cost center reports. This guarantees regular internal communication of the results of the EnMS to the management. Regularly announce the trends of EnPIs and consumption figures in individual business units to help drive employee motivation.

11 GUTcert 2018

Communicate what you do, what you need and what the results are. Use the regular information of your employees together with the improvement of the energy situation to motivate and encourage participation. Celebrate successes together.

The success of the EnMS is supported by a corporate culture in which employees can actively contribute suggestions for improvement and are encouraged to submit relevant comments. According to ISO 50001:2018, you need to develop a process for this, for example using a company suggestion system. All collected comments and suggestions for improvement should be reviewed and answered. Name a responsible person and create a plan for internal communication in the context of energy management – this facilitates the flow of information.

Make your EnMS credible for external parties. External communication of the results of your EnMS help the presentation of your company and has a positive effect on corporate image. You can use it as an opportunity to show that your business is energy- and climate-conscious. To do this, you should determine who is responsible for external communication, what type of information is communicated and how it should be done. You should consider clearly presenting actions and objectives, but also continual improvement in terms of the ISO 50001 philosophy.

For example, you can include information from your EnMS into business or sustainability reports. Furthermore, it is advisable to define target groups, to identify optimal communication channels (such as newsletters, journals, events, company homepage) and to develop corresponding marketing strategies. A separate menu item titled “Energy” or “Energy Management” on your homepage can help to more strongly emphasize the importance of the topic for your company. If you have set an ambitious and credible climate protection objective, you can also communicate this to the outside world.

In principle, external communication is not a mandatory requirement for certification according to ISO 50001; it is up to each organization. If you decide against external communication after certification, you should give reasons. In general, you can view external communications as an opportunity to add vigor and credibility to your company’s energy policy.

A fundamental objective of EMAS is to initiate a dialog with the public and the stakeholders of an organization and to actively involve employees at all levels of an organization in the environmental management system. An integral part of EMAS and the basis for its credibility and transparency is therefore also the creation of a **publicly available and externally validated environmental statement** containing the following elements:

- Description of the company's activities, products and services
- Environmental policy
- Significant environmental aspects
- Environmental program (objectives and actions)
- Data and other information about environmental performance based on core indicators and other performance indicators
- Reference to the main environmental legislation

The EMAS environmental statement must be updated annually and validated by the environmental verifier. For small and medium-sized organizations, the update cycle can be extended to two years.

Successfully EMAS-validated organizations are also eligible to use the official EMAS logo for external communications about their environmental management system. A guide from the German EMAS Advisory Board provides information on the possible uses of the EMAS logo: https://ec.europa.eu/environment/emas/pdf/EMAS_Logo_Guide.pdf (available via QR code)

ALBA Group
the recycling company

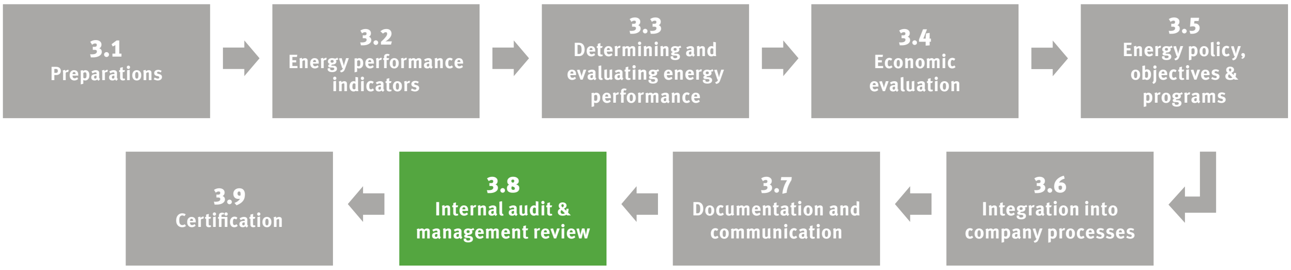
The ALBA Group operates an energy management system according to ISO 50001 for all companies and also communicates this externally via various channels: Energy management is a topic at events, but also appears in the online presence of the company.

In direct business contact, the company's commitment to energy efficiency is also a topic. It is firmly anchored as a selection criterion in the purchasing conditions when it comes to the procurement and design of technical equipment. Suppliers receive regular information on this.

In the past, there have been cases in which companies have used the logos of standardization organizations such as CEN or ISO. However, these logos are registered as trademarks and thus protected. You should therefore make sure not to use them. Also make sure to describe your certification correctly. If you have had an EnMS introduced and certified in your company, you are certified according to EN ISO 50001:2018 or ISO 50001:2018. Expressions such as “ISO certified” or “ISO 50001 certified” are not precise.

You should avoid giving the impression that ISO 50001 is a product standard. The standard does not refer to a product of your company, but to processes that affect the energy efficiency and energy consumption of your company. Do not advertise products with your EnMS certification.

3.8 Internal audit & management review



HLS
9. Evaluation of performance

Step 1: Check your EnMS using regular internal audits.

The internal audit is a systematic element for verifying the effectiveness of your EnMS and thus a key step in ensuring the ongoing improvement of the EnMS and energy performance.

You must plan your audits in an **audit program**. This also includes responsibilities, methods (such as inspections, checklists, surveys, examination of documented information), as well as requirements for planning and reporting. For each audit, the criteria by which the audit is performed must be listed. This may include compliance with functionality and internal processes, requirements of the standard and regulations. In addition, specify type (e. g. internal, external, planned, unscheduled), content and scope (boundaries, locations, processes, etc.) and familiarize yourself with the objective of the audit (checking requirements, identifying potential savings, etc.).

Internal audits should generally be performed according to the standard **"ISO 19011:2018 – Guidelines for auditing management systems"**. The standard is applicable to all sizes and types of companies as well as management system standards and can therefore be used for both ISO 50001 and EMAS. ISO 19011 supports the audit planning, execution and administration of audit programs and contains recommendations on the competence of auditors. The use of audit methods is explained in Annex A.1 of ISO 19011.

The internal audit can be conducted either externally or by employees of your company who have the necessary knowledge of your EnMS, the ISO 50001 standard requirements and the aspects and audit techniques to be examined. In any case, the person performing the audit must be **qualified, experienced, impartial and independent** of the area of the organization to be audited.

When **conducting the internal audit by a member of staff**, it is advisable to interview other management representatives in advance to exchange tips.

The **training of your own workforce to be internal auditors** not only saves costs, but also gives them a different perspective on their own company.

Inform yourself of the tasks in the internal audit. When conducting an internal audit, the auditor must:

- Review the improvement in energy performance
- Examine the performance of the EnMS and its processes and systems
- Compare the results with the energy policy, the objectives and the energy targets

In addition, problems should be investigated and causes and weaknesses identified. It is also advisable to work out possibilities for the continual improvement of the EnMS and the energy performance in the course of the audit.

Document the results of the internal audit in a report. In addition to the current state of the EnMS, the report should also include a description of follow-up activities, an assessment of the results and a description of the responsibilities. The report not only refers to the improvement of the EnMS, but more specifically to the improvement of energy performance. It compares the results of the activities with the plans and targets of the energy management programs and determines to what extent energy consumption, energy efficiency and energy use have actually been improved.

The results of the audit must be submitted to top management for management review. It is also advisable to present the report to the staff whose work area is affected by the internal audit. This will give you the opportunity to show results, explain deviations and nonconformities, and plan for potential actions for improvement.

For EMAS, programs **for the internal environmental audit** are carried out annually and their results are communicated to the management of the organization (environmental audit report). In addition to the progress in environmental protection related to the environmental policy of the organization and its significant environmental aspects, the effectiveness and reliability of monitoring of environmental impacts, compliance with environmental regulations and corrective action are at center stage.

Step 2: Evaluate compliance with legal regulations.

Compliance with laws and other requirements must be assessed at scheduled intervals. To do this, designate a responsible person who assumes the task of monitoring. If you have introduced a legal register, it can be a useful tool for assessing compliance. For this purpose, a "Status" column with additional explanations is recommended.

Step 3: Based on the internal audit and the evaluation of legal compliance, conduct a management review.

A **management review** must occur at regular intervals and include the following aspects:

- The status of the actions from previous management reviews
- Changes in external and internal issues affecting the EnMS and related risks and opportunities
- Possibilities of continual improvement and the
- Energy policy

Top management must be kept up to date with the state of energy performance, with the following issues to be addressed in terms of ISO 50001:2018:

- The degree of energy target achievement or failures
- The results of monitoring and measurements, including EnPIs, and how these affect energy performance
- Current status of action plans

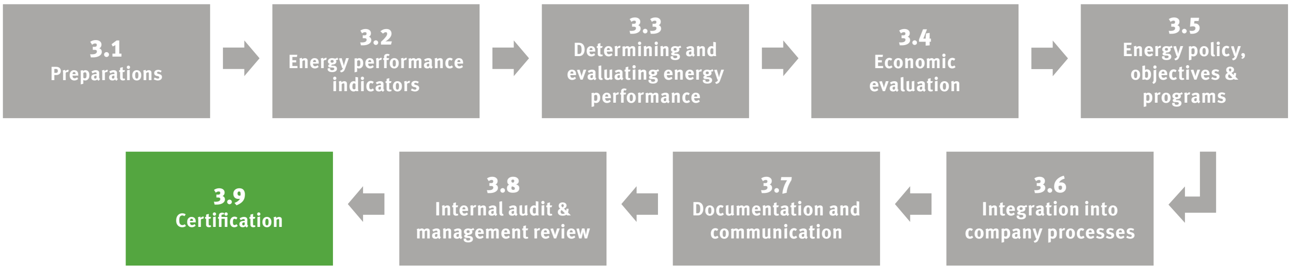
NEW in ISO

Information for the management about the performance of the EnMS itself must be anchored in the management review. In addition to the current situation with respect to compliance with legal and other requirements, this also includes developments in the audit results and, if applicable, non-compliance with the requirements of the standard and the corrective actions derived from them. Identified risks and opportunities from a changing business environment should be considered in the management review. For example, if there are not enough resources for actions for improvement, it may be appropriate to present the associated risks to the company and the EnMS.

Based on the results of the review, decisions must be made as to which actions are to be taken for continual improvement. If objectives have not been met or standard requirements have not been fulfilled, the necessary changes need to be defined and initiated for the EnMS. To ensure that the recommendations made by top management are taken into account, the results of the management review need to be documented (e. g. in the form of a protocol or action plan). You should also identify follow-up activities and the people responsible for implementation.

If you not only consider the management review as a check of the EnMS' status quo, it can be an important tool for identifying ways to improve energy efficiency and thus reduce energy costs in your company. A **in-depth management review** should be based on the results of internal audits and take place **at least annually**.

3.9 Certification of the EnMS



Once the EnMS has been fully implemented in your company, you have the option of having it certified by an external, independent body. For this purpose, however, the system must first exist for some time and demonstrate energy performance improvement, as this is a certification requirement.

Certification increases the importance of your management system to your employees and suppliers among others, while at the same time improving your corporate image. Upon receiving the certificate, the company has officially demonstrated that it meets the requirements of ISO 50001. Certifications are carried out by independent third parties, whereby certificates must be renewed regularly. In external certification and surveillance audits, it is assessed whether you are continually improving your management system and energy performance.

Choose your certification company carefully as this relationship usually lasts for a long time. Then make an agreement with the certification body at an early stage and get to know the auditor personally in order to develop a common understanding and to clarify the conditions of the cooperation.

Have your EnMS certified. The certification is possible with environmental verifiers under the European EMAS regulation or with accredited certification bodies. The ISO 50001 certification can also be linked to the EMAS registration or ISO 14001 certification.

If you have decided in favor of a certification company, a **pre-audit** is usually carried out first. Among other things, the company location, business strategies and requirements of the standard that your company already fulfills can be reviewed. Based on these initial assessments, priorities can be set for actions to be taken. In a second step, the documentation of your EnMS will be reviewed to see to what extent it already meets the requirements of the ISO 50001 standard.

During the actual **certification audit**, a check is done to determine to what extent the practical functioning of your management system meets the requirements of the standard. The important factor here is how the objectives you have set correspond to the results. In addition to the examination of documented information and (energy) performance, the effectiveness can be assessed by additional discussions with the workforce or by observing business processes.

Confirmation of the conformity of your EnMS with the requirements of ISO 50001 will result in your company receiving the certificate.

In order to guarantee the continual improvement of your management system, annual verification audits are carried out by the certification body. In doing so, the key elements of performance are checked, further developed and possibly optimized. In this way, nonconformities can be detected early on and appropriate corrective actions can be taken.

ISO 50003:2016 contains **requirements for bodies that audit and certify the EnMS.** Although these are requirements for the certification bodies, your company should also know some important elements. The audit time will be determined according to a procedure defined in ISO 50003 and will depend, among other things, on the energy consumption, the number of energy sources, the number of SEUs and the number of energy-related personnel actively contributing to the fulfillment of the requirements of the EnMS. Organizations with multiple (similar) sites can make use of a sampling audit procedure, which is explained in the standard.

Environmental verifiers and organizations as well as accredited certification bodies are required to review company energy performance improvement, as the improvement of energy performance is part of the company's obligations from ISO 50001.

The EMAS registration is acquired via the verification of the organization's sites and validation of the environmental statement by accredited industry-specific environmental verifiers. Organizations that have been proven to meet the requirements of the EMAS Regulation will then be registered in the public EMAS register by the competent bodies (in Germany the Chamber of Industry and Commerce or Chamber of Trade): http://ec.europa.eu/environment/emas/register/

If you have already implemented another management system, make sure that your certification body or environmental verifier can not only certify the EnMS but also other management systems (e. g. ISO 9001, ISO 14001 or EMAS). It is possible to have **integrated management systems** audited as part of an integrated or combined certification audit. The audit effort for several management system standards can be reduced by up to 20 % with the existence of an integrated management system[13] because documents and records of the various management systems can be audited in parallel. In addition, depending on different factors such as the maturity of the management system, the certification body can grant a further audit time reduction of up to 30 %.[14] Overall, integration allows one to keep both the workload and additional costs for the certification of an EnMS low. Further information on the advantages of an integrated management system and the HLS can be found in an annex accesible via the QR code.

ZEPPELIN
WE CREATE SOLUTIONS

"Having demonstrated the successes of ISO 50001, the step towards implementing an environmental management system that now incorporates additional aspects such as water & waste has become easier for the top management. We are therefore now also striving to achieve ISO 14001 certification in 2019 along with the recertification of ISO 50001."
Ms. Ramona Wallner, Energy and Environmental Management Representative, Zeppelin GmbH

12 Cf. International Accreditation Forum (IAF) Mandatory Document 11:2019: Mandatory Document on the Application of ISO/IEC 17021 for Audits of Integrated Management Systems
13 Cf. IAF Mandatory Document 5:2019: Determination of Audit Time of Quality, Environmental, and Occupational Health & Safety Management Systems

Get re-certified. Make sure that you have a re-certification done on time and before the expiration date of the current certificate.

Also, be careful not to have a “gap” in the certificate. **Re-certification** audits must take place every three years. So-called surveillance audits take place annually. This includes a check that you have improved your EnMS and energy performance. In practice, however, this does not mean that you will not receive certification if you have not improved the energy performance of the entire organization. In this case, for example, the improvement in an SEU is sufficient.

Bibliography

EN ISO 14001:2015, Environmental management systems – Requirements with guidance for use.

EN 16247-1:2012 Energy audits – Part 1: General requirements.

EN ISO 50001:2018, Energy management systems – Requirements with guidance for use.

GUTcert 2018: in 18 Schritten über 3 Stufen zum effizienten Energiemanagement nach ISO 50001. Ein Leitfaden für Einsteiger.

ISO 50003:2016, Energy management systems – Requirements for bodies providing audit and certification of energy management systems.

ISO 50006:2014, Energy management systems – Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) – General principles and guidance

ISO 50015:2014, Energy management systems – Measurement and verification of energy performance of organizations – General principles and guidance.

perpendo GmbH 2005: EDV-gestütztes Energiemanagement. Strategische Aspekte für den Aufbau. http://www.perpendo.de/files/tga-1-2005.pdf.

List of abbreviations

CEN	European Committee for Standardization
ECF	Energy consumption function
EnB	Energy baseline
EMAS	Eco-Management and Audit Scheme
EMS	Environmental management system
EN	European standard
EnMS	Energy management system
EnPI	Energy performance indicator
HLS	High Level Structure
ISO	International Organization for Standardization
M&V	Measurement and verification
PDCA	Plan, Do, Check, Act
SEU	Significant energy use
SWOT	Strengths, Weaknesses, Opportunities, Threats
UBA	German Environment Agency

Annex

- Energy Management Checklist
- Payback period as a benchmark for energy efficiency actions
- Exemplary calculation of the net present value of an energy efficiency action
- Advantages of the “High Level Structure” in relation to the implementation and operation of an energy management system according to ISO 50001

The annexes are available via the QR code on the left or the following link: https://www.umweltbundesamt.de/publikationen/energy-management-systems-in-practice

Presentation of the sample companies

In the guide, you will find practical examples from companies that have already introduced an EnMS. The five companies that helped to create this guide by sharing their own experiences are briefly presented below.

:DÜSSELDORF Bädergesellschaft


The **Bädergesellschaft Düsseldorf mbH** is a 100 % subsidiary of the Holding der Landeshauptstadt Düsseldorf GmbH. The function of the company is the operation of seven public indoor swimming pools, four public outdoor swimming pools and eight instructional swimming pools. The “Düsselstrand” recreational swimmimg pool is owned by the company.

Industry: Sports/Recreation/Tourism

Energy consumption: Example of the Düsselstrand recreational pool: Approx. 1,800,000 kWh of electricity, approx. 3,300,000 kWh of heat

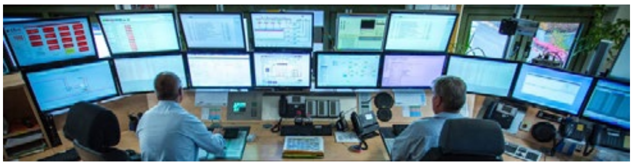
Successes: Energy costs were significantly reduced as part of the renewal of installation components (new ventilation systems, pool water technology) and the conversion to LED in all spa locations. As an added value, the awareness for the topic of energy efficiency was increased in the company. Communication, information exchange and cooperation between different areas have also been intensified by the management system. Another positive effect was the implementation of idea management, which was initiated by the EnMS.

Employees: 277 (9 locations)

Initial certification ISO 50001: 2016

Outlook: The objective of the Bädergesellschaft Düsseldorf mbH is to increase the transparency of the reproducibility of main energy consumption by allowing at least 50 % of the recorded energy consumption to be substantiated by actual values. This requires the installation of additional meters.

tba Technisches Gebäudemanagement




The Technische Betriebsamt **tba** is a service provider for the technical building management of the University Hospital Tübingen (UKT). The **UKT Energiegesellschaft mbH (UEG)** procures, generates and trades energy for the hospital and supplies it with heating, cooling, heated drinking water, steam, lighting and electricity. The UEG supplies other companies exclusively with electricity.

Industry: Power supply

Energy consumption: 57.8 MWh of electricity (2017 in Germany)

Successes: The annual electricity demand has been reduced by 7,559 MWh since 2010 (cost savings approx. € 1.3 million) with a simultaneous increase in the area which is supplied with energy. Improving process flows also simplifies the planning, implementation and monitoring of actions. This increases the efficiency of the employees and gives them time to test innovations in the field of energy management.

Employees: 6

Initial certification ISO 50001: 2013

Outlook: Actions are constantly monitored and further actions derived from the results. There is therefore a well-functioning PDCA cycle, which solidifies the topic. As a future action, the company plans the optimization of compressed air systems, among other things.

For over 40 years, **City Clean** has been active in the laundry industry. Starting with dust control mats for rent, they now offer a varied range in the area of mat, washroom and mop service. In the owner-managed company, each employee feels responsible for the quality of all products and services, for quick and easy processes, for environmentally-friendly procedures and for customer satisfaction in every way.

Industry: Laundry

Energy consumption: Electricity: 1,350 MWh, gas: 6,900 MWh at the Bötzow site

Successes: City Clean has already implemented numerous energy efficiency actions. In addition to the use of efficient components, the focus is on energy-efficient operation. Continuous energy efficiency monitoring ensures that the savings achieved in the long term are maintained.

Employees: About 100 (Bötzow site)

Initial certification ISO 50001:12/21/2016

Outlook: City Clean has set itself the objective of continuously increasing energy efficiency and is also implementing energy efficiency benchmarking in its drying systems.

ALBA Group
the recycling company

© ALBA Group Amin Akhtar

The ALBA Group operates in the fields of recycling, environmental services, waste management and commodity trading. Great importance is attached to responsible action with regard to climate and resource conservation. As the energy costs also have a certain magnitude in the ALBA Group, the topic of energy savings has been around for years.

Industry: Recycling

Energy consumption: Approx. 110 GWh of electricity, approx. 75 GWh of gas, approx. 210 GWh of fuels (diesel, heating oil, etc.)

Successes: The company's own energy consumption is mapped using state-of-the-art measuring technology and a precise energy controlling system. In addition, a new energy-related key performance indicator system has been set up. The resulting reduction in energy consumption saves enormous costs and also protects the environment thanks to the lower consumption of resources.

Employees: 7,500 nationwide

Initial certification ISO 50001: 2016

Outlook: In the future, the fleet will also be optimized according to energy efficiency criteria. eMobility is one of the important topics for the future that needs to be considered. Furthermore, the operation of technical systems will be further optimized.

Zeppelin GmbH with its legal office in Friedrichshafen is the holding company of an internationally operating corporation, which offers products in the areas of sales and service of construction machines, rental, propulsion and energy systems as well as engineering and plant construction.

Industry: Trade, engineering and service

Energy consumption: Approx. 100,000 MWh (2017 in Germany, of which was 18 % electricity, 35 % heat, 47 % fuels)

Successes: Already in the period from 2014 to 2017, around 5,300 MWh (corresponding to around € 600,000 or 6.2 %) was saved due to numerous building-related and organizational actions.

Employees: 5,000 in Germany

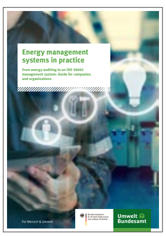
Initial certification ISO 50001: 2016

Outlook: The group-wide objective is to reduce energy consumption by ten percent in the period from 2014 to 2020, taking business development into account.

Correspondence of ISO 50001:2018 clauses with the subchapters of this guide

ISO 50001:2018	Energy management systems in practice
4.1 Understanding the organization and its context	3.1 Preparations
4.2 Understanding the needs and expectations of interested parties	3.1 Preparations, Step 3: Context analysis, section: Interested parties
4.3 Determining the scope and boundaries of the energy management system	3.1 Preparations, Step 4: Scope and boundaries
4.4 Energy management system	3.9 Certification of the EnMS
5. Leadership 5.1 Leadership and commitment	3.1 Preparations, Step 1: Requirements for top management
5.2 Energy policy	3.5 Energy policy, objectives & programs
5.3 Organization roles, responsibilities and authorities	3.1 Preparations, Step 2: Energy management team
6.1 Action to address risks and opportunities	3.1 Preparations, Step 3: Context analysis, section: Risks and opportunities
6.2 Objectives, energy targets, and planning to achieve them	3.5 Energy policy, objectives & programs
6.3 Energy review	3.2 Building a system of energy performance indicators (EnPIs) 3.3 Determinng and evaluating energy performance
6.4 Energy performance indicators	3.2 Building a system of energy performance indicators (EnPIs), energy performance indicators
6.5 Energy baseline	3.2 Building a system of energy performance indicators (EnPIs), energy use analysis 3.3 Determining and evaluating energy performance
6.6 Planning of energy data collection	3.3 Identifying and assessing energy performance
7.1 Resources	3.1 Preparations; Step 1: Requirements for top management
7.2 Competence	3.1 Preparations; Step 5: Building competence and awareness
7.3 Awareness	3.1 Preparations; Step 5: Building competence and awareness
7.4 Communication	3.7 Documentation and communication; Sections on internal and external communication
7.5 Documented information	3.7 Documentation and communication; Section: Documentation
8.1 Operational planning and control	3.6 Integration into the company processes, Section: Ensure energy-conscious operation

ISO 50001:2018	Energy management systems in practice
8.2 Design	3.6 Integration into the company processes, Section: Ensure an energy-conscious design
8.3 Procurement	3.6 Integration into the company processes, Section: Make energy efficiency an evaluation criterion in your procurement processes
9.1 Monitoring, measurement, analysis and evaluation of energy performance and the EnMS – 9.1.1 General	3.2 Building a system of energy performance indicators (EnPIs) 3.3 Determining and evaluating energy performance
9.1.2 Evaluation of compliance with legal requirements and other requirements	3.8 Internal audit & management review Evaluate compliance with legal regulations
9.2 Internal audit	3.8 Internal audit & management review
9.3 Management review	3.8 Internal audit & management review
10.1 Nonconformity and corrective action	3.6 Integration into company processes Section: Perpetuate the management cycle to continually improve the EnMS and your company's energy performance
10.2 Continual improvement	3.6 Integration into company processes Section: Perpetuate the management cycle to continually improve the EnMS and your company's energy performance



▸ **Our brochures to download**
Short link: bit.ly/2dowYYI

www.facebook.com/umweltbundesamt.de
www.twitter.com/umweltbundesamt
www.youtube.com/user/umweltbundesamt
www.instagram.com/umweltbundesamt/