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Energy management systems — Guidance for the implementation, maintenance and improvement of an energy management system

Systèmes de management de l'énergie — Lignes directrices pour la mise en oeuvre, la maintenance et l'amélioration d'un système de management de l'énergie

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is Technical Committee ISO/TC 242, *Energy management*.

Introduction

This International Standard provides guidance when implementing the requirements of an energy management system (EnMS) based on ISO 50001 and guides the organization to take a systematic approach in order to achieve continual improvement in energy management and energy performance. This International Standard is not prescriptive and each organization determines how to best approach meeting the requirements of ISO 50001.

This International Standard provides guidance to users with varying levels of energy management and EnMS experience, including those:

— with little or no experience of energy management or management system standards;

— undertaking energy efficiency projects but with little or no EnMS experience;

— having an EnMS in place, not necessarily based on ISO 50001;

— having experience with ISO 50001 and looking for additional ideas or suggestions for improvement.

Energy management will be sustainable and most effective when it is integrated with an organization's overall business processes (e.g. operations, finance, quality, maintenance, human resources, procurement, health and safety and environmental).

ISO 50001 can be integrated with other management system standards, such as ISO 9001, ISO 14001, and OHSAS 18001. Integration can have a positive effect on business culture, business practice, embedding energy management into daily practice, operational efficiency and the operating cost of the management system.

The examples and approaches presented in this International Standard are for illustrative purposes. They are neither intended to represent the only possibilities, nor are they necessarily suitable for every organization. In implementing, maintaining or improving an EnMS, it is important that organizations select approaches appropriate to their own circumstances.

This International Standard includes practical help boxes designed to provide the user with ideas, examples and strategies for implementing an EnMS.

Ongoing commitment and engagement by top management is essential to the effective implementation, maintenance and improvement of the EnMS, in order to achieve the benefits in energy performance improvement. Top management demonstrates its commitment through leadership actions and active involvement in the EnMS, ensuring ongoing allocation of resources, including people to implement and sustain the EnMS over time.

Energy management systems — Guidance for the implementation, maintenance and improvement of an energy management system

1 Scope

This International Standard provides practical guidance and examples for establishing, implementing, maintaining and improving an energy management system (EnMS) in accordance with the systematic approach of ISO 50001. The guidance in this International Standard is applicable to any organization, regardless of its size, type, location or level of maturity.

This International Standard does not provide guidance on how to develop an integrated management system.

While the guidance in this International Standard is consistent with the ISO 50001 energy management system model, it is not intended to provide interpretations of the requirements of ISO 50001.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 50001:2011, *Energy management systems — Requirements with guidance for use*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 50001 and the following apply.

3.1.1
commissioning
process by which equipment, a system, a facility or a plant that is installed, is completed or near completion is tested to verify if it functions according to its design specification and intended application

3.1.2
energy balance
accounting of inputs and/or generation of energy supply versus energy outputs based on energy consumption by energy use

Note 1 to entry: Where present, energy storage can be considered within energy supply or energy use.

[SOURCE: ISO 50002:2014, 3.6, modified — Deleted original Notes 1 and 2 to entry; added new Note 1 to entry]

3.2 Abbreviated terms

EnMS	energy management system
EnPI	energy performance indicator
PDCA	Plan–Do–Check–Act
SEU	significant energy use
HDD	heating degree days

4 Energy management system requirements

4.1 General requirements

It is good practice to keep the EnMS as simple and easy to understand as possible while still meeting the ISO 50001 requirements. For example, organizational objectives for energy management and energy performance should be reasonable and achievable and aligned with current organizational or business priorities. Documentation should be straight forward and responsive to organizational needs, as well as easy to update and maintain. As the system develops based on continual improvement, simplicity should be maintained.

Defining the scope and boundaries of the EnMS allows the organization to focus their efforts and resources in energy management and energy performance improvement. When defining the scope and boundaries, an organization should not divide or exclude energy using equipment or systems unless it is separately metered or a dependable calculation can be made. Over time, the scope and boundaries may change due to energy performance improvement, organizational change or other circumstances, and the EnMS is reviewed and updated as needed to reflect the change.

Documenting the scope and boundaries of the EnMS can be in any format. For example, it may be a simple list, or a map or line drawing indicating what is included within the EnMS.

Practical Help Box 1 – Items to consider in defining scope and boundaries
Scope:
— What facilities are included?
— What operations and activities are included?
— Is energy for transport included?
— Are other media, for example, water and gas flows such as nitrogen included?
— Who is top management within the defined scope and boundaries?
Boundaries:
— What parts of the site are included?
— Are all buildings and processes included?
— Are other sites included?
— What parts of the site or locations are not included?

4.2 Management responsibility

4.2.1 Top management

Ongoing top management commitment is a critical factor in the continued success of the EnMS and the improvement of energy performance. Top management demonstrates its commitment through its leadership actions and active involvement in the EnMS. Top management needs to retain its EnMS responsibilities and should make its actions visible to employees across the organization.

Top management should understand that a fundamental requirement for demonstration of its commitment is ongoing allocation of resources – which includes people to implement, sustain and improve the EnMS and energy performance over time. One resource area that is often overlooked and needs to be specifically addressed is the means of gathering and reporting data to support the ongoing maintenance and improvement of the EnMS.

Early in the EnMS implementation process, top management should initiate ongoing communications across the organization about the importance of energy performance and energy management. A communication approach that has proven itself within the organization and the organizational culture is more likely to be effective. Initial communication can be accomplished by top management's announcement of the appointment of the management representative, the establishment of the energy team and by presenting the energy policy and the decision to implement an EnMS directly to the employees.

Energy management and energy performance improvement should align with the organization's business strategy and long-term planning and resource allocation processes.

4.2.2 Management representative

Regardless of whether the management representative has a technical background, certain capabilities are key to the success of the role. The following capabilities should be considered in the choice of management representative:

— leading and motivating personnel;

— managing or effecting change;

— communicating effectively across all levels of the organization;

— problem solving and conflict resolution skills;

— understanding energy use and consumption concepts;

— basic analytical skills to understand energy performance.

Often the management representative is the individual responsible for the operation of a process or facility.

Whether the management representative is internal or external to the organization, top management needs to ensure that the representative has the appropriate authority to fulfil their duties. Additional communications by top management with employees may be needed in order to clearly establish the authority of an external management representative.

Practical Help Box 2 – Communication of energy management responsibilities and authorities
Energy management responsibilities and authorities can be defined and communicated in a variety of ways. For example, they can be:
— included in EnMS procedures or instructions;
— incorporated into job descriptions;
— identified in a responsibility matrix;
— set forth in an energy or EnMS manual;
— included in operational and technical training, including workbooks;
— part of employee performance reviews;
— reinforced during awareness training or shift meeting presentations.

Ways that the management representative can ensure that both the operation and control of the EnMS are effective could include:

a) scheduling regular team meetings;

b) reviewing internal audit and corrective action results;

c) the use of management tools such as business scorecards and trends in energy data;

d) reviewing of energy performance indicator (EnPI) control limit anomalies.

Integration of energy management responsibilities with the organization's performance evaluation (appraisal) system may improve EnMS outcomes by institutionalizing responsibilities.

Good practice is to have a cross functional energy management team of more than one person that includes representatives from areas that can affect energy performance. This approach provides an effective mechanism to engage different parts of the organization in the planning, implementation and maintenance of the EnMS. Membership of the team may change over time and should be based on defined roles rather than named individuals.

Practical Help Box 3 – Considerations in selecting members of the energy management team
Selection of members of the energy management team (as appropriate to the organization's size and complexity) should consider the following: — personnel representing a mix of skills and functions to address both the technical and organizational components of the EnMS; — financial decision makers or access to them; — procurement personnel; — operational personnel, particularly those performing tasks associated with SEUs; — representatives of tenants in commercial buildings, where appropriate; — individuals who can take responsibility for operational controls or other elements of the EnMS; — maintenance and facility personnel; — production or other personnel who may be already involved in improvement mechanisms such as continuous improvement teams; — individuals that will further the integration of EnMS into the organization; — people who are committed to energy performance improvement and able to promote the EnMS throughout the organization; — representatives from different shifts, where applicable; — supply chain managers as appropriate; — personnel who may not be directly working with energy uses but may be important, for example accessing critical data (utility energy bills, building management data, financial data, etc.), making changes to work practices, raising awareness.

The team approach takes advantage of the diversity of skills and knowledge of individuals. The organization should consider building energy management and improvement capability and capacity throughout the organization. This could include additional training and rotation of the management representative position and membership of the energy management team.

4.3 Energy policy

The energy policy sets the direction for implementing and improving the organization's EnMS and energy performance. The policy demonstrates the commitment of top management so that the organization is able to continually maintain and enhance its efforts to achieve improved energy performance.

The energy policy can be developed either before or after the initial energy review. In either case the energy policy should be reviewed to ensure its appropriateness to the nature and scale of the organization's energy use and consumption. Developing the energy policy before the initial energy review can provide a strong platform of management commitment on which to build the initial energy review. Developing it after the energy review can provide solid data and information on which to build a strong policy. Developing the energy policy before the energy review and then revisiting it to ensure its appropriateness to energy use and consumption afterwards is a good practice.

Whether the energy policy is made available to the public is a decision by the organization, consistent with its own priorities and needs. Once the EnMS is fully implemented and begins to mature, the policy could be made publicly available as part of an improvement to the system (e.g. the energy policy could be included in sustainability, corporate social responsibility and other annual reports, the organization's website, etc.).

Top management's commitment is required to fully integrate the energy policy into the underlying culture of the organization to ensure its continuity. As a part of an integrated management system, it may be possible to integrate an energy policy with an existing organizational policy (e.g. environmental, sustainability, health and safety, quality). Care should be taken to ensure that the energy policy is not weakened or compromised and conforms with ISO 50001 requirements.

During the initial EnMS implementation, defining the energy policy should focus on the commitments explicitly required. The commitments can be stated using terminology consistent with the culture of the organization. It is recommended to avoid lengthy policy statements that may be difficult for personnel to understand and apply. Implementation of lengthy policies can consume significant training and communication resources. The organization should avoid duplicating within the policy other components of the EnMS i.e. scope and boundaries. The policy statement itself need not include the fact that it is documented, communicated, regularly reviewed and updated as necessary, however, it includes the required commitments of ISO 50001.

The energy policy's support for the procurement of energy efficient products and services and design would not require the organization to always purchase the most energy efficient items. Support for the purchase of energy efficient products and services and design for energy performance improvement should support business productivity and longer term profitability.

In general, the energy policy does not change often. Decisions on changes to the policy are made as part of the management review process. Possible reasons to change the policy include changes in organizational ownership, structure, legal and other energy requirements, and major changes in energy uses, sources, operations or business conditions or as part of continual improvement.

NOTE Examples of energy policies are given in Annex A.

4.4 Energy planning

4.4.1 General

Energy planning is the "Plan" part of the PDCA cycle of the EnMS.

Energy planning provides the foundation for developing an EnMS that is based on an understanding of an organization's energy performance. This is the step where the organization's analysis of its energy data, along with other energy information is used to make informed decisions on actions to continually improve energy performance.

Examples of the relationship between objectives, associated energy targets, action plans, EnPIs, operational control, monitoring and measurement are given in Table E.1. Examples of the relationship between significant energy uses (SEUs), operational controls, competency and training, procurement, associated EnPIs, monitoring and measurement and calibration are given in Table E.2.

4.4.2 Legal requirements and other requirements

Legal requirements refer to applicable mandatory requirements related to an organization's energy use, consumption, or energy efficiency.

Other requirements could refer to voluntary agreements, contractual arrangements or corporate requirements subscribed to by the organization related to energy use, energy consumption and energy efficiency.

Information on legal requirements and other requirements can be obtained from a variety of sources, such as in–house legal departments, government or other official websites, consultants, professional bodies and various regulatory bodies. If the organization already has a process to determine legal requirements, that process may be used to identify and access energy related legal requirements. The process used to identify and evaluate legal compliance should be clear and include a description of how compliance is assessed. In addition, it should establish the responsibilities for monitoring, reviewing and ensuring compliance.

In addition to reviewing legal requirements and other requirements at defined intervals, examples of occasions when additional review may be required include:

a) changes in applicable legal requirements and other requirements;

b) changes in the operations of the organization that might affect applicable requirements.

Early consideration of legal requirements and other requirements can assist the organization in identifying related data requirements to address in the energy review. It may be useful to establish a list of legal requirements and other requirements so their implications can be considered for other parts of the EnMS including SEUs, operational controls, records, and communication.

Practical Help Box 4 – Examples of legal requirements and other requirements
Legal requirements:
— Local, state, provincial, national and international legal requirements;
— Energy performance standards required by law for equipment;
— Regulated energy assessment or audit requirements;
— Building energy codes;
— Energy source installation codes.
Other requirements to which the organization may subscribe, if applicable:
— Organizational guidelines or requirements;
— Agreements with customers or suppliers;
— Non-regulatory guidelines;
— Voluntary principles or codes of practice;
— Voluntary energy agreements;
— Requirements of trade associations;
— Agreements with community groups or non-governmental organizations;
— Public commitment of the organization or its parent organization;
— Voluntary minimum specifications for energy performance issued by government or private agencies;
— Network limits on electricity or gas supply, or limitations on electricity exports to the network.

4.4.3 Energy review

The energy review is the analytical part of the energy planning process. The quality of the energy review is influenced by the availability, quality and analysis of the data collected.

When implementing an energy review for the first time, the starting point is the available data. The energy review can be improved as the organization gains more experience with energy data management and decision making based on energy data analysis.

A good practice is to utilize the output of any available energy audits or engineering studies as part of the energy review.

NOTE ISO 50002 provides information on energy audits.

a) **Analysis of energy use and consumption**

Developing an understanding of the organization's energy use and consumption is the first step in an energy review. This is accomplished through:

— identifying current energy sources;

— identifying current energy uses;

— evaluating energy use and consumption, including past and present trends.

The resulting information is used to identify SEUs and energy performance improvement opportunities.

Energy sources can include, but are not limited to: electricity, natural gas, fuel oil, propane, solar, wind, biomass, cogeneration and recovered waste energy. In some organizations, it can include externally supplied energy sources such as compressed air, chilled or hot water and steam. Typically, energy sources should exclude feedstock except where the feedstock also contributes energy within the scope and boundaries of the EnMS.

Identification of energy sources can be accomplished through the review of existing records (e.g. utility bills, fuel delivery receipts, procurement records, etc.). It is good practice to examine energy flows and end uses to ensure all energy sources are identified. These results form the basis for the remainder of the energy review.

The next step in the energy review is linking the energy sources to energy uses. A single energy source can be associated with multiple energy uses. Interviews with organizational personnel responsible for the operation of equipment, systems and processes can be helpful in identifying energy uses. Other possible sources for energy use information and energy consumption data can be found in Practical Help Box 5.

Once the energy uses are identified, evaluate past and present energy use and consumption. A suitable period (e.g. one, three, six or twelve months) is established to evaluate historic energy consumption and identify trends. The period(s) selected should be representative of the variation in organizational operations (e.g. seasonal production, occupancy levels). It is good practice to analyse data for a period of at least one year to account for seasonal effects and other variables.

Additionally, the data should be of a suitable frequency to understand the variability in energy performance and any anomalies in energy consumption. The frequency of data collection should be at least monthly to allow for identification of trends in energy use and consumption. For some operations, more frequent data collection may be appropriate.

Energy use and consumption information should be presented by graphs, charts, tables, spreadsheets, process maps and simulation models.

Practical Help Box 5 – Possible sources of energy use and consumption data

Possible sources of energy use and consumption data include:

— compiled utility bills for the period of examination for each energy source, including individual line items for energy charges:

— whenever possible bills should be checked for accuracy against utility meter readings and not based on utility estimates;

— attention is needed to check that the period of energy consumption and the period represented by the compiled bills correspond to each other;

— meter readings from utility meters and applicable submeters (recorded manually or electronically), for energy consumption of facilities, equipment, systems and processes;

— estimations of energy consumption;

— model simulations of energy use and consumption;

— equipment data (e.g. name plate energy rating, stated efficiencies from manufacturer's equipment manuals, asset inventory lists and data sheets);

— weekly or daily maintenance logs (e.g. boiler house logs, compressor run hours);

— service logs (e.g. vendor or distributer service visit records);

— control system data;

— bills or other records of purchase of other energy sources, such as fuel oil, coal, biofuels, that may be delivered periodically and stored onsite;

— bills or other records of purchase of compressed air, steam, hot and chilled water;

— energy audit reports or engineering studies;

— records of previous energy reviews.

The outputs from the analysis of energy use and consumption include:

— identified current energy sources;

— identified energy uses;

— measured or estimated energy consumption associated with each identified energy use for the period established as suitable.

This information provides a basis for the identification and analysis of SEUs.

b) **Based on the analysis of energy use and consumption, identify the areas of SEUs**

SEUs are determined for the purpose of establishing priorities for energy management, energy performance improvement and resource allocation. In identifying areas of SEU, it may be helpful for the organization to take a holistic view of its uses and consumption of energy within the scope and boundaries.

The selection of the number of SEUs should consider available resources since for SEUs there are requirements for competency and training, procurement, operational controls, and monitoring and measurement. Organizations starting to implement an EnMS may find it helpful to limit the number of SEUs with a plan to develop additional SEUs as resources are available.

Based on the definition of SEU, the organization has the flexibility to determine SEUs based on energy consumption, energy improvement opportunity, or a combination of both. Establishing a process for determining SEUs involves deciding the criteria for:

— "substantial energy consumption", which could include the use of an energy balance to determine energy uses that account for at least a certain percentage of the organization's total energy consumption (alternatively, Pareto analysis could be used for this purpose);

— "considerable opportunity for energy performance improvement", which could include the outputs of energy audits, engineering studies, interviews with personnel with responsibilities related to the energy use, comparison with internal and external benchmarks and other information to evaluate and prioritize energy improvement opportunities.

The determination of SEUs may be an iterative rather than a sequential process. Opportunities for improvement can be an input into the determination of SEUs at this point in the energy review process. This includes consideration of how the behaviour of personnel working for or on behalf of the organization, and the organization's work practices can influence energy performance.

Practical Help Box 6 – Possible methods to assist in the identification of an organization's SEUs
Possible methods to assist in the identification of an organization's SEUs include:
— energy audits (e.g. ISO 50002 and other energy assessment standards);
— process maps;
— graphs and charts;
— spreadsheets or tables;
— Sankey diagrams;
— mass and energy balance;
— mapping of energy use;
— energy use and consumption simulation models;
— surveys of end-use equipment, systems, or processes;
— inventory of energy-using equipment, including energy rating and typical hours of operation;
— regression analysis of energy consumption of equipment, systems, or processes against relevant variables that affect their energy consumption.

Analysis of energy uses will result in a list for consideration as SEUs. In the absence of measured data, energy consumption should be estimated. Final determination of SEUs will consider whether the energy consumption of these energy uses is substantial or whether they represent considerable opportunity for improvement or both. Any use with substantial energy consumption should receive consideration as an SEU.

Energy consumption is affected by many variables. Data should be collected and analysed to determine the effects of the relevant variables on the SEU. If estimates of SEU energy consumption are made, then additional analysis will be needed to determine the effects of relevant variables.

Submetering of SEUs represents a good practice to establish the current energy performance of SEUs and to track future improvements in their energy performance. Careful consideration should be given to the submetering and its potential use in the EnMS. The energy management team should engage with appropriate operations personnel when identifying and defining the relevant variables.

ISO 50001 requires energy data to be monitored in order to fulfil the requirements of several of its clauses, including energy baselines, EnPI, monitoring and measurement and analysis. When appropriate, normalize the energy data to levels of production, weather or other relevant variables that affect energy consumption.

NOTE ISO 50006 provides additional information on normalization of energy data.

Practical Help Box 7 – Examples of relevant variables that can affect SEUs

Examples of relevant variables that can affect SEUs (preferably over the same time period as the energy consumption data) include the following:

— weather, including heating and cooling degree days;

— production related, such as rate, product mix, quality, rework or output;

— process parameters such as ambient temperature, cooling water temperature setpoint, steam temperature;

— material flows, properties and characteristics (including raw materials);

— building occupancy levels;

— daylight availability and ambient light levels;

— operating hours;

— levels of activity (e.g. work load, occupancy);

— distances travelled for transportation energy;

— vehicle loading and utilization;

— variation in availability or energy content of the energy sources (e.g. moisture content, calorific value).

The current energy performance of the SEUs should be established using available energy consumption data and information concerning the identified relevant variables.

Practical Help Box 8 – Example of methods for determining current energy performance of the SEUs

Examples for determining current energy performance of the SEUs include comparisons such as:

— normalization of:

  — air compressor electricity consumption against production volumes and ambient air temperature;

  — refrigeration plant electricity consumption against cooling load, supply temperature and ambient temperature;

  — building electricity consumption against occupancy and cooling degree days;

  — building natural gas consumption against occupancy and heating degree days;

  — aircraft fuel consumption against flying hours and the number of take offs;

— energy consumption per unit of output and other simple ratio such as energy efficiency and coefficient of performance;

— coefficient of performance of refrigeration systems at their operating loads and environmental conditions compared to energy efficient systems;

— comparison of current energy consumption with historical consumption if consumption is not affected by a relevant variable.

After collecting and analysing energy use and consumption data and relevant variables for the suitable period, estimate future energy use and consumption for an equivalent time period. The estimation should consider each SEU, relevant variable, and anticipated changes to facilities, equipment, systems and processes during this future period. Some organizations choose to complete the future estimates after decisions regarding action plans have been finalized for the coming period.