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Energy management systems — Guidance for the implementation, maintenance and improvement of an ISO 50001 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 de l'ISO 50001

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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 301, *Energy management and energy savings*.

This second edition cancels and replaces the first edition (ISO 50004:2014), which has been technically revised. The main changes compared with the previous edition are as follows:

— the document has been restructured as per the high level structure (HLS) for management system standards (MSS), which helps to ensure a high level of compatibility with other MSS, including the addition of context of the organization and risk[12];

— stronger emphasis has been placed on the role of top management;

— exclusions of energy types have been clarified;

— the energy review has been clarified;

— details on the energy data collection plan and related requirements have been added (previously the energy measurement plan);

— the EnPI and EnB text has been clarified to provide a better understanding of these concepts;

— the examples based on the experience of implementation have been included;

— the format has been modified to remove the practical help boxes and integrate the information within the text;

— the annexes have been removed.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides practical guidance when implementing the requirements of an energy management system (EnMS) based on ISO 50001. It shows the organization how to take a systematic approach to achieve continual improvement in the EnMS and energy performance. This document is not prescriptive. Each organization can determine the best approach to adopt the requirements of ISO 50001. The user is advised to use this document with ISO 50001 and its annexes.

This document provides guidance to users with different levels of energy management, energy consumption and EnMS experience. Each clause explains how an organization can approach a part of an EnMS. Practical tools, methods, strategies and examples are provided to help organizations implement an EnMS and to continually improve energy performance. The examples and approaches presented in this document are for illustrative purposes only. They are not 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 needs.

Energy management is 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 policy).

ISO 50001 can be integrated with other management system standards (MSS), such as ISO 9001, ISO 14001, ISO 45001 and ISO 55001. Integration can have a positive effect on business culture and business practice, embedding energy management into daily practice, improving operational efficiency and reducing the operational costs related to the management system. The common HLS of MSS supports this integration[12].

Ongoing commitment and engagement by top management is essential for the effective implementation, maintenance and improvement of the EnMS, and for achieving continual energy performance improvement. Top management ensures the EnMS is aligned with the strategic direction of the organization and demonstrates its commitment through leadership actions that ensure the ongoing allocation of resources, including the people to implement, maintain and improve the EnMS over time.

Energy management systems — Guidance for the implementation, maintenance and improvement of an ISO 50001 energy management system

1 Scope

This document gives practical guidelines and examples for establishing, implementing, maintaining and improving an energy management system (EnMS) in accordance with the systematic approach of ISO 50001:2018. The guidance in this document is applicable to any organization.

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

While the guidance in this document is consistent with the requirements of ISO 50001:2018, it does not provide interpretations of those requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 50001:2018, *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 50001:2018 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.2 Abbreviated terms

EnB	energy baseline
EnMS	energy management system
EnPI	energy performance indicator
GHG	greenhouse gas
HLS	high level structure
HVAC	heating, ventilation and air conditioning
MSS	management system standard
PDCA	Plan-Do-Check-Act

PESTLE political, economic, social, technological, legal, environmental

SEU significant energy use

SWOT strengths, weaknesses, opportunities, threats

TDODAR time, diagnose, options, decide, act/assign, review

4 Context of the organization

4.1 Understanding the organization and its context

This subclause involves determining strategic issues, i.e. issues that can affect, either positively or negatively, the intended outcomes of the EnMS. Determining these issues (both internal and external) serves to connect the EnMS with the organization's strategic direction and goals.

EXAMPLE 1 Examples of internal issues include but are not limited to:

— strategic direction and organizational management;

— processes, systems and operational factors;

— the age and condition of equipment and systems;

— the organization's performance indicators;

— the organization's financial circumstances;

— organizational structure and hierarchy;

— employee knowledge and organization culture;

— mission and vision of the company.

EXAMPLE 2 Examples of external issues include but are not limited to:

— economic and financial;

— security of energy supply;

— technology;

— cultural, social and political;

— geographical;

— legal/other requirements;

— environmental;

— restrictions on energy consumption;

— natural and competitive circumstances.

When the context of an organization is well understood, it assists in establishing, implementing, maintaining and continually improving the organization's EnMS and energy performance. Understanding the context promotes discussion between top management and the relevant interested parties (see 4.2) and ensures that changing circumstances and other issues are addressed to benefit the EnMS. Integral to this process is understanding the aims and culture of the organization. This helps to align the EnMS with the preferred practices and approaches used by the organization to conduct its business operations. The outputs of context are used to plan, implement and operate the EnMS in ways that provide ongoing value to the organization. Top management is best placed to ensure the EnMS reflects the organizational context and that it continues to provide the expected benefits to the organization. Internal and external issues change over time. To ensure the context remains current,

the organization can conduct reviews of its context at planned intervals and through activities such as management review.

Organizations can approach this requirement through discussions and structured conversations, and by reviewing sources of information. At the strategic level, tools such as SWOT analysis, PESTLE analysis or TDODAR analysis may be used for the identification and evaluation of contextual issues. A simpler approach, such as brainstorming, can be useful for organizations, depending on the size and complexity of their operations. The processes and outputs of processes used for evaluating the organization's context can be considered necessary for the effectiveness of the EnMS, and may be maintained as documented information. The triggers and review frequency for conducting these processes should also be defined in documented information.

4.2 Understanding the needs and expectations of interested parties

This subclause is designed to ensure that the organization structures a formal framework to identify and respond to internal and external relevant parties' needs and expectations.

An organization determines the interested parties relevant for its energy performance or for its EnMS. The relevant parties can be internal (e.g. employees related to SEUs that affect energy performance, an energy management team that affects EnMS performance) or external (e.g. providers of equipment that could impact energy performance, clients that could be perceived as affected by the energy performance of the organization).

The organization is expected to gain sufficient understanding of the expressed needs and expectations of those internal and external interested parties that have been determined by the organization to be relevant. Understanding these needs and expectations should be sufficient to meet the requirements of the organization.

Legal requirements reflect needs and expectations that are mandatory because they have been incorporated into laws, regulations, permits and licences by governmental or court decisions. Legal requirements refer to applicable mandatory requirements related to an organization's energy use, energy consumption and energy efficiency.

EXAMPLE 1 Examples of legal requirements can include but are not limited to:

— local, state, provincial, national and international legal requirements;

— energy performance standards required by law for equipment;

— regulated energy assessment or energy audit requirements;

— energy-related building codes and construction requirements;

— energy storage, distribution and transportation codes;

— minimum energy efficiency standards;

— prohibition or limitation of application of a particular energy for a particular purpose;

— energy-type installation codes.

Other requirements can refer to voluntary agreements or initiatives, contractual arrangements or corporate requirements subscribed to by the organization related to energy efficiency, energy use and energy consumption. Other requirements only become requirements of the organization when the organization adopts them.

EXAMPLE 2 Examples of other requirements include but are not limited to:

— organizational guidelines or requirements;

— agreements with customers or suppliers;

— agreements with "central office";

— 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.

The organization can consult interested parties or use other methods to categorize their needs and requirements. One category can be information on legal requirements and other requirements, which can be obtained from a variety of sources, such as in-house legal departments, government or other official sources, 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 legal requirements should be clear and include a description of how compliance is assessed and ensured. Guidance on evaluating compliance is given in 9.1.2.

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

A second category can arise from the organization voluntarily incorporating the needs and requirements of interested parties as its own. For example, an organization could see improved energy performance (as advocated by an external interested party) as providing the organization with business advantages and choose to adopt the recommendations from the external interested party.

As the needs and requirements of interested parties can change over time, the organization can include a process for a periodic review of their requirements that have been incorporated into the EnMS. This review can alert the organization to items such as:

a) changes in applicable legal requirements and other requirements;

b) changes in the operations of the organization that could affect applicable requirements;

c) changes in the needs and recommendations of external interested parties;

d) changes in equipment or technology that bring new operating and maintenance requirements.

4.3 Determining the scope of the energy management system

The intent of this subclause is to ensure that the organization defines the scope and boundaries of the EnMS, which allows the organization to focus its efforts and resources on energy management and energy performance improvement. Over time, the scope and boundaries can change due to energy performance improvement, organizational changes or other circumstances. The EnMS is reviewed and updated as needed to reflect the changes. Items to consider when defining the scope and boundaries are found in Table 1.

Table 1 — Scope and boundary considerations

Scope considerations	Boundary considerations
What operations and activities are included?	What parts of the site are included?
Is energy for transport included?	What facilities are included?
Are other media, e.g. water and gas flows such as hydrogen or nitrogen, included?	Which buildings, systems and processes are included?
Who is top management within the defined EnMS scope and boundaries?	Are other sites included?
How are outsourced processes considered?	What parts of the site or locations are not included?
Are all energy types purchased by the organization included?	Are measurements of energy data available for the chosen boundaries?
Can the authority of control be demonstrated for the selected scope?	

Typically, the energy management team develops the documented EnMS scope and boundaries based on input from top management regarding the activities and physical or organizational limits to be covered by the EnMS.

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

4.4 Energy management system

The intent of this subclause is to ensure that the organization determines and implements the processes needed for continual improvement. This includes the processes that are needed for the effective implementation and continual improvement of the system, such as internal audit, management review and others. It also includes the processes needed for quantifying and analysing energy performance.

The level to which processes need to be determined and detailed can vary according to the context of the organization.

ISO 50001:2018 uses ISO's common approach to MSS, where the aim is to enhance the consistency and alignment of MSS by providing a unifying and agreed upon HLS, identical core text and common terms and core definitions. This is particularly useful for those organizations that choose to operate a single (sometimes called "integrated") management system that can meet the requirements of two or more MSS simultaneously. The HLS is not intended to provide a sequential order of activities to undertake when developing, implementing, maintaining and continually improving a MSS. The HLS as a whole is intended to enable an organization to achieve continual improvement and is based on the PDCA approach. The MSS elements are organized around functional activities in an organization as shown in Figure 1.

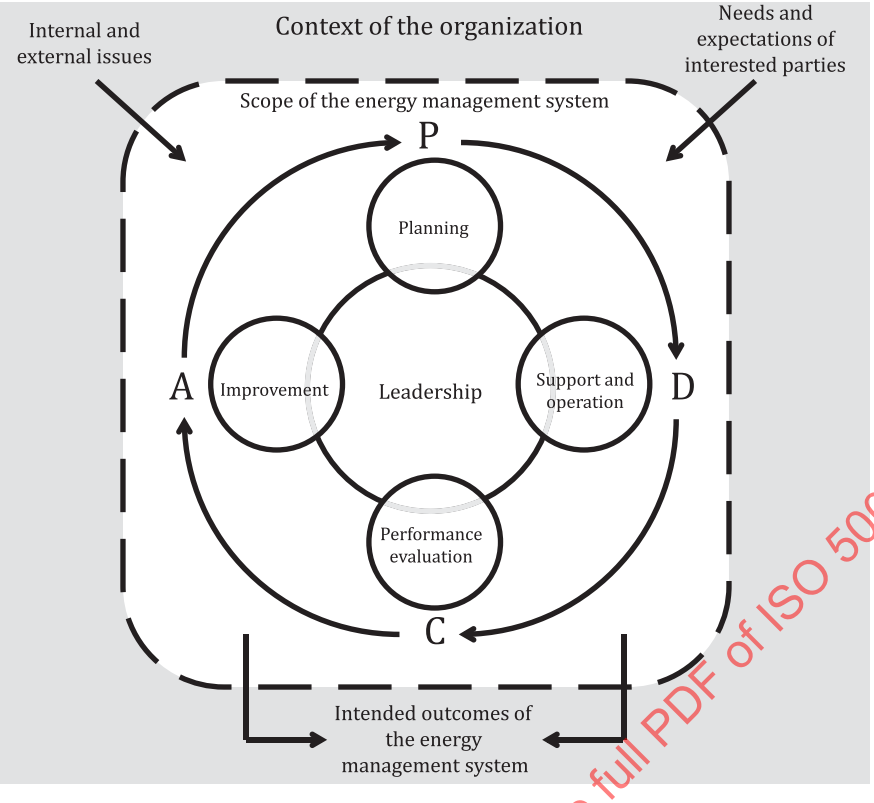

Figure 1 — Plan-Do-Check-Act cycle

It is good practice to keep the EnMS as simple and easy to understand as possible while still meeting the ISO 50001:2018 requirements. For example, organizational objectives for energy management and energy performance should be reasonable, achievable and aligned with current organizational or business priorities. Documentation should be straightforward and responsive to organizational needs, as well as easy to update and maintain. As the management system develops based on continual improvement, simplicity should be maintained. The EnMS for each organization should reflect and be as unique as that organization.

The processes of the EnMS for a complex organization may be more detailed in order to effectively manage energy efficiency, use and consumption. Lower complexity organizations could only require simple approaches and the minimum processes and documented information as defined in ISO 50001:2018 for an effective EnMS. For example, in a low complexity organization, collection of energy data can be as simple as logging utility meter readings for gas and electricity, manually, in a spreadsheet. For a complex organization to effectively manage energy, the data collection would likely need to include electronic gathering and transmitting of multiple data sources across the organization, including sub-meter data.

5 Leadership

5.1 Leadership and commitment

This subclause is intended to ensure that top management actively demonstrates leadership and commitment to continually improving energy management and energy performance. Ongoing top management commitment and engagement are critical factors in the continual improvement of the EnMS and energy performance.

Top management demonstrates its commitment through:

a) its leadership actions and active involvement in the EnMS;

b) understanding the ongoing allocation of the needed resources, which includes people to implement, maintain and improve the EnMS and energy performance over time, including the means of gathering and reporting data to support the ongoing maintenance and improvement of the EnMS and energy performance.

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

Early in the EnMS implementation process, top management should initiate ongoing communications across the organization about the benefits and importance of energy performance and energy management. Initial communication typically includes the energy policy and announcing the energy management team.

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

Good practice is to have a cross-functional energy management team of more than one person, which 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. The members of the energy management team can change over time and should be based on defined roles rather than named individuals. The energy management team size can vary with the size or complexity of the organization and their processes.

NOTE In the case of a small and medium-sized enterprise (SME), the roles and responsibilities of the team could be fulfilled by a single individual (see ISO 50001:2018, 3.2.5).

The personnel that make up the energy management team should be empowered by top management to communicate decisions to their respective areas and to ensure that changes to improve energy performance are implemented. The energy management 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 can include additional training and rotation of the members of the energy management team.

When selecting the members of the energy management team (as appropriate to the organization's size and complexity), top management 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 personnel with access to them;

— business development managers;

— representatives of other management systems;

— an environmental manager;

— procurement personnel or supply chain managers, as appropriate;

— operational personnel, particularly those performing tasks associated with SEUs;

— representatives of tenants or the building administrator 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 could already be involved in improvement mechanisms, such as continuous improvement teams;

— individuals who will further the integration of the 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;

— personnel responsible for training or professional development, as appropriate;

— representatives of contractors and/or outsourced activities;

— personnel who are not necessarily working directly with energy uses but who could be important, e.g. accessing critical data (utility energy bills, building management data, financial data, etc.), making changes to work practices or raising awareness.

5.2 Energy policy

This subclause is intended to demonstrate the organization's commitments, as approved by top management, related to its energy performance. The energy policy sets the direction for implementing and improving the organization's EnMS and energy performance. The energy policy demonstrates the commitment of top management to enabling the organization 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. The energy management team or other personnel can propose the energy policy, but it needs to be formally adopted by top management.

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

Top management's commitment is required to fully integrate the energy policy into the underlying culture and business strategy of the organization to ensure its continuity. If the EnMS is part of an integrated management system, it could be possible to integrate the energy policy with an existing MSS policy (e.g. environmental, sustainability, health and safety, quality). Attention should be paid to ensure that the energy policy conforms to ISO 50001:2018 requirements.

During the initial EnMS implementation, defining the energy policy should focus on the explicit requirements of ISO 50001:2018. The wording and intent of the policy should be kept as simple as possible to aid with its understanding and acceptance by all employees, and interested parties as appropriate. The commitments can be stated using terminology consistent with the culture of the organization. It is recommended to avoid lengthy policy statements that can be difficult for personnel to understand and apply. Implementation of lengthy policies can consume significant training and communication resources. The organization should avoid the duplication, within the policy, of other components of the EnMS. The policy statement itself does not need to include the fact that it is documented, communicated, regularly reviewed and updated as necessary. However, it should include the required commitments of ISO 50001:2018.

5.3 Organization roles, responsibilities and authorities

This subclause addresses the roles, responsibilities and authorities that need to be addressed within the EnMS. ISO 50001:2018 specifies that top management is responsible for assigning responsibility and authority to an energy management team and for communicating their roles. Methods for demonstrating organizational roles, responsibilities and authorities include but are not limited to:

— organizational charts;

— standard operating procedures (SOPs), work instructions;

— lists of actions with responsibilities;

— process maps;

— job descriptions or position statements;

— a responsibility matrix;

— training materials;

— management resolution.

The energy management team is assigned responsibility for establishing and implementing the EnMS, including action plans. The team also keeps top management informed of the status and performance of the EnMS.

The organization may choose a team structure appropriate to the nature of its systems, capabilities and personnel. Roles and responsibilities usually follow logically from existing roles. The organization should review the current structures and processes to determine where the integration of energy performance improvement responsibilities fits best.

Organizations with multiple sites may form a multidisciplinary energy management team at each large site. In organizations with limited resources, some team roles may be outsourced. An (temporary) implementation team may be set up to focus on implementation and to develop the added responsibilities.

6 Planning

6.1 Actions to address risks and opportunities

The planning clause specifies what needs to be considered and what needs to be addressed in planning the EnMS. The planning is performed at a strategic level, versus the tactical planning done for operational planning and control (see ISO 50001:2018, 8.1). Planning ensures adequate consideration of organizational risks and opportunities and a connection to the business priorities. The aim is to ensure:

— energy performance improvement;

— EnMS effectiveness in achieving the intended outcomes;

— opportunities are determined that can achieve the organization's objectives.

Most organizations are subject to several risks and opportunities that can be prioritized based on their potential impacts on the successful achievement of the continual improvement of the EnMS and energy performance. Determining and prioritizing the risks and opportunities in order to take effective action to address these risks and to take advantage of the opportunities presented leads to an effective EnMS. The risk-management approach helps the organization to consider energy-related risks and opportunities to its business operations and processes.

In implementing these requirements, it is possible that an organization has management initiatives or other actions already in place to mitigate strategic risks or leverage strategic opportunities. Planning risks can include minimizing the loss of opportunities, such as the chance to optimize energy performance at the design stage.

In determining risks and opportunities, the organization can use techniques such as SWOT or PESTLE brainstorming, the structured "what if" technique and consequences/probability matrices.

Risk analysis can include, for example:

— people availability and competencies;

— prices of energy types;

— energy supply disruptions;

— carbon emissions costs.

Opportunity analysis can include:

— improvements in energy technologies, including measurement and control systems;

— consideration of new or alternative energy types;

— improvements in raw materials, process technology or information technology;

— a review of available support programmes;

— a review of available subsidies or rebate programmes.

6.2 Objectives, energy targets and planning to achieve them

The intent of this subclause is to ensure that the organization establishes objectives, energy targets and plans with appropriate actions to achieve them. Setting objectives and energy targets provides the means for transforming the energy policy into action plans. Objectives and energy targets provide the direction for improvement actions related to both energy management and energy performance, including the allocation of resources needed to achieve those improvements. Objectives can be defined at multiple levels (e.g. strategic, tactical, operational), and vary in detail and timeframe.

The data analysis and other information outputs from the energy review (see 6.3) are used in setting the objectives and energy targets. Objectives and energy targets can only be achieved if people and resources are provided, which enables action plans to be effective. Top management is responsible for ensuring that objectives and energy targets are established, and action plans are approved and implemented. The energy management team presents the objectives, energy targets and action plans to top management for approval, with support from others working for the organization, as appropriate.

Energy targets are measurable and should be specific, achievable, relevant and time-based. There should be a sufficient number of specific action plans associated with the objectives and energy targets to achieve the planned results.

In addition to the elements of an action plan required by ISO 50001:2018, an effective action plan should include, but is not limited to, the following:

a) a statement of objectives and energy targets addressed by the action plan;

b) necessary changes or additions to competencies and awareness;

c) necessary changes or additions to operational and maintenance practices, and communication;

d) consideration of design and procurement practices;

e) measures that will be taken to monitor and predict energy performance.

Examples of actions by which objectives and energy targets can be achieved include:

— implementing simple actions, such as turning equipment off when not needed;

— establishing maintenance programmes to reduce wasted energy, such as a compressed air leak reduction programme;

— adopting energy-efficient procurement practices;

— implementing a capital project that involves the installation of new, more efficient equipment.

Examples of alternative strategies for implementing action plans include:

— alternative funding mechanisms;

— alternative contractual mechanisms;

— alternative energy service providers;

— energy performance contracts;

— energy supplier obligation schemes.

The method of verifying the energy performance improvement is included in the action plan. It should use a combination of available energy and non-energy data for the selected EnPIs and other forms of pre- and post-implementation measurement. In some cases, engineering estimates of savings achieved are adequate, provided they can account for the effect of relevant variables. The verification of the results should ensure that actions outlined in the plan were properly executed and result in the intended outcomes.

An action plan can lead to revised operating criteria and maintenance practices, which could require changes to process controls and maintenance procedures, as well as retraining of operators and/or maintenance personnel. Objectives can be used to ensure maintenance of EnMS performance over time.

Characteristics of a good action plan include a plan that:

— presents simple and clear information;

— contains the required components (who, what, when, resources, methods to verify energy performance improvement);

— contains the components (why, where, how actions will be implemented);

— is searchable;

— shows progress toward the objective based on the actions listed (what);

— sets out how the actions can be integrated into business practices;

— provides management with the business value;

— provides connections to the other requirements in the EnMS, e.g. operational controls, training, change management.

It can be useful to the organization to set objectives or energy targets for various parts of the organization. This allows flexibility in how an organization approaches energy performance improvements.

Objectives and energy targets should also consider the organization's environmental strategy, e.g. GHG emission reduction, sustainability, how the EnMS can help the organization to implement its strategy. A reduction of energy consumption, increase of energy efficiency and related improvement opportunities usually result in the reduction of GHG emissions. Renewable energy is an important means to reduce GHG emission. Organizations often have GHG reduction targets and renewable energy targets.

NOTE Regarding GHG, see the ISO 14060 family.

Objectives and energy targets should also consider other business strategies (e.g. competitiveness improvement, market position, reputation concerns) and how they relate to the EnMS.

EXAMPLE 1 Energy target: The energy efficiency target for vehicles in 2020 is 25 km/l as compared with the 2018 value of 22 km/l.

EXAMPLE 2 Objective with energy target: To achieve a reduction of electrical consumption in 2020 by 5 % with an energy target of a 2 % reduction from lighting and 3 % from the motor system compared with 2018.

EXAMPLE 3 Energy target: By August 2020, the lighting power density (W/m^2) in a specific commercial building will be reduced by 50 % by installing fixtures with LED bulbs.

6.3 Energy review

6.3.1 General

The intent of this subclause is to describe the set of activities that characterize the analytical part of the planning process.

The quality of the energy review is influenced by the availability, quality and analysis of the collected data, and the competence and availability of the people undertaking the analysis.

When developing 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 data (energy and relevant non-energy) management and decision-making based on energy data analysis.

Good practice is to utilize the output of energy audits or engineering studies as part of the energy review.

The defined intervals for updating the energy review can be different for each element of the energy review. Effective change management and robust communication processes support timely updating of the energy review in response to major changes in facilities, equipment, systems and processes.

NOTE For the purpose of clarity, the list in ISO 50001:2018, 6.3, is presented in this document as subclauses. Bullets "a" to "e" are presented as 6.3.2 to 6.3.6, respectively.

6.3.2 Analysis of energy use and consumption

Analysis of energy use and consumption provides an understanding of the organization's energy use and consumption. The organization evaluates those energy types that cross into the boundary(ies) of the EnMS at a minimum; they can include additional energy types in the analysis.

Energy types can include heat (steam), biomass (e.g. sugar cane, charcoal), electricity and fossil fuels (e.g. natural gas, oil products). In some organizations, this can include energy such as compressed air, steam, chilled or hot water, and cooling water. Typically, types of energy should exclude feedstock except where the feedstock also contributes to energy within the scope and boundaries of the EnMS.

Determination of the types of energy can be accomplished through a review of existing records (e.g. utility bills, fuel delivery receipts, procurement records,). It is good practice to examine energy flows and end uses to ensure that all energy types are identified, which can include waste heat or intermediate products with useful energy content. Possible types of energy, energy use and consumption data include:

— compiled utility bills for the period of examination for each energy type (electricity, fuel oil, natural gas, steam, etc.), 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;

— if data are missing during the selected year for one month, interpolated or comparable data for the same month in a different year can be used to ensure the baseline record represents typical operating conditions of the missing month; documented information on the rationale for the new data point is important;

— bills or other records of purchase of other energy type(s), such as fuel oil, coal or biofuels, that could be delivered periodically and stored onsite;

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

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

— estimations of energy consumption (consumption data);

— 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, data sheets);

— equipment operating conditions, such as machine settings and operating schedules;

— 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 and extracts from a data history/database;

— energy audit reports or engineering studies;

— portable instruments and data loggers;

— records of previous energy reviews.

Analysis of energy use and consumption links the types of energy to energy uses. A single type of energy can be associated with multiple energy uses. Interviews with personnel responsible for the operation of equipment, systems and processes can be helpful in determining energy uses. A useful technique is to sort equipment into logical groups also known as energy systems (e.g. thermal systems, compressed air systems, pump, ventilation/exhaust systems, HVAC). Analysing energy consumption of systems as a whole rather than individual components will help to determine the interdependency of systems around their function, larger potential energy performance improvements and the overall impact of those functions on the organization.

Analysis of energy use and consumption is important to evaluate past and present energy use(s) and consumption. A suitable time period is established to evaluate historical energy consumption and identify trends. The time period(s) selected should be representative of the variation in organizational operations (e.g. seasonal production, occupancy levels) and reflect one full operating cycle of the facility. It is good practice to analyse data for a period long enough to account for seasonal effects and other variables.

Additionally, the data should be collected at a suitable frequency to understand the variability in energy performance and any anomalies in energy consumption. As a starting point, the frequency at which energy is billed may serve as the frequency of data collection.

Data sets with different frequency of collection will reveal different trends and information. Each data set can provide unique insights.

Energy use and consumption information can be presented by graphs, charts, tables, spreadsheets, process maps and simulation models. The outputs from the analysis of energy use and consumption include:

— identified and quantified current energy types;

— identified energy uses;

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

As energy performance improvement relates to energy consumption and efficiency related to energy uses, renewable energy does not always lead to improved energy performance. Even so, organizations can incorporate renewable energy targets or objectives into their EnMS and manage and/or control renewable energy sources through their EnMS. This can help to reduce energy costs and exposure to energy price fluctuations. Improvements in energy performance can reduce energy demand, enabling a greater proportion of demand to be supplied from onsite renewable sources.

The information from the analysis of energy use and consumption along with information on opportunities provides a basis for the identification and analysis of SEUs.

6.3.3 Identification of SEUs based on the analysis

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

Selecting a limited number of SEUs initially can facilitate the EnMS implementation. As the EnMS matures over time, the determination of SEUs can be expanded to include additional energy uses and may vary for different parts of the organization.

The organization has the flexibility to determine the SEU(s) based on energy consumption, potential for energy performance improvement or a combination of both. This can lead to an SEU that is not necessarily one of the largest energy consumers. For example, in manufacturing sites, the lighting in the office or the HVAC could be a small energy consumer yet could offer a larger potential for energy performance improvements than some larger energy consumers. The determination of SEUs can be an output from the analysis of energy use and consumption:

— "substantial energy consumption", e.g. energy uses that account for at least a specified percentage of the organization's total energy consumption (energy balance or Pareto analysis can be used for this purpose);

— "considerable potential for energy performance improvement", which can include the outputs of energy audits, engineering studies, interviews with personnel with responsibilities related to the energy use and other information to evaluate and prioritize energy improvement opportunities.

The determination of SEUs can be an iterative rather than a sequential process. Possible tools and techniques to assist in the identification of an organization's SEUs include but are not limited to:

— energy audits;

— process maps;

— graphs and charts;

— spreadsheets or tables;

— a data sheet of the main equipment;

— Sankey diagrams;

— mass and energy balance;

— mapping of energy use;

— energy use and consumption simulation models;

— pareto analysis of energy consumption by areas or equipment;

— surveys of equipment, systems or processes;

— an inventory of energy-using equipment, including energy rating and typical hours of operation.

Potential opportunities for energy performance 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.

Analysis of the energy consumption data for the energy uses will result in a list for consideration as SEUs. In the absence of measured data, estimated energy consumption can be used. The final determination

of SEUs will consider whether the energy consumption of these energy uses is substantial or whether they represent a considerable potential opportunity for energy performance improvement or both.

6.3.4 Actions related to SEUs

For the identified SEUs, information concerning the possible relevant variables is collected.

The current energy performance of the SEUs should be established using available energy consumption and/or efficiency data. For the first energy review, the EnPIs may not have been established, therefore the current energy performance may not be normalized (see 6.4). However, for subsequent energy reviews, the SEU current energy performance should be normalized. It is good practice to determine the correlation of the relevant variable(s) to energy performance of the SEU. If the EnPI is going to be used to demonstrate energy performance improvement, the EnPI must be normalized using the relevant variables.

Outputs from this part of the energy review include the relevant variables affecting the identified SEUs and an analysis of the current energy performance of the SEUs.

Identifying persons under the control of the organization whose work can affect the SEUs helps to establish priorities for addressing competency, training needs, and operational planning and control. These persons can include service contractors, part-time personnel and temporary staff. They can work with different kinds of activities that influence or affect the SEUs, such as design, procurement, operation, calibration, measurement, maintenance and communication.

6.3.5 Determination and prioritization of potential opportunities for improving energy performance

Potential opportunities for improving energy performance involves a range of activities. Replacing existing equipment or systems with similar ones of greater energy efficiency is one approach to improving energy performance (e.g. replacing inefficient motors with more energy efficient motors). A close examination of the desired output from a system or process can also reveal opportunities for achieving this same output with smaller energy inputs, often by changing the way that energy is used (e.g. replacing compressed air with mechanical energy, replacing lighting with daylighting, the use of waste heat). Improved control/maintenance procedures and optimizing or changing the operational patterns of systems or processes all represent possible opportunities for energy performance improvement.

Organizations can express concerns about exhausting their opportunities for energy performance improvement. Experience has shown that, over time, even the most energy-efficient organizations continue to identify opportunities for improvement from new technologies, improved controls/ maintenance procedures, energy services, and better integration of renewable energy systems and processes. Often, opportunities are created by changes in conditions, such as changes in production levels, which allows improvement in equipment or system utilization, introducing new technology or controls differing from the original design specifications. Changes in technology or equipment prices (such as lower priced sensors) can also create new opportunities.

The identification of opportunities for improving energy performance and the development of a prioritized list of these improvement opportunities is an output from the energy review. The collection and analysis of data forms the foundation for prioritizing opportunities for improvement. Examples of tools and techniques for identifying opportunities can include:

— challenge and optimize process operating parameters;

— monitor and review new and emerging technology;

— employee suggestions, including from those who work with operation, maintenance and activities related to the SEUs;

— computational tools;

— other business improvement methodologies (e.g. lean manufacturing, Six Sigma, Kaizen);

— energy audits, ranging in cost and complexity from walk through to detailed audits;

— analysis to ensure the best energy efficient design decisions;

— internal or external benchmarking;

— equipment specification and data sheets;

— metering reviews;

— maintenance techniques (e.g. maintenance assessments, predictive maintenance);

— examination of the age, condition, operation and level of maintenance of the energy uses;

— review of case studies;

— energy management team meetings, brainstorming and opportunity identification workshops;

— opportunity lists and energy saving tips available on various government and efficiency organization websites;

— continuous monitoring systems that report any deviations from pre-established energy performance parameters (fully or partially automated);

— energy efficiency networks, seminars, forums and conferences to exchange ideas and experiences;

— review of integration of design criteria (passive), systematic systems (active), and renewable energy for cost-effectiveness and energy efficiency optimization;

— discussions with energy efficiency and clean renewable energy service providers;

— engineering analysis techniques and modelling (e.g. review of pump and systems curves, pinch analysis).

Opportunities for improvement begin with ideas that can be generated from the analysis of energy consumption and efficiency related to energy uses, the determination of SEUs or from a variety of other sources. Involving a range of people in this process, such as operational and maintenance staff, can help to reveal a full range of ideas. These ideas become opportunities through examination and refinement, using data analysis to determine the potential for energy performance improvement and feasibility.

The identification of opportunities for the improvement of energy performance should be part of a continuous process, but may also involve periodic analysis using proven techniques.

Prioritizing energy performance improvement opportunities starts with evaluation. Evaluation involves data analysis to quantify the expected energy performance improvement, benefits and costs of opportunities. Evaluation of opportunities can include technical feasibility and business considerations, such as asset management strategies and maintenance impacts. The evaluation should include additional impacts of energy performance improvement opportunities resulting from the examination of system interactions wherever applicable.

Having evaluated the identified opportunities, the organization prioritizes its energy performance improvement opportunities based on its own criteria, and maintains and updates the information in a format selected by the organization.

Example of criteria to prioritize opportunities can include:

— estimated energy savings;

— benchmarking;

— return on investment or other organizational investment criteria (capital or operational);

— other business impacts or priorities (e.g. improved competitiveness);

— estimated cost of implementation;

— energy efficiency specifications or data from equipment manufacturers;

— ease and timing of implementation;

— improved environmental impacts;

— actual or potential legal requirements;

— potential or actual impact on GHG;

— perceived level of risk including technological risk;

— availability of funding (internal or external);

— perceived impact on organizational reputation;

— impact and value of additional non-energy benefits (e.g. reduced maintenance, increased comfort, improved safety, increased throughput).

NOTE An example of prioritization can be found in ISO 50046:2019, Annex E.

Organizations should examine the prioritized list of opportunities to determine which opportunities proceed to a detailed investigation.

Once the organization's criteria have been applied to establish prioritized opportunities, the energy management team typically compiles recommendations for improvement and determines whether opportunities should undergo further investigation, be implemented or not be implemented. The team should communicate to top management the results from the energy review together with the recommendations for improvement including prioritized opportunities. There are often many low cost and simple opportunities that do not require top management approval and can be implemented following an assessment of feasibility and associated risk.

The information on prioritized opportunities should summarize the main information on actions proposed, financial information such as annual energy cost savings, the implementation cost and the criterion for investment adopted by the organization.

Management with the authority to allocate the required resources decides which opportunities are considered priorities for implementation, subject to further investigation, and which are not to be implemented. In establishing these priorities, management ensures that the necessary resources are made available.

6.3.6 Estimation of future energy use(s) and energy consumption

The estimation of future energy use(s) and consumption should consider anticipated changes to facilities, equipment, systems and processes during the estimation period. Factors that can increase energy consumption should be considered in the estimation process. Organizations can choose to complete the future estimation after decisions regarding action plans have been finalized for the coming period.

Often organizations conduct annual budget planning, which includes information on the expected energy consumption and costs. This activity can be leveraged to fulfil this requirement of the EnMS.

6.4 Energy performance indicators

Energy performance includes the broad concepts related to energy efficiency, energy use and energy consumption. EnPIs are quantifiable metrics of the whole organization or of various parts of the organization. The EnPIs are selected and used by the organization to understand and monitor energy performance, and/or demonstrate energy performance improvement. Monitoring energy performance

provides an organization with information so that the organization can make operating, equipment maintenance or behavioural changes that maintain and/or improve energy performance. Changes in EnPI values between two periods enable an organization to demonstrate energy performance improvement. EnPIs can aid in diagnosing the causes of changes in energy performance.

The general relationship between energy performance, EnPIs, EnBs and energy targets, and EnPI value is illustrated in Figure 2.

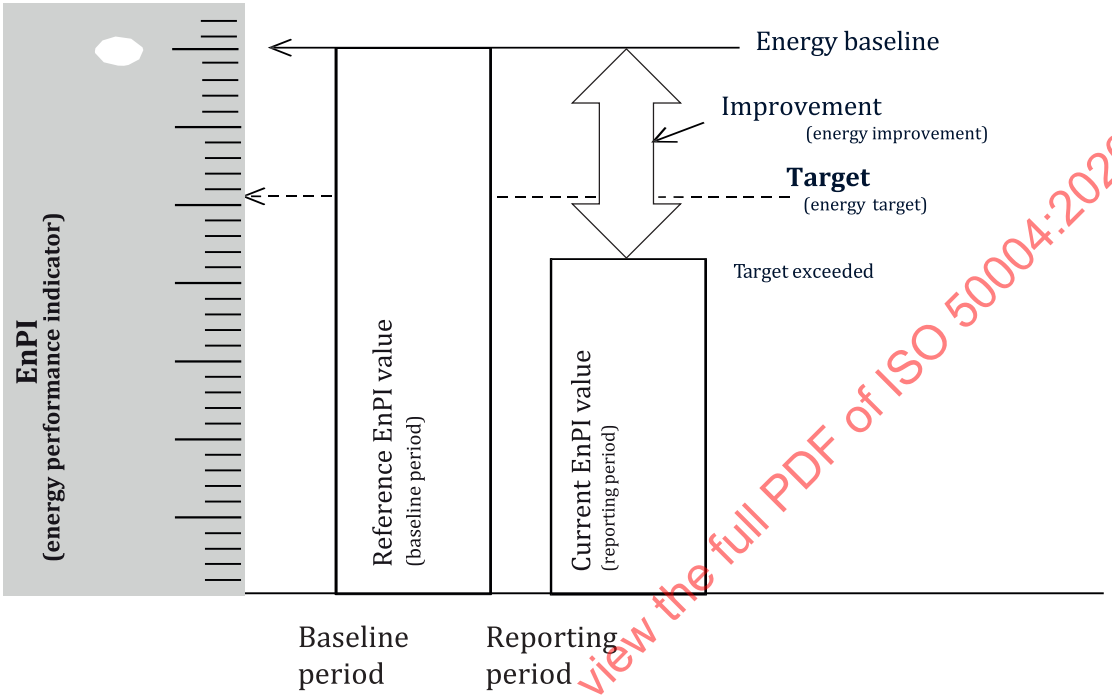

Figure 2 — EnPI and EnPI value

Energy performance can be affected by relevant variables and static factors (see 6.5 for examples). Examples of relevant variables that can affect EnPIs (over the same time period as the energy consumption data) include:

— the weather, including heating and cooling degree days or humidity;

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

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

— building occupancy levels;

— factors of inputs/raw materials (e.g. the use of recycled glass in a glass furnace instead of sand and silica);

— daylight availability and ambient light levels;

— operating hours;

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

— distances travelled for transportation energy;

— vehicle loading and use;

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

These can be due to changing business conditions, such as market demand, sales and profitability. Examples include identifying how to normalize for the effects of changes in relevant variables on energy consumption. Normalization enables EnPI values to be compared to the EnB under equivalent conditions. ISO 50006 provides additional details on the topic of EnPIs and EnBs.

Depending upon the level of monitoring and analysis the organization chooses to conduct, an organization may use one or more EnPIs to assess its progress towards, and success in meeting, its objectives and energy targets. The selection of EnPIs can be influenced by different considerations, including:

— the part of the organization that the EnPI relates to: physical (e.g. individual facility, equipment, process, system) or organizational (business unit, department, function) components;

— the time span that the resulting EnPI values will cover (e.g. hour, day, month, year);

— the data available for the EnPI;

— whether the resulting EnPI value will be used to monitor energy performance and/or determine energy performance improvement.

The EnPIs can be applied at facility, system, process or equipment levels to provide various levels of focus.

EnPIs should enable various groups within an organization to understand the energy performance and energy performance improvement for which they are responsible, inform continual improvement efforts, and take necessary actions. Additionally, whereas one EnPI can be of value to monitor energy performance, a different EnPI could be better suited to demonstrate energy performance improvement.

An EnPI has an appropriate baseline for comparative purposes. ISO 50006 provides detailed guidance on EnPIs and baselines.

In order to measure energy performance improvement, EnPIs must have an energy component. This means that some parameters or simple ratios used to monitor or control energy performance, such as excess oxygen ratios for boilers, are not suitable EnPIs. However, in some cases, engineering-based modelling can be used to determine the change in energy consumption due to such variables. For example, in the case of excess oxygen, the direct energy impact of changes can be simply calculated from the change in the mass of air and the specific heat of the air. There can be other changes that also need to be taken into account.

6.5 Energy baseline

The EnB is a reference that characterizes and is used to quantify an organization's energy performance during a specified time period (see Figure 2). The EnB enables an organization to assess changes in energy performance between the selected time periods. The EnB can be used for the calculation of energy savings, and as a reference before the implementation of energy performance improvement actions. The EnB is the EnPI value associated with the baseline period. The same EnPI must be used for both the baseline and reporting periods in order to determine energy performance improvement.

Since an EnB is used as a reference, an organization needs a baseline for each category of EnPI. The time period of the EnB should cover a full operating cycle, occupancy cycle or season.

NOTE 1 Every EnPI that will be used to demonstrate energy performance improvement needs an EnB, but for other business/operational purposes a baseline is not always needed.

In almost all cases, energy consumption is affected by relevant variables. That means the EnB data should be normalized for relevant variables affecting energy performance using the data from the energy review (see 6.3) and the energy data collection plan (see 6.6). The appropriate normalization approach depends on the nature and scale of the activities being measured. Normalization can be undertaken using statistical (regression analysis) or engineering modelling. Statistical models are generally used where there are few relevant variables that are independent. Engineering modelling may be used where the physics of a process is easily quantified or where energy performance is affected by a large number of variables, especially where some variables, such as temperature and pressure, are

not independent. Engineering modelling could be the only option for normalizing energy performance changes where there are no historical data available to develop a statistical model, such as for new projects.

To establish a baseline, the starting point is to examine trends in energy consumption and relevant variables such as output, and to assess data availability. The data can indicate the most appropriate type of EnPI, such as a linear or nonlinear regression model. Knowledge of the processes that consume energy can also help to establish an EnPI that accurately accounts for changes in relevant variables and accounts for baseload consumption.

The raw data used to normalize and the method used to normalize are retained as documented information. This facilitates the potential changes needed in the EnB when there is a change in boundaries or other static factors.

Changes in operations can occur that warrant modifying or changing the baseline. This can happen when there are changes to the current EnPIs or their corresponding boundaries, or when the EnBs are no longer appropriate and effective in determining energy performance improvement.

The organization needs to modify an EnB when it is no longer appropriate and/or effective in determining energy performance improvement. This could be due to changes in static factors.

EXAMPLE The EnB could need to be updated if a division is sold, a new plant is brought online, a change is made to the product mix, the type of building occupancy changes, the manufacturing square footage is reduced or there is an update to the energy review.

The EnMS may include changes to a baseline based on a predetermined method. These can include:

— update the EnB using a moving EnB or at a defined interval;

— an EnB associated with legal requirements.

NOTE 2 Simple (non-normalized) EnPIs and baselines required by interested parties are not always sufficient for demonstrating energy performance improvement under ISO 50001:2018.

6.6 Planning for collection of energy data

For an EnMS to quantitatively determine energy performance and improvements in energy performance, data related to the key characteristics of its operation affecting energy performance will need to be systematically collected. Data collection can be a challenge in implementing an EnMS. Accordingly, planning for data collection and implementing a system of reliable data acquisition at planned intervals, including agreements to regularly obtain data from within and from outside the organization, is an important task best undertaken during early stages of the implementation of an EnMS.

Even as an organization begins to consider developing and implementing an EnMS, it can record each type of data used and its source. As development of the EnMS proceeds, the data used and the sources can continue to be recorded. This includes data used to determine the SEUs, EnBs, measurement of energy performance and changes in energy performance, EnPIs and other indicators of operational control or performance. Concurrent with the deployment of the EnMS (i.e. its operational data), the data system that supports the EnMS can also be implemented.

Data needed for an EnMS include the following:

— energy consumption related to SEUs and to the organization;

— relevant variables needed to calculate the SEUs, EnPIs or other metrics used by the EnMS;

— operational criteria related to SEUs;

— static factors, if applicable;

— data specified in the EnMS action plans.

What specific data to gather and how it can be gathered can be summarized in an energy data collection plan. The complexity and detail of the energy data collection plan is based on the needs of the organization.

When establishing the energy data collection plan, consideration should be given to the complexity of energy use. For example, a single organization using just one type of energy (e.g. electricity) at a single site can warrant a simple plan compared to a multi-site, multi-energy type organization using energy for multiple purposes. The choice of data to collect and the determination of EnPIs and SEUs may be an iterative process.

The energy data collection plan can include a description of each type of data needed for the EnMS and the data to be retained. The recommended items to be recorded are:

a) what data are measured and why, and how the data are used in the EnMS;

b) how the data are measured (e.g. device or sensor, method, frequency, accuracy, calibration);

c) where the data are stored and how the EnMS can access the data;

d) any processing the data requires, due to missing or unusual values or in order to be usable by the analysis in the EnMS;

e) the personnel responsible for data collection and measurement;

f) the power supply schemes and connection schemes to electric and thermal networks;

g) whether any measurements or parameters are process or safety critical.

An energy management information system is a useful tool that complements an EnMS.

EXAMPLE 1 An EnPI for measuring differences in energy consumption caused by the way different personnel operate a particular facility. It requires measurements to be taken during the different times that the different operators are in control of the facility.

EXAMPLE 2 In the mining industry, daily consumption of diesel by a dump truck is normalized by payload and "equivalent flat haul". This normalizes for the weight of ore carried by the truck and the distance travelled and meters climbed out of the mine pit by the truck. These data items require the recording of the fuel loaded into the truck, the payload and the movement of the truck.

Similarly, measurements can be scheduled to reveal fluctuations in energy consumption due to equipment or production variations, signs of equipment failure or occupancy levels. In justifying the relevance of the measurement frequency in relation to the identified energy use, risk analysis or benefit-cost analysis may be used.

Where operating conditions have changed, the expected energy performance and the energy data collection plan could also need to be changed.

Before analysing the data, the organization should evaluate data quality by checking for missing data and outliers, ensuring that the data are in a feasible range and ensuring that the data for different variables apply to a consistent time period.

In addition, the energy data collection plan can include discussion of future measurement needs. Future data needs can be ways to streamline the collection of current data or the anticipation of future data needs based on known future events, including the implementation of energy performance improvement actions.

7 Support

7.1 Resources

The intent of this subclause is to ensure that top management makes the necessary resources available for the EnMS implementation, consistent with the organization's capabilities. Top management

is responsible for ensuring the availability of resources needed for the EnMS. In order for needed resources to be provided, they should be communicated to top management. This communication may take place as an input to management review, or as part of the organization's annual budgeting and capital planning processes.

In determining the resources that need to be provided, the organization should consider the current capabilities of its internal resources (e.g. people, capability of equipment, organizational knowledge) and any constraints (e.g. budget, number of resources, schedule). A decision should then be made on the resources needed, including those to be sourced externally, and the necessary actions taken to ensure that the resources needed are provided.

Generally, when establishing, implementing and maintaining the EnMS, the organization will use its own internal resources. However, there can be external resources available as well.

7.2 Competence

This subclause provides guidance to ensure that competency requirements for personnel who affect the EnMS and energy performance are defined, and competence is maintained and evaluated. Ensuring competency begins with clearly defining the education, training, skills or experience required for employees and contractors whose work activities affect energy performance and the EnMS.

To determine competency requirements for personnel doing work that affects energy performance and the EnMS, an organization could begin by evaluating job descriptions, position statements and contractor agreements. This process should start by evaluating the competency of those personnel with the greatest impact on energy performance to identify and address any additional competency needs. The results of the energy review and management reviews can assist in the determination of the competency requirements.

It can be the case that not all personnel and contractors affect energy performance and the EnMS in the same way or to the same extent. A good starting point for addressing the competency requirements of ISO 50001:2018 is to focus initially on those who actively contribute to energy performance and meeting the requirements of the EnMS. This can include:

a) top management;

b) the energy management team;

c) persons responsible for major changes affecting energy performance;

d) persons responsible for the effectiveness of the EnMS;

e) persons responsible for developing, implementing or maintaining energy performance improvements, including objectives, energy targets and action plans;

f) persons whose work is related to the SEUs;

g) persons whose work is related to the operation and maintenance of facilities and energy systems;

h) persons whose work is related to the installation and maintenance of the instrumentation and data acquisition systems.

The evaluation of the competency of those personnel with the greatest impact on energy performance is to identify any gaps that need to be addressed, including consideration of the need for outsourced competence, e.g. consultants.

Competence can be maintained or improved through training, mentoring, coaching and career planning. The competency of contractors may be addressed through contractor agreements or terms of service provision. The effectiveness of the actions taken to ensure competence can be evaluated by different methods, e.g. supervisor observation.

Managing competency is supported by the retention of documented information demonstrating that the personnel performing that work have met the applicable competency requirements.

7.3 Awareness

The intent of this subclause is to ensure that relevant persons doing work under the organization's control are aware of the energy policy, relevant objectives and energy targets, their contribution to the effectiveness of the EnMS, improvement in energy performance and the implications of not conforming with EnMS requirements.

Top management has a responsibility in the communication of the importance of energy performance and the EnMS that supports organizational awareness. Awareness is attained when persons understand their responsibilities and authorities, and how their actions contribute to the improvement in energy performance and the improvement of the EnMS. Awareness of personnel assists organizations in fostering and maintaining an energy-conscious culture.

Awareness is typically created through a combination of communication and training. Examples of approaches to promote employee awareness and approaches to achieve awareness among on-site contractors are shown in Table 2.

Table 2 — Approaches to awareness

Approaches to promote employee awareness	Approaches to achieve awareness among site contractors
Bulletins or newsletters	Incorporating objectives and energy targets into contracts
Shift meetings	Environmental, health and safety communications to contractors
Briefings of personnel	Site orientation and induction
Face-to-face or online/virtual trainings	Procurement policies
Internal events and seminars	Visitor brochures
A kick-off meeting/workshops	
Presentation by top management via multi-media formats	
Intranet postings/display boards	
Corporate branding around energy use	
Posters	
Labelling campaigns detailing the energy consumption of equipment, processes and systems	
Incentive programmes and reward schemes	
Employee or team competitions	
New employee orientation	
Electronic messaging	
Social media platforms and applications	
Signage on equipment (e.g. reminding operators to switch off when not in use)	

Personnel need to be aware of how their activities relate to energy use and consumption, and also understand the consequences when their activities deviate from defined processes, operational or maintenance controls, objectives or targets. The effectiveness of the processes that support ongoing energy awareness can be continually improved by a variety of means. The use of updated communication techniques and new awareness materials can help sustain the awareness programme. EnMS awareness training and communications should be maintained and updated over time.

See the ISO/TC 301 website for additional information: https://committee.iso.org/home/tc301.

7.4 Communication

This subclause describes the role of internal and external communication in the development and implementation of EnMS, and provides examples of communication methods. Effective communication within the organization strengthens the commitment of employees to the organization's energy policy and helps to motivate them to contribute to achieving the objectives and energy targets. Communication outside the organization can be driven by mandatory reporting under energy-related legal requirements and other requirements. External communication provides opportunities for the organization to publicize their improvements in energy management and energy performance, which can help in demonstrating sustainability leadership.

The communication process starts with planning internal and external communications related to the EnMS. The organization defines the topics to be communicated, the frequency of the communication, the target audience, how the communication will be delivered and who is communicating. It can be helpful to use the interested parties' information developed in ISO 50001:2018, 4.2, as a starting point for identifying the target audience(s) for both internal and external EnMS communications.

It is recommended that internal communication provide information on energy performance improvement and the performance of the EnMS. Other topics for consideration may include:

a) the financial benefits achieved;

b) progress on achieving the objectives, energy targets and energy management action plans;

c) other benefits of energy performance improvements, such as improved product quality, productivity, competitiveness or environmental performance;

d) initiatives to further energy performance;

e) contact points for information;

f) feedback from management review;

g) energy policy.

Communication is a multi-directional activity. Employees, contractors or those working on behalf of the organization should be encouraged to contribute ideas and propose actions to improve energy performance and the EnMS. Incentives and other rewards for these ideas and actions that are implemented can help stimulate interest and participation in the suggestion process.

There are many reasons why an organization decides to communicate externally about its energy performance or its EnMS. For example, it can be to:

— meet legal requirements or other requirements;

— communicate with customers and suppliers;

— satisfy investors, shareholders and financiers;

— demonstrate leadership in energy performance and energy management.

It is convenient to identify who within the organization is authorized to receive and respond to the EnMS and energy-related communication requests. This can involve integrating this information into the organization's existing media or other communications policy. Examples of external communication methods can include:

— statements of certification to ISO 50001;

— the EnMS policy or portions of it;

— commitments to the energy policy or to energy savings, improvements in energy efficiency or energy conservation;

— energy stewardship statements or commitments;

— awards received from various bodies, customers or agencies;

— cost improvements/profitability;

— objectives and energy targets, and progress made towards them;

— energy performance improvements;

— emissions data related to energy performance improvement;

— sustainability reports.

7.5 Documented information

7.5.1 General

The intent of this subclause is to ensure that the organization controls the documented information needed for conformity to ISO 50001:2018, as well as the documented information that it has determined is needed for the effectiveness of its EnMS (see ISO 50001:2018, 7.5.1).

ISO 50001 does not require the organization to maintain documented information on the core processes of the EnMS and their interaction. However, if the organization wishes to do so, common approaches can include the preparation and use of an energy manual, a graphical representation of the PDCA cycle that maps the organization's EnMS processes, or a matrix or hierarchy that identifies specific documentation relevant to each of the core elements of the EnMS.

It is strongly recommended to keep the documented information simple so that it is easy to understand and maintain.

The organization determines the documented information of external origin needed for EnMS planning and control.

Documented information originally created for purposes other than the EnMS may be used.

The documented information required by ISO 50001:2018 to be maintained includes:

— scope and boundaries of the management system;

— energy policy;

— methods and criteria for the energy review;

— methods for determining and updating the EnPIs;

— documented information of external origin necessary for the planning and operation of the EnMS.

The documented information required by ISO 50001:2018 to be retained includes:

— evidence of competence;

— objectives and energy targets;

— action plans;

— results of energy reviews;

— EnBs;

— relevant variable data;

— energy consumption;

— documented information necessary to have confidence that the processes have been carried out as planned;

— relevant variables for SEUs;

— energy consumption related to SEUs and to the organization;

— operational criteria related to SEUs;

— static factors, if applicable;

— data specified in action plans;

— modification to EnBs;

— documented information determined by the organization as being necessary for the effectiveness of the EnMS and to demonstrate energy performance improvement necessary to have confidence that the processes have been carried out as planned;

— monitoring and measuring and other means of establishing accuracy and repeatability;

— design activities related to energy performance;

— results of investigation and response to significant deviations in energy performance;

— results of monitoring and measurement;

— results of the evaluation of compliance and actions taken;

— evidence of internal audit programme implementation;

— internal audit results;

— management review results;

— results of top management meetings regarding the EnMS;

— nature of nonconformities and actions taken;

— corrective action results.

The organization determines other documents to be maintained or retained that are necessary for their EnMS.

7.5.2 Creating and updating

The intent of this subclause is to ensure that, when the organization creates and updates documented information, the appropriate identification, format and media are used, and it is reviewed and approved. The organization should use its established process for the review and approval of its documented information, e.g. having an identified person with the authority to approve the documented information.

The identification, format and media used for documented information are the choice of the organization implementing the EnMS; it is not required to be in the form of a textual format or a paper manual. Documented information should include an identification and description. There are many methods for this, such as defining a title, date, author or reference number (or a combination of two or more of these methods), that an organization can use to determine information and its status.

7.5.3 Control of documented information

The intent of this subclause is to ensure that documented information is available in a suitable medium whenever needed, and that it is adequately protected.

Having decided on what documented information is needed for the EnMS, the organization should ensure that it is available for relevant areas, departments and personnel. The documented information should also be in a form that is suitable for intended use. Information can be in an electronic format that can be downloaded or posted, for example, the temperatures for the proper operation of a boiler.

Where appropriate, the organization may use an existing process for document control.

Correct identification of the EnMS documents is crucial to ensure that the most up-to-date documents are in use, that they can be easily located and that obsolete documents are removed from the points of use.

Having established a process for controlling distribution and access to documented information, the organization should then consider how it is stored, maintained and disposed of as necessary over time.

When documented information is retained as evidence of conformity, it should be protected from unintended alterations. It is recommended that an organization allow only controlled access to such information, e.g. authorized access for relevant persons working on behalf of the organization or restricted electronic access such as "read only", as appropriate.

Documents of external origin are those generated outside of the organization. They cannot be changed or updated by the organization but can be needed for effective planning and control of the EnMS. For example, ISO 50001:2018 is an external document.

Examples of external documents include:

— laws, ordinances and regulations;

— building codes;

— voluntary codes of practice;

— industry or other standards;

— utility rate and tariff schedules;

— protocols, such as measurement and verification, GHG emissions or sustainability reporting.

8 Operation

8.1 Operational planning and control

Operational planning and control help to ensure that SEUs and related equipment and systems are operated and maintained effectively. It also provides the means for operational personnel to identify and report problems with equipment operation, such as faulty valves or meters. As part of continual improvement, operational and maintenance controls can be extended to other energy uses beyond the designated SEUs. Energy cost savings provide a financial incentive to address these problems where they do not affect production or reliability.

Effective operational control and associated training of relevant personnel often provide considerable energy performance improvement opportunities, typically at low cost. In some cases, it is possible to reduce variability in energy performance caused by human factors through technical improvements such as automated switching, control system automation or engine speed limiters for vehicles. It is also important to update or modify operator training in response to changes in operational and maintenance controls.

When implementing the requirements of ISO 50001:2018, 8.1, it is important to start by identifying the existing operational and maintenance controls for facilities, equipment, systems or processes associated with the SEUs. Examples of operational controls can include but are not limited to:

— documented procedures;

— operating instructions;

— critical operating parameters;

— physical devices (e.g. flow control valves, automation systems, programmable logic controllers);

— set points and set point adjustments;

— maintenance procedure;

— licensed personnel;

— design or other specifications;

— monitoring techniques, such as control charts;

— maintenance criteria plan (e.g. analysis on whether to rewind a damaged motor or buy a new one);

— any combination of the above.

These could only need to be updated with energy specifics. This provides an opportunity to leverage what is already in place and to ensure that there are criteria for effective operation and maintenance, that the criteria are implemented and communicated to relevant personnel, and that appropriate documented information is kept.

Maintenance is an important and often cost-effective element of operational control. Examples of maintenance techniques that can be operational controls include but are not limited to:

— preventive maintenance;

— predictive maintenance, such as thermal monitoring or vibration analysis;

— reliability centred maintenance (requiring equipment-specific maintenance routines);

— overall equipment effectiveness;

— total productive maintenance;

— other principles, such as “right first time” (i.e. aiming to ensure that the desired outcome is achieved at the first attempt);

— a breakdown contingency plan;

— maintenance work orders;

— a preventive maintenance programme;

— set points in control systems;

— standard work or operating procedures;

— operational manuals;

— visual factory controls.

When planned changes are to be introduced in operations, the organization ensures that those changes are carried out in a controlled manner, with minimum impact on other operations. On the other hand, for unplanned events, the organization mitigates any adverse effect, via, for example, developing contingency plans.

When outsourcing a process, the organization controls any relevant SEU, i.e. even if the process is carried out by another organization, its energy performance remains the responsibility of the organization.

8.2 Design

Identifying opportunities for the improvement of energy performance at the earliest stages of design and throughout the entire design process typically yields the most effective and least costly results for a given design. Consideration of energy performance in the design is about improving energy performance by taking advantage of improvements in engineering, metering, instrumentation, operating techniques and technology at the earliest stage possible. This enables the organization to obtain energy performance improvements while modernizing equipment and business processes, improving productivity and business competitiveness.

Identifying opportunities early can avoid frequent barriers to appropriate energy performance, such as oversized equipment, over-specified systems and the use of lower cost but inefficient technology.

Examples of failures to consider energy performance in the design process include the following:

— decisions are made prior to the consideration of energy performance;

— buying less efficient equipment by not considering the total life cycle cost of equipment, including small or auxiliary equipment;

— specifying new equipment rather than optimizing the performance of existing equipment of equivalent energy efficiency;

— continued use of existing equipment in systems and processes when a more efficient alternative could be more appropriate and aligned with the organization's objectives;

— oversizing of systems, e.g. pumping systems, compressed air systems, motors, exhaust systems, fan systems;

— lack of coordination across the design team professions, e.g. architectural design resulting in inefficient mechanical systems;

— lack of consideration of innovative approaches, e.g. natural ventilation, daylight harvesting, heat recovery;

— not spending sufficient time considering energy efficiency in the detailed design;

— design that does not account for energy performance with fluctuating or varying loads;

— use of general solutions rather than solutions designed to meet system needs;

— lack of integration of automated control systems to maximize energy performance;

— lack of attention to small or auxiliary systems, such as pumps and piping, as compared to larger systems, e.g. boilers, process chillers.

The opportunity to overcome these barriers narrows as the design progresses. The design process should seek to optimize energy performance by evaluating a range of options that minimize energy consumption and meet system needs. Measurement of energy consumption and process variables should be considered during the design process to provide optimal monitoring of energy performance during the life of the operations. Typically, the cost of installing appropriate metering after construction is significantly more than the cost of incorporating it at the design stage.

When designing new, modified or renovated facilities, equipment, systems and processes, that have or could have a significant impact on energy performance, the organization should consider energy-efficient techniques, practices including consideration of energy recovery opportunities and emerging technology trends. This promotes greater awareness of design options and can move the organization towards more innovative and energy-efficient designs and use of energy types. Projects with the potential to significantly impact energy performance need to be managed from an energy perspective. Design should consider the management of the risks and opportunities associated with using emerging technologies. The design process should provide a framework for projects to deliver the most energy-