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Energy management systems — Evaluating energy performance using energy performance indicators and energy baselines

Systèmes de management de l'énergie — Évaluation de la performance énergétique à l'aide d'indicateurs de performance énergétique et de situations énergétiques de référence

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Foreword

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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 document 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).

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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 50006:2014), which has been technically revised.

The main changes are as follows:

— concepts and technical aspects have been harmonized with the latest edition of ISO 50001:2018;

— definitions in Clause 3 have been updated in accordance with the latest edition of ISO 50001:2018 and considering a new approach for general harmonization under ISO/TC 301;

— upgrades have been made related to the normalization of energy performance indicators (EnPIs) and corresponding energy baselines (EnBs);

— upgrades and new considerations have been made related to the new definition and requirement to demonstrate energy performance improvement.

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

0.1 Background

Energy performance evaluation is a tool which applies to all types of organizations and can be used to evaluate the results of its efforts in energy management. Relevant variables affect the energy consumption and energy efficiency of organizations. To effectively evaluate energy performance under equivalent conditions, the effects of relevant variables should be taken into account by using the process of normalization.

Measuring and monitoring of energy performance and demonstration of energy performance improvement can be challenging because of the complexity of determining energy performance indicators (EnPIs) and corresponding energy baselines (EnBs) which are appropriate for an organization to better understand the energy consumed within the facilities, equipment, systems or energy-using processes.

Improving energy performance helps organizations to become more competitive by reducing their energy costs. In addition, improving energy performance can help organizations to reduce their energy-related greenhouse gas emissions. Climate change and the need for decarbonization are major global concerns. Reducing greenhouse gas emissions associated with energy consumption is a significant tool in tackling climate change. Methods for monitoring and measuring energy performance to ensure appropriate results are key aspects of this activity.

In those activities or processes in which no energy performance improvement has been planned, benefits can also be obtained by using EnPIs and EnBs to manage operational control, identify maintenance needs or identify significant deviations in energy performance.

Communicating the energy performance of the organization and its processes to appropriate person(s) in the organization is a key element for success. It is also a key to building ongoing commitment and engagement of top management to allocate resources for energy management including the effective establishment of EnPIs and EnBs.

The technical information in this document enables an organization to meet the requirements of ISO 50001 including using normalization in measuring, monitoring, analysing and evaluating its energy performance and energy performance improvement. In this way, it can demonstrate continual improvement in energy performance using EnPIs and corresponding EnBs.

0.2 Overview of contents

This document provides an organization with practical guidance related to managing energy performance, including its evaluation, control and continual improvement through the establishment, use and maintenance of EnPIs and the corresponding EnBs.

This document gives guidance on the selection of appropriate EnPIs according to the objectives of the organizations which can achieve significant benefits by implementing them.

This document is intended to guide an organization in establishing, using and maintaining EnPIs and EnBs in accordance with the requirements in ISO 50001.

The process described in this document can provide benefits to any organization, including those that do not have an EnMS. Nevertheless, additional benefits can be obtained if this process is embedded within an EnMS in accordance with ISO 50001.

Energy management systems — Evaluating energy performance using energy performance indicators and energy baselines

1 Scope

This document gives guidance on how to establish, use and maintain energy performance indicators (EnPIs) and energy baselines (EnBs) to evaluate energy performance in any organization including those using ISO 50001. Additional guidance is given on how to measure and monitor energy performance and demonstrate energy performance improvement.

This document is applicable to any organization, regardless of its type, size, complexity, geographical location, organizational culture, the products and services it provides or its level of maturity in the field of energy management.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1.1
baseline period
period of time used for comparison with *reporting period* (3.1.16)

Note 1 to entry: The purpose of the comparison can be monitoring of performance, evaluation of performance improvement or determination of energy savings.

3.1.2
boundary
physical, virtual and/or organizational limits as defined by the entity for a stated purpose

Note 1 to entry: The entity may be an *organization* (3.1.14), group of organizations, region(s), subset of an organization or other depending on the application.

Note 2 to entry: Physical can be equipment, systems, a building, a process, a group of processes, a site, or multiple sites, under the control of an organization.

3.1.3
energy
electricity, fuels, steam, heat, compressed air and other similar media

Note 1 to entry: For the purposes of this document, energy refers to the various types of energy, including renewable, which can be purchased, stored, treated, used in equipment or in a process, or recovered.

[SOURCE: ISO 50001:2018, 3.5.1]

3.1.4
energy baseline
EnB
value providing a basis for comparison of *energy performance* (3.1.9)

Note 1 to entry: The data and method used to determine the EnB shall be retained as documented information.

Note 2 to entry: If the process for determination of the EnB uses *relevant variables* (3.1.15) for *normalization* (3.1.13) or if the EnB is adjusted for changes in *static factors* (3.1.18), the information shall be retained as documented information.

3.1.5
energy consumption
quantity of *energy* (3.1.3) applied

Note 1 to entry: Energy consumption can be represented in volume (e.g. litres of fuel), mass, weight units or energy units (e.g. GJ, kWh).

[SOURCE: ISO 50001:2018, 3.5.2, modified — Note 1 to entry added.]

3.1.6
energy efficiency
ratio or other quantitative relationship between an output of process and an input of *energy* (3.1.3)

EXAMPLE Conversion efficiency, energy required/energy used, output/input, theoretical energy used to operate/energy used to operate.

Note 1 to entry: The output of a process can be products, services, or energy.

Note 2 to entry: Both input and output should be clearly specified in terms of quantity and quality, and should be measurable.

3.1.7
energy use
energy end-use
application of *energy* (3.1.3)

EXAMPLE Ventilation, lighting, heating, cooling, transportation, processes, data storage.

Note 1 to entry: Energy use is based on “what the energy is used for” as compared to *energy consumption* (3.1.5) which is based on “how much energy is used”.

Note 2 to entry: This application can be from any energy type including renewables.

3.1.8
energy model
mathematical representation based on a data set describing the relationship between *relevant variables* (3.1.15) and *energy consumption* (3.1.5) or *energy efficiency* (3.1.6) over a specified period of time

Note 1 to entry: The specified period of time can represent different perspectives of time such as *baseline period* (3.1.1), *reporting period* (3.1.16), or period that reflects standard conditions.

3.1.9
energy performance
measurable result(s) related to *energy efficiency* (3.1.6), *energy use* (3.1.7) and *energy consumption* (3.1.5)

3.1.10
energy performance indicator
EnPI
measure used to quantify *energy performance* (3.1.9)

Note 1 to entry: If the EnPI is used for the demonstration of *energy performance improvement* (3.1.11) it refers to *energy efficiency* (3.1.6) or *energy consumption* (3.1.5).

Note 2 to entry: The EnPI is defined by the *organization* (3.1.14).

Note 3 to entry: EnPI(s) can be calculated by using an *energy model* (3.1.8).

3.1.11
energy performance improvement
improvement in measurable results of *energy efficiency* (3.1.6) or *energy consumption* (3.1.5) related to *energy use* (3.1.7), compared to the *energy baseline* (3.1.4)

3.1.12
energy target
quantifiable objective of *energy performance improvement* (3.1.11)

Note 1 to entry: An energy target can be included within an objective.

[SOURCE: ISO 50001:2018, 3.4.15]

3.1.13
normalization
process to enable analysis under equivalent or standard conditions

Note 1 to entry: Normalization can be used for the purpose of comparison of *energy performance* (3.1.9) or *energy performance improvement* (3.1.11), which accounts for the changes in *relevant variables* (3.1.15).

3.1.14
organization
person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

Note 1 to entry: The concept of organization includes, but is not limited to, sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

3.1.15
relevant variable
quantifiable factor that significantly impacts *energy performance* (3.1.9) and routinely changes

Note 1 to entry: Significance criteria are determined by the *organization* (3.1.14).

Note 2 to entry: In a statistical approach, relevant variables are identified from independent variables by using significance criteria.

EXAMPLE Weather conditions, operating conditions (indoor temperature, light level), working hours, production output.

3.1.16
reporting period
defined period of time selected for evaluating *energy performance* (3.1.9) and *energy performance improvement* (3.1.11)

Note 1 to entry: In this document, the concept of reporting period includes the concept of monitoring period.

3.1.17
significant energy use
SEU
energy use (3.1.7) accounting for substantial *energy consumption* (3.1.5) and/or offering considerable potential for *energy performance improvement* (3.1.11)

Note 1 to entry: Significance criteria are determined by the *organization* (3.1.14).

Note 2 to entry: SEUs can be related to facilities, systems, processes or equipment.

[SOURCE: ISO 50001:2018, 3.5.6]

3.1.18
static factor
identified factor that significantly impacts *energy performance* (3.1.9) and does not routinely change

Note 1 to entry: Significance criteria are determined by the organization.

EXAMPLE Facility size, design of installed equipment, number of weekly shifts, range of products.

[SOURCE: ISO 50001:2018, 3.4.8]

3.2 Abbreviated terms

CDD cooling degree day

CUSUM cumulative sum

EnB energy baseline

EnMS energy management system

EnPI energy performance indicator

HDD heating degree day

SEC specific energy consumption

SEU significant energy use

4 Overview of EnPIs, EnBs and energy performance

An organization establishes EnPIs and EnBs to measure and monitor energy performance and demonstrate energy performance improvement.

EnPIs provide relevant energy performance information to interested parties (e.g. internal users, supply chain), to understand energy performance and take actions to control and improve energy performance.

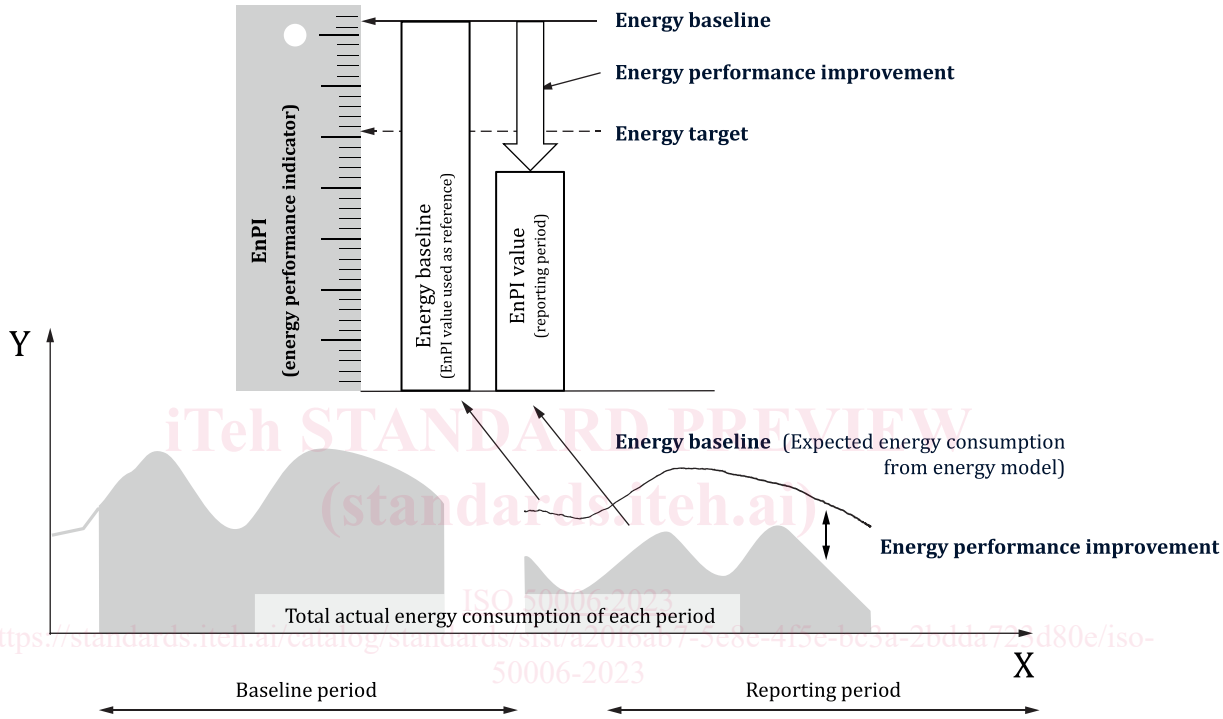
EnPI values quantify the energy performance of the entire organization or its various parts (e.g. facilities, equipment, systems or energy using processes). Potential EnPIs need to be analysed to decide if they are appropriate before being selected. EnPIs can be expressed by using an energy model and can be reported in units of energy consumption (e.g. GJ, kWh) or energy efficiency (e.g. km/l).

Energy consumption of an organization can be significantly affected by relevant variables such as weather, production, etc. If the organization has data which indicates that relevant variables significantly affect energy performance, normalization should be carried out to enable comparison of energy performance. Normalization is used to account for the changes in the relevant variables to monitor and evaluate energy performance, and evaluate and demonstrate energy performance improvement.

Energy targets are set by the organization and may be based on identified and planned energy performance improvement opportunities.

Figure 1 illustrates an example of the relationship between energy performance improvement, EnPIs, EnBs, EnPI values and energy targets. Figure 1 also illustrates how energy performance improvement is achieved when an EnPI value improves compared with the EnB, whether or not energy targets are met.

The process to develop, use and update EnPIs and EnBs is described in detail in Clauses 5 to 10. This process helps the organization to monitor and evaluate energy performance and demonstrate energy performance improvement. The processes within the EnPI and EnB planning are presented in Annex A.



Key

X time

Y energy consumption

NOTE The trend of changing energy consumption indicates that there is (are) relevant variable(s) and normalization is required.

Figure 1 — Example of conceptual relationship between energy performance, EnPIs, EnBs, EnPI values and energy targets

5 Obtaining relevant energy performance information

5.1 Initial-energy-performance-related information

Organizations should identify current types of energy uses and evaluate current and past energy consumption and energy efficiency based on measurement and other data. Significant energy uses (SEUs) are identified by analysing this information together with factors that affect energy performance.

This process helps to identify the SEUs and prioritize opportunities for energy performance improvement.

NOTE This process is defined in ISO 50001:2018, 6.3 as “energy review”.

5.2 Determining users of energy performance indicators

EnPIs should be developed to meet the needs and expectations of different users and should be easily understandable.

Multiple EnPIs can be required to meet user needs. Aligning the EnPI boundaries with functional roles can ensure that the EnPIs meet user needs and that responsibility for managing the EnPI can be effectively assigned.

EnPIs can be developed for internal or external users. Internal users can use EnPIs for a wide variety of purposes such as, but not limited to, maintenance, operation and energy performance evaluation. External users typically use EnPIs to meet information requirements derived from legal requirements and other requirements (e.g. sustainability reports).

NOTE EnPIs and EnBs required for external purposes, such as those for government reporting, are not always sufficient for managing energy performance improvement under ISO 50001 or for organizations wishing to understand their actual energy performance improvement.

Table 1 describes some common EnPI users.

Table 1 — EnPI users

Types of EnPI users	Typical needs
Top management	Top management needs information from EnPIs to understand the energy performance of the organization and to support energy performance improvement actions.
Energy management team	Group who supports the organization, including top management in: a) setting up an EnPI, b) maintaining an EnPI, c) monitoring EnBs, current EnPI values, values of all relevant variables in predetermined intervals, d) setting energy targets and calculating extent of achievement of energy target, e) conducting normalization and comparison of current EnPI values with EnBs and energy target, f) reporting of EnPI values and deviations, and g) interpreting the results.
Plant or facility management	Typically controls resources within the plant or facility and is responsible for results. The plant or facility manager should understand both planned energy performance and investigate and respond to significant deviations in energy performance and in financial terms. Plant or facility managers may use all of the EnPIs in their plant or facility including the EnPIs regarding their SEUs, and comparable EnPIs from other sites for benchmarking purposes.
Operation and maintenance personnel	Responsible for using EnPIs to control and ensure efficient operation by taking actions for significant deviations in energy performance, eliminating energy waste and undertaking preventive maintenance. Operation and maintenance personnel may use the EnPIs relevant to the process or equipment for which they have responsibility.
Engineers	Plan, execute and evaluate an energy performance improvement action using suitable EnPIs including the method(s) used to evaluate energy performance improvement.
External users	External users such as regulatory bodies, professional and sector associations, EnMS auditors, customers or other organizations can need information from EnPIs to feed into their relevant processes.
EnPI owner	Person who is responsible for monitoring, analysing and reporting an EnPI and its values.

5.3 Defining the energy performance indicator boundaries

To measure energy performance, suitable measurement boundaries for each EnPI should be specified. When specifying an EnPI boundary the organization should consider the user needs (see 5.2) and also:

— organizational responsibilities in relation to energy management, including the level of control and/or influence which the organization has over its energy performance;

— the SEUs;

— facilities, equipment, systems or energy-using processes that the organization wishes to isolate and manage;

— the ease of isolating the EnPI boundary by measuring energy consumption and relevant variables;

— the EnMS boundary;

— available data for energy consumption and relevant variables.

The three primary EnPI boundary levels are individual, system and organizational as described in Table 2.

Additional information on EnPI boundaries can be found in Annex B.

Table 2 — The three EnPI boundary levels

EnPI boundary levels	Description and examples
Individual (facility/equipment/ energy-using process)	The EnPI boundary can be defined around the physical perimeter of a facility, equipment or energy-using process which the organization wishes to isolate and manage. EXAMPLE 1 The energy use of steam production equipment separate from other energy uses.
System	The EnPI boundary can be defined around the physical perimeter of a group of facilities/equipment/energy-using processes interacting with each other that the organization wants to control and improve. EXAMPLE 2 The steam production and the steam using equipment, such as a dryer.
Organizational	The EnPI boundary can be defined around the organization also taking into account the responsibility in energy management of individuals, teams, groups or business units as designated by the organization. EXAMPLE 3 Steam purchased for a factory(ies), or a department of the organization.

5.4 Defining and quantifying energy flows

The organization should identify energy flows across the boundary. The organization can use a diagram (e.g. see Figure 2) to determine the energy information required to establish EnPIs. The diagram shows energy flows within and across the EnPI boundaries. They can also include additional information, such as metering points and product flows which are important for energy analysis and establishment of EnPIs.

The organization should measure energy flows across each EnPI boundary. This includes delivered and on-site generated energy. Consideration should be given to energy which crosses the EnPI boundary and is stored.