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General methods for predicting energy savings

Méthodes générales d'estimation des économies d'énergie

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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 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).

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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*.

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 specifies general methods for the calculation of predicted energy savings (PrES). It also provides a process that should result in PrES satisfactory for the relevant stakeholders. It is meant to be used after the opportunities for energy performance improvements have been identified, but prior to the implementation of energy performance improvement actions (EPIAs). It is, therefore, meant to be used when selecting or specifying the EPIAs or the action plan, programme or policy to be subsequently implemented, as represented in Figure 1.

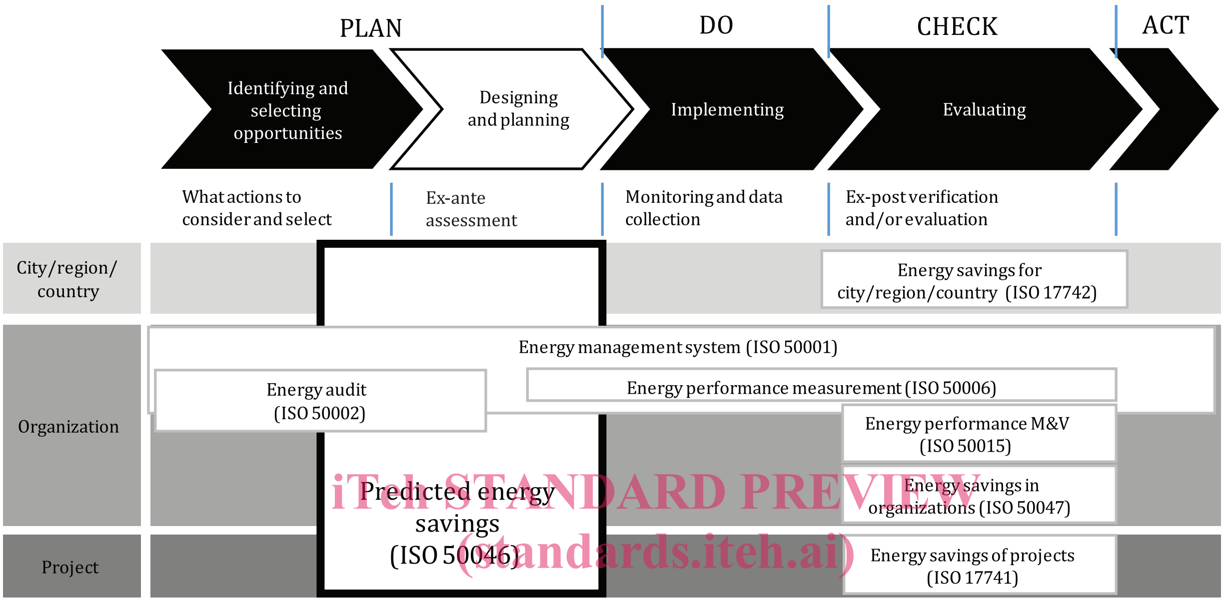

Figure 1 — The place of this document in a continual improvement process

The calculation of PrES can be undertaken on its own, or as part of a more comprehensive evaluation cycle. In the latter case, complementary guidance can be found in other documents, as illustrated in Figure 1.

This document builds on the general principles outlined in ISO 17743, which provides a methodological framework applicable to the calculation of and reporting on energy savings.

ISO 17742 deals with energy savings at the level of countries, regions or cities, distinguishing indicator-based and measure-based calculation methods.

ISO 50047 deals with energy savings in organizations. It uses an organization-based approach (a form of top-down approach), and an EPIA-based approach (sometimes referred to as being a “bottom-up” approach).

ISO 17741 deals with general technical rules for the measurement, calculation and verification of energy savings of projects.

This document uses the distinction between measure-based methods and indicator-based (or total-consumption-based) methods. Instead of distinguishing between the scopes of geographical entities, operational entities and physical systems, it makes a distinction between the levels of aggregation of energy savings: either unit level (action or project) or aggregated level (action plan, programme or policy).

This document provides a process for increasing the transparency of data and calculations used to predict energy savings. Examples of the use of PrES include:

— for selecting among energy savings opportunities;

— for investment decisions;

— for accounting or crediting energy savings (e.g. energy savings certificates[14]).

It provides methods that can be used, for example, in the context of energy audits, energy savings obligations, energy efficiency portfolio standards[14], voluntary agreements or energy performance contracting.

Irrespective of the methods chosen, validation and documentation of the calculation of PrES add value by increasing their credibility and reliability.

Following a bottom-up approach (measure-based methods, see ISO 17742), this document starts with the calculation of the PrES at the level of an EPIA or a group of EPIAs to be jointly implemented at the same site or by the same organization or energy end-user. These unitary PrES might then be aggregated to calculate the PrES of an action plan, programme or policy under consideration, taking into account causality issues wherever applicable.

For the calculation of the PrES of an EPIA, this document presents three different methods, classified as empirical estimation, statistical modelling and engineering modelling. These methods can be applied to different types of situations. The two general situations considered are (see 4.2):

— when users want to determine PrES according to the specific context in which the EPIA will be implemented;

— when users want to determine reference values of PrES for given types of EPIA.

Clause 4 of this document explains the objectives, context and principles of calculation of PrES. Clause 5 describes the preparation of the calculation process (preliminary step). Clause 6 describes the calculation process at the level of an EPIA. Clause 7 describes the additional steps needed for aggregating the PrES of an action plan, policy or programme. Clause 8 provides guidance on quality and uncertainty analysis. Clauses 4, 5, 6 and 8 are common to both aggregation levels (EPIA level and aggregated level).

General methods for predicting energy savings

1 Scope

This document specifies general methods for the calculation of predicted energy savings (PrES), using measure-based calculation methods, also known as bottom-up or energy performance improvement actions (EPIAs)-based methods (see ISO 17742). Indicator-based methods (see ISO 17742) and total-consumption-based methods (see ISO 50047) are not included in the scope of this document.

This document provides general principles for categorizing and choosing the method, taking account of the context, targeted accuracy and resources available for calculating the PrES. It also provides guidance on the conditions for ensuring the quality of the PrES, their documentation and validation.

It is applicable to calculation of PrES for any:

— type of EPIA;

— end-use sector;

— energy end-use;

— level of aggregation of energy savings;

— stakeholder.

NOTE 1 Stakeholders can include private or public organizations, energy auditors, energy services companies, energy and equipment suppliers, policy makers, etc.

This document considers PrES from:

— an EPIA; and/or

— an action plan, programme or policy (aggregated energy savings).

NOTE 2 An action plan, programme or policy can be implemented at different scales (organization, city, region, country).

This document describes how to calculate PrES over a prediction period. It can be used to calculate PrES in terms of primary energy or final (or delivered) energy (as defined in ISO 50047 and ISO/IEC 13273-1).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
baseline period
defined period of time used to compare *energy performance* (3.10) with the *prediction period (*3.19)

[SOURCE: ISO 50006:2014, 3.2, modified — "prediction period" has replaced "reporting period".]

3.2
boundary
physical or virtual limit around *energy using systems* (3.15) or facilities which are related to (an) *EPIA(s)* (3.11)

[SOURCE: ISO 17741:2016, 3.2, modified — Notes 1 and 2 to entry have been removed.]

3.3
context-specific data
data relating to a specific situation

EXAMPLE Electricity consumption for lighting in a particular office building, number of cars manufactured on a particular production line.

Note 1 to entry: *Reference data* (3.21) can be used when context-specific data are not available

3.4
empirical estimation
calculation method based on empirical expertise, experiments, tests or previous analyses

Note 1 to entry: Empirical expertise and experiments can be based on expert knowledge and practical experience using measurements and/or information from similar previously implemented *EPIAs* (3.11), previous benchmarking studies, manufacturers' data, and/or proven references (e.g. scientific literature).

3.5
energy
electricity, fuels, steam, heat, compressed air and other similar media

[SOURCE: ISO 50001:2018, 3.5.1, modified — Note 1 to entry has been removed.]

3.6
energy baseline
EnB
quantitative reference(s) providing a basis for comparison of *energy performance* (3.10)

Note 1 to entry: An EnB is based on data from a specified period of time and/or conditions, as defined by the organization, city, region or country.

Note 2 to entry: An EnB can be normalized using variables that affect *energy use* (3.14) and/or consumption, e.g. production level, degree days (outdoor temperature), etc.

[SOURCE: ISO 50001:2018, 3.4.7, modified — "city, region or country" has been added at the end of Note 1 to entry; Notes 2, 3 and 4 to entry have been removed; a new Note 2 to entry has been added.]

3.7
energy consumption
quantity of *energy* (3.5) applied

[SOURCE: ISO 50001:2018, 3.5.2]

3.8
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods, commodities or energy, and an input of *energy* (3.5)

EXAMPLE Conversion efficiency, energy required/energy consumed.

Note 1 to entry: Both input and output should be clearly specified in terms of quantity and quality and be measurable.

[SOURCE: ISO 50001:2018, 3.5.3]

3.9
energy end-user
individual or a group of individuals or organization with responsibility for operating an *energy using system* (3.15)

Note 1 to entry: The energy end-user may differ from the customer who might purchase the *energy* (3.5) but does not necessarily use it.

[SOURCE: ISO 17743:2016, 3.5]

3.10
energy performance
measurable result(s) related to *energy efficiency* (3.8), *energy use* (3.14) and *energy consumption* (3.7)

[SOURCE: ISO 50001:2018, 3.4.3, modified — Notes 1 and 2 to entry have been removed.]

3.11
energy performance improvement action
EPIA
action or measure or group of actions or group of measures implemented or planned intended to achieve *energy performance* (3.10) improvement through technological, managerial or operational, behavioural, economic, or other changes

Note 1 to entry: In other documents (e.g. ISO 17742), "elementary unit of action" is used instead of EPIA.

Note 2 to entry: EPIAs can have other purposes than saving *energy* (3.5), for example, to reduce peak loads.

Note 3 to entry: EPIAs can be tailored (relating to a specific situation) or pre-specified (relating to a general context).

[SOURCE: ISO 50015:2014, 3.5, modified — "within an organization" has been deleted from the definition; Notes 1, 2 and 3 to entry have been added.]

3.12
energy performance indicator
EnPI
measure or unit of *energy performance* (3.10)

Note 1 to entry: EnPIs can be expressed by using a simple metric, ratio or a model, depending on the nature of the activities being measured.

Note 2 to entry: For additional information on EnPIs, see ISO 50006.

[SOURCE: ISO 50001:2018, 3.4.4, modified — "as defined by the organization" has been deleted from the definition.]

3.13
energy savings
reduction of *energy consumption* (3.7) compared to an *EnB* (3.6)

Note 1 to entry: Energy savings can be actual (realized) or expected (predicted).

[SOURCE: ISO 17743:2016, 3.8, modified — Note 2 to entry has been deleted.]

3.14
energy use
application of *energy* (3.5)

EXAMPLE Ventilation, lighting, heating, cooling, transportation, data storage, production process.

Note 1 to entry: Energy use is sometimes referred to as “energy end-use”.

[SOURCE: ISO 50001:2018, 3.5.4]

3.15
energy using system
physical items with defined system *boundaries* (3.2), using *energy* (3.5)

EXAMPLE Facility, building, part of a building, machine, equipment, product, etc.

[SOURCE: ISO/IEC 13273-1:2015, 3.1.9]

3.16
measure-based method
determination of *energy savings* (3.13) from *EPIA(s)* (3.11)

Note 1 to entry: When calculating aggregated *PrES* (3.18) (for cities/regions/countries), the process starts with calculating *unitary PrES* (3.22) at the EPIA level.

[SOURCE: ISO 17742:2015, 2.29, modified — “energy performance improvement action(s)” has replaced “end-user actions using unitary energy savings and elementary units of action”; Note 1 to entry has been replaced; the example has been removed.]

3.17
operating conditions
description of the conditions under which *energy using systems* (3.15) are operated

EXAMPLE Temperature setpoint, volume of production, types of products, driving style, weather conditions, etc.

3.18
predicted energy savings
PrES
energy savings (3.13) calculated prior to the implementation of *EPIA(s)* (3.11)

Note 1 to entry: PrES are also known as expected or ex-ante energy savings.

3.19
prediction period
defined period of time over which the *PrES* (3.18) are calculated

3.20
calculation assumptions
conditions chosen for calculating *PrES* (3.18) in order to make the *EnB* (3.6) and the predicted *energy consumption* (3.7) comparable

3.21
reference data
data relating to a general context

Note 1 to entry: When available, *context-specific data* (3.3) are preferred.

EXAMPLE National statistics about the average heat transfer coefficient of walls according to the year of construction, annual lighting hours based on similar facilities.

3.22
unitary predicted energy savings
unitary PrES
PrES (3.18) calculated for a unit being a single *EPIA* (3.11) or a group of EPIAs implemented at the same site or by the same organization or *energy end-user* (3.9)

3.23
validation
review, agreement and approval of proposed choices or decisions, by the stakeholders

4 Objectives, context and principles of calculation of PrES

4.1 Clarifying the objectives

The choice of a calculation method depends substantially on the context and objectives of the calculation of PrES. Before calculating PrES, objectives should be specified as described in 5.4. Examples of some objectives are:

— arriving at preliminary stage investment decisions (rough estimate to identify EPIA opportunities);

— ranking EPIAs while developing an action plan;

— taking final investment decisions (a detailed or comprehensive estimate is required);

— performance monitoring of an energy management system or an energy performance contract (for further comparison between predicted and actual energy savings).

Benefits, risks, costs or other factors that influence the accuracy, timeliness or cost in calculating the PrES should be considered in making a decision.

Specifying the objectives is important in determining the applicable clauses of this document:

— objective = to determine PrES at the level of an EPIA → Clause 7 does not apply;

— objective = to determine aggregated PrES → all clauses apply.

Annex A provides more details about the main criteria to take into account while using this document.

4.2 Analysing the context

When calculating PrES, two general situations can be considered:

a) in which data are based on a specific context (context-specific data);

b) in which data are based on a general context and independent of a specific context (reference data).

Both situations can co-exist, as they are not mutually exclusive. As far as possible, the use of context-specific data is recommended as it results in higher accuracy. Reference data may be considered when:

— the specific context is not known in advance; or

— many EPIAs are being assessed, which makes it very difficult or costly to collect context-specific data for each EPIA.

The choice between context-specific data and reference data also depends on the calculation objectives (as shown in Figure 2, see also the examples in Table A.1).

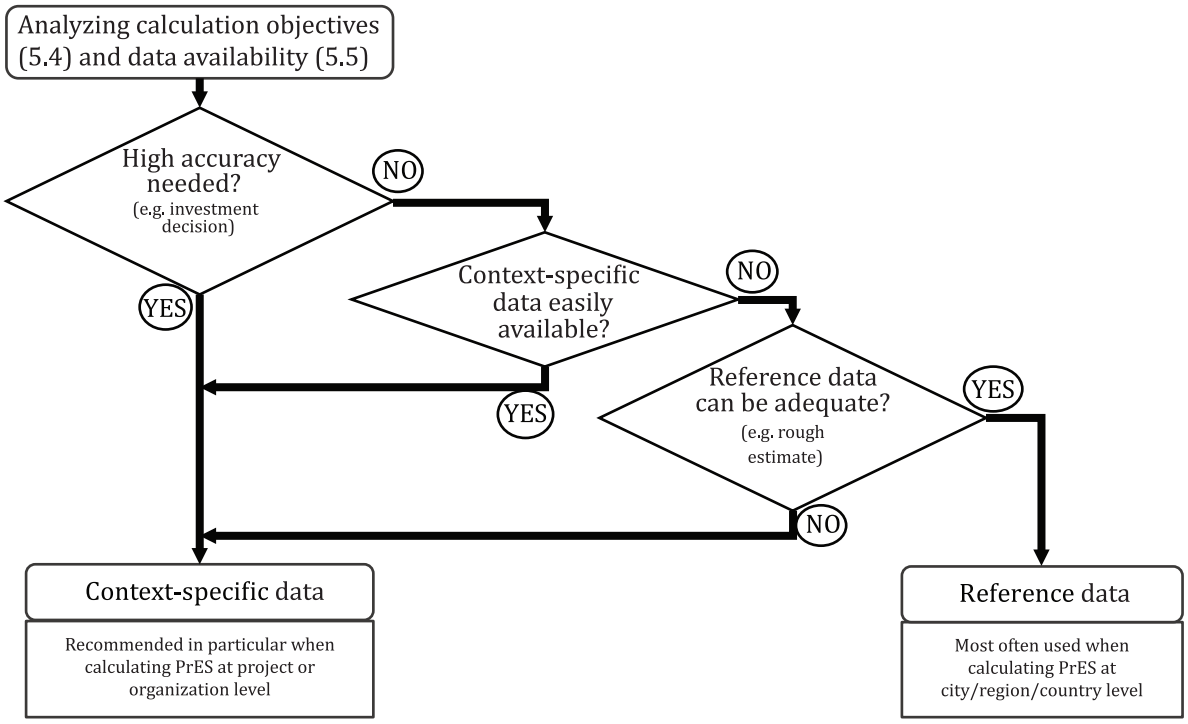

Figure 2 — Indicative decision path for choosing between context-specific and reference data

The following examples describe situations in which context-specific data, reference data or a combination of both are required:

— context-specific data:
  — contract or agreement between a service provider and a customer;
  — recommendations of an energy audit;
  — assessment of PrES while preparing a project;
— reference data:
  — accounting or crediting of energy savings for an energy efficiency obligation scheme or energy efficiency portfolio standards[14];
  — impact assessment of a future energy efficiency policy or programme;
— combined situations:
  — the energy savings of the same EPIA considered by a company can be calculated with context-specific data through an energy audit to ascertain the particular energy performance improvement it can bring to the company, and with reference data to ascertain the energy savings that could be credited if the EPIA were reported for an energy efficiency obligation scheme having its own rules for calculation of PrES.

In some cases, the PrES can be determined while comparing alternative potential EPIAs. For example, in determining which change(s) or new installation of lighting to designate as the EPIA, an organization might predict the energy savings of several candidate EPIAs. The PrES of the selected EPIA will have already been determined.

4.3 Principles

4.3.1 General

The general principles (detailed in 4.3.2 to 4.3.5) provide the basis for the calculation of PrES. The overall aim of the calculation methods is to provide reliable results in order to give confidence to the stakeholders when making a particular decision or pursuing a particular course of action.

The principles to ensure the quality of the PrES are:

— initial planning (simultaneous design of the EPIAs and their calculation);

— appropriate level of accuracy;

— transparency and reproducibility (of the calculation methods and of the PrES);

— reliability and validation.

4.3.2 Initial planning

Initial planning helps to ensure the feasibility of calculation.

Planning the calculation process simultaneously with the design of EPIA(s) makes it possible to account for the available resources and time (in particular the budget and the timing of the decision to be made, and the resources and time required for different calculation methods). Analysis of data availability and quality is particularly important while preparing for the calculation process (see Clause 5 for more details).

4.3.3 Appropriate level of accuracy

An appropriate level of accuracy should be selected depending on the objectives of the calculations. Accuracy of the PrES is considered to be appropriate when the stakeholders have confidence in using it. It does not always need to be the highest possible level. Assumptions that make the calculations simpler and that are consistent with the calculation objectives may be used if agreed to by the stakeholders[10].

The requirement about accuracy might differ greatly, for example, between the case of an approximate estimation to evaluate whether to implement a low-investment EPIA and the case of a detailed estimation to evaluate a high-investment EPIA. The costs of calculating PrES might thus differ greatly, mainly due to differences in the resources needed to collect additional data and/or to perform additional analyses (see the example in Annex E).

More details about accuracy and uncertainty are provided in Clause 8.

4.3.4 Transparency and reproducibility

To ensure transparency and reproducibility, this document identifies the information to be documented at each step of the calculation process. Documentation is the key to ensuring that the PrES can be understood and used in a correct manner. Transparency should make it possible for external experts to reproduce the calculations and results. See Annex B for an overview of documentation guidance, Annex C for an example of documentation template and Annex D for an example of using this template.

4.3.5 Reliability and validation

Reliability of the results can depend on several criteria, including:

— the choice of the calculation method;

— the availability and quality of the data to be used;

— the expertise and experience of the team applying the method;

