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**General methods for predicting  
energy savings**

*Méthodes générales d'estimation des économies d'énergie*

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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](http://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](http://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](http://www.iso.org/iso/foreword.html).

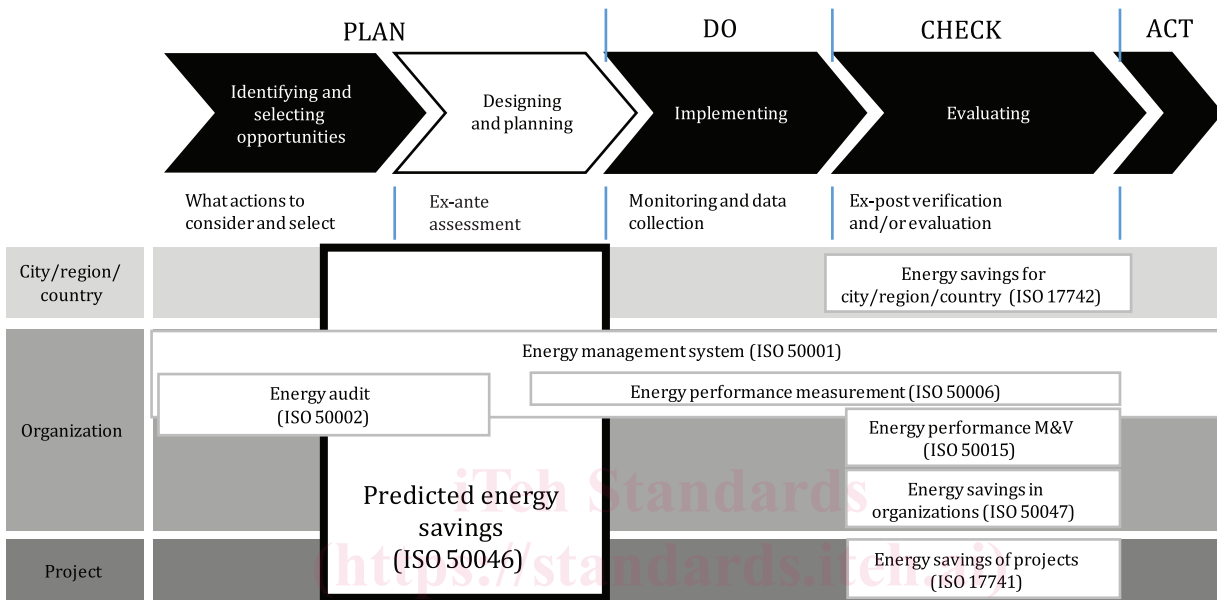
This document was prepared by Technical Committee ISO/TC 301, *Energy management and energy savings*.

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](http://www.iso.org/members.html).

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## 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<sup>[14]</sup>).

It provides methods that can be used, for example, in the context of energy audits, energy savings obligations, energy efficiency portfolio standards<sup>[14]</sup>, 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).

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# 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 <https://standards.itih.ai/catalog/standards/iso/d23c4303-2e4a-4d69-854b-7f80fdae87ff/iso-50046-2019>

**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.]

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### 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](#)).

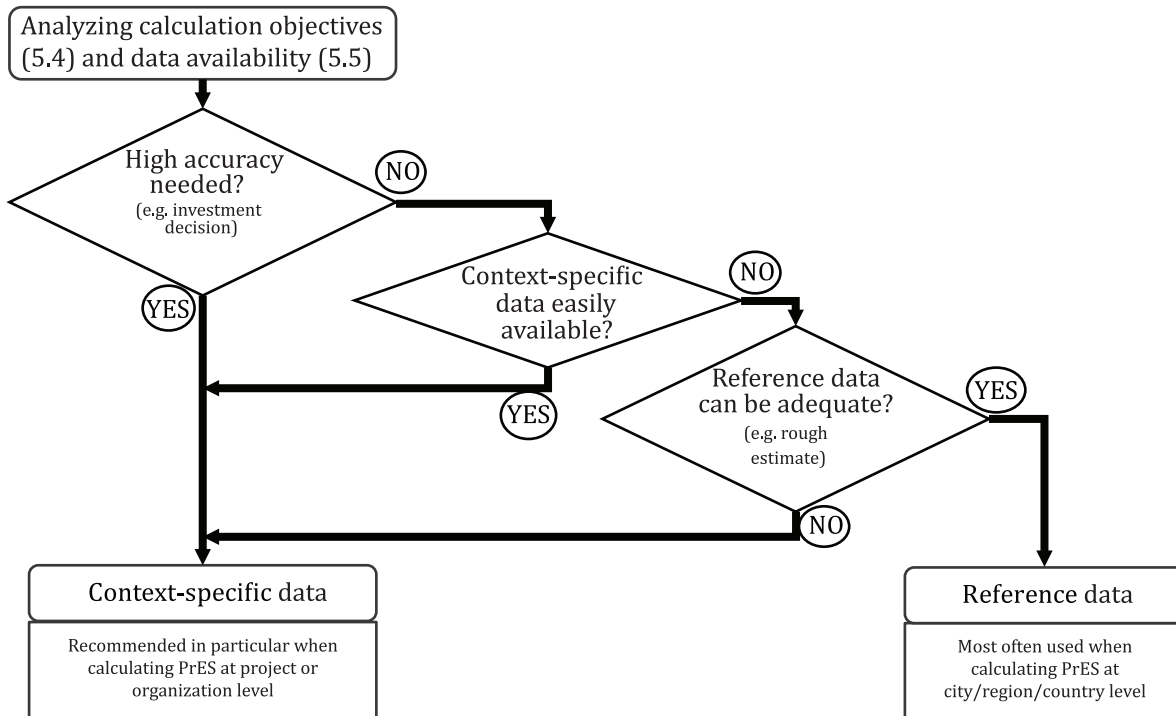


Figure 2 — Indicative decision path for choosing between context-specific and reference data

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<sup>[14]</sup>;
  - 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.