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Energy efficiency and savings calculation for countries, regions and cities

Calcul de l'efficacité énergétique et des économies d'énergie pour les pays, villes et régions

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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).

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

The committee responsible for this document is ISO/TC 257, *Evaluation of energy savings*.

Introduction

Due to the recognized role of savings in international climate and energy policy, e.g. expressed by International Energy Agency,[9] there is a need for harmonized methods at the international level. In addition, many countries that have formulated policies and targets have a need for evaluating the energy savings achieved, or the impact of implemented policies, and need these calculation methods as well.

This International Standard concerns savings at the level of countries, regions, and cities. The practical application can be different due to specific restrictions, such as the availability of data at lower levels.

This International Standard is meant to calculate both realized savings (ex-post evaluation) as well as expected savings (ex-ante evaluation). The latter is only possible if detailed data on future energy developments is available.

This International Standard can be used by any stakeholder (decision makers, companies, NGO, etc.) that wants to quantify the energy savings over a specific period.

This International Standard is part of a set of International Standards developed in TC 257 (see Figure 1) and builds on the general principles outlined in ISO 17743, including reporting and system boundaries.

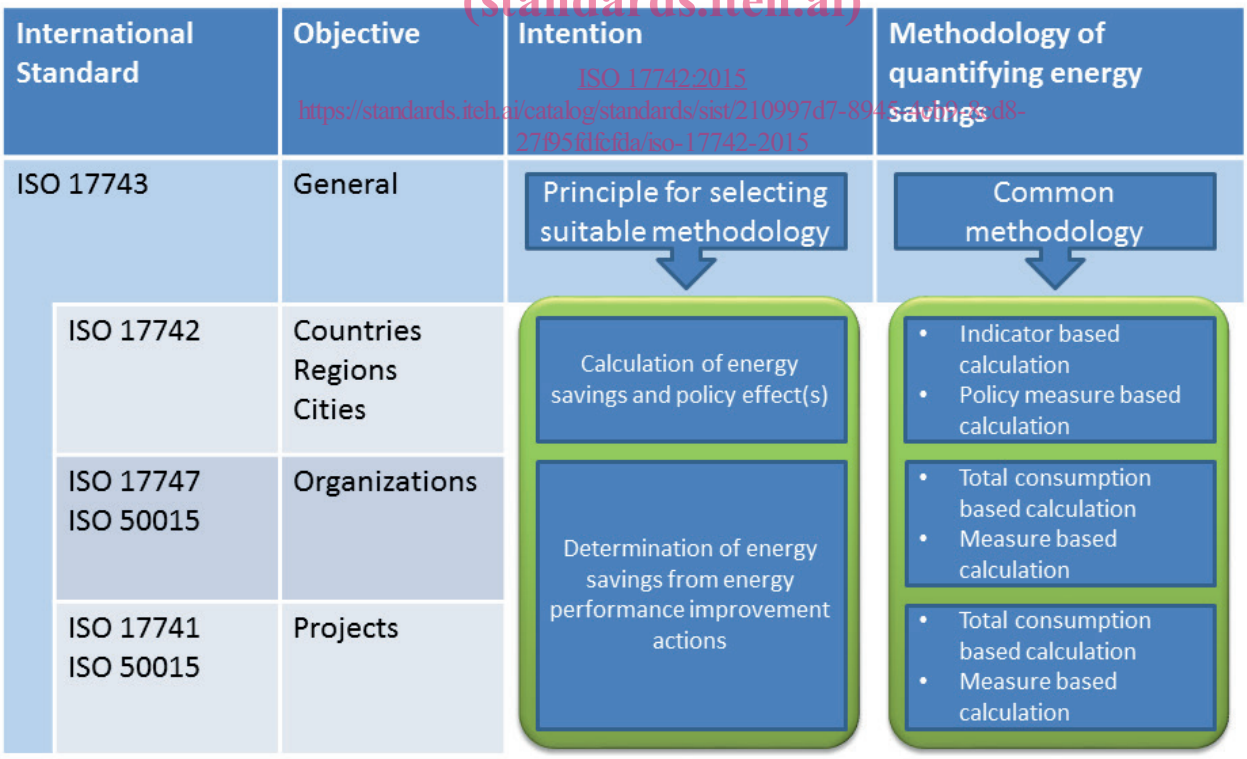

Figure 1 — Work programme of ISO/TC 257

This International Standard covers both indicator-based and measure-based calculation methods. The indicator method is based on energy indicators (e.g. mean gas consumption per dwelling) which are

often calculated from statistical data. The measure-based method considers the saving effect of policy measures or measures taken by other stakeholders to enhance energy efficiency.

The indicator-based and measure-based calculation methods are presented as two separate calculation methods. Using a combination of indicator-based and measure-based methods is not part of this International Standard. However, the differences and application of both methods are highlighted.

This International Standard provides a general framework for calculating energy savings. For the indicator-based methods, examples of specific calculations per indicator are presented separately in Annex A.

When applying this International Standard, the user can choose between different variants of the indicator- or measure-based method. In order to be transparent on the way results have been obtained, the user of this International Standard has to specify the variant used when presenting the results.

In order to ensure the credibility of the results, all savings calculations have to be documented to the point of allowing them to be duplicated or reproduced by an independent analyst. The requirements are specified in detail when this International Standard is elaborated for concrete calculation applications (see also ISO 17743).

The energy-saving types to be calculated, and the characteristics of the indicator-based and measure-based methods, are presented in Clause 3. The standard on the indicator-based calculation method is described in Clause 4 and that on the measure-based calculation methods in Clause 5. Annex A provides some example indicators that can be used in indicator-based calculations. Annex B shows the levels of detail at which measure-based methods can be applied.

Energy efficiency and savings calculation for countries, regions and cities

1 Scope

This International Standard provides a general approach for energy efficiency and energy savings calculations with indicator-based and measure-based methods for the geographical entities countries, regions, and cities.

This International Standard considers all end-use sectors, such as households, industry, tertiary (services, etc.), agriculture, and transport. It does not incorporate calculation of energy efficiency and energy savings in energy supply sectors, such as power plants, refineries, and coal mines.

Energy consumption does not include feedstock energy, such as oil products for the production of plastics.

This International Standard is not intended to be used for calculating energy savings of individual households, organizations, companies, or other end users.

Energy from renewable energy sources "behind-the-meter" (e.g. from solar water heating panels) decreases the amount of supplied energy and can be part of the calculated energy savings. Users of this International Standard should be aware that this energy from renewable energy sources behind-the-meter can also be claimed as part of the total energy from renewable sources.

2 Terms and definitions

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

2.1
adjustment factor
quantifiable parameter affecting energy consumption

Note 1 to entry: In this International Standard, adjustment factors for indicator-based methods are restricted to corrections for variations in weather conditions.

Note 2 to entry: In this International Standard, adjustment factors for measure-based methods include production throughput, weather conditions, working hours, behaviour related parameters (e.g. indoor temperature and light level), etc.

Note 3 to entry: Factors at high aggregation level that affect the savings attributed to policies or programs (e.g. free rider effect or rebound effect) are not part of the adjustment factors.

[SOURCE: ISO 17743, modified — with notes instead of examples.]

2.2
city
geographical area under control of a municipal administration

Note 1 to entry: The municipal administration is subject to provincial and national governance.

2.3
country
geographical area under control of a national government

Note 1 to entry: According to the definition of the UN Statistical Office.

2.4
deemed savings
default value for unitary energy savings, estimated and/or agreed to by stakeholders

Note 1 to entry: The default value can be based on available measurements or calculations.

2.5
diffusion indicator
indicator showing the penetration of energy-saving devices, systems, or practices

EXAMPLE Number of solar water heaters, efficient lamps or electrical appliances with a label A+ or A++, fraction of passenger transport by public modes, or transport of goods by rail and water.

2.6
double counting
counting the savings for a combination of facilitating measures, focusing on the same end-user action, as the sum of what would be saved by each measure alone, when the combined savings is less than the sum

Note 1 to entry: In this International Standard, double counting is not valid for elementary units of action (e.g. the saving effect of insulation and high efficiency boiler) where it is termed technical interaction.

Note 2 to entry: In this International Standard, double counting is used for calculation at high aggregation level (e.g. all dwellings), while the term consequential effects can be used at lower aggregation level (e.g. individual company) in other International Standards.

[SOURCE: CEN 16212, modified — definition adapted.]

2.7
driver
quantity that is assumed to predominantly influence the level of energy consumption under consideration in indicator-based methods

Note 1 to entry: A driver can be an activity (e.g. production) but also a property of a system (e.g. amount of floor space).

2.8
elementary unit of action
entity for which unitary energy savings can be defined and summed up

Note 1 to entry: Generally, it relates to an energy using system or a participant in an energy savings programme.

2.9
end-user action
energy efficiency improvement measure implemented on the site of an end user

2.10
energy baseline
quantitative reference(s) providing a basis for comparison of energy performance

Note 1 to entry: An energy baseline usually reflects a specified period of time.

Note 2 to entry: An energy baseline can be adjusted using variables affecting energy use and/or consumption such as production level, degree days (outdoor temperature), etc.

Note 3 to entry: With respect to energy performance, the definition for this International Standard only concerns energy efficiency.

[SOURCE: ISO/IEC 13273-1, 3.3.10, modified — adapted notes.]

2.11
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate a process

EXAMPLE Electricity, hydrogen, and automotive fuels that can be used by energy using systems.

[SOURCE: ISO/IEC 13273-1, 3.1.2, modified — without note.]

2.12
energy consumption
quantity of energy applied

Note 1 to entry: The unit of energy consumption can be expressed related to the involved energy carrier but also in the standard unit for energy, Joule.

[SOURCE: ISO/IEC 13273-1, 3.1.15]

2.13
energy consumption in final units
final energy when energy carriers are counted according to their energy content

Note 1 to entry: The energy content values can be taken from energy statistics where they are applied to sum up the energy consumption of different energy carriers.

2.14
energy consumption in primary units
final energy when energy carriers are counted according to the energy consumption needed to deliver them to the end users

Note 1 to entry: For instance, the consumption of electricity is multiplied with a factor of 2,5 when the conversion of fuels to electricity has an efficiency of 40 %.

Note 2 to entry: In this way, it is possible to account for the fact that savings on final energy consumption can also reduce transformation losses in the energy supply system.

2.15
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods, or energy and an input of energy

EXAMPLE Energy conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

[SOURCE: ISO/IEC 13273-1, 3.4.1, modified — without notes.]

2.16
energy efficiency improvement
increase in energy efficiency as a result of technological, design, behavioural, and/or economic changes

[SOURCE: ISO/IEC 13273-1, 3.4.3]

2.17
energy efficiency improvement measure
action normally leading to an energy efficiency improvement which can be verified, measured or estimated

Note 1 to entry: Measure encompasses both end-user action and facilitating measure.

2.18
energy end user
individual or a group of individuals or organization with responsibility for operating an energy using system

Note 1 to entry: The energy end user can differ from the customer who might purchase the energy but does not necessarily use it.

[SOURCE: ISO/IEC 13273-1, 3.1.12]

2.19
energy savings
reduction of energy consumption compared to an energy baseline

Note 1 to entry: Energy savings can be realized or expected.

Note 2 to entry: Energy savings can be the result of implementation of an action(s) or of autonomous progress.

[SOURCE: ISO/IEC 13273-1, 3.3.11, last part of definition and notes adapted]

2.20
energy use
manner or kind of application of energy

Note 1 to entry: Characteristics of energy use include, but are not limited to, the purpose of the use, source(s) choice, and application.

[SOURCE: ISO/IEC 13273-1, 3.1.14]

2.21
energy using system
physical item with defined system boundaries, using energy

Note 1 to entry: An energy using system can be one or many plants, processes, parts of a process, buildings, parts of a building, machines, equipment, products, etc.

[SOURCE: ISO/IEC 13273-1, 3.1.11]

2.22
facilitating measure
energy efficiency service or an improvement programme offered to an energy end user

Note 1 to entry: A facilitating measure is offered by a stakeholder that is not the energy end user.

EXAMPLE A subsidy scheme for insulation of dwellings or a label on the efficiency of appliances.

2.23
feedstock energy
energy of raw materials which is used for non-energy purposes

EXAMPLE Oil for producing plastics and natural gas for producing fertilizers.

[SOURCE: ISO/IEC 13273-1, 3.1.3, modified — adapted example.]

2.24
final energy
energy as delivered to the energy using system

Note 1 to entry: This concept is sometimes referred to as delivered energy.

[SOURCE: ISO/IEC 13273-1, 3.1.13]

2.25
free rider effect
provision of financial incentives for saving measures to end users who would have taken the measures anyway

EXAMPLE Savings arising from subsidies, or tax reductions, provided to end users that would have taken the measures anyway.

Note 1 to entry: The free rider effect can be estimated through, for example, a comparison with energy savings realized in similar circumstances but without the subsidy scheme.

2.26
gross energy savings
energy savings using adjustment factors, but except correction for double counting, multiplier effect, free riders, and rebound effect

Note 1 to entry: Gross energy savings include adjustment factors mentioned in 2.1.

2.27
indicator-based method
determination of energy savings from the variation of energy consumption indicators over a period

EXAMPLE For industry, a decrease in energy consumption per tonne of steel is accounted for as savings.

2.28
indicator-based savings
energy savings calculated with indicator-based methods

2.29
measure-based method
determination of energy savings from end-user actions using unitary energy savings and elementary units of action

Note 1 to entry: If end-user actions are due to facilitating measures, such as policy, the measure-based methods consider savings due to policy.

EXAMPLE In case of a subsidy scheme for boilers in households, the savings are calculated from the average savings per boiler (compared to a chosen reference boiler) times the number of subsidized boilers (corrected for free riders that apply for subsidy but would have installed the efficient boiler anyway).

2.30
measure-based savings
energy savings calculated with measure-based methods

2.31
multiplier effect
effect of a facilitating measure after the measure has ended or in fields outside the focus

EXAMPLE Temporarily promotion of efficient appliances changes the market for these appliances in such a way that further penetration occurs after ending the promotion activity.

Note 1 to entry: In the standard, the multiplier effect is used for calculations at high aggregation level (e.g. all dwellings), while the term consequential effects can be used at lower aggregation level (e.g. individual company) in other standards.

2.32
net energy savings
energy savings with use of the adjustment factor(s) and, if relevant, correction factors for double counting, multiplier effect, free riders and rebound effect

2.33
rebound effect
change in energy using behaviour that yields an increased level of service and that occurs as a result of taking an end-use action

EXAMPLE Some households can take some of the benefits of energy efficiency improvements to their home in the form of higher internal temperatures, and so use more energy than might be calculated from the end-user action.

Note 1 to entry: The rebound effect can take many forms. Apart from the case in the example (higher internal temperature setting) the effect is often difficult to determine.

2.34
region
geographical area with the ability to influence energy savings, not being a city or a country

2.35
saving lifetime
number of years for which savings of end-user actions remain present

Note 1 to entry: The savings lifetime can take into account deterioration of yearly savings.

EXAMPLE See list of specified lifetimes in Annex of Reference [8].

2.36
specific energy consumption
quotient describing the total amount of energy necessary to generate a unit of output, activity, economic value, or service

EXAMPLE Gigajoule (GJ) per ton of steel, annual kilowatt hour (kWh) per square meter (m^2), litres of fuel per kilometre (km), etc.

[SOURCE: ISO/IEC 13273-1, 3.1.17]

2.37
structure effect
changes in activities or characteristics of energy using systems that affect energy consumption, not being energy savings

EXAMPLE Intensity of use for appliances, occupation rate for buildings, and shift in between sectors for industry.

Note 1 to entry: The actual form of the structure effects differs for the various aggregation levels in calculations (country, sector, organization, building, etc.).

Note 2 to entry: For the indicator-based method, the effect of the driver on energy consumption is, by definition, not part of the structure effect.

Note 3 to entry: For the measure-based method, the demarcation between structure effect and savings can be dependent on formulating policy as savings measure or another measure (e.g. speed limits for traffic to avoid accidents or to save petrol).

2.38
system boundary
physical or site limits as defined for a stated purpose

EXAMPLE A process; a site; an organization; a city, a region, or a country.

Note 1 to entry: The stated purpose could be for a management system, or for a savings program with a given national, regional, or local scope.

[SOURCE: ISO/IEC 13273-1, 3.3.2, modified — example with extended scope, notes adapted.]

2.39
technical interaction
relation of the elementary unit of action to the surrounding technical system, or to other elementary units of action, which influences the unitary energy savings

Note 1 to entry: In case of technical interaction between two elementary units of action, both energy savings cannot be simply summed up.

EXAMPLE The combination of thermal insulation and a new efficient boiler where the combined savings are smaller than the sum of the savings for each unit of action apart.

2.40
unitary energy savings
calculated energy savings per elementary unit of action

Note 1 to entry: Also called "unitary gross annual energy savings". Gross depicts that corrections can be made.

3 Savings to be calculated

3.1 General

This Clause is an introduction to Clauses 4 and 5 on indicator-based and measure-based methods. It describes common issues, such as the need for differently defined energy savings and the various ways to calculate them. This should clarify what kind of savings the standards for indicator-based and measure-based calculation methods provide.

The indicator-based method considers observed trends for energy consumption and the drivers behind these trends, normally at an aggregated level. Therefore, it is sometimes called top-down method, e.g. in Reference [12].

The measure-based method considers the saving effect of measures, i.e. end-user actions taken, or the facilitating measures enabling them. Because of the focus on specific measures, it is sometimes referred to as bottom-up method, e.g. in Reference [12].

Savings are calculated for a period of time, normally one or more calendar years. A distinction can be made between past years or future years.

The indicator-based method makes use of statistical data and is normally restricted to calculating realized savings in past years. However, if a comparable set of data are available, e.g. from an energy scenario study, the method can be applied for future years.

The measure-based method can apply to observed as well as estimated data and can calculate realized savings for past years as well as expected savings for future years.

3.2 Types of savings to be calculated

3.2.1 Energy savings as part of energy consumption development

Energy consumption trends are defined by:

— volume effect: increase or decrease of socio-economic activities;

— structure effect: changes in the composition of the activities;

— energy savings.

The relation between energy consumption trends and the three effects is shown in Figure 2. The explanation following the keys goes as follows.