SLOVENSKI STANDARD

SIST EN 15459:2008

01-januar-2008

Grelni sistemi v stavbah - Postopek ekonomskega vrednotenja stavbnih energijskih sistemov

Energy performance of buildings - Economic evaluation procedure for energy systems in buildings

Energieeffizienz von Gebäuden - Wirtschaftlichkeitsberechnungsverfahren für Energiesysteme in Gebäuden

Performance énergétique des bâtiments - Méthode d'évaluation économique des systemes énergétiques des bâtiments

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Energy performance of buildings - Economic evaluation procedure for energy systems in buildings

Performance énergétique des bâtiments - Procédure d'évaluation économique des systèmes énergétiques des bâtiments

Energieeffizienz von Gebäuden - Wirtschaftlichkeitsberechnungen für Energiesysteme in Gebäuden

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Foreword

This document (EN 15459:2007) has been prepared by Technical Committee CEN/TC 228 “Heating systems in buildings”, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2008, and conflicting national standards shall be withdrawn at the latest by May 2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/343), and supports essential requirements of EU Directive 2002/91/EC on the energy performance of buildings (EPBD). It forms part of a series of standards aimed at European harmonisation of the methodology for calculation of the energy performance of buildings. An overview of the whole set of standards is given in prCEN/TR 15615.

The subjects covered by CEN/TC 228 are the following:

- design of heating systems (water based, electrical etc.);
- installation of heating systems;
- commissioning of heating systems;
- instructions for operation, maintenance and use of heating systems;
- methods for calculation of the design heat loss and heat loads;
- methods for calculation of the energy performance of heating systems.

Heating systems also include the effect of attached systems such as hot water production systems.

All these standards are systems standards, i.e. they are based on requirements addressed to the system as a whole and not dealing with requirements to the products within the system.

Where possible, reference is made to other European or International Standards, a.o. product standards. However, use of products complying with relevant product standards is no guarantee of compliance with the system requirements.

The requirements are mainly expressed as functional requirements, i.e. requirements dealing with the function of the system and not specifying shape, material, dimensions or the like.

The guidelines describe ways to meet the requirements, but other ways to fulfil the functional requirements might be used if fulfilment can be proved.

Heating systems differ among the member countries due to climate, traditions and national regulations. In some cases requirements are given as classes so national or individual needs may be accommodated.

In cases where the standards contradict with national regulations, the latter should be followed.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This standard presents a method for economic calculation of the heating systems, relying on data from other systems that may influence the energy demand of the heating system.

This method can be used, fully or partly, for the following applications:

— consider economic feasibility of energy saving options in buildings;

— compare different solutions of energy saving options in buildings (e.g. plant types, fuels);

— evaluate economic performance of an overall design of the building (e.g. trade-off between energy demand and energy efficiency of heating systems);

— assess the effect of possible energy conservation measures on an existing heating system, by economic calculation of the cost of energy use with and without the energy conservation measure.

The user shall refer to other European Standards or to national documents for input data and detailed calculation procedures not provided by this standard, especially regarding dynamic economical calculations, which are not detailed in this standard. The methods to calculate the building heating energy demand are provided by CEN/TC 89 (EN 832, EN ISO 13790) and CEN/TC 228 (EN 15316 series of standards) related to the EPBD (see prCEN/TR 15615).

1 Scope

This standard provides a calculation method for the economical issues of heating systems and other systems that are involved in the energy demand and energy consumption of the building. This standard applies to all types of buildings.

The fundamental principles and terminology are explained in this standard.

The main items of the standard are:

— definitions and structure of the types of costs, which shall be taken into account for calculation of the economical efficiency of saving options in buildings;

— data needed for definition of costs related to systems under consideration;

— calculation method(s);

— expression of the result of the economic calculation;

— informative annexes indicating default values of e.g. lifetime, costs for repair, costs for maintenance, in order to introduce default values for calculations.

This standard is applicable to calculation of economic performance of energy saving options in buildings (e.g. insulation, better performing generators and distribution systems, efficient lighting, renewable sources, combined heat and power).

The scope of this standard is to standardise:

— required inputs;

— calculation methods;

— required outputs

for economic calculations of energy systems related to the energy performance of buildings.

NOTE Sensitivity of results increases with the number of parameters under consideration (e.g. lifetime, interest rates, development of different types of costs). The more parameters one changes when comparing different solutions, the more difficult it is to draw conclusions from the economic results of the calculations.

Economical results are closely related to the specific project under consideration, and no general conclusions should be drawn from any such results.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

3 Terms and definitions, symbols and units

3.1 Terms and definitions

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

3.1.1
costs
comprise initial investment costs and annual costs, including running costs, periodic or replacement costs due to repair or change of components and systems

3.1.2
initial investment costs [C_I]
costs to be considered when the building (or the specified equipment) is delivered to the customer, ready to use. These costs include design, purchase of systems and components, connection to suppliers, installation and commissioning process. The initial investment costs are the costs presented to the customer

3.1.3
running costs [C_r]
comprise maintenance costs, operational costs, energy costs and added costs

NOTE Running costs are annual costs.

3.1.4
maintenance costs [C_m]
annual costs for measures for preserving and restoring the desired quality of the installation. This includes annual costs for inspection, cleaning, adjustments, repair under preventive maintenance, consumable items

3.1.5
operational costs [C_o]
annual costs for operators

3.1.6
energy costs [C_e]
annual costs for energy and standing charges for energy (and other consumables as well as costs)

NOTE Contracts for energy delivered are included in energy costs. Use of energy implies external costs, which are not included in the official price. It is considered good practice to include the external costs and metering costs in economic calculations and to specify them.

3.1.7
added costs [C_{ad}]
annual costs for insurance, other standing charges, taxes (including environmental taxes for energy). Subsidies for renewable energy delivered or produced locally are considered as benefits and are taken into account as negative annual costs

3.1.8
periodic costs of year i [$C_p(i)$]
substitute investment, which is necessary for ageing reasons (corresponds to replacement costs for components (or systems), according to their lifespan)

3.1.9
replacement costs for component or system [$C_{R,i}(j)$]
comprise periodic costs for component j at time i= τ_n, 2 τ_n, etc. (where τ_n corresponds to the lifespan of the component)

3.1.10
annual costs [$C_a(i)$]
sum of running costs and periodic costs or replacement costs paid in the year i

3.1.11
inflation rate [R_i]
annual depreciation of the currency expressed in %

3.1.12
discount rate [R_d]
definite value for comparison of the value of money at different times

3.1.13
market interest rate [R]
interest rate agreed by lender expressed in %

3.1.14
real interest rate [R_R]
market interest rate adjusted according to inflation rate. Real interest rate may vary during the calculation period (dynamic calculation)

3.1.15
annuity factor [$a(n)$]
factor by which any annual costs and annual incomes are to be divided in order to be referred to the starting year

3.1.16
price development for energy, human operation, products, maintenance and added costs
development of the prices for energy, human operation, products, maintenance and added costs may differ from the inflation rate. The subsequent rates (expressed in %) can be introduced in the calculation process:

$R_{e,k}$ rate of development of the price for energy type k (the rate may be different for different types of energy)

R_o rate of development of the price for human operation

R_p rate of development of the price for products

R_m rate of development of the price for maintenance

R_{ad} rate of development of added costs

3.1.17
lifespan [$\tau_n(j)$]
expected lifetime for component j (or system) normally specified in years

3.1.18
present value factor [$f_{pv}(n)$]
factor by which any annual costs and annual incomes are to be multiplied in order to be referred to the starting year

NOTE $f_{pv}(n) = 1/a(n)$, where $a(n)$ = annuity factor

3.1.19
design payback period of building [$\tau\_{Building}$]
period decided by the owner to complete the payback of the building

3.1.20
starting year [τ_0]
date on which any calculation is based

3.1.21
calculation period [τ]
time period considered for the calculation

3.1.22
final (or residual) value [$V_f(j)$]
value of component j at the end of the calculation period, considering its lifespan and referred to the starting year

3.1.23
present value
value of all costs and all incomes occurring during the calculation period and referred to the starting year

3.1.24
nominal value
value of costs (or incomes) considered at the time (year) of payment

3.1.25
present value of component [$V_{pv,i}(j)$]
value of all costs (and incomes) related to component or system or charge j, and referred to the starting year

3.1.26
real value or present value
corresponds to the prices of the starting year

3.1.27
global cost [$C_G(\tau)$]
sum of the present value of all costs (referred to the starting year) including investment costs. At the end of the calculation period, the deconstruction costs or the residual value of the components should be taken into account to determine final costs

NOTE 1 Global cost is directly linked to the duration of the calculation period.

NOTE 2 Taking into account the deconstruction costs means that the calculation period corresponds to the lifetime of the building.

3.1.28
annuity cost [*AC*]
distribution of the costs on an annual basis. Initial investment costs and replacement costs are distributed according to duration of the calculation period and lifetime of the components, respectively. Annuity cost does not depend on the calculation period

3.2 Symbols and units

For the purposes of this document, the symbols and units in Table 1 apply.

Table 1 — Symbols and units

Symbol	Name of quantity	Unit
$a(n)$	Annuity factor (for year n)	-
AC	Annuity cost	€
β_x	Price dynamic present value factor for costs of type x	-
$C_G(\tau)$	Global cost (corresponding to calculation period τ)	€
C_I	Initial investment costs (at time τ_0)	€
$C_{R,i}(j)$	Replacement costs for component or system j in the year i, where i = τ_n, 2 τ_n, …	€

Table 1 — Symbols and units

Symbol	Name of quantity	Unit
$C_a\ (i)$	Annual costs of the year i (nominal value)	€
$C_{a,i}\ (j)$	Annual costs for component or system j of the year i (nominal value)	€
C_{ad}	Added costs (annual)	€
C_e	Energy costs (annual)	€
C_m	Maintenance costs (annual)	€
C_o	Operational costs (annual)	€
$C_p\ (i)$	Periodic costs of the year i	€
C_r	Running costs (annual)	€
$f_{pv}\ (n)$	Present value factor (for year n)	-
$n_\tau\ (j)$	Number of replacements of component or system j within the calculation period	- (Integer)
$R(i)$	Market interest rate (for year i)	%
$R_R\ (i)$	Real interest rate (for year i)	%
$R_d\ (i)$	Discount rate (for year i)	-
$R_i\ (i)$	Inflation rate (for year i)	%
R_{ad}	Rate of development of the price for added costs	%
$R_{e,k}$	Rate of development of the price for energy type k	%
R_m	Rate of development of the price for maintenance	%
R_o	Rate of development of the price for human operation	%
R_p	Rate of development of the price for products	%
τ	Calculation period	Year
$\tau_{\_Building}$	Design payback period of building	Year
$\tau_n\ (j)$	Lifespan or design duration for component or system j	Year
τ_0	Starting year for the calculation	Year
$V_{f,\tau}\ (j)$	Final value of component or system j (corresponding to calculation period τ)	€

4 Organisation of the costs

The approach of the calculation method is according to a global point of view (overall costs). However, depending on the objectives of the investor, the calculation method may be applied considering only selected specific cost items. For example, calculations concerning alternative solutions for heating systems may be performed considering only costs for the domestic hot water system and the space heating system.

Costs are separated into investment costs (including periodic replacement of components) and running costs.

Organisation of the various types of costs is given in Figure 1.

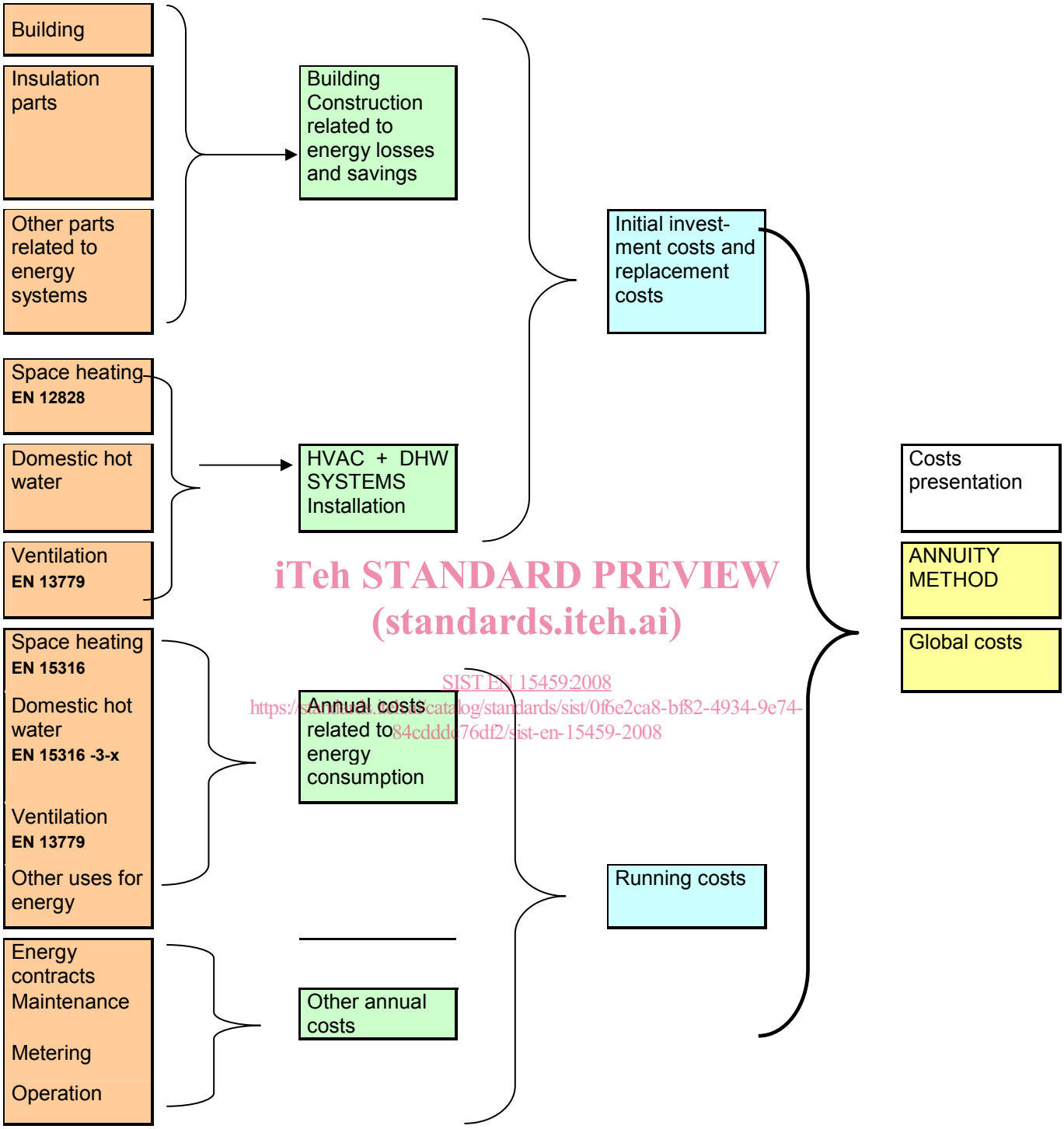


Figure 1 — Organisation of costs.

5 Basic calculations

5.1 Interest rate, discount rate, present value factor and annuity factor

5.1.1 Real interest rate

Real interest rate depends on the market interest rate R and on the inflation rate R_i (which both may depend on the year i, but here are assumed constant):

$$R_R = \frac{R - R_i}{1 + R_i / 100} \quad \% \quad (1)$$

5.1.2 Discount rate

The discount rate depends on the real interest rate R_R and on the timing of the considered costs (i.e. number of years after the starting year)

$$R_d(p) = \left(\frac{1}{1 + R_R / 100} \right)^p \quad (-) \quad (2)$$

5.1.3 Present value factor

The present value factor depends on the real interest rate R_R and on the number of years n considered for the annual costs:

$$f_{pv}(n) = \frac{1 - (1 + R_R / 100)^{-n}}{R_R / 100} \quad (-) \quad (3)$$

5.1.4 Annuity factor

The annuity factor is the inverse value of the present value factor:

$$a(n) = \frac{1}{f_{pv}(n)} \quad (4)$$

5.2 Global cost

5.2.1 Principles of the calculation

Calculation of global cost may be performed by a component or system approach, considering the initial investment C_I and – for every component or system j – the annual costs for every year i (referred to the starting year) and the final value. Global cost is directly linked to the duration of the calculation period τ.

$$C_G(\tau) = C_I + \sum_j \left[\sum_{i=1}^{\tau} (C_{a,i}(j) \times R_d(i)) - V_{f,\tau}(j) \right] \quad (€) \quad (5)$$

where:

$C_G(\tau)$ global cost (referred to starting year τ_0)

C_I initial investment costs

$C_{a,i}$ (j) annual cost year i for component j (including running costs and periodic or replacement costs)

R_d (i) discount rate for year i

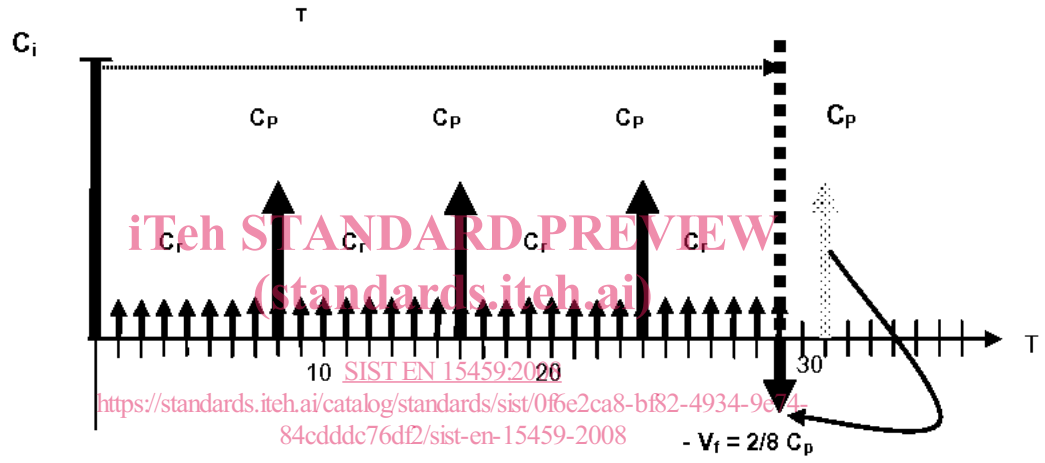
$V_{f,\tau}$ (j) final value of component j at the end of the calculation period (referred to the starting year τ_0)

The calculation may be performed either from detailed data on costs on an annual basis or from general data on economic calculations for every component.

Dynamic calculations take into account annual variations of the discount rate as well as annual variations of the rate of development of prices for any of the costs considered in the annual costs (i.e. energy costs, operational costs, periodic or replacement costs, maintenance costs and added costs).

5.2.2 Calculation of the final value

The final value $V_{f,\tau}$ (j) of a component is determined by straight-line depreciation of the initial investment until the end of the calculation period and referred to the beginning of the calculation period.



Key:

C_i initial investment costs
C_r running costs
C_p periodic costs
V_f final value
T calculation period

Figure 2 – Illustration of final value concept

If the calculation period τ exceeds the lifespan τ_n (j) of the considered component (j), the last replacement cost is considered for the straight-line depreciation:

$$V_{f,\tau}(j) = V_0(j) \times (1 + R_p / 100)^{n_\tau(j) * \tau_n(j)} \times \left[\frac{(n_\tau(j) + 1) \times \tau_n(j) - \tau}{\tau_n(j)} \right] \times R_d(\tau) \qquad (6)$$

where:

$V_0(j) \times (1 + R_p / 100)^{n_\tau(j) * \tau_n(j)}$ represents the last replacement cost (at the time of replacement), when taking into account the rate of development of the price for products (R_p)