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

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ICS 91.140.10

National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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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of an identical text or by endorsement, at the latest by May 2008, and conflicting national standards shall be withdrawn at the latest by May 2008.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.

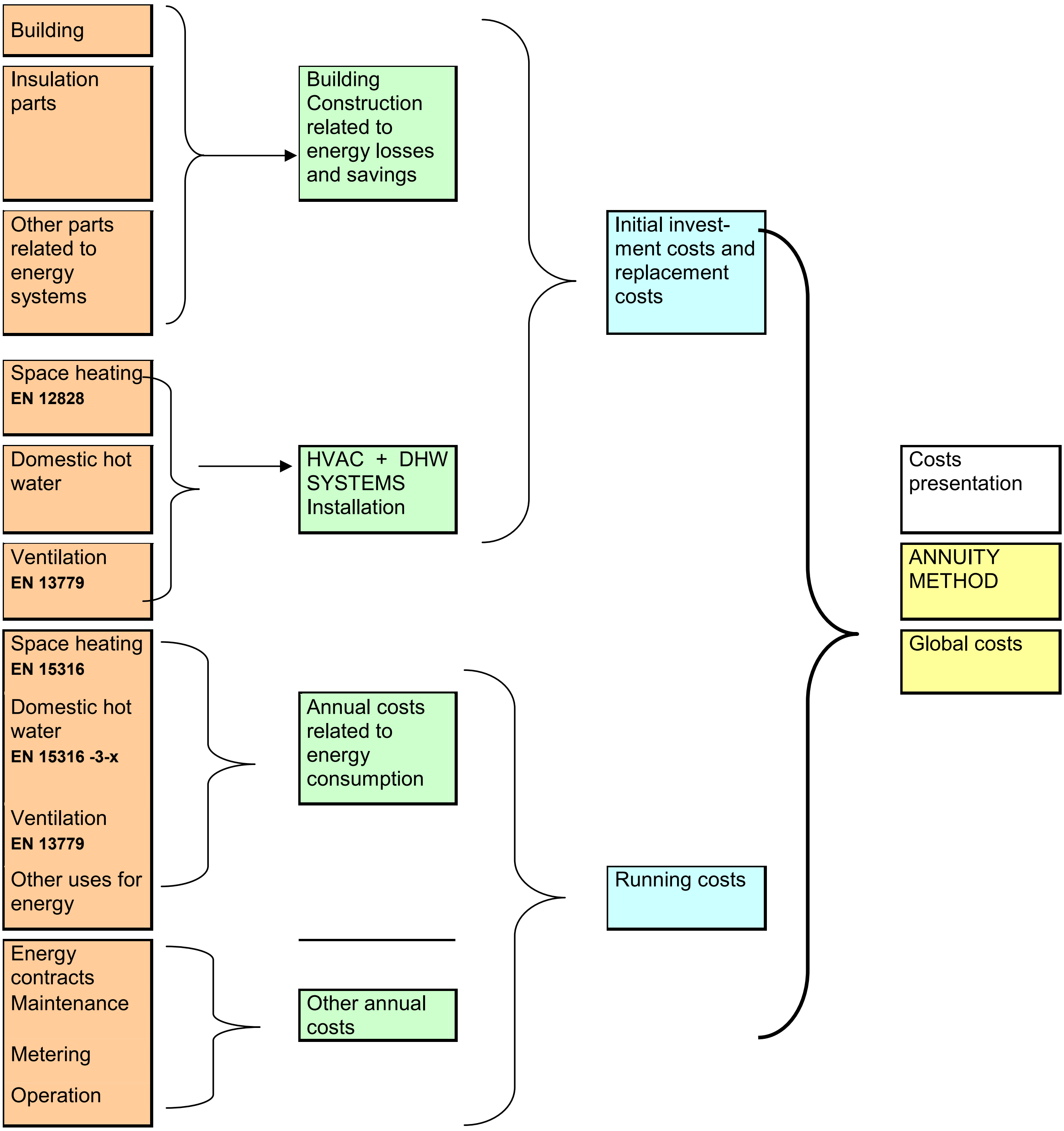


Figure 1 — Organisation of costs.

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):

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

5.1.2 Discount rate

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

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

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:

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

5.1.4 Annuity factor

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

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

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.

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

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

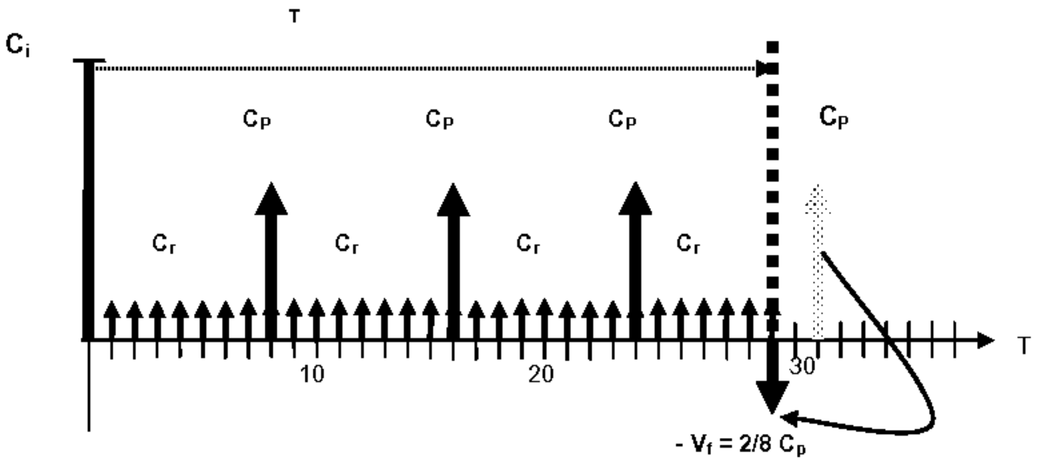
$V_{f,\tau}$ (j) final value of component j at the end of the calculation period (referred to the starting year τ_0)

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)

n_τ (j) represents the total number of replacements of component j throughout the calculation period

$\left[\frac{(n_\tau(j)+1)*\tau_n(j)-\tau}{\tau_n(j)}\right]$ represents the straight-line depreciation of the last replacement cost (i.e. remaining lifetime at the end of the calculation period of the last replacement of component j divided by the lifespan of component j)

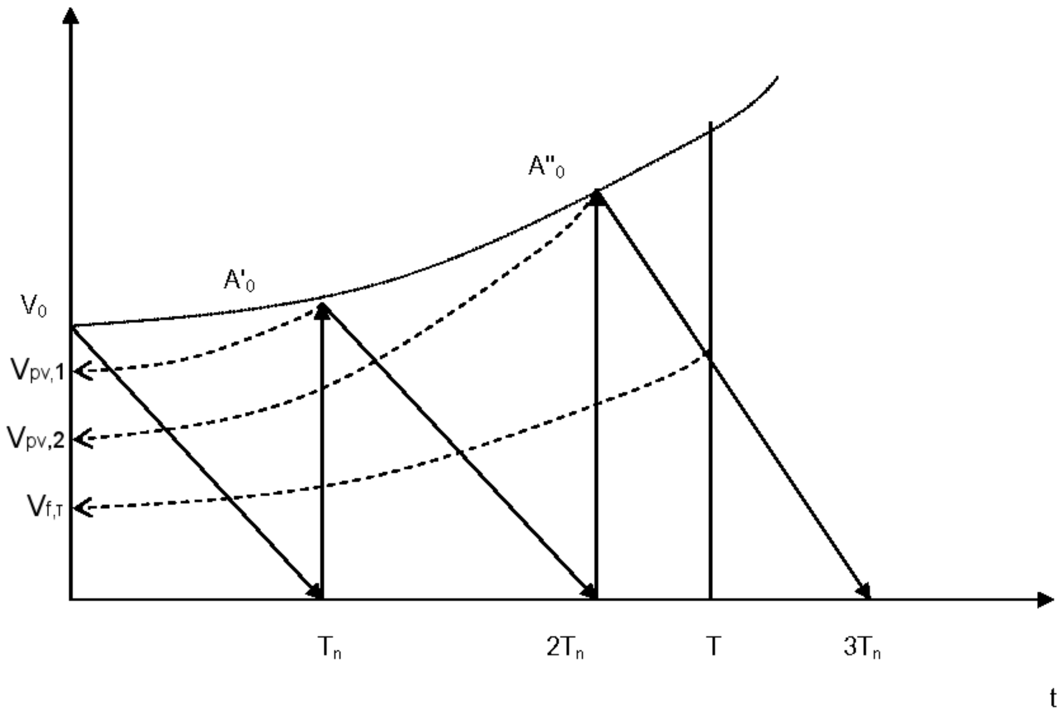
$R_d(\tau)$ represents the discount rate at the end of the calculation period

Total costs for replacement of component j during the calculation period considered (including initial investment), is the sum of:

— initial investment V_0;

— replacement costs (A'_0, A''_0, etc.): any time the lifespan of the component is reached, the component shall be replaced, the cost of which shall take into account the rate of development of the price for products and the discount rate.

Figure 3 illustrates an example of this principle with the calculation period (τ = T = e.g. 30 years) and lifespan of the component (τ_n = T_n = e.g. 12 years).



Key:

V_0 investment cost
A_0' nominal cost of replacement of the component at T_n
A_0'' nominal cost of replacement of the component at $2T_n$
$V_{pv,1}$ present value of replacement of the component at T_n
$V_{pv,2}$ present value of replacement of the component at $2T_n$
$V_{f,\tau}$ final value
T_n life span of component
T calculation period

Figure 3 — Development of value during the calculation period

The total cost is determined by V_0 + $V_{pv,1}$ + $V_{pv,2}$, where:

$$V_{pv,1} = A'_0 \times R_d(\tau_n) \quad \text{and} \quad A'_0 = V_0 \times (1 + R_p / 100)^{\tau_n}$$

$$V_{pv,2} = A''_0 \times R_d(2\tau_n) \quad \text{and} \quad A''_0 = V_0 \times (1 + R_p / 100)^{2\tau_n}$$

The final value is calculated by linear depreciation of the last replacement cost, thus:

$$V_{f,\tau} = A''_0 \times R_d(\tau) \times \frac{3 \times \tau_n - \tau}{\tau_n} = V_0 \times (1 + R_p / 100)^{2\tau_n} \times R_d(\tau) \times \frac{3 \times \tau_n - \tau}{\tau_n}$$

5.3 Annuity calculation

5.3.1 General

An alternative approach is to determine annuity costs of the building. The annuity calculation method transforms any costs to an average annualized cost.

Whereas the global cost calculation method provides a value of the total costs throughout the considered calculation period τ, the annuity calculation method transforms, by the use of the annuity factor *a*(n), all costs to annual costs.

Calculations are separated into 3 parts for the considered calculation period τ:

- investment costs, related to the part of the building structure to be taken into account and any components and systems with a lifespan greater than or equal to the design payback period of the building, are distributed evenly on the design payback period of the building;
- periodic or replacement costs are distributed evenly on the number of years between occurrence of the cost;
- running costs given on an annual basis are by definition annual costs.

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 (see 5.3.5).

A simplified version of the calculations for annualized costs emerges when discount rate and annual costs are constant during the calculation period:

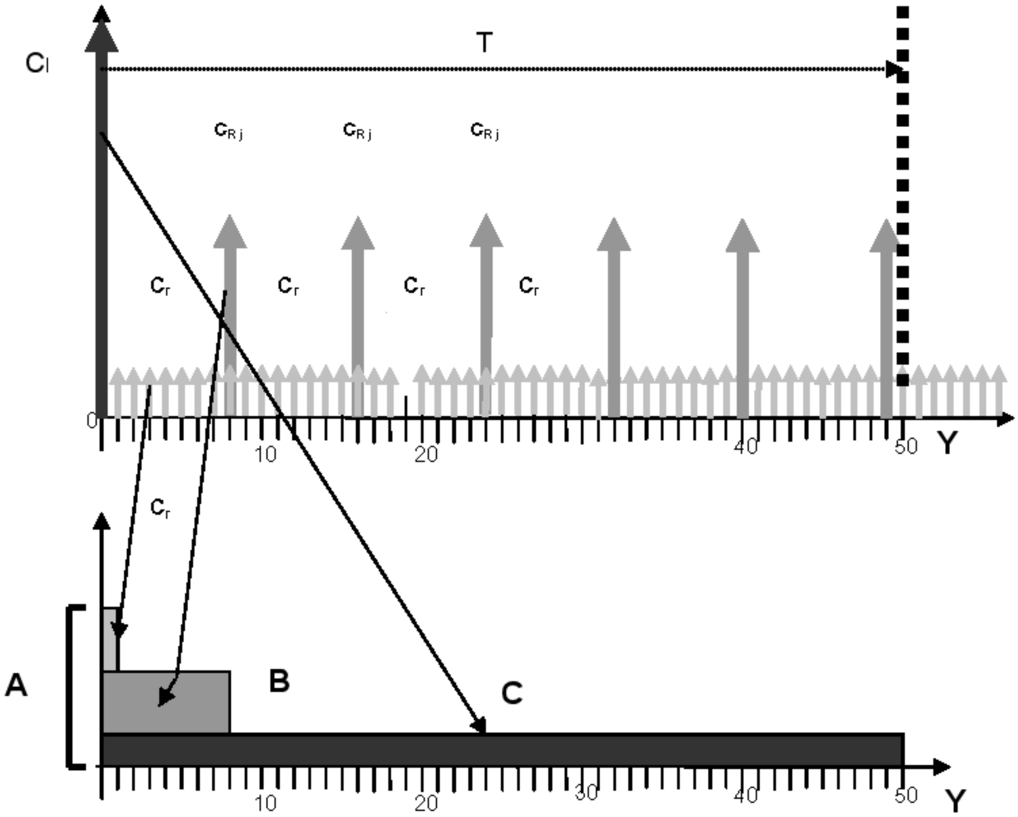
$$AC = C_r + \sum_i (a(i) \times (\sum_{\substack{j \\ for\ j, where \cdot \tau_n(j) = i < \tau\_Building}} V_0(j))) + a(\tau_{\_Building}) \times (\sum_{\substack{j \\ for\ j, where \cdot \tau_n(j) \geq \tau\_Building}} V_0(j)) \quad (7)$$

where:

C_r	represents the total running costs (see 5.3.4.)
$\sum_i (a(i) \times (\sum_j V_0(j))$	represents the total annualized costs related to replacement of the components or systems j, for which the lifespan is less than the design payback period of the building (see 5.3.3)
$a(\tau_{\_Building}) \times (\sum_j V_0(j))$	represents the total annualized costs for the components or systems j, that remain unchanged during the lifetime of the building (see 5.3.2)

Table 2 – Organisation of annuity calculation

Compon. no.	**Initial value**		**2**	**3**		**n**			**τ_Building** **(components unchanged)**	**Σ**
1	$V_0(1)$		0	1	0	0	0		0	Σ (line) = 1
			0	0	1	0	0		0	1
j	V_0 (j)		0	0	0	1	0		0	1
k	V_0 (k)		0	0	0	1	0		0	1
l	V_0 (l)		0	0	0	0	1		0	1
			0	0	0	0	1		0	1
y	V_0 (y)		0	0	0	0	0		1	1
Sum			a(2) **Σ**	a(3) **Σ**		a(n) **Σ**			a(τ_Building) **Σ**	



Key:

C_I initial investment costs

C_r running costs

$C_{R\,j}$ replacement costs

T design payback period of building (50 years)

A Cost repartition

B C_{Rj} on 8 years

C C_I on 50 years

Y year

Figure 4 — Annuity cost presentation

5.3.2 Annuity calculation for unchanged components during the design payback period of the building

All initial costs of the components or part of the systems that remain unchanged during the design payback period of the building are multiplied by the corresponding annuity factor $a(\tau_{\_Building})$.

For R_i = 2 %, R = 4,5 % and $\tau_{\_Building}$ = 50 years, the annuity factor $a(\tau_{\_Building})$ is 0,0349 (see Annex E Step 6).

5.3.3 Annuity calculation for replaced components

The initial replacement costs shall be multiplied by the corresponding annuity factor depending on R_p (rate of development of the price for products) and the lifespan of the considered component (See Annex A).

For R_p = 2 %, R = 4,5 % and τ_n (Boiler) = 15 years, the corresponding annuity factor is 0,0805 (see Annex E step 6).

5.3.4 Annuity calculation for running costs

Running costs cover annual energy costs, operational costs, maintenance costs and added costs on installation and building:

$$C_r = \left(C_e + C_o + C_m + C_{ad}\right) \qquad (8)$$

where:

C_r running costs

C_x particular running cost (i.e. index e: energy, o: operational, m: maintenance, ad: added)

For dynamic calculations, the price dynamic factor β_x is introduced (see 5.3.5) and the running costs are determined by:

$$C_r = \left(C_e \times \beta_e + C_o \times \beta_o + C_m \times \beta_m + C_{ad} \times \beta_{ad}\right) \qquad (9)$$

where:

C_r running costs throughout the calculation period

C_x particular running costs

β_x particular price dynamic factor

index x: e = energy costs, o = operational costs, m = maintenance costs, ad = added costs.

5.3.5 Influence of price development for dynamic calculations

If annual costs are considered to change during the calculation period, these costs shall be multiplied by the price dynamic factor β_x in order to determine the present value of the annual costs throughout the calculation period. The price dynamic factor is a function of the inflation rate R_i, the market interest rate R and the rate of development of the prices considered R_x:

$$\beta_x = \frac{1 - \left(\dfrac{1 + R_x / 100}{1 + R / 100}\right)^{\tau\_building}}{1 - \left(\dfrac{1 + R_i / 100}{1 + R / 100}\right)^{\tau\_building}} \times \frac{\left(R - R_i\right) / \left(1 + R_i / 100\right)}{\left(R - R_x\right) / \left(1 + R_x / 100\right)} \qquad (10)$$

and $R_x = R_i$ implies $\beta_x = 1$

Dynamic calculations are detailed in national methods or standards.

6 Principles of the method

6.1 General

Figure 5 illustrates the different stages of the method, which are described in the following.

The process is linear.

Some of the data is given for information (environment of the project), but shall be documented in order to provide possibility for comparison between buildings or use of conventional costs ratio in the building construction (e.g. cost per surface unit).

The parameters shall be chosen in accordance with those considered for the energy certification of the building.

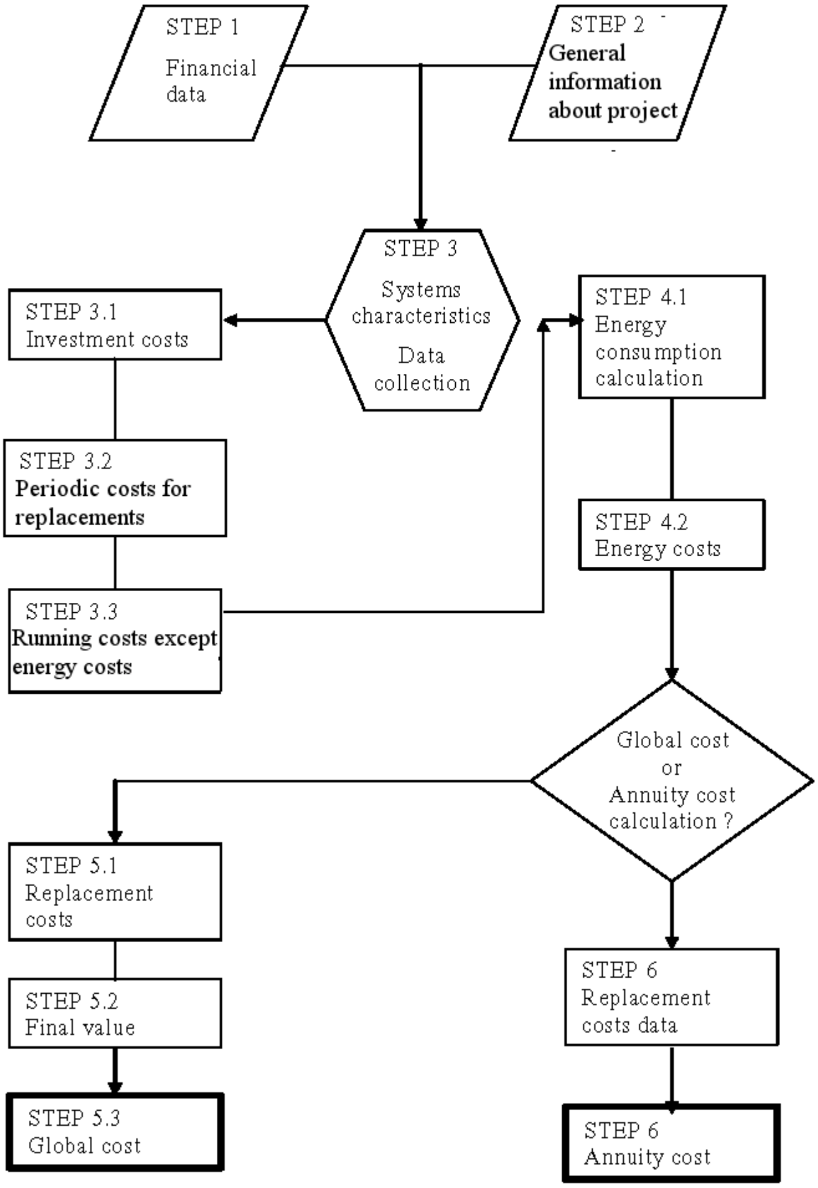


Figure 5 — Flowchart of the different stages of the method

6.2 STEP 1 - Financial data

6.2.1 Duration of the calculation

Duration of the calculation can be fixed according to the objectives of the calculation (or be given by the owner of the building). Default value could be the expected lifetime of the building. But it may also be interesting to perform the calculation for a shorter calculation period, e.g. for evaluation of the costs during the mortgaging period subscribed.

Duration of the calculation is taken into account by the number of years to be considered for the global cost calculation method. For the annuity calculation method, only the design payback period of the building is relevant.

6.2.2 Financial rate

Inflation rate is obtained or estimated from available economical institute data as an average value over the calculation period.

Market interest rate is the average expected value of the interest rate over the calculation period.

6.2.3 Human operation costs

The rate of development of human operation costs depends on the costs for operational staff (usually the rate of development of human operation costs is higher than the inflation rate). The average expected value over the calculation period is to be applied.

6.2.4 Energy prices

As a basis, the rate of development of energy prices is considered equal to the inflation rate. Available information can be obtained from energy utilities or from economical analysis regularly provided by the European Commission or national energy forecasting organizations.

NOTE Supplementary information about costs of supplied water to the building can be added for annual costs.

6.3 STEP 2 - General information about the project

6.3.1 Identification of systems

In this step, the systems to be considered in the economic calculations are identified and project data necessary to perform the calculations are provided. Information is obtained from the design project and from the contractors.

6.3.2 Environment of the project

These data are given for information as they are necessary in order to identify the constraints that could define or influence the energy consumption and the choices between the alternative solutions, which are being analysed:

- country or region;
- location of the building, e.g. city center, urban zone;
- construction constraints on the external aspects of the building (roof, envelope);
- type of buildings (e.g. row house, detached house, co-housing, multistory building);
- noise.

6.3.3 Meteorological and environmental data (not mandatory)

These data are given for information.

6.3.4 Constraints/oppportunity related to energy

Official energy requirements on building fabric and systems (these data are necessary in order to identify the constraints/opportunities on HVAC systems related to energy):

- forbidden fuels;

- orientation of the building;
- flue (possible or impossible);
- district heating (existing or not existing);
- difficulties for energy access for fuel distribution;
- fuel gas network proximity;
- possibilities for renewable energy sources (e.g. solar collectors, fuel cells, natural ventilation, heat pump);

Identify customers approach on comfort and occupancy.

6.4 STEP 3 - Systems characteristics

6.4.1 Data collection

Data concerning components and systems are collected and information about lifespan, maintenance and operation are gathered.

Annex A provides some default values for main components.

6.4.2 STEP 3.1 - Investment costs for systems related to energy

6.4.2.1 General

This step is applied to the systems identified in step 2, which are related to energy and energy conservation.

Table 3 provides examples for different applications of the calculation method.

Table 3 — Example of systems under consideration for costs calculation

Example of costs calculation	Heating	Domestic Hot Water	Ventilation	Cooling	Lighting	Building fabrics and insulation
Existing building Comparison between 2 heating systems	X	X				
New building Estimation of the annualized cost	X	X	X	X	X	X
Existing building Comparison between 2 heating systems with reduction of heat demand (insulation of the building)	X		X	X		X
Existing building Balancing between better performing heating system and	X					X

Table 3 — Example of systems under consideration for costs calculation

Example of costs calculation	Heating	Domestic Hot Water	Ventilation	Cooling	Lighting	Building fabrics and insulation
insulation of the envelope						

Descriptions of systems are given as examples in Annex B.

Lists given in 6.4.2.2 to 6.4.2.8 are meant for information and shall be completed according to the objectives of the calculation.

6.4.2.2 Investment cost for building construction

Indicates part of the structure that is related to energy efficiency or energy consumption (e.g. building fabrics, insulation, openings, glazing, doors, solar protection).

The calculation may be performed with all of the building structure taken into account, but in this case, the influence of the energy system will be reduced.

6.4.2.3 Space Heating

Generation and storage:

- includes boiler or heat pump or substation with control and heat exchanger;
- solar collectors;
- others (e.g. district heating, combined heat and power production, fuel cells);
- includes storage tank and control system (valve, sensor, heat exchanger, pump).

Distribution:

- main piping, pump(s) and equilibrium valves;
- wiring for control;
- wiring for electrical emitters.

Emission:

- radiators;
- embedded systems (floor emission, wall emission) should be considered as part of the heat emission system and not part of the building construction;
- electrical emitters (includes radiators, convectors and storage emitters with their control system).

Control:

- consider functions and products which are necessary to control heating in an efficient way (cf. EN 12098 series).

6.4.2.4 Domestic hot water

Domestic hot water systems include:

- generation (e.g. boiler, heat pump, heat exchanger, electric storage water heater);
- storage (intermediary storage heater);
- distribution (e.g. piping, mixing valve, thermostatic valve);
- emission (thermostatic valve, mixing valve);
- control (temperature, charge control for storage).

6.4.2.5 Ventilation

Ventilation systems include:

- air supply;
- distribution (ducts, fans);
- emission;
- control (includes filters, room control).

NOTE Natural ventilation is directly linked to the conception of the building, but specific items needed for air inlet and air outlet should appear in this part.

6.4.2.6 Space cooling

Space cooling systems include:

- generation (related to heating or specific chiller);
- storage (if necessary);
- distribution (piping, equilibrium valves);
- emission;
- control.

6.4.2.7 Lighting

- type of lighting and associated control system;
- solar protection and closing may be concerned if natural lighting is enhanced.

6.4.2.8 Connection to energy supplies

- consider the specific cost to be connected to energy network and the specific protection in the electric board;
- storage tank for fuel oil, gas or biomass.

6.4.2.9 Other systems

Any processes involving energy that could be recoverable for the building.

Building Management Systems, which introduce supervising functions that authorize coupling between the different systems or reduction of the costs of energy contracts, should be considered as a specific cost. If not, control functions (and associated costs) are considered within the specific systems.

6.4.3 STEP 3.2 - Periodic costs for replacements

In this step, timing of and costs for replacement of systems and components are gathered.

Some data about lifetime of components are presented in Annex A.

6.4.4 STEP 3.3 – Running costs except energy costs

6.4.4.1 Operational costs (excluding energy)

Operational costs represent the cost for energy operators of the building.

6.4.4.2 Maintenance and repairs

Consider staff inspection and consumable items or annual contracts for cleaning and maintenance of components and systems.

As periodic inspection of energy systems for heating and air conditioned systems are mandatory, these verifications shall be included in periodic maintenance operations (e.g. for boilers, chillers).

6.4.4.3 Added costs

Includes insurance and taxes which are related to energy systems. For example, special taxes related to pollutants or energy use.

6.5 STEP 4 - Energy costs

6.5.1 General

Energy costs are mainly separated in two parts:

— first part is directly related to energy consumption according to meters or fuel consumption of the building. The method for determination of energy consumption shall be coupled to energy content of the fuel according to data from the provider;

— second part is fixed according to the quantity of energy subscribed with energy utilities or rental for energy systems (e.g. gas tank, electricity transformation).

For district heating systems, special subscription conditions may apply.

Environmental (or social) costs could also be introduced as a cost related to energy.

Energy sales (if relevant) are counted separately as negative costs.

6.5.2 STEP 4.1 - Calculation of energy consumption

Calculation should be performed according to standardized methods. prEN 15603 allows calculation of the energy consumption for the whole building. If the economical analysis only takes into account some of the energy systems, then the energy consumption calculation shall similarly only take these systems into account (i.e. prEN 15316 series for space heating and domestic hot water systems)

Reference to the standards (or specific methods, if needed) should be referenced in the results report.

6.5.3 STEP 4.2 - Energy costs

Energy consumption is coupled with tariff for the energy considered.

In some cases, the energy consumption can be calculated according to the variable tariffs of the utility. These tariffs (mainly for electricity) may vary during the day and during specific periods of the year.

Renewable energy sources or energy sales (electricity or hot water) shall be considered either as a financial income (as electricity from Photovoltaic cells can be sold directly on the electric grid) or as a way to reduce energy cost of the building (example solar collectors). Design of the system shall be considered in accordance with these two possibilities.

6.6 STEP 5 - GLOBAL COST CALCULATION

6.6.1 Step 5.1 Calculation of replacement costs

Replacement costs throughout the calculation period are calculated based on timing of and costs for replacement of systems and components, as gathered in step 3.2.

Present value factor or discount rate is used to refer costs to the starting year.

6.6.2 Step 5.2 Calculation of final value

Final value by the end of the calculation period is determined by summing up the final value of all systems and components.

The final value of a specific system or component is calculated from the remaining lifetime (by the end of the calculation period) of the last replacement of the system or component, assuming linear depreciation over its lifespan. The final value is determined as remaining lifetime divided by lifespan and multiplied with the last replacement cost and referred to the starting year by the appropriate discount rate.

Figure 3 illustrates the calculation process for one unit (component or system).

6.6.3 Step 5.3 Calculation of global cost

The different types of costs (initial investment costs, periodic and replacement costs, running costs) as well as the final value are converted to global cost (i.e. referred to the starting year) by applying the appropriate present value factor (or discount rate).

The present value factor (or discount rate) may be different for different types of costs, due to different rates of price development for energy, human operation, products, maintenance and added costs.

The total global cost is determined by summing up the global costs of initial investment costs, periodic and replacement costs, annual costs and energy costs and subtracting global cost of the final value.

Annex C illustrates organization of the result data sheet.

6.7 STEP 6 - ANNUITY COST CALCULATION

Annuity cost calculation is performed for any component of part of the system according to 5.3.

For the annuity cost calculation, the calculation period is fixed and corresponds to the design pay back period of the building.

The total annualized cost is determined by summing up the annualized costs of systems and components (investment and replacements), the annual costs (operation costs, maintenance costs, added costs) and the energy costs (see Annex D).

The different types of costs are converted to annualized costs by applying the appropriate annuity factor (see example in Annex E).

For systems and components with a lifespan greater than or equal to the design payback period of the building, the annualized cost is determined from the initial investment cost and the annuity factor corresponding to the payback period.

For systems and components with a lifespan less than the calculation period, the annualized cost is determined from the replacement cost and the annuity factor corresponding to the lifespan.

Annual costs and energy costs are by definition annualized costs.

Annuity cost corresponds to the average annual cost at year 0.

Annex A
(informative)
Economical data for energy systems

Table A.1 presents some data about lifespan, annual maintenance costs and disposal cost for components and products. Column 3 displays a global value. National annexes can provide more detailed values of the costs for maintenance, repair and service.

Terms and definitions are in accordance with existing standards.

Table A.1 - Data for lifespan and maintenance costs

Component	**Lifespan** **Min – Max (years)**	**Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment**	**Disposal cost in % of the initial investment**
Air conditioning units	15	4	
Air coolers	15 - 20	2	
Air heaters, electric	15 – 20	2	
Air heaters, steam	15 – 20	2	
Air heaters, water	15 – 20	2 - 4	
Boiler - condensing	20	1 - 2	
Boiler – direct evacuation	20	1 - 2	
Boiler – Flue evacuation	20	1 - 2	
Burners, oil and gas	10	4 – 6	
Chimney	15 – 20		
Condensers	20	2	
Control equipment	15 –20	2 - 4	
Control system - Central	15-25	4	
Control system – room control	15 -25	4	
Control valves, automatic	15	6	
Control valves, manual	30	4	
Convectors	20	1	
Cooling compressors	15	4	

Table A.1 - Data for lifespan and maintenance costs

Component	Lifespan Min – Max (years)	Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment	Disposal cost in % of the initial investment
Cooling panels and ceilings	30	2	
Dampers	20	1	
Dampers with control motors	15	4	
Diffusers	20	4	
Dual duct boxes	15	4	
Duct system for filtered air	30	2	
Duct system for non filtered air	30	6	
Electric board	30	0,5 - 1	
Electric heater – thermal storage heater	20 – 25	1	1
Electric heating – convector	20 – 25	1	
Electric floor heating	25 –50* (*) if lifespan agreed according with tests results	2	20
Electric wiring	25 - 50	0,5 - 1	
Water floor heating	50	2	20
Evaporators	15 - 20	2	
Expansion vessels – membrane	15	0,5	
Expansion vessels with pad	15 - 25	2	
Expansion vessels, stainless	30	1	
Expansion vessels, steel	15	2	
Extract air grills	20	10	
Fan coil units	15	4	

Table A.1 - Data for lifespan and maintenance costs

Component	Lifespan Min – Max (years)	Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment	Disposal cost in % of the initial investment
Fans	15 - 20	4	
Fans with variable flow	15	6	
Filter frames	15	2	
Filter material to be exchanged	1	0	
Filter material, to be cleaned	10	10	
Fire dampers, easy accessible	15	8	
Fire dampers, hidden	15	15	
Fuel tank	30	0,5	5 – 10
Gas tank	30	0,5	5
Grills in general	30	4	
Heat pumps	15 - 20	2 - 4	
Heat recovery units, cyclic	15	4	
Heat recovery units, static	20	4	
Humidifiers, steam	4 - 10	4	
Humidifiers, water	10	6	
Meters	10	1	
Valve	10	1	
Motors, diesel	10	4	
Motors, electric	20	1	
Pipes, Cu	30	1	
Pipes, composite or (look at Water floor heating)	50	1	
Pipes, stainless	30	1	

Table A.1 - Data for lifespan and maintenance costs

Component	**Lifespan** **Min – Max (years)**	**Annual preventive maintenance including operation, repair and servicing costs in % of the initial investment**	**Disposal cost in % of the initial investment**
Pipes, steel in closed system	30	1	
Pipes, steel in open system	15	1	
Piping systems	30	0,5	
Pumps – circulation	10 -20	2	
Pumps - regulated	10 - 15	1,(5 - 2	
Radiators paint	20 - 30	0	
Radiators, water	30 -40	1- 2	
Shut off valves, automatic	15	4	
Shut off valves, manual	30	2	
Solar collector (Vacuum collector or plate collector	15 - 25	0,5	
Sound traps	30	1	
Tank storage for domestic hot water	20	1	
Tank storage with internal heat exchanger for domestic hot water	20	1	
Thermostats for radiators	15	4	
Valve with auxiliary power	10	1	5
Valve - Thermostatic	20	1,5	5
Variable flow units	15	6	
V-belt drive	10	6	
Wiring	30	1	

Annex B
(informative)

Systems description

Table B.1 - Description of space heating system with heat pump as hot water generator

Heating system: **Electrical heat pump for space heating**	**Component**	**Investment costs**	**Running costs** **Maintenance (as percentage of investment)**
Conception of the system			Information from prEN 15450
Emission	Embedded heat emission	X	Water treatment against corrosion and deposits
	Room control	X	Check set up
	Radiators	X	Cleaning and evacuate waste
	Fan coil units	X	Clean filters
Distribution	Pump	X	Check speed (or noise)
	Piping	X	Corrosion Deposit from the pipe (from cleaning operation)
	Mixing valve (including control)	X	Flow equilibrium
	Collectors	X	
	Expansion vessel	X	Pressure
Storage	Tank	X	Corrosion protection Prevent tartar deposit
	Seasonal storage	X	
Generation	Heat pump	X	Check pressure
	Control	X	Check set point
	Source collector	X	Corrosion Cleaning
	Electric board	X	Specific rate for electric charge Check connection and wire

Table B.2 - Description of heating system with combined gas boiler as hot water generator for space heating and domestic hot water

Heating system: **Combi boiler for space heating and domestic hot water**	**Component**	**Investment costs**	**Specific running costs** **Maintenance**
Conception of the system			EN 12828
Emission	Embedded heat emission	X	Water treatment against corrosion and deposits
	Room control	X	Check set up
	Radiators	X	
Distribution	Pump	X	
	Piping	X	
	Mixing valve (including control)	X	Flow equilibrium
	Collectors	X	
	Expansion vessel	X	
Storage	Vessel if combined DHW	Optional	
	Pump and valve	Optional	
Generation	Energy supply -fuel or gas tank or gas connection - electric connection	X	
	Specific room for boiler	Optional	Depends on regulation and power of the boiler
	Boiler	X	Annual Inspection for combustion and safety
	Control system	X	
	Condensing discharge	X	
	Flue system or chimney	X	
Other cost	Metering (cost attribution)	X	In case of individual repartition from centralized boiler

Table B.3 - Description of heating system for domestic hot water with solar collectors

System: **Solar system for domestic hot water**	**Component**	**Investment costs**	**Running costs** **Maintenance (as percentage of investment)**
Performance of the system			EN 12975
Emission	Valve	X	
Distribution	Piping	X	
	Heat exchanger	X	
Storage	Tank	X	
	Thermal charge control	X	
Solar Generation	Solar collector	X	Cleaning
	Piping and insulation	X	
	Pump and regulation	X	
	Frost protection	X	Check the composition of the fluid
	Energy supply for pump and regulation	X	
Secondary generation	Boiler or electrical resistance in the tank	X	

Table B.4 - Description of direct electrical heating system

Heating system: **Direct electrical heating system**	**Component**	**Investment cost**	**Running cost** **Maintenance (as percentage of investment)**
Conception of the system			EN 14437
Emission	Direct heating including temperature control	X	
Distribution			
Storage			
Generation			
Energy supply	Electric board	X	

Table B.5 - Description of domestic hot water systems with electrical storage water heater

System: **Electrical storage water heater for domestic hot water production**	**Component**	**Investment costs**	**Running costs** **Maintenance (as percentage of investment)**
Conception of the system			
Emission	Valve Thermostatic valve Low flow valve	X Optional Optional	
Distribution	Piping	X	
Storage			
Generation	Hot water storage tank including temperature control	X	
Energy supply	Electric board	X	

Table B.6 - Description of electrical heat pump for space heating and domestic hot water

Heating system: **Electrical heat pump for space heating and domestic hot water**	**Component**	**Investment costs**	**Running costs** **Maintenance (as percentage of investment)**
Conception of the system			prEN 15450
Emission	Radiators Heating floor VAV Louvres (air)	X X X Optional	
Distribution	Piping (water) Ducts (air)	X X	
	Pump Heat exchanger	X X	
Storage	Tank	X	
Generation	Heat pump	X	
Energy supply	Electric board	X	

Table B.7 - Description of ventilation system with VMC

VENTILATION SYSTEM : **VMC**	**Component**	**Investment costs**	**Specific running costs** **Maintenance**
Conception of the system			
Emission	Terminal	X	Water treatment against corrosion and deposits
Distribution	Flexible ducts	X	
Storage			
Generation	Fan	X	
Connection to energy source	Electric board	X	

Table B.8 - Description of ventilation system with heat recovery unit(s)

VENTILATION SYSTEM : **VMC WITH HEAT RECOVERY UNITS**	**Component**	**Investment costs**	**Specific running costs** **Maintenance**
Conception of the system			
Emission	Extract air grills	X	Water treatment against corrosion and deposits
Distribution	Flexible ducts	X	
Storage			
Generation	Fan and heat recovery units	X	
Connection to energy source	Electric board	X	

Table B.9 - Description of natural ventilation system

Ventilation system : **Natural ventilation**	**Component**	**Investment costs**	**Specific running costs** **Maintenance**
Conception of the system			
Emission	Air grills	X	
Distribution	Conducts	X	
Storage			
Generation	Static extractors on the roof	X	
Connection to energy source			

Table B.10 - Description of ventilation system with humidity control

Mecanical ventilation: **VMC with humidity control**	**Component**	**Investment costs**	**Specific running costs** **Maintenance**
Conception of the system			
Emission	Extract air grills	X	
Distribution	Flexible ducts	X	Cleaning
Storage			
Generation	Fan and heat exchanger or exhaust air (static or dynamic)	X	Cleaning filters
Connection to energy source	Electric board	X	

Table B-11 - Description of building envelope system

SYSTEM: **BUILDING CONSTRUCTION**	**Component**	**Investment costs**	**Running costs** **Maintenance (as percentage of investment)**
Wall	Structure External cover Internal/external Insulation Internal cover (finish) …	X X X X	
Facade – glazing	Doors Windows Solar protection	X X Optional	
Roof	Structure Cover Insulation Finish	X X X X	
Floor	Structure Insulation	X X	
Thermal bridges	Industrial product Customised realisation	Optional Optional	
Boiler adaptation	Chimney Room Flue systems	Optional Optional Optional	Depends on power of boiler
Others features	Technical galleries Access Building adaptation for fuel storage Building adaptation for electric transformer, gas valve, counting units	Optional Optional Optional Optional	

Annex C
(informative)
Calculation sheet for global cost calculation

Duration of calculation (τ)		Years	Rate of development of operation cost		%	
Inflation rate		%	Rate of development of cost for energy type 1		%	
Market interest rate		%	Rate of development of cost for energy type 2		%	
Rate of development of cost for products		%	Rate of development of cost for electricity		%	(for auxiliary components)

		Total, incl. VAT year 0	Inflation rate	Present value factor		Cost due to owner		Costs due to occupancy
1 – INITIAL COSTS								
Investment costs for HVAC and DHW systems				1,0000				
Investment costs for part of building construction related to energy savings and losses				1,0000				
2 – PERIODIC COSTS				Calculated for any year				
Costs for year 2								
Costs for year i								
Final value reduction					-			
3 – RUNNING COSTS (except energy)				Consider τ years				
Annual costs (for operation, insurance, etc.)								
4 – ANNUAL COSTS FOR ENERGY				Consider τ years				
Annual costs energy 1	(to be multiplied by τ)							
Annual costs energy 2	(to be multiplied by τ)							
Annual costs auxiliary energy (electricity)	(to be multiplied by τ)							
		GLOBAL COST						
		TOTAL GLOBAL COST						

Annex D
(informative)
Annuity calculation, organisation of data and results

Systems		Annuity cost	Initial Investment	Year 1						Year i						Year k			…			Year τ ($\tau = \tau_{\_Building}$)			
		any Item to be considered		Operation	Maintenance	Repair				Operation	Maintenance	Repair				Operation	Maintenance	Repair				Operation	Maintenance	Repair	Final Value
System	Compon. 1			X	X					X	X					X	X	X				X	X		$V_{f,\tau}(1)$
HVAC				X	X					X	X	X				X	X					X	X		
DHW				X	X					X	X					X	X					X	X		
Building	Compon. 1		$V_0(1)$	X	X					X	X					X	X					X	X		$V_{f,\tau}(1)$
	Compon. 2		$V_0(2)$	X	X					X	X					X	X					X	X		$V_{f,\tau}(2)$
	Etc.		$V_0(j)$	X	X					X	X					X	X					X	X		$V_{f,\tau}(j)$
Operation cost				Σ						Σ						Σ						Σ			
Maintenance cost					Σ						Σ						Σ						Σ		
Repair cost						Σ						Σ						Σ						Σ	
Energy	Energy 1																								
	Energy 2																								
	Etc.																								
Taxes, insurance																									
Annuity factor																									
		RESULT	V_0	AC(1)						AC(i)						AC(k)						AC(τ)			

Annex E
(informative)

Example 1 – Dwelling 100 m² with gas heating system

E.1 STEP 1 - Financial Data

Design payback period of building: 50 years

Duration of the calculation: 30 years

Inflation rate: 2 %

Market interest rate: 4,5 %

Rate of development of human operation costs: 2 %

Rate of development of energy prices: 2 % (gas and electricity)

E.2 STEP 2 - General information about project

E.2.1 Identification of systems

Building construction: walls, glazing and doors, cover and floor

Energy systems: heating system, domestic hot water system and ventilation system

The project is operated by the owner

E.2.2 Environment of the project

Low rise building (ground floor)

Surface: 100 m² located in a residential area

Heated volume: 250 m^3

3 rooms – 1 bathroom

Design room temperature: 18 °C

E.2.3 Meteorological and environmental data (for information)

Heat demand: 2.583 degree days

Summer season E3 (french rating)

Noise area: BR3 (french rating)

Heating period: from 1st October to 20th May (232 days)

Energy chosen for space heating and domestic hot water: natural gas (network close to the construction)

E.3 STEP 3 - System characteristics

E.3.1 STEP 3.1 – Investment costs for building construction and systems related to energy

Table E.1 – Description of the components used to define the energy systems

Building construction	**Identification**	**Number of units**	**Total cost incl. VAT**	**Lifespan**
Walls	Concrete bricks	89	3.083	Building
	External cover	89	1.558	Building
	Insulation TH 38 8+1	89	1.720	Building
Glazing and doors	Insulating windows, 4/12/4	8	2.451	30
	External door	1	229	25
	Service door (to garage)	1	152	25
	Shutters	8	2.100	25
Cover	Roof cover (wooden structure and terracosta cover)	140	8.278	30
	Rockwool, thickness: 200 mm	100	1.021	40
	Plaster coating	100	1.860	Building
Floor	Floor structure concrete : thickness : 18 cm	100	6.564	Building
	Floor insulation	100	820	Building
TOTAL BUILDING CONSTRUCTION			**29.836**	
Heating system				
Emission	Steel Radiators including hydraulic valve control, thermostatic valve and room control system	8	3 792	20
Distribution	Steel pipe		474	30
Generation	Gas combi boiler with flue Power :23 kW		1.494	15
Connection to energy	Gas Electricity		457 762	25
Domestic Hot Water				
Emission	Thermostatic valve (kitchen and bathroom)	3	153	20
Distribution	Copper Piping	20 m	237	30
Generation	See heating system			
Ventilation				
Emission	Air input VMC in kitchen and bathroom	48 255	303	25
Generation	Fan and flexible ducts	273	273	20
Connection to electric board		69	69	25
TOTAL ENERGY SYSTEMS			**8.014**	

E.3.2 STEP 3.2 – Periodic costs for replacements

Table E.2 – Costs for components of building

Building			lifespan	lifespan	lifespan	lifespan	lifespan	lifespan
	Constituants	Investment costs	20 years	25 years	30 years	40 years	50 years	Building
Walls	Concrete bricks	3.083						3.083
	External cover	1.558						1.558
	Insulation TH 38 8+1	1.720						1.720
Glazing and doors	Insulating windows, 4/12/4	2.451			2.451			
	External door	229		229				
	Service door (to garage)	152		152				
	Shutters	2.100		2.100				
Cover	Roof cover (wooden structure and terracosta cover)	8.278			8.278			
	Rockwool, thickness: 200 mm	1.021				1.021		
	Plaster coating	1.860						1.860
Floor	Floor structure concrete : thickness : 18 cm	6.564						6.564
	Floor insulation	820						820
TOTAL		**29.836**	**0**	**2.481**	**10.729**	**1.021**	**0**	**15.605**

Table E.3 – Costs for components of the energy systems

1 – Heating			lifespan	lifespan	lifespan	lifespan	lifespan	lifespan
	Constituants	Investment cost	5 years	10 years	15 years	20 years	25 years	30 years
Emission	8 steel radiators (including fixing and connection)	3.792				3.792		
	thermostatic valve							
	+ Equilibruum valve + room thermostat							
Distribution	Steel piping	474						474
Generation	Combi boiler with flue	1.494			1.494			
	23 kW							
Connection to energy source	Gas connection	457					457	
	Electricity connection	762					762	
2 – Domestic hot water			lifespan	lifespan	lifespan	lifespan	lifespan	lifespan
	Constituants	Investment cost	5 years	10 years	15 years	20 years	25 years	30 years
Émission	Mixing valve : 3	153				153		
	42,68 Euro HT / unit							
	2 in bathroom - 1 in kitchen							
Distribution	Copper piping	237						237
	9,91 Euro HT / m							
3 – Ventilation			lifespan	lifespan	lifespan	lifespan	lifespan	lifespan
	Constituants	Investment costs TTC	5 years	10 years	15 years	20 years	25 years	30 years
Emission	Inlet air	48					48	
	Mechanical extraction (2 rooms)	255					255	
Generation	Fan unit + gains	273				273		
connection to energy suplly / and network	see heating	69					69	
TOTAL		**8.014**	**0**	**0**	**1.494**	**4.218**	**1.591**	**711**

NOTE 1 Costs indicated in Table E.2 at different times are not actualised or calculated with real interest rate. As the rate of development of costs for equipment, human operation and repairs are the same; costs are not displayed in the different categories.

NOTE 2 Replacement will be ordered in the future. Hopefully better quality of replaced component is expected, and therefore lower energy consumption after this first lifespan can be foreseen. At least the energy consumption should not be higher than the original one.

E.3.3 Step 3.3 – Running costs except energy costs

Maintenance costs: 2,75 % of the investment costs related to emission and generation for heating and distribution : 150 €

E.4 STEP 4 – Energy costs

E.4.1 STEP 4.1 - Energy consumption

Table E.4 – Energy consumption

1 – Heating									
Method of software used	Main assumption	Degree-day	2583	Dj 18 °C	Rating according to standard requirements or regulation			5	%
Method AC V6 (French)		Heating season	232	days	From		to		
		Room temperature	18	°C	Night temperature		°C		
					Exhaust air recuperation (Y/N			N	
Main energy used	**Type**	**Unit for energy**		Power	Unit		Storage	Unit	
	Gas	**9446 kWh**			kW				
2 - Domestic Hot Water	Main assumption	Average daily consumption				m³ / j			
		Inlet temperature for water				°C			
Main energy used	**Type**	**Unit for energy**		Power	Unit		Storage	Unit	
	Gas	**2787 kWh**							
3 – Ventilation									
		minimum flow rate		m³/h		maximal flow rate		m³/h	
Electricity				Consumption	Unit				
				680	**kWh**				

E.4.2 Step 4.2 - Energy costs

Table E.5 – Energy costs for the different systems

1 - Heating

				Reference	Price per unit	%	Consumption	Total HT	VAT and Taxes	Total TTC
Main energy	Energy	Gas	annual access		98			98	5,5	103
	Annual consumption	9446	Consumption		0,023	100	9446	217	19,6	260
	Power		Period 2							
	Tariff	B1	Period 3							
Auxiliary	Energy	Electricity	annual access		49			49	16,98	57
	Annual consumption		Consumption							
	Power		Period 2							
	Tariff (utility description)	6 kVA HP	Period 3							
			TOTAL HEATING					364		**420**

2 - Domestic hot water

				Reference	Price per unit	%	Consumption	Total HT	VAT and Taxes	Total TTC
Main energy used	Energy	Gas	annual access							
	Annual consumption	2787	Consumption		0,023	100	2787	64	19,6	77
	Power or price per delivery		Period 2							
	Tariff	with heating	Period 3							
			TOTAL DOMESTIC HOT WATER					64		**77**

Table E.5 – Energy costs for the different systems

3 - Ventilation

				Reference	Price per unit	%	Consumption	Total HT	VAT	Total TTC
Electricity	Energy	Electricity	annual access							
	Annual consumption	680	Consumption		0,078	100	680	53	31,08	70
	Power		Period 2							
	Tariff (utility description)	with heating	Period 3							
			TOTAL VENTILATION					53		**70**

			Total HT		Total TTC
TOTAL Energy 1		Gas	379		**440**
TOTAL Electricity including auxiliary)		Electricity	102		**127**
	TOTAL ENERGY		**481**		**567**

E.5 STEP 5 - Global costs

E.5.1 Step 5.1 and 5.2 - Calculation of replacement costs and final value

Table E.6 - Final value of the components

Calculation period τ	30	years		
			Design payback period of building	50 years

		lifespan 5 years	lifespan 10 years	lifespan 15 years	lifespan 20 years	lifespan 25 years	lifespan 30 years	lifespan 35 years	lifespan 40 years	lifespan 45 years	lifespan 50 years	lifespan Building
Replacement costs (building part)						2 481	10 729		1 021			15 605
Replacement costs (energy systems)				1 494	4 218	1 591	711					
TOTAL (see NOTE 1)				1 494	4 218	4 072	11 440		1 021			15 605
At the end of calculation period τ	30 years											
Final value		100,00 %	100,00%	100,00%	50,00%	80,00%	100,00%	14,29%	25,00%	33,33%	40,00%	40,00%
	Total											
Final value at τ_n (see NOTE 2	24 798	0	0	1 494	2 109	3 258	11 440	0	255	0	0	6 242

NOTE 1 Part of the table dealing with replacement costs present only the value of replacement at the first replacement. Depending on the lifespan of components and the calculation period chosen, subsequent replacements may occur, e.g. for components with a lifespan of 15 years, see Table E.7.

NOTE 2 Final value determined in this table is the value by the end of the calculation period. Final value referred to the starting year is determined in Table E.7 by applying the appropriate discount rate coefficient depending on inflation rate and market interest rate.

E.5.2 Step 5.3 - Global cost report

Table E.7 – Data sheet report for global cost calculation

General data for calculation

Calculation period	30	years	Operation cost, rate of development	2	%	
Inflation rate	2	%	Gas price, rate of development	2	%	
Market interest rate	4,5	%			%	
Payback period of building	50	years	Electricity price, rate of development	2	%	

	Total VAT incl. year 0	Inflation rate	Present value factor		**Total due for owner**	**Total duefor occupant**
1 - Investment (Step 3.1)						
Investment cost for energy systems	8 014		1,0000		8 014	
Investment cost for building	29 836		1,0000		29 836	
2 - Replacement costs (Step 3.2)			Discount rate coefficient			
Replacement program for lifespan 15 years	1 494	2,0 %	0,6954		1 039	
Replacement program for lifespan 20 years	4 218	2,0 %	0,6161		2 599	
Replacement program for lifespan 25 years	4 072	2,0 %	0,5459		2 223	
Replacement program for lifespan 15 years	1 494	2,0 %	0,4836		723	
Replacement program for lifespan 30 years	11 440	2,0 %	0,4836		5 533	
Final value at the end of the period of calculation	24 798	2,0 %	0,4836	-	11 993 *	
3 – Running costs except energy costs (Step 3.3)			Present value factor			
	150	2,0 %	21,0678			3 160
4 – Energy costs (Step 4.2)			Present value factor			
Energy cost 1 – Gas	440	2,0 %	21,0678			9 270
Energy cost for electricity (including auxiliary)	127	2,0 %	21,0678			2 676
Total global per actor					**37 974**	**15 106**
TOTAL GLOBAL COST					**53 080**	

E.6 STEP 6 – Annuity calculation costs

Table E.8 - Data sheet report for annuity calculation

General data for calculation (from STEP 1)

Design payback period of building	50	Years	Operation cost, rate of development	2	%
Inflation rate	2	%			
Market interest rate	4,5	%			

	Value TTC year 0	Inflation rate	Annuity factor	**Annualized cost for owner**	**Annualized cost for occupant**
1 - Investment					
Components unchanged during design payback period of building	15 605	2,0 %	0,0349	545	
2 - Replacement costs			For each period		
Lifespan 5 years		2,0 %			
Lifespan 10 years		2,0 %			
Lifespan 15 years	1 494	2,0 %	0,0805	120	
Lifespan 20 years	4 218	2,0 %	0,0639	269	
Lifespan 25 years	4 072	2,0 %	0,0540	220	
Lifespan 30 years	11 440	2,0 %	0,0475	543	
Lifespan 35 years		2,0 %			
Lifespan 40 years	1 021	2,0 %	0,0395	40	
Lifespan 45 years		2,0 %			
Lifespan 50 years		2,0 %			
3 - Running costs (except energy costs (Step 3.3)					
Annual cost for operation, insurance, maintenance	150		1,0000		150
4 - Energy costs (Step 4.2)					
Annual cost for all energies delivered	567		1,0000		567
Annualized costs depending on actors				1 737	717
Total annualized cost results				**2 454**	

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