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Sustainability of construction works — Assessment of economic performance of buildings — Calculation methods

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/558, Sustainability of construction works.

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

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Foreword

This document (EN 16627:2015) has been prepared by Technical Committee CEN/TC 350 “Sustainability of construction works”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by December 2015 and conflicting national standards shall be withdrawn at the latest by December 2015.

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Introduction

The purpose of this European Standard is to provide calculation rules for the assessment of the economic performance of new and existing buildings as one part of an assessment of the sustainability of the building. It complements the European Standard EN 15643-4.

In EN 15643-4 the following economic assessment indicators are described:

This standard describes the methods and the rules for calculating the cash flows over the life cycle of buildings, with an emphasis on the field of life cycle costing. Principles developed in ISO 15686-5 are included, but have been adapted for sustainability assessment in the European context.

This standard describes two approaches to the calculation of economic performance:

a) Life Cycle Costing: Economic performance expressed in cost terms over the life cycle, taking account of negative costs related to energy exports and from re-use and recycling of parts of the building during its life cycle and at the end of life. Calculation of this indicator is mandatory for compliance with the standard.

b) Life cycle economic balance: Life Cycle Costing (see above) and in addition incomes over the life cycle and at the end of life. Calculation of this additional indicator is optional for compliance with the standard.

NOTE 1 Annex C describes a further optional approach, value stability.

This European Standard is part of a suite of European Standards, Technical Specifications and Technical Reports for the assessment of the economic performance of buildings that together support quantification of the contribution of the assessed building to sustainable construction and sustainable development.

The economic performance of a building is only one aspect of its sustainability. The environmental and social performance of the building are also aspects of sustainability that are assessed as part of a sustainability assessment. These are described in the framework standards (EN 15643-1, EN 15643-2, and EN 15643-3, EN 15643-4).

NOTE 2 The economic assessment is undertaken at the building level. However, it requires technical and cost information about individual products and components within the building and its services and systems, including service life data, type and frequency of inspection, replacement, cleaning, maintenance and repair, and deconstruction and disposal. This information is used as input quantities for the calculation of cost in the life cycle of buildings.

The evaluation of technical and functional performance is beyond the scope of this European Standard. Technical and functional characteristics are taken into account here by reference to the functional equivalent, which also forms a basis for comparison of the results of assessments.

This European Standard is intended to support the decision-making process and documentation of the assessment of the economic performance of a building. Although the assessment results are based on realistic scenarios, they may not fully reflect the actual and future performance of the building. Figure 1 illustrates how the assessment of the economic performance takes place within the concept of the sustainability assessment of buildings.

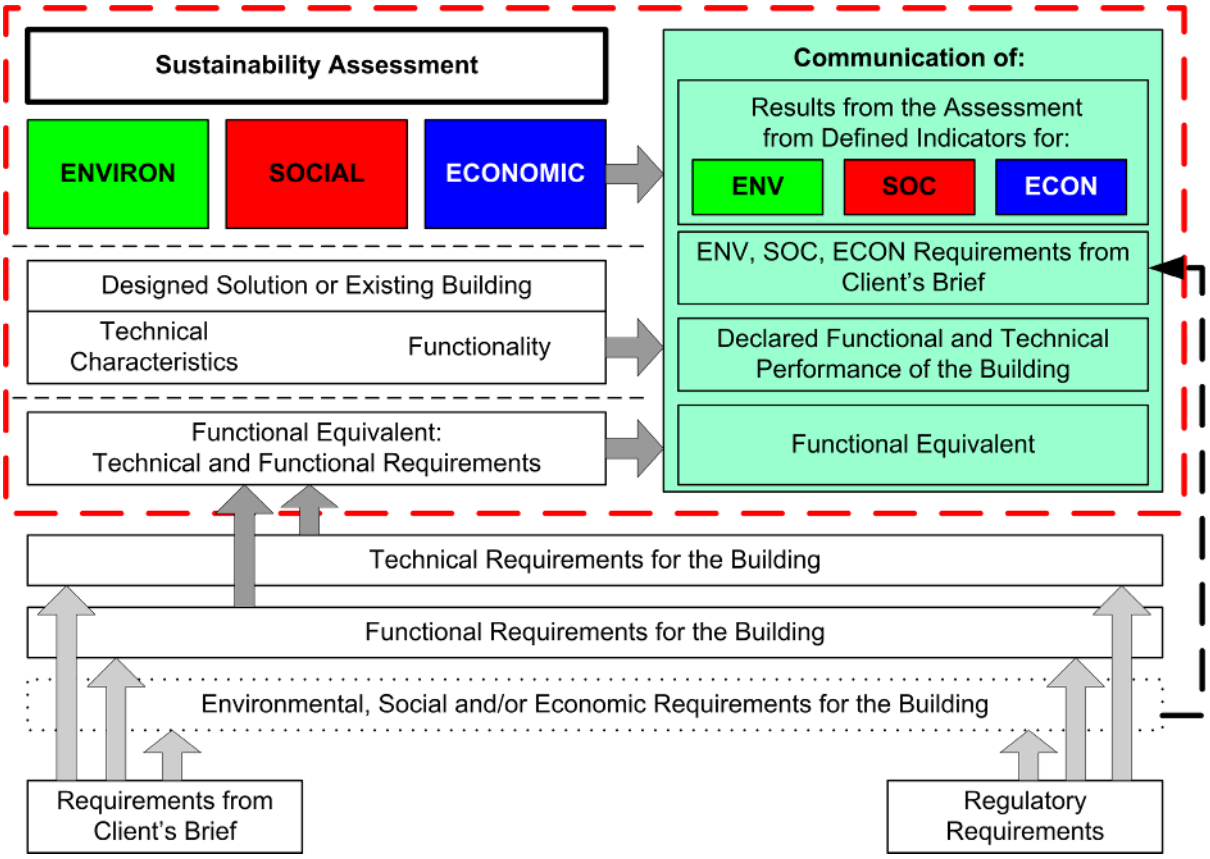


Figure 1 — Concept of sustainability assessment of buildings

In this European Standard, the assessment method for the quantitative evaluation of the economic performance of the building is based on a life cycle, cash flow approach. The general requirements for sustainability assessment of buildings are described in EN 15643-1 (the general framework standard).

It is important to use a consistent model for describing and recording the building and its life cycle for assessing the environmental, social and economic performance. The same reference study period is used for all three elements of the assessment.

Additional specific requirements for the assessment of economic performance are given in EN 15643-4, including additional pre-construction activity and costs such as site costs and professional fees, which are quantified and reported in the additional information module A0.

The calculation of economic indicators uses a model of the building and its life cycle with associated time and financial costs. An economic performance assessment supports a complete sustainability assessment, including an environmental or social performance assessment or both. The economic assessment can also provide data for:

— budgeting, by estimation of future maintenance or operational costs;

— tendering, e.g. by estimation of future cleaning costs sensitivity analysis, e.g. estimation of future energy costs (nominal values);

— estimating end of life costs and waste streams;

— specific economic analyses (e.g. cost benefit analysis);

— assigning cash flows to individual actors (landlord/tenant);

— applying methods of valuation (e.g. investment appraisal).

Other European Standards developed by CEN/TC 350 in this area, and how they are related to this European Standard, are shown in Figure 2.

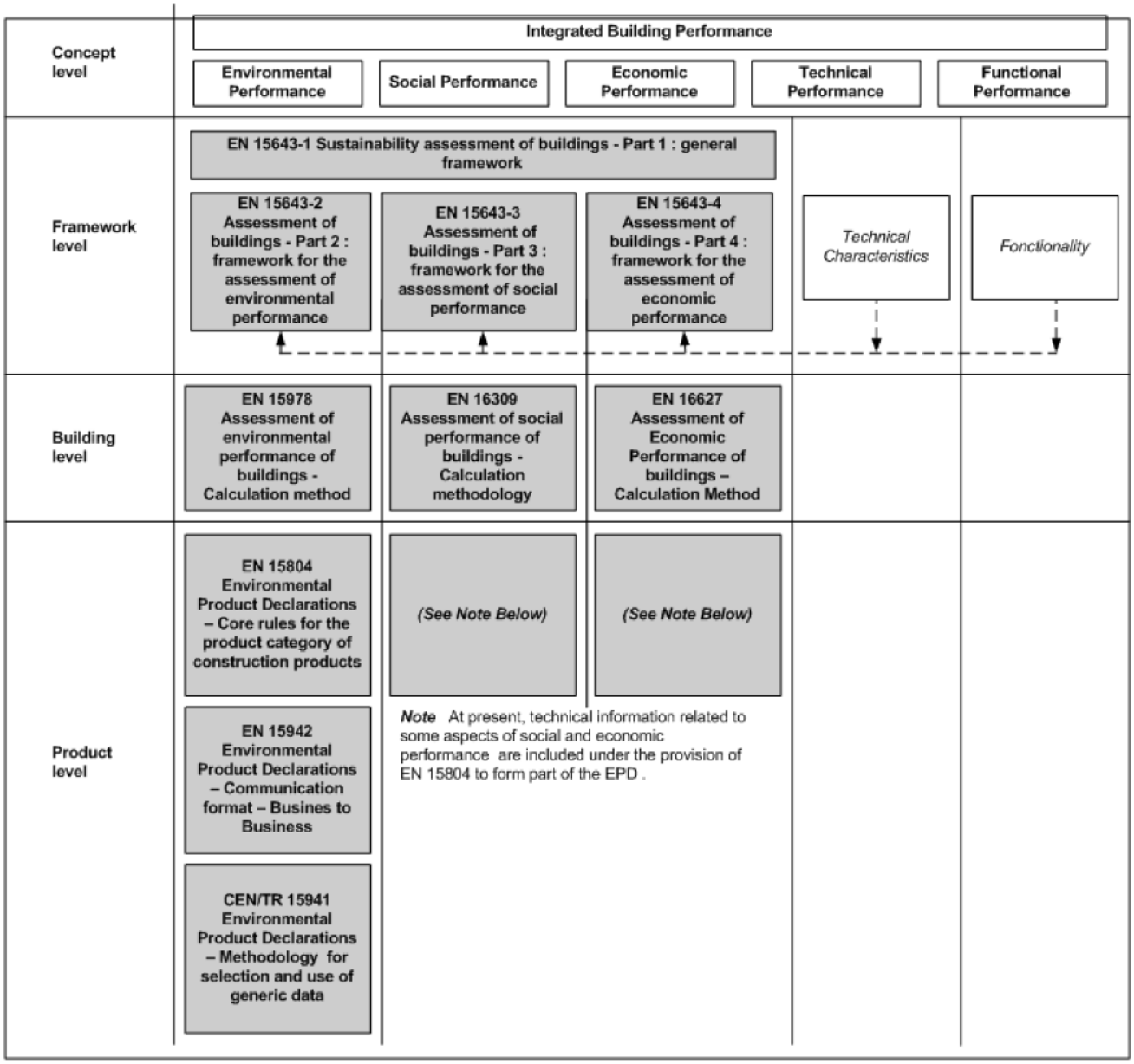


Figure 2 — Work program of CEN/TC 350

NOTE 3 This European Standard is intended for use to assess the economic aspects of sustainable performance of a building. This is a distinct activity from the Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings, which is a methodology for the setting of energy performance standards in national and regional building regulations by Member States, and not for use on specific buildings.

NOTE 4 EN 15459 is the European Standard which provides a calculation method for the costs of heating systems and other systems that are involved in the energy use of a building. It does not address the calculation of the whole economic impact of a building.

1 Scope

This European Standard specifies the calculation methods, based on Life Cycle Costing (LCC) and other quantified economic information, to assess the economic performance of a building, and gives the means for the reporting and communication of the outcome of the assessment. This European Standard is applicable to new and existing buildings and refurbishment projects.

This European Standard gives:

— the description of the object of assessment;

— the system boundary that applies at the building level;

— the scope and procedure to be used for the analysis;

— the list of indicators and procedures for the calculations of these indicators;

— the requirements for presentation of the results in reporting and communication;

— and the requirements for the data necessary for the calculation.

The approach to the assessment covers all stages of the building life cycle and includes all building related construction products, processes and services, used over the life cycle of the building.

The interpretation and value judgments of the results of the assessment are not within the scope of this European Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 15603:2008, *Energy performance of buildings — Overall energy use and definition of energy ratings*

EN 15643-1, *Sustainability of construction works — Sustainability assessment of buildings — Part 1: General framework*

EN 15643-2:2011, *Sustainability of construction works — Assessment of buildings — Part 2: Framework for the assessment of environmental performance*

EN 15643-3, *Sustainability of construction works — Assessment of buildings — Part 3: Framework for the assessment of social performance*

EN 15643-4:2012, *Sustainability of construction works — Assessment of buildings — Part 4: Framework for the assessment of economic performance*

ISO 15392:2008, *Sustainability in building construction — General principles*

ISO 15686-1:2011, *Buildings and constructed assets — Service life planning — Part 1: General principles and framework*

ISO 15686-2, *Buildings and constructed assets — Service life planning — Part 2: Service life prediction procedures*

ISO 15686-7, *Buildings and constructed assets — Service life planning — Part 7: Performance evaluation for feedback of service life data from practice*

ISO 15686-8:2008, *Buildings and constructed assets — Service-life planning — Part 8: Reference service life and service-life estimation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15643-2:2011, EN 15643-4:2012, ISO 15686-1:2011 and the following apply.

3.1
assembled system
part of works
component or set of components incorporated in the **construction works**

Note 1 to entry: Adapted from the definitions in the Construction Products Directive (CPD) Guidance Paper C and from the definition of "construction" in ISO 6707-1:2014, 5.5.6.

3.2
brief
written document that states the **client's** requirements for a construction project

[SOURCE: ISO 6707-2:2014, 3.1]

3.3
building
construction works that has the provision of shelter for its occupants or contents as one of its main purposes and is usually enclosed and designed to stand permanently in one place

[SOURCE: ISO 6707-1:2014, 3.1.3]

3.4
building fabric
all **construction products** that are fixed to the **building** in a permanent manner, so that the dismantling of the product decreases the performance of the building and the dismantling or replacement of the product constitute construction operations

3.5
building site
specified area of land where a **building** is located or is defined to be located and **construction work** of the **building** and associated **external works** are undertaken

Note 1 to entry: Adapted from the definition of site in ISO 6707-1:2014, 3.1.6.

3.6
built environment
collection of **buildings**, **external works** (landscape area), infrastructure and other **construction works** within an area

Note 1 to entry: Adapted from the definition of environment in ISO 6707-1:2014, 10.3.

3.7
client
person or organization that requires a **building** to be provided, altered or extended and is responsible for initiating and approving the **brief**

[SOURCE: ISO 6707-1:2014, 8.3]

3.8
component
construction product manufactured as a distinct unit to serve a specific function or functions

[SOURCE: ISO 6707-1:2014, 6.1.3]

3.9
construction product
item manufactured or processed for incorporation in **construction works**

Note 1 to entry: Construction products are items supplied by a single responsible body.

Note 2 to entry: Adapted from the definition in ISO 6707-1:2014, 6.1.2 according to the recommendation of ISO/TC59/AHG Terminology.

3.10
construction work
activities of forming a **construction works**

[SOURCE: ISO 6707-1:2014, 7.1.1]

3.11
construction works
everything that is constructed or results from construction operations

Note 1 to entry: This covers both **building** and civil engineering works, and both structural and non-structural elements.

Note 2 to entry: Adapted from the definition in ISO 6707-1:2014, 3.1.1.

3.12
decommissioning
activities that change a **building** or an **assembled system (part of works)** from an operational status to a non-operational status

3.13
delivered energy
total energy, expressed per energy carrier, supplied to the **technical building system** through the system boundary to satisfy the uses taken into account (heating, cooling, ventilation, domestic hot water, lighting, appliances etc.) or to produce electricity

Note 1 to entry: For active solar and wind energy systems the incident solar radiation on solar panels or on solar collectors or the kinetic energy of wind is not part of the energy balance of the building. Renewable energy produced on site is part of the delivered energy.

Note 2 to entry: Delivered energy can be calculated for defined energy uses or it can be measured.

[SOURCE: EN 15603:2008, 3.3.4]

3.14
design life
service life intended by the designer

[SOURCE: ISO 15686-1:2011, 3.3]

3.15
disposal
waste treatment operation other than **recovery**

Note 1 to entry: Adapted from the definition in Directive 2008/98/EC.

3.16
durability
ability to maintain required **technical performance** throughout the **service life** subject to specified **maintenance**, under the influence of foreseeable actions

Note 1 to entry: Foreseeable actions are related to “normal” agents that could be expected to act on the works or parts thereof). Potential degradation agents include, for example, temperature, humidity, water, UV radiation, abrasion, chemical attack, biological attack, corrosion, weathering, frost, freeze–thaw and fatigue.

Note 2 to entry: Adapted from the definition on CPD Guidance Paper F and in ISO 6707-1:2014, 9.3.82.

3.17
economic aspect
aspect of **construction works**, **part of works**, processes or services related to their **life cycle** that can cause change to economic conditions

[SOURCE: ISO 15392:2008, 3.9]

3.18
economic impact
any change to the economic conditions, whether adverse or beneficial, wholly or partially resulting from **economic aspects**

Note 1 to entry: Derived from the definitions of impact and economic impact in ISO 15392:2008, 3.13.1.

3.19
economic performance
performance related to **economic impacts** and **economic aspects**

Note 1 to entry: Adapted from the definition of "environmental performance " in ISO 15392:2008, 3.12.

3.20
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

Note 1 to entry: Adapted from the definition in EN 15603:2008, 3.3.2.

3.21
environmental aspect
aspect of **construction works**, **part of works**, processes or services related to their **life cycle** that can cause change to the environment

EXAMPLE Use of energy and mass flow, production and segregation of wastes, water use, land use, emissions to air.

Note 1 to entry: The examples added to the definition of environmental aspect in ISO 15392:2008, 3.10.

[SOURCE: ISO 21931-1:2010, 3.3]

3.22
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partially resulting from **environmental aspects**

Note 1 to entry: Derived from the definitions of impact and environmental impact in ISO 15392:2008, 3.13 and 3.13.2.

[SOURCE: ISO 21931-1:2010, 3.4]

3.23
environmental performance
performance related to **environmental impacts** and **environmental aspects**

[SOURCE: ISO 15392:2008, 3.12]

3.24
environmental risk assessment
process of systematic estimation of the probability of a particular set of circumstances and its negative environmental consequences and process of comparing the estimation results against given criteria to determine their environmental significance

3.25
estimated service life
service life that a **building** or an **assembled system (part of works)** would be expected to have in a set of specific **in-use conditions**, determined from **reference service life data** after taking into account any differences from the **reference in-use conditions**

[SOURCE: ISO 15686-1:2011, 3.7]

3.26
external works
construction works external to the building structure but within the **building**'s site

3.27
financial value
aggregate of costs and revenues of **economic aspects** expressed in monetary units

3.28
functional equivalent
quantified **functional requirements** and/or **technical requirements** for a **building** or an **assembled system (part of works)** for use as a basis for comparison

Note 1 to entry: Adapted from ISO 21931-1:2010, 3.7.

3.29
functional performance
performance related to the **functionality** of a **construction works** or an **assembled system (part of works)**, which is required by the **client**, **users** and/or by regulations

Note 1 to entry: Adapted from the definition in ISO 15686-10:2010, 3.11.

3.30
functional requirement
type and level of **functionality** of a building or assembled system which is required by the **client**, **users** and/or by regulations

Note 1 to entry: Adapted from the definition in ISO 15686-10:2010, 3.12.

3.31
functionality
suitability or usefulness for a specific purpose or activity

[SOURCE: ISO 15686-10:2010, 3.13]

3.32
handover
step at which possession of the **construction works** is surrendered to the **client** upon completion with or without reservation

[SOURCE: ISO 6707-2:2014, 9.9]

3.33
in-use condition
any circumstance that can impact the **performance** of a **building** or **assembled system (part of works**) under normal use

[SOURCE: ISO 15686-8:2008, 3.5]

3.34
life cycle
consecutive and interlinked stages in the life of the object under consideration

3.35
life cycle assessment
LCA
compilation and evaluation of the inputs, outputs and the potential **environmental impacts** of a product system throughout its **life cycle**

Note 1 to entry: In this context a **building** or **assembled system** is considered a “product” and a part of a “product system”.

[SOURCE: EN ISO 14044:2006, 3.2]

3.36
Life Cycle Costing
LCC
cost of a **building** or **part of works** throughout its **life cycle**, while fulfilling **technical requirements** and **functional requirements**

3.37
life cycle impact assessment
LCIA
phase of **life cycle assessment** aimed at understanding and evaluating the magnitude and significance of the potential **environmental impacts** for a product system throughout the **life cycle** of the product

Note 1 to entry: In this context a **building** or **assembled system** is considered a “product” and a part of a “product system”.

[SOURCE: EN ISO 14044:2006, 3.4]

3.38
life cycle inventory analysis
LCI
phase of **life cycle assessment** involving the compilation and quantification of inputs and outputs for a product throughout its **life cycle**

Note 1 to entry: In this context, a **building** or **assembled system** is considered a “product” and a part of a “product system”.

[SOURCE: EN ISO 14044:2006, 3.3]

3.39
maintainability
ability of a **component**, an **assembled system (part of works)** or **construction works** to be retained in a state in which it can perform its required functions or be restored to such a state when a fault occurs

Note 1 to entry: Adapted from the definition in ISO 6707-1:2014, 9.3.88.

3.40
maintenance
combination of all technical and associated administrative actions during the **service life** to retain a **building** or an **assembled system (part of works)** in a state in which it can perform its required functions

Note 1 to entry: Maintenance includes cleaning, servicing, repainting, repairing, replacing parts of the **construction works** where needed, etc. (Construction Products Directive Guidance Paper F).

Note 2 to entry: Adapted from the definition in ISO 15686-1:2011, 3.13, ISO 6707-1:2014, 7.1.41, and in Construction Products Directive Guidance Paper F.

3.41
non-renewable energy
energy from sources which are not defined as **renewable energy** sources

3.42
non-renewable resource
resource that exists in a finite amount that cannot be replenished on a human time scale

[SOURCE: ISO 21930:2007, 3.8]

3.43
operational energy use
energy use of **technical building system** during use and operation of the **building**

3.44
operational water use
building related water use of **technical building system** or **user** during use and operation of the **building**

3.45
performance
expression relating the magnitude of a particular aspect of the object of consideration relative to specified requirements, objectives and/or targets

Note 1 to entry: Adapted from the definition in ISO 6707-1:2014, 9.1.1, according to the draft recommendation of ISO/TC59/AHG Terminology.

3.46
project specification
specification of **construction works** for a specific project that prescribes the **construction work** and the **construction products** to be used and how they are to be applied

[SOURCE: ISO 6707-2:2014, 4.1]

3.47
recovery
waste treatment operation that serves a purpose in replacing other resources or prepares **waste** for such a use

Note 1 to entry: Adapted from the definition in Directive 2008/98/EC.

3.48
recycling
any **recovery** operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes

Note 1 to entry: Recycling operations include:

— *Recycling* of organic substances which are not used as solvents (including composting and other biological transformation processes),

— *Recycling* of metals and metal compounds, and

— *Recycling* of other inorganic materials

as defined in Directive 2008/98/EC, Annex II.

Note 2 to entry: Recycling does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations or other recovery operations as defined in Directive 2008/98/EC, Annex II.

Note 3 to entry: Adapted from the definition in Directive 2008/98/EC, 3.49.

3.49
reference in-use conditions
in-use condition under which **the reference service life data** are valid

Note 1 to entry: The reference **in-use conditions** can be based upon information gathered through testing or from recorded performance and actual **service life** data of a **component**.

[SOURCE: ISO 15686-8:2008, 3.9]

3.50
reference service life
RSL
service life of a **construction product** which is known to be expected under a particular set i.e. a reference set of **in-use conditions** and which may form the basis of estimating the **service life** under other **in-use conditions**

[SOURCE: ISO 21930:2007, 3.12]

3.51
reference service life data
RSL data
information that includes the **reference service life** and any qualitative or quantitative data describing the validity of the **reference service life**

EXAMPLE Typical data describing the validity of the **RSL** include the description of the **component** for which it applies, the **reference in-use conditions** under which it applies, and its quality.

[SOURCE: ISO 15686-8:2008, 3.8]

3.52
refurbishment
modification and improvements to an existing **building** in order to bring it up to an acceptable condition

[SOURCE: ISO 6707-1:2014, 7.1.50]

3.53
renewable energy
energy from renewable non-fossil sources

EXAMPLES Wind, solar aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas sewage treatment plant gas and biogases.

Note 1 to entry: Adapted from the definition in Directive 2009/28/EC.

3.54
renewable resource
resource that is grown, naturally replenished or naturally cleansed, on a human time scale

Note 1 to entry: A renewable resource is capable of being exhausted, but may last indefinitely with proper stewardship. Examples include: trees in forests, grasses in grassland and fertile soil.

[SOURCE: ISO 21930:2007, 3.13]

3.55
required service life
service life required by the **client** or through regulation

3.56
re-use
any operation by which products or components that are not **waste** are used again for the same purpose for which they were conceived or used for other purposes without reprocessing

Note 1 to entry: Adapted from the definition in Directive 2008/98/EC.

3.57
service life
working life
period of time after installation during which a **building** or an **assembled system (part of works)** meets or exceeds the **technical performance** and **functional requirements**

[SOURCE: ISO 15686-1:2011, 3.25]

3.58
sketch plan stage
stage at which alternative outline proposals are evaluated and a preferred solution produced sufficiently to obtain **client's** approval

[SOURCE: ISO 6707-2:2014, 5.2]

3.59
social aspect
aspect of **construction works**, **part of works**, processes or services related to their **life cycle** that can cause change to society or quality of life

[SOURCE: ISO 15392:2008, 3.19]

3.60
social impact
any change to society or quality of life, whether adverse or beneficial, wholly or partially resulting from **social aspects**

Note 1 to entry: Derived from the definitions of impact and social impact in ISO 15392:2008, 3.13 and 3.13.3.

3.61
social performance
performance related to **social impacts** and **social aspects**

Note 1 to entry: Adapted from the definition of "environmental performance " in ISO 15392:2008, 3.12.

3.62
sustainability
ability of system to be maintained for the present and future generations

Note 1 to entry: In this context, "system" comprises **environmental, social and economic aspects**.

3.63
sustainability assessment of buildings
combination of the assessments of **environmental performance**, **social performance** and **economic performance** taking into account the **technical requirements** and **functional requirements** of a **building** or an **assembled system (part of works)**, expressed at the building level

3.64
system boundary
interface in the assessment between a **building** and the environment or other product systems

Note 1 to entry: System boundary defines what is included and what is not included in the assessment.

[SOURCE: ISO 21931-1:2010, 3.13]

3.65
technical building system
technical equipment for heating, cooling, ventilation, hot water, lighting or for a combination thereof

3.66
technical performance
performance related to the capability of a **construction works** or an **assembled system (part of works)** to fulfil its required functions under the intended use conditions

3.67
technical requirement
type and level of technical characteristics of a **construction works** or an **assembled system (part of works)**, which are required or are a consequence of the requirements made by the **client**, users and/or by regulations

3.68
transparency
open, comprehensive and understandable presentation of information

[SOURCE: EN ISO 14044:2006, 3.7]

3.69
user
person or organization for which a **building** is designed (including building owner, manager and occupants)

Note 1 to entry: Adapted from the definition in ISO 6707-1:2014, 8.1.

3.70
waste
substance or object which the holder discards or intends or is required to discard

Note 1 to entry: Adapted from the definition in Directive 2008/98/EC.

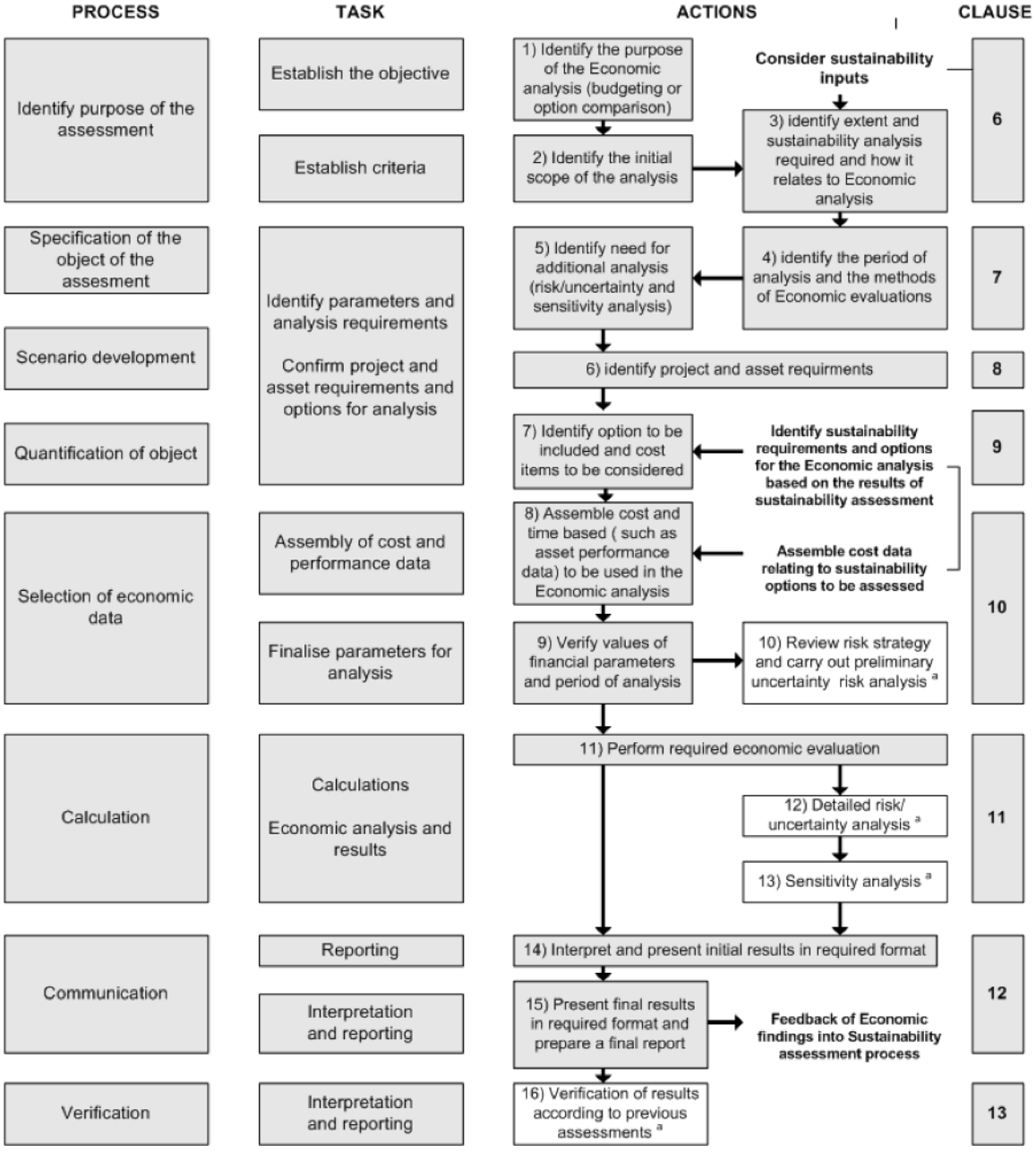
4 Abbreviations

For the purposes of this document, the following abbreviations apply.

EPD	Environmental Product Declaration
ESL	Estimated Service Life
LCC	Life Cycle Costing
NPV	Net Present Value
NPC	Net Present Cost
RSL	Reference Service Life
RSP	Reference Study Period
WLC	Whole Life Costing

5 The process for setting up the calculations required for the assessment

In order to carry out and complete the calculations necessary for the assessment of economic performance of buildings, the steps illustrated in Figure 3 shall be followed. This will help ensure that the essential information is gathered and processed in accordance with the requirements of this European Standard. The clauses numbered in the right column that follow the diagram explain in more detail each step specified in the central column of Figure 3.



Key

a white boxes are optional

Figure 3 — Flowchart of the process for the calculation of the economic performance

6 Purpose of the assessment

6.1 General

The purpose of the assessment is to quantify economic performance of the object of assessment, usually a building within its site perimeter, as one part of an integrated assessment of the sustainability of the building.

The scope and intended use of the assessment of a building in terms of economic impacts and aspects shall be defined, agreed and documented before an assessment is carried out.

The scope of an assessment shall identify and record what is included in the assessment with respect to Clauses 7, 8, 9 and 10.

The intended use of the economic assessment described in this standard may also include, but is not limited to, the following:

a) assistance in a decision-making process, for example:

   1) comparisons of the economic performance of different design options;

   2) comparisons of the economic performance of refurbishment, reconstruction and/or new construction;

   3) contributing to identification of the potential for improved performance;

   4) contributing to the setting of budgets;

NOTE A financial or investment analysis serves a different purpose and can lead to different conclusions to this economic analysis of sustainability performance.

b) declaring performance with respect to legal, funding or other requirements;

c) documenting the economic performance of a building;

d) support for policy development.

The scope and intended use determine the level of detail and accuracy required for the inputs to and outputs from the calculations.

6.2 Expected users

This standard will be useful to building designers, owners, sustainability advisors and cost consultants.

7 Specification of the object of assessment

7.1 General

The object of assessment is the building, including its foundations and external works within the perimeter of the building's site, over its life cycle. The perimeter used to characterize the site shall be consistent with the definition and intended use of the building, and should include connections to utilities from the site boundary to the building, including connections to the existing utility infrastructure which is considered to be a specific cost arising from the works on the building.

NOTE 1 The site is identified as the physical space of land occupied by and attached to the building.

NOTE 2 Subclause 7.3 describes how the life cycle results can be adapted to give the results for the chosen reference study period.

If the assessment is restricted to a part of a building or to an assembled system (part of works), or to a part of the life cycle, or if any relevant impacts or aspects are not addressed, this shall be documented, reported and reasons given.

NOTE 3 The economic assessment of the building excludes permanent construction works outside of the perimeter of the site such as construction of infrastructure for communication, energy, water, waste and transportation. A building on a site which requires such construction works will generate economic impacts other than those strictly related to the building. The assessment of these economic impacts and aspects is outside of the scope of this European Standard.

The object of assessment shall be described in terms of its physical and time-dependent characteristics (including cost related information).

7.2 Functional equivalent

The functional equivalent is a representation of the required technical characteristics and functionalities of the building. It is the means by which the characteristics of the building are rationalized into a minimum description of the object of assessment.

Although assessments may be carried out on an individual object, they will in most instances form part of the process for the evaluation of decisions in relation to the object of assessment. This includes the decision whether to build new, or refurbish/reconstruct an existing building, the evaluation of the design options, locations, etc.

Comparisons between the results of assessments of buildings or assembled systems (part of works), at the design stage or whenever the results are used, shall be made only on the basis of their functional equivalency. This requires that the major functional requirements shall be described together with intended use and the relevant specific technical requirements. This description allows the functional equivalency of different options and building types to be determined and forms the basis for transparent and fair comparison.

If the assessment results based on different functional equivalents are used for comparisons, then the basis for comparison shall be made clear.

NOTE 1 If appropriate, the assessment results of the buildings that have different functional equivalents (e.g. design options for different types of buildings on the same site or the same types of buildings exposed to different conditions) can also be compared based on a common unit of reference. The choice of the common reference unit for all buildings being compared depends on a specific requirement of a technical, functional, economic, social or economic aspect, or combination thereof, which is common to all these buildings and is linked to their corresponding functional equivalents.

NOTE 2 A reference unit can be derived from the functional equivalent and be used to present the result of the indicators of the economic assessment relative to the functional equivalent. A reference unit can be dimensionless or qualified with a dimension (e.g. per m^2, per year, per employee, per room per year, per m^2 per year).

When combining separate assessments of environmental (EN 15643-2), social (EN 15643-3) and economic (EN 15643-4) performance in a sustainability assessment of the same object of assessment, the functional equivalent used in the assessments of the individual dimensions of sustainability shall be the same.

The functional equivalent of a building or an assembled system (part of works) shall include, but is not limited to, information on the following aspects:

— building type (e.g. office, factory);

— relevant technical and functional requirements (e.g. the regulatory and client’s specific requirements);

— pattern of use (e.g. occupancy);

— required service life (ReqSL).

NOTE 3 Other specific requirements and exposure to climate and to other conditions from the immediate surroundings could be relevant for inclusion in the information on the functional equivalent.

Where the client's brief and regulations do not provide information for defining the functional equivalent, the assessment shall include the assumptions made by the assessor to define the functional equivalent and, the scenarios and the sources of information used by the assessor.

Where the client's brief and regulations do not specify the required service life, the design life (which may exceed the required service life) may be used. The basis on which the design life is selected shall be described, e.g. whether it is determined on the basis of empirical, probabilistic or statistical data.

NOTE 4 Eurocodes and ISO 15686-1 provide guidance on determining the design life of a building.

7.3 Reference study period

Assessments are carried out on the basis of a chosen reference study period (RSP).

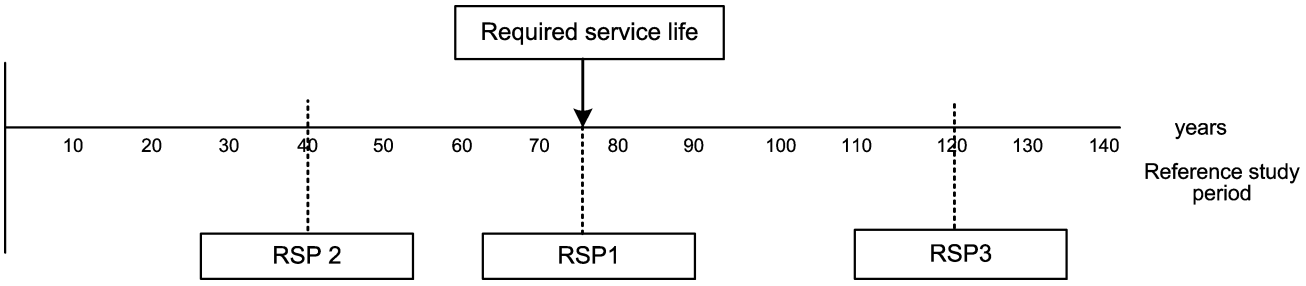
The default value for the reference study period building (RSP2 in Figure 4) shall be the required service life of the building. Any deviations from this (see below) shall be clearly stated and reasons explained.

The reference study period may differ from the required service life given for the object of assessment (Figure 4) depending on the intended use of the assessment, or on regulatory requirements or national guidance. However, in all cases, the assessment is based on the whole building life cycle, including the end of life.

Where the reference study period is less than the required service life (RSP1 in Figure 4), the end of life costs are calculated and then discounted to the end of the required service life (see 10.2 and Clause 11).

Where the reference study period is longer than the required service life (RSP3 in Figure 4), scenarios for refurbishment, or for demolition and construction of an equivalent new building shall be developed. These scenarios shall provide for an extension of the service life which, when combined with the required service life of the object of assessment, is equal to or more than the reference study period. The economic assessment shall include the full costs and incomes for both the actual required service life and the extension to the service life.

Further detailed information on the calculation procedure for end of life costs is given in Annex C.



All numbers in the figure are illustrative.

Figure 4 — Examples of possible reference study periods versus required service life of the assessed object

The relationship between the Reference Study Period, Required Service Life and the information modules is outlined in greater detail in Figure 5.

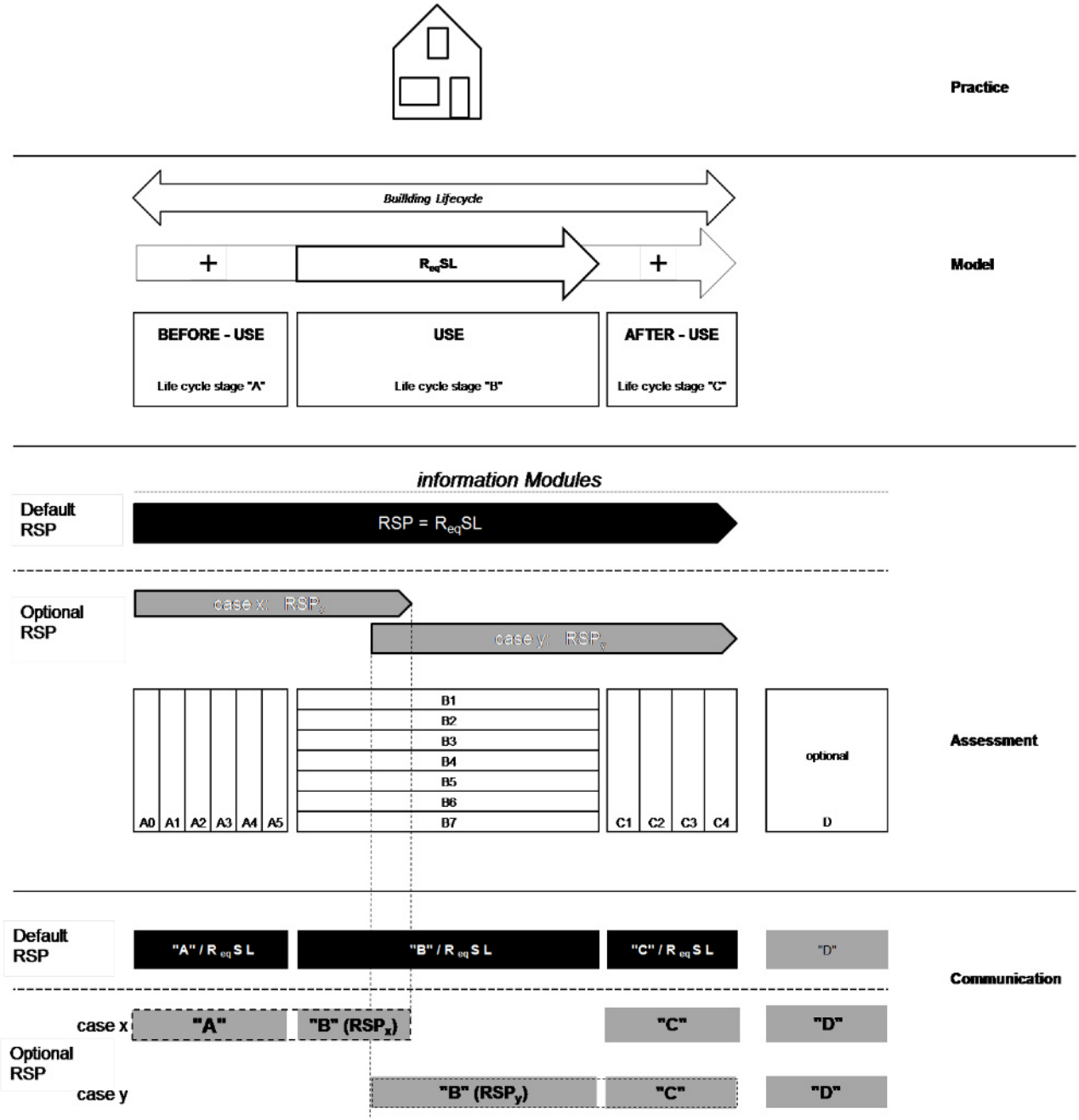


Figure 5 — The relationship between reference service life and the information modules.

7.4 System boundary

7.4.1 General

The system boundary determines the processes that are taken into account for the object of assessment. For a new building, the system boundary shall include the building life cycle as shown in Figure 6. For an existing building (or part thereof), the system boundary shall include any acquisition costs and all the remaining stages of the service life, and the end of life stage of the building.

In this context, the object of assessment is the building and its site. This includes all the costs associated with the acquisition of the site and the building, through the use stage and the end of life stage at the end of the building life cycle. It also includes revenues associated with building integrated renewables.

The setting of the system boundaries follows the “modularity principle”: where processes influence the building’s economic performance during its life cycle, they shall be assigned to the module in the life cycle where they occur.

EXAMPLE All impacts and aspects due to the replacement of a broken window pane in the use stage which include production, transport, use of ancillary materials, packaging waste and recycling are assigned to ‘Repair’, module B3.

All the building sustainability standards developed by CEN/TC 350 use a common format for reporting information from the sustainability assessment. Figure 6 illustrates the organization of the different information modules used for reporting the assessment of the building.

For the economic assessment some costs may be incurred before the construction stage commences. These are reported in information module A0, which is specific to the economic assessment.

Modules A0 to C4 cover economic impacts and aspects that are directly linked to processes and operations taking place within the system boundary of the building, while module D reports the income relating to exported energy and secondary materials, secondary fuels or secondary products resulting from reuse, recycling and energy recovery that take place beyond the system boundary. Costs of waste disposal at the end of life are allocated to Module C, incomes from products or materials which are recycled are included in Module D.

To assess the economic performance of some projects, it is essential to include revenues in the assessment. For example, a building integrated renewable energy installation cannot be justified on economic performance without taking into account revenue from the energy generated and any avoided energy costs arising from the renewable energy source.

The information allocated to the relevant modules (see Figure 6) should be taken from appropriate sources, for example following the procedures in ISO 15686-5 or using historical cost data.

7.4.2 Boundary of the before use stage (Modules A0-A5)

7.4.2.1 General

The boundary for the before use stage includes pre-construction, product manufacture, delivery to site and construction.

When assessing economic performance of the building, the costs associated with all the before use life cycle stages, including planning costs, land costs and professional fees should be considered and reported using information modules A0 – A5.

NOTE The costs of manufacture, transport and installation, might only be available in aggregated form and not as individual itemized costs.

7.4.2.2 Boundary of the pre-construction stage (Module A0)

The pre-construction stage includes the costs that relate to activity carried out before a development site is selected, including any purchase, rental costs and taxes incurred for the site or any existing building during the reference study period. These costs are reported in information module A0.

EXAMPLE Prior purchase of the site, a pre-owned building, or purchase of a site with a building which has been demolished prior to redevelopment.

7.4.2.3 Boundary of the product stage (Modules A1 to A3)

The product stage includes the 'cradle to gate' processes for the materials and services used in the construction. These costs are reported in information modules A1 to A3.

NOTE The costs of manufacture, transport and installation, might only be available in aggregated form and not as individual itemized costs.

7.4.2.4 Boundaries of the construction process stage (Modules A4 and A5)

7.4.2.4.1 General

The construction process stage includes the processes from the factory gate of the different construction products to the practical completion of the construction work.

It also includes the direct costs of equipment related to the construction, such as site accommodation, access equipment, contractors transport and cranes. These costs are reported in information modules A4 and A5.

NOTE Direct costs include hire or leasing charges, which could include amortization for capital items, but exclude the total capital cost of those items.

7.4.2.4.2 Boundary of the transport to and from site (Module A4)

The transport stage includes:

— cost of transport of materials and products from the factory gate to the building site;

— cost of transport of construction equipment such as site accommodation, access equipment and cranes to and from the site.

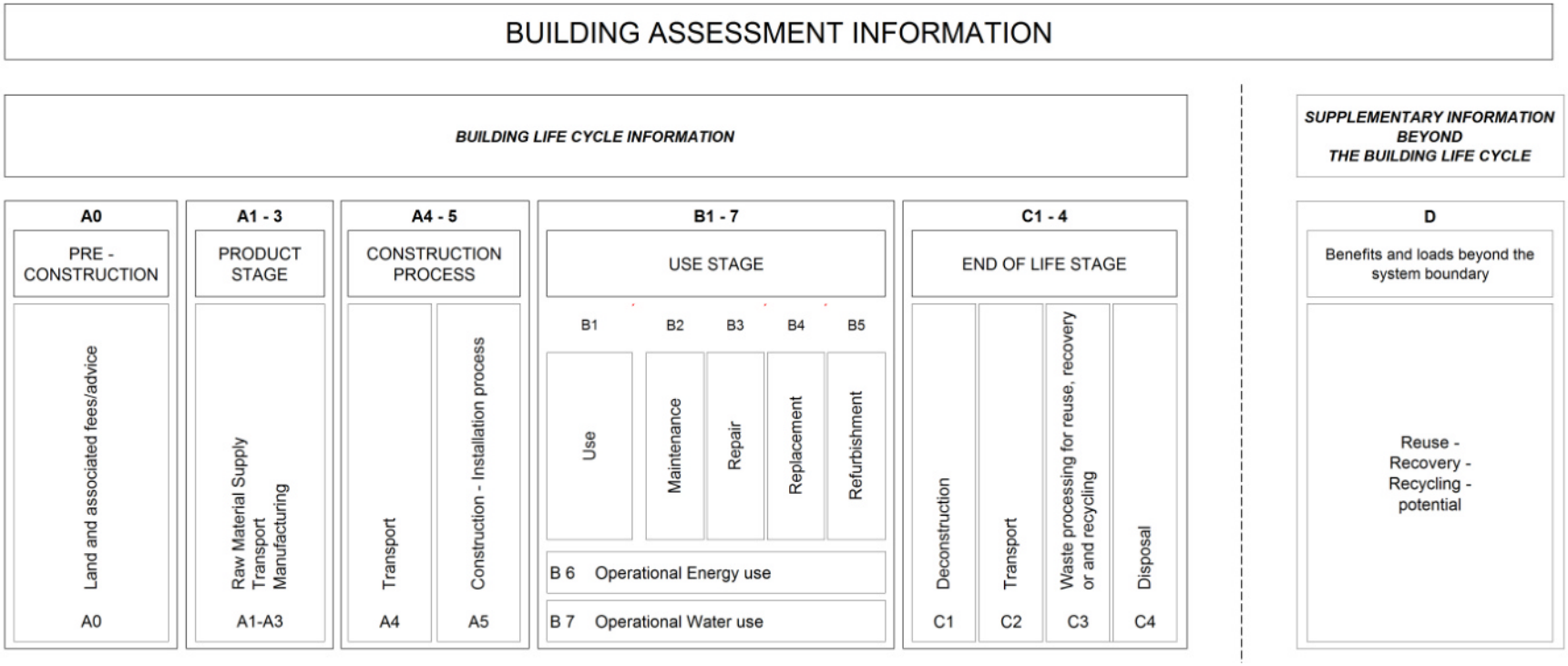


Figure 6 — Display of modular information for the different stages of the building assessment

7.4.2.4.3 Boundary of the construction installation process (Module A5)

The construction installation stage includes but is not limited to the costs for the following processes:

— ground works and landscaping;

— storage of products, including the provision of heating, cooling, humidity, etc.;

— transport of materials, products, waste and equipment within the site;

— temporary works, including temporary works located off site as necessary for the construction installation process;

— on site construction activity;

— provision of heating, cooling, ventilation, humidity control etc. during the construction process;

— installation of the products into the building including ancillary materials;

— water use for cooling of the construction machinery or on site cleaning;

— waste management processes of other wastes generated on the construction site. This includes all processes (including transportation from the building site) until final disposal or until end of waste state is reached;

— production, transportation and waste management of products and materials lost during the construction and installation process;

— commissioning and handover related costs;

— professional fees relating to work on the project;

— taxes and other costs related to the permission to build and inspection or approval of works;

— incentives or subsidies related to the installation.

7.4.3 Boundaries of the use stage (Modules B1 – B7)

7.4.3.1 General

The use stage covers the period from the practical completion and handover of the construction work to the point of time when the building is deconstructed/demolished.

The use stage includes, but is not limited to, all costs related to the use, maintenance, management, inspection, repair, replacement and refurbishment of the building throughout this life cycle stage. It may include, for example, all costs of operating the building, such as heating, cooling, lighting, water supply, lifts and escalators, for maintenance (including cleaning), for operation and replacement or repair of construction products and machinery.

The assessment shall include costs of operating the building-integrated technical systems and building-related furniture, fixtures and fittings. The system boundary for the assessment shall exclude all costs relating to the appliances and furniture, fixtures and fittings that are not building-related.

Where costs that are not building-related, such as security, regular inspections, insurance and performance guarantees are assessed separately these costs shall be recorded and reported and communicated separately.

NOTE 1 Appliances that are not building-related are domestic, commercial and industrial appliances and other non-building related goods, e.g. entertainment electronics, washing machines, refrigerators, cooking appliances, office electronics and appliances of industrial processes.

NOTE 2 Building-related furniture, fixtures and fittings are products that are fixed to the building, so that the dismantling of the product decreases the performance of the building and the dismantling or replacement of the product constitutes construction operations.

7.4.3.2 Boundary of the building in use stage (Module B1)

The boundary of module B1 encompasses the costs arising from the normal anticipated conditions of use of the building and building related incomes. This includes any taxes, regulatory, insurance and, security costs or other costs normally incurred during the operation of the building that do not fall within modules B2 – B7.

7.4.3.3 Boundary of maintenance (Module B2)

The boundary of maintenance shall include the costs of:

— all components and ancillary products used for maintenance;

— all cleaning processes for the interior and exterior of the building and building related fixtures and fittings;

— all processes for maintaining the functional and technical performance of the building fabric and building-integrated technical systems, as well as aesthetic qualities of the building's interior and exterior components.

EXAMPLE Painting work on window frames, doors, etc. and also the annual inspection and maintenance of the (oil or gas) boiler, replacement of filters in the heat recovery or air conditioner.

7.4.3.4 Boundary for repair (Module B3)

The boundary for repair shall include any repair processes to the building components during the use stage of the building.

The boundary for repair shall include the costs of:

— the repaired part of a component and ancillary products;

— the repair process of the repaired part of component and ancillary products;

— waste management of the removed part of the component and of ancillary products.

EXAMPLE For a window with a broken pane, this includes the cost of handling and disposing of the waste generated by the pane, installation costs of the new pane and any other costs due to the repair process.

7.4.3.5 Boundary for replacement (Module B4)

The boundary for replacement shall include the costs of:

— the replacement component and ancillary products;

— the process of removal of the replaced component and installation of the replacement components (and ancillary products);

— waste management of the removed component and of ancillary products.

EXAMPLE Cost of replacement of a roof beam, replacement of a partition wall, a complete covering of an existing roofing felt, or a complete renewal including removal of the existing roofing felt, replacement of a heating system or boiler, replacement of a window (frame, glass), etc.

7.4.3.6 Boundary for refurbishment (Module B5)

The refurbishment stage of a building shall include the costs of:

— Management, design and associated fees

— the new building components;

— the process of refurbishment;

— waste management of the building components replaced as part of the refurbishment process.

EXAMPLES A major change of the internal layout (partitioning) and/or the building envelope, change of the technical systems related to heating, cooling or air conditioning, modifications for the purposes of a planned or expected change of use.

If a building which has previously had an assessment of its economic performance carried out subsequently undergoes a major refurbishment in a way that was not included in the previous assessment, where the refurbishment changes the building type, building use, or required service life, i.e. changes the functional equivalent, then a new assessment should be carried out. In the new assessment of the refurbished building, the costs of the refurbishment materials and reconstruction/installation processes are allocated to modules A1 to A5.

7.4.3.7 Boundary of the operational energy use (Module B6)

The cost of operational energy use shall include energy used by building-integrated technical systems during the operation of the building.

NOTE 1 For practical reasons some simplifications of the setting of system boundaries for module B6 are defined in this clause in order to:

— comply with the Energy Performance of Buildings Directive (2010/31/EC), and its National implementations. The Energy Performance of Buildings Directive (EPBD) requires taking into account the energy supply by renewable energy generation units;

— ensure consistency between the standards dealing with environmental and social aspects of sustainability in accordance with the requirements of EN 15643-1.

NOTE 2 A building can import energy for supply of the building's energy demand but it can also generate energy and export (part of) that energy to another building or to a grid of energy distribution, e.g. the electricity network, the district or local heat network.

The energy use in the building refers to the activity and processes described in the Energy Performance of Buildings Directive (2010/31/EC) as presented in EN 15603. The energy performance of a building is determined on the basis of the calculated or the actual annual energy that is used in order to meet the different needs associated with defined uses of the building.

For the assessment of the economic performance of the building-related energy flows reference is made to Annex I of the Energy Performance of Buildings Directive: energy used for:

— heating;

— domestic hot water supply;

— air conditioning (cooling and humidification/de-humidification);

— ventilation;

— lighting;

— auxiliary energy used for pumps, control and automation.

The building-related energy use of other building-integrated technical systems, which are not covered by the Energy Performance of Buildings Directive (e.g. lifts, escalators, safety and security installation and communication systems) necessary for the technical and functional performance of the building shall be included in B6 and reported and communicated separately (see Figure 7).

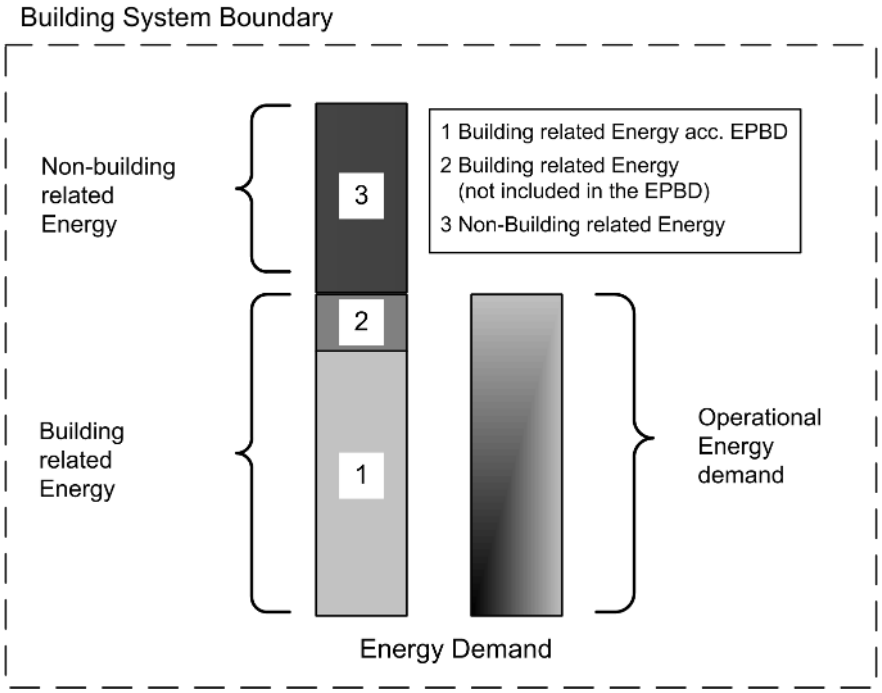


Figure 7 — Building system boundary for operational energy

If the energy use of appliances that are not building-related (plug-in appliances, e.g. computers, washing machines, refrigerators, audio, TV and production or process-related energy in the use of the building) is included within the energy calculation, then this shall be documented and reported and communicated separately.

All costs related to the operational energy use are fully allocated to the building.

To align with the Energy Performance of Buildings Directive (from which the energy use and energy supply information is taken) the site generated energy that is used within the building, is assumed to satisfy firstly building-related energy demand and then the energy demand that is not building-related. Exported energy shall not be deducted from the import of energy required to operate the building, but instead only the income resulting from the generated energy shall be reported in module B6. Annex B provides additional guidance on the treatment of exported energy.

All energy generating units located within the building's site shall be included in the assessment.

These energy generating units may include both renewable sources (e.g. photovoltaic cells, wind mills, solar thermal panels, ground or air source type heat pumps) and non-renewable energy sources (e.g. gas boilers, CHP (Combined Heat Power, fuel cells, heat pumps).

NOTE 3 No distinction is made between energy producing units that are part of the building fabric and energy producing units that are not part of the building fabric and so do not perform any additional building function.

EXAMPLE Solar thermal panels or photovoltaic panels that are part of the building envelope, whether or not they have functions other than energy generation, e.g. providing protection against rain and wind penetration through the roof or facade - are part of the building assessment. In addition, a photovoltaic panel installed in the garden of the site and thus not being a part of the building envelope but delivering energy for the use in the building or as exported energy is part of the building assessment.

All costs for imported energy (either for the direct use or for generation of energy) shall be assigned in module B6. Any incentive or subsidy for on-site generation shall be assigned to information module B6.

7.4.3.8 Boundary of the operational water use (Module B7)

The operational water use stage shall include the costs of all water used and its treatment (pre- and post-use) during the normal operation of the building (excluding during maintenance, repair, replacement and refurbishment), together with associated costs. Module B7 covers the period from the handover of the construction works to the point in time when the building is deconstructed/demolished.

NOTE 1 Aspects related to the production, transportation, maintenance and disposal of equipment required to supply water to the building would be covered within modules B2-B5.

NOTE 2 Energy usage associated with providing domestic hot water and other water use related systems are included in module B6.

Module B7 shall include all building-integrated water-consuming processes of the building under operation, such as processes for:

— drinking water;

— water for sanitation;

— domestic hot water;

— irrigation of associated landscape areas, green roofs, green walls;

— water for heating, cooling, ventilation and humidification;

— other specific water use of building-integrated systems e.g. fountains, swimming pools, saunas.

If water use of appliances that are not building-related (e.g. dishwashers, washing machines) is included within the assessment, this shall be reported and communicated separately.

7.4.4 Boundary of the end of life stage (Modules C1 – C4)

7.4.4.1 General

The end-of-life stage of a building starts when the building is decommissioned and is not intended to have any further use. At this point, the cost of the building's demolition/deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that shall be discarded, recovered, recycled or reused. The scenarios for these end-of-life options for the products and materials determine the system boundary (see 7.4.2, 8.4 and 8.7). These scenarios shall only model processes that have proven to be economically and technically viable.

The building is deemed to have reached the end of its life when:

— all components and materials that were to be cleared from the site have been removed;

— the site is made ready for future re-use (i.e. cleared ready for new activity).

The end-of-life stage includes the following modules:

— C1 deconstruction, including dismantling or demolition, of the building, including initial on site sorting of the materials;

— C2 transportation of the discarded materials as part of the waste processing, e.g. to a recycling site and transportation of waste e.g. to final disposal;

— C4 waste disposal including physical pre-treatment and management of the disposal site.

NOTE Waste processing is part of the building life cycle under study. In the case of materials leaving the system as secondary materials or fuels, such processes as collection and transport before the end-of-waste state are, as a rule, part of the waste processing of the building. However, after having reached the “end-of-waste” state further processing might also be necessary in order to replace primary material or energy from primary fuels in another product system. Such processes are considered to be beyond the system boundary.

7.4.4.2 Boundary for the deconstruction (Module C1)

The boundary of the deconstruction process includes on site operations and operations undertaken in temporary works located off site as necessary for the deconstruction processes after decommissioning up to and including on site deconstruction, dismantling and/or demolition.

7.4.4.3 Boundary for transport (Module C2)

The boundary shall include all costs due to transport for disposal and/or until the end-of-waste state is reached (see 7.4.4.4). This includes transport costs to and from possible intermediate storage/processing locations.

7.4.4.4 Boundary for waste processing for reuse, recovery or recycling (Module C3)

The boundary at the end of an end-of-life stage of the building to module D is set where the end-of-waste state of outputs, e.g. materials, products or building elements, is reached.

During the end-of-life stage of the building, all output from dismantling, deconstruction or demolition of the building, from maintenance, repair, replacement or refurbishing processes, all debris, all construction products, materials or construction elements, etc. leaving the building, are at first considered to be waste. This output however reaches the end-of-waste state when it complies with all of the following conditions:

— the recovered material, product or construction element is commonly used for specific purposes;

— a market or demand, identified e.g. by a positive economic value, exists for such a recovered material, product or construction element;

— the recovered material, product or construction element fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;

— the use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

NOTE The “specific purpose” in this context is not restricted to the function of a certain product but can also be applied to a material serving as input to the production process of another product or of energy.

Any costs incurred by on site operations and operations undertaken in temporary works located off site to process waste shall be allocated to module C3.

Any income which is received by the building owner from the sale of the land, waste processing for reuse, recovery or recycling shall be allocated to Module D.

7.4.4.5 Boundary for the disposal (Module C4)

Disposal includes the possible post-transportation treatment that is necessary before disposal. Costs of waste disposal in module C4 are considered part of the building life cycle, according to the “polluter pays” principle. Any income to the building owner arising from the sale of the land or from the waste disposal process is assigned to Module D.

Module C4 quantifies all the costs resulting from final disposal of materials, including neutralization, incineration or land filling.

7.4.5 Boundary for the benefits and loads beyond the system boundary (Module D))

Components for reuse and materials for recycling and energy recovery are considered as potential resources for future use and have the potential for generating income

Module D quantifies the income to the building owner resulting from reuse, recycling and energy recovery resulting from flows of materials and exported energy exiting the system boundary.

NOTE Module D acknowledges the “design for reuse and recycling” concept.

Where a material flow exits the system boundary and has an economic value or has reached the end-of-waste stage and substitutes another product, then the incomes may be calculated and shall be based ontypical currently available technology and current practice.

7.5 The building model

7.5.1 Purpose and information needed

To prepare a cost model of the building a full description of the technical and physical characteristics of the building, including the site and location, is required.

The purpose of the building cost model for economic assessment is to enable the costs associated the construction or refurbishment of the building to be quantified in a structured way.

The description of the building is separated into:

— its constituent parts (all building elements, building components, building products, building materials);

— related processes such as transport, construction, maintenance, repair, replacement, end-of-life processes;

— operational use including management inspection and insurance

— operational energy and water use.

The choice of the level of detail depends on the goal and scope of the assessment and of the availability of data at the time the assessment is carried out (sketch plan, design, procurement and handover).

7.5.2 Description of the physical characteristics of the building

The description of the physical characteristics of the building shall include (but is not limited to) the building-related construction and technical equipment and services including:

— shape and size of the building;

— number of storeys;

— the storey height, and overall dimensions (gross floor area);

— the structural frame (beams, columns, slabs) and foundations;

— non load-bearing elements;

— external walls;

— windows;

— roof;

— internal walls;

— doors and staircase(s);

— floors and ceilings;

— the technical systems;

— sanitary systems (water, waste water, piping, pump and fixed equipment);

— fixed fire-fighting systems;

— heating and hot water systems;

— mechanical ventilation and air conditioning;

— fixed lighting systems;

— communication and security systems;

— transportation inside the building (lifts, escalators);

— drainage system;

— the site construction;

— landscaping;

— external lighting;

— external parking;

— on site drainage;

— water treatment systems.

8 Scenarios for defining the building life cycle

8.1 General

Assessments shall be established on the basis of specified scenarios that represent the building life cycle stages. The scenarios shall be realistic and representative and in accordance with the technical and functional requirements as given in the functional equivalent (7.2) and as taken from the client's brief, the regulatory requirements and the project specification. This clause describes the requirements for defining the scenarios to be used for the assessment; it does not describe the types of costs within the scenarios or stages. The costs are detailed in Clause 11.

For consistency between assessments of environmental, social and economic performance of a building, equivalent scenarios shall be used for all three assessments. Scenarios shall be defined and modelled explicitly, and included in the assessment reports.

The estimated service life of a building or assembled system (part of works) shall be established in accordance with specific rules of European product standards and shall take into account rules and guidance given in the standards ISO 15686-1, ISO 15686-2, ISO 15686-7 and ISO 15686-8.

To provide the complete description of the object of assessment, geographic and time-related characteristics of the building need to be added to the physical description of the building (e.g. reference study period, service life, maintenance and replacement periods, hours of operation of the building and its pattern of use). This requires the development and use of appropriate scenarios describing the assumptions (or, where known, real information) that will be used to develop the cost model through the before use, construction, use, and end-of-life stages (modules A0 to C4) of the object of assessment. If supplementary information on module D is provided, the assumptions relating to incomes included in Module D need to be stated.

The assessor shall ensure that the scenarios developed within the boundaries defined in Clause 7, together with any other relevant information (which shall be included in the assessment report), are consistent with general scenarios defined at the building level.

In order to provide full transparency, any change of, or adaptation from, the given information modules shall be reported.

8.2 Requirements for scenarios

The scenarios employed in an assessment shall be described and documented, making clear the assumptions used, the requirements for information and data, and the limits of their application in the context of the building and its life cycle. It should be clear from the assessment report whether information or data has been assumed, estimated or calculated, or is based on actual measurement. Sources of information shall be documented.

Scenarios should also distinguish clearly when they relate to specific functions undertaken within the building (e.g. scenarios for lighting energy used in a theatre, electricity supplied to a data centre within an office building or for energy and water use associated with the use of a restaurant or catering kitchen).

NOTE EN 15643-4:2012, Annex B describes the economic aspects of building performance through the life cycle of the building, and provides examples of where different aspects occur during a project.

8.3 Time-related characteristics and associated scenarios

8.3.1 General

Time-related characteristics and associated scenarios include maintenance, replacement, cleaning and other periodic operations.

The replacement scenarios and the underlying assumptions for all major items of plant, machinery, windows, wall and flooring finishes shall be described, as well as the cleaning, maintenance and regular facilities management activities.

These scenarios shall take into account the following:

— client requirements (as expressed in the brief);

— service life planning in accordance with principles defined in ISO 15686-1, ISO 15686-2, ISO 15686-7 and ISO 15686-8;

— manufacturers' information on time dependent performance of products;

— pattern(s) of use.

The scenarios may be refined as additional information and detail becomes known, and shall be based on real-life data.

NOTE Scenarios can be based on detailed analysis of a similar building, with appropriate adjustments to reflect the assumptions for the proposed building.

8.3.2 Climate conditions

Climate conditions that are compatible and consistent with those required under European legislation for other construction-related purposes (e.g. EN 15603) and representative of the location of the building, shall be used in the relevant scenarios.

8.3.3 Other specific requirements for scenarios

Other specific requirements may have to be considered in the description of the life cycle of the object of assessment. Such requirements can include building performance indicators defined by local regulation or in the client's brief, such as requirements for energy efficiency, fire safety, adaptability or seismic performance. These requirements have an influence on the design, choice of the type of the construction process and the selection of products.

8.4 Scenarios for the pre-construction stage (Module A0)

The scenarios shall describe the assumptions made about the activities prior to the start of construction work. The scenario shall describe the key assumptions which will influence the costs of the project, for example:

— selection of a site or an existing building for retrofitting,

— site related taxes, subsidies and incentives,

— relevant professional fees.

8.5 Scenarios for the product and construction process stages (Modules A1 – A5)

Scenarios for the product and construction process stage cover the manufacture or extraction of the different construction products through to the practical completion of the construction work. The scenario shall describe the key assumptions which will influence the costs of the project, for example:

— preliminary and/or temporary works, structures or facilities, including site clean-up and land remediation,

— client requirements relating to their corporate environmental objectives,

— relevant professional fees,

— special arrangements for transport or supply of products, materials, equipment and waste to and from the building site,

— accessibility of the site during the construction stage,

— offsite construction activities,

— duration of the construction programme and limits on working hours,

— assembly, installation, commissioning and waste management.

NOTE The costs of manufacture, transport and installation, might only be available in aggregated form and not as individual itemized costs.

8.6 Scenarios for use stage (modules B1 to B7)

8.6.1 General

The scenarios shall describe the assumptions made about the operation of the building. The scenario shall describe the key assumptions which will influence the costs of the project, for example:

— building management activities, in particular inspection, cleaning, routine maintenance and repair, and whether any business support activities, such as a receptionist, are included,

— replacement of major systems and components,

— use of energy for heating, cooling, lighting, domestic hot water and controls,

— use of water for operational use,

— any proposed leasing arrangements.

If the object of assessment provides energy for use outside of its boundaries, the management activities (maintenance, repair and cleaning) of the relevant equipment for energy production shall be allocated in accordance with rules defined in 7.4.3.1.

NOTE It is important to recognize that the actual service life of any given product and component in any situation will be the result of a complex set of factors including its specification, its location, the way in which it is incorporated into the building, its level of maintenance (especially quality and frequency of inspection and maintenance) and its intensity of use.

8.6.2 Scenario related to use stage (except energy and water) – Module B1

The scenarios shall describe the general assumptions made about the internal and external conditions in the building not covered by Modules B2 – B7. For example, this may cover the costs of retaining the building when it is unoccupied or unused.

8.6.3 Scenarios for maintenance, repair, replacement – Module B2, B3 and B4

The scenarios shall describe the assumptions made about inspection, maintenance repair and replacement activities taking account of the pattern of use, (see 7.4.3.1) for example:

— client requirements as expressed in the brief,

— service life planning in accordance with ISO 15686-1, ISO 15686-2, ISO 15686-7 and ISO 15686-8,

— project specific definitions of what constitutes maintenance, what is repair and what is replacement,

— service level agreements required for maintenance or other on site attendance,

— manufacturers' information.

Different scenarios based upon predefined or default values or based on statistical comparison may be defined.

EXAMPLE A window could be replaced either when its functionality is failing (e.g. 2 % failure rate every year after 10 years) or at a predefined time period (30 years).

8.6.4 Scenarios for refurbishment – Module B5

The scenarios shall describe the assumptions made about planned refurbishment of the building, building elements and/or technical equipment. If no requirements for refurbishment are stated in the client's brief, the scenarios for refurbishment shall be typical for the type of building being assessed.

The scenarios for refurbishment shall define what activities constitute refurbishment and describe all activities with costs arising from the refurbishment process, in accordance with the system boundary described in 7.4.3.6.

Where refurbishment is done or planned in conjunction with a change of use or extension of service life (i.e. changes the functional equivalent), the costs relating to the new functional equivalent shall be taken into account for the remainder of the required service life, and for the end of life.

8.6.5 Scenarios for operational energy use – Module B6

The scenarios shall describe the assumptions made about energy use, including (but not be limited to) energy consumed by the following systems, as defined in the Energy Performance of Buildings Directive: heating, cooling, ventilation, domestic hot water, lighting and control. Lifts and escalators and other building-integrated technical systems shall also be included.

The scenario shall define the energy escalation rate (or rates) for each energy carrier which the client has agreed for use in the assessment.

The assessment of energy use may employ methods for energy modelling and assumptions about the pattern of use, which shall be described and documented. In the absence of a specific scenario, default scenarios for the energy use shall be obtained from EN 15603.

If additional energy uses such as catering facilities or IT server rooms are included, the scenarios related to these additional energy uses shall be documented and reported separately.

For building-related energy production, the scenarios used shall take account of the priority given to, and the distribution of the generated energy, i.e. whether it is for use within the object of assessment or exported for use by others (see Figure 7).

The scenario shall specify per energy carrier (e.g. fuel) the imported energy used to satisfy the specified demand and per energy carrier the energy that is exported. The scenario shall specify how the imported and exported energy flows are quantified (e.g. the solar panel specifications, including quantifying the amount of energy produced on site and how much of this is exported).

8.6.6 Scenarios for operational water use (Module B7)

The scenarios shall describe the assumptions made about water use, including (but not be limited to) the following:

— consumption of potable water for sanitary purposes,

— water input and output flows for waste water treatment

— other water use directly related to the object of assessment (e.g. drinking water, swimming pool, watering of landscaped areas) where possible, or appropriate.

These scenarios shall also take into account and justify any reduction of potable water use through the use of rainwater harvesting, water recycling and/or other sources. These amounts may be reported separately as additional information.

8.7 Scenarios for the end of life stage (Modules C1 to C4)

8.7.1 General

The scenarios shall describe the processes used during the end of life stage in accordance with the system boundary for the end of life stage as described in 7.4.5. Costs may be aggregated for the various activities undertaken during the end of life stage.

NOTE For a projected long required service life of a building the assumptions made in the scenarios might contain a high level of uncertainty. In this case it is advised to concentrate the end-of-life scenarios to case c) in 9.8.

8.7.2 Scenarios for deconstruction – Module C1

The scenarios for dismantling and deconstruction shall be restricted to the onsite process and activities.

It shall describe all the relevant processes that are assumed to be necessary for the deconstruction of building.

8.7.3 Scenarios for transport – Module C2

Scenarios for transport, if required, shall specify the level of detail necessary to determine the relevant costs.

8.7.4 Scenarios for waste processing for reuse, recycling and energy recovery – Module C3

The scenarios shall describe the waste treatment processes: for example, sorting, preparatory processes for reuse, recycling and energy recovery, up to the moment where the output from dismantling, deconstruction or demolition of the building or construction works ceases to be waste. These processes may also generate materials for disposal and are assigned to module C3.

These scenarios shall be based only on solutions and technologies that have been proved to be economically and technically viable.

8.7.5 Scenarios for disposal – Module C4

The scenarios shall describe the processes (neutralization, incineration with or without utilization of energy, land filling with or without utilization of landfill gases, etc.), or activities (packaging) necessary before final disposal where not covered in modules C1 to C3, as well as the final disposal itself.

8.8 Scenarios beyond the system boundary – Module D

For calculating the potential income related to the substitution of resources beyond the system boundary of the object of assessment, the scenarios for reuse, recycling and recovery of the whole building or its materials shall be described.

9 Calculation of costs and income related to the building over its life cycle

9.1 General

The calculation of costs of the building over the life cycle shall be based on the functional equivalent (7.2) and the building model (7.5) as well as the scenarios defined in accordance with the requirements of Clause 8. Costs and, where appropriate, incomes included in each information module and examples are given in Table 1.

Costs shall be determined based upon the design description of the object of assessment (new building or refurbishment of an existing building) or with the actual quantities (existing buildings, post-refurbishment) and the scenarios for each module of the life cycle of the object of assessment.

When calculating each cost item all the relevant assumption shall be clearly specified.

9.2 Calculation of pre-construction costs

Where the pre-construction costs are included, the calculation shall include the cost of the site on which the building stands or will stand, including any associated purchase or rental costs, and any other costs of assessments and fees before the site is selected.

9.3 Calculation of construction costs

The calculation of the construction costs shall include the costs of the products supplied at the factory gate, the costs of transport to site, the costs of temporary and enabling works to prepare the site and provide infrastructure for the site, construction, installation and fit out costs, professional fees incurred during design and construction and any taxes, subsidies or other payments related to permission to build and approval of the completed works.

Table 1 — CEN/TC 350 life cycle stage — Before use stage (Modules A0 — A5)

Cost/Income category	Costs included in category	Examples of costs
Life-Cycle Cost (LCC)		
For assessments carried out before the development site is selected; where the site has already been selected, this element is not required (A0)	Site costs Costs include purchase or rental costs.	Cost of the site on which the building stands
Product Stage (A1-A3)	Aggregated cost of products supplied at factory gate ready for construction	
Transport to Site (A4)	Costs incurred between factory and site	
Professional Fee (A0-A5) (where these are not included in the construction costs)	Professional fees – any fees paid to the project team for work on the project, including feasibility, planning and design	Project and engineering
Construction – feasibility, planning, design and construction (A5) including commissioning and handover	Temporary and enabling works: activities to prepare the building site for construction and to provide infrastructure and services (gas, electricity and water) within the site of the building	Site clearance, etc, where required and not covered within land costs
	Construction of asset – all aspects of the procurement and construction of the building, including directly associated parking within the immediate site	Including infrastructure, labour, products, fixtures, fitting-out, commissioning, valuation and handover, security systems. Need to cover the people/equipment issue for security
Fit Out (A5)	Initial adaptation or fit out of asset – fitting out or modification of new buildings	Including infrastructure, fixtures, fitting-out, commissioning, within the curtilage and handover (excluding unfixed furniture and non-building equipment)
Landscaping (A5)	Landscaping, external works on the curtilage	Costs for external works such as lawn, trees on the land within the curtilage of the building and is not covered within the construction costs
(A1-A5)	Taxes and other costs related to permission to build	Taxes on construction goods and services (e.g. VAT.) Costs incurred to obtain permission to build, e.g. provision of additional facilities for community benefit as a condition of building

Cost/Income category	Costs included in category	Examples of costs
(A1-A5)	Subsidies and incentives	Incomes related to renewable energy, and energy efficiency measures installed on the building, including loans

9.4 Calculation of costs of operation in use, maintenance and repair (B1-B3)

The calculation of the costs shall include the costs of the building in use, maintenance and repair as defined in 7.4.3.2, 7.4.3.3 and 7.4.3.4.

Table 2 — CEN/TC 350 life cycle stage — Use stage (Modules B1 — B7)

Cost/Income category	Costs included in category	Examples of costs
Operation and Maintenance (B2)	Building-related facility management costs	Costs for regular and routine activities such as inspections, caretaking, management of planned service contract, products or materials used for mentioned activities Professional Service
Operation and Maintenance (B2)	Building-related insurance costs	Building owner and/or occupiers
Operation and Maintenance (B2)	Leases and Rentals payable to third parties	Leases and rents, excluding land rental (ground rent)
Operation and Maintenance (B2)	Cyclical regulatory costs	Fire, access inspections declarations relating to energy performance etc.
Operational energy use (B6)	Energy costs (default is for usage as defined by EPBD related standards)	Including fuel and electricity for heating, cooling, power, domestic hot water and lighting costs (as defined by EPBD)
Operational water use (B7)	Water related costs	Including, water and sewerage costs
Operation and Maintenance (B2)	Taxes	Rates, local charges, environmental taxes
Operation and Maintenance (B2)	Subsidies and incentives	Incomes related to renewable energy, emissions, energy efficiency measures on the building, including loans
Replacement (B4)	Revenue from sale of asset or elements, but not part of a final disposal	Revenue from re-use, recycling, energy recovery of interest in salvaged materials
Operation and Maintenance (B2)	Third party income during operation	Rent and service charges to third parties
Operation and Maintenance (B2)	Other economic aspects	Available for use if required

Cost/Income category	Costs included in category	Examples of costs
Repair (B3)	Repairs and replacement of minor components/small areas	Defined by value size of area, contract terms
Replacement (B4)	Replacement of major systems and components	Including associated design and project management
Operation and maintenance (B2)	Cleaning	Regular or cyclical cleaning and periodic specific cleaning of the building
Operation and Maintenance (B2)	Grounds maintenance Needs defining to be consistent with the environmental assessment	Within defined site area
	Redecoration	Including regular periodic and specific decoration
	Taxes	Taxes on maintenance goods and services
Operation and Maintenance (B2)	Disposal Inspections at end of lease period (excluding end of life final disposal)	Final condition inspections to identify remedial works required at end of leasehold period
Operation and Maintenance (B2)	End of lease	Reinstatement End of Lease inspections
Refurbishment (B5)	Planned Adaptation or planned refurbishment of asset in use	Including infrastructure, fitting out commissioning, validation and handover

Table 3 — CEN/TC 350 life cycle stage — End of life stage (Modules C1 — C4 and D)

Cost/revenue category	Costs/revenues included in category	Examples of costs/revenues
Deconstruction (C1)	Deconstruction/ Dismantling Demolition	End of life inspection, decommissioning, planning Reinstatement of site to meet contractual requirements, Site cleanup
Transport (C2)	All transport costs associated with the process of deconstruction and disposal of the built asset	On-site transport, transport of materials from site to first place of storage or disposal.
End of life (C1 - C4)	Fees &Taxes	Taxes on goods and services Landfill and other disposal costs
Waste processing for re-use, recovery and or recycling((C3)	Costs from re-use, recycling and energy recovery at end of life	Costs from re-use, recycling, energy recovery of interest in salvaged materials such metals, aggregates, timber, plastics, etc.
Recycling (D)	Revenue from sale land	Revenue from disposal of interest in land

9.5 Calculating costs for replacements (B4)

9.5.1 Components that will not be replaced under defined conditions

No replacement costs are required when the Estimated Service Lives (ESL) of the installed products, structural element(s) or component (foundations, column, beam), meets or exceeds the Estimated Service Life of the building.

9.5.2 Replaceable components and costs

For all components or elements that may be repaired or replaced, the ESL and information on processes for repair, replacement and disposal shall be defined. This shall be established in accordance with ISO 15686-1 and ISO 15686-8.

The number of replacements for products, components, elements, used in the building is directly linked to its estimated service life (ESL). Only a full number of replacements (no partial replacements) is allowed; in the case of a partial number of replacements resulting from the estimated service life of the component relative to the reference study period of the building, the value obtained is rounded up.

Formula (1) gives the number of replacement(s) $N_R(j)$ for products, component or element j as a function of the required service life of the building *ReqSL*.

$$N_R\ (j) = E[(ReqSL\ /\ (ESL(j))-1] \quad (1)$$

where

$E[(ReqSL\ /\ (ESL(j))]$ is the function that rounds up function *ReqSL* /(*ESL*(j) to the higher integer value;

ESL(j) is the estimated service life for product j;

$N_R(j)$ is the number of replacements for product j;

ReqSL is the required service life of the building.

The actual likelihood of the final scheduled replacement occurring should be taken into account, having regard to the estimated service life of a particular component. When considering the likelihood of the replacement being made, the required technical and functional performance for the product shall be considered.

If the economic assessment assumes that the final replacement is not installed then this shall be recorded in the assessment report.

This assessment shall be carried out in such a way that the scenario and the assessment of replacements are consistent with any environmental assessment that is carried out.

The number of replacements for the components or products shall be applied in the respective modules where they occur (replacement or refurbishment).

This assessment shall cover the use stage, including maintenance, repair, replacement and refurbishment Modules B1-B5).

9.5.3 Cost of replacements

Replacement costs occur when a component of a building needs to be replaced at the end of its service life.

This includes

— the cost of dismantling and disposal of the old component to be upgraded;

— the cost of production, delivery and installation of the new component to be installed, including access and provisions for occupiers during installation.

There are two possibilities for the calculation of the cost of replacement of components.

a) the actual number of replacements that occur within the reference study period will be taken into account for the calculation of the costs.

NOTE 1 This provides an expected cash flow profile for financial planning purposes.

b) for all components the costs for replacements is calculated and divided by the duration of their service life. The annual cost of replacements can be derived from this.

NOTE 2 This approach is typical from the perspective of budgeting or maintenance contracts.

9.6 Calculation of energy costs (B6)

Calculation of the energy required during the use stage of the building shall be carried out in accordance with EN 15603. The required energy use by each carrier shall be multiplied by the unit energy cost. The selection of energy costs or charges used for the calculation shall be reported in relation to the purpose of the assessment and scenario for energy supply.

The calculated or estimated energy delivered for use is counted separately for each of the different energy carriers (electricity, gas, etc.) supplied to the building for use in heating, cooling, hot water, lighting, building automation and control systems and other integrated systems.

Energy (heat, electricity) generated on site (e.g. from photovoltaic cells, wind turbines, biomass, cogeneration, fuel cells), should be separately measured. Where this energy is exported for use off site any income shall be treated as a negative cost.

9.7 Calculation of costs of operational water use

The calculation of the quantities of operational fresh water use and waste water (and rainwater if applicable) for disposal shall be taken from the environmental assessment undertaken in accordance with the scenario for operational water use.

The required water use and waste water disposal shall be multiplied by the relevant unit cost. Calculation of additional cost and income related information (information module D).

9.8 Calculation of additional cost and income related information (information module D)

Based on the specified scenario (8.8) potential incomes can be calculated and declared in Module D:

a) the assumed potential economic value of the building at the end of the Reference Study Period (RSP)

or

b) the potential net income from the reuse of the construction frame or structure of the building after its end of life

and/or

c) the potential net income for the building owner resulting from the sale of products and materials for reuse, recycling or recovery. Hence, module D shall be fully consistent with the scenarios developed for the various life cycle stages and modules.

   Each of the processes in the lifecycle stage A, B and C (described in the information modules) might have a potential income to be calculated for and declared in Module D.

   The calculation is based on the quantified mass flows (amount of secondary products) and its assumed unit price.

9.9 VAT

The economic assessment shall be calculated excluding VAT, and the VAT treatment shall be reported separately, as it will be dependent on the tax status of the client and project.

10 Selection of economic data for economic assessment

10.1 General

The economic assessment of the building shall cover the stages of the building life cycle as described in Figure 6 and as described in the scenarios prepared according to Clause 8 of this standard.

In addition, Module D provides information on the incomes from reuse, recycling and recovery beyond the system boundary.

10.2 Specification of the discount rate

For the assessment of the Life Cycle Costing in terms of net present value (cost) it is necessary to specify the discount rate that shall be used for the calculation. Selection of the discount rate has a major impact on the outcome of the calculations.

For the purposes of comparability the net present value (cost) shall be undertaken with a real discount rate of 3 %.

The assessor may also carry out additional calculations using other discount rates, selected in consultation with the client. Commercial, political, regulatory and sustainability-related objectives or requirements may be the basis for selecting and specifying different discount rates.

NOTE 1 The discount rate of 3 % is taken from the Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 for calculation of cost optimal measures, supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings

NOTE 2 The additional discount rate selected can be influenced, for example, by the borrowing costs of the clients, financial risks and considerations of the interests of future generations.

NOTE 3 The higher the selected discount rate, the less influence costs later in the required service life have on the calculation of NPV(cost). Higher discount rates tend to favour lower initial cost solutions which can have higher annual operating costs.

10.3 Escalation rates

Escalation rates may be used as a form of sensitivity analysis where there are grounds to anticipate that the standard rate of inflation does not apply in the case of a specific option. Typically, real rates should be used; these exclude the impact of future inflation. Nominal rates may be used by agreement, if that is what is required by the client or justified by the situation.

Different escalation rates may be used for different components of the analysis, including energy costs, water, and waste water costs, construction, services and in use costs.

10.4 Data quality

When preparing an economic assessment of the building, the following data quality requirements shall be applied:

— data should be as current as possible;

— data shall have been checked for plausibility;

— the technological coverage shall reflect the physical reality for the declared product or product group;

— the geographical coverage shall be representative of the region where the production is located.

The significance of the influence of the data chosen for the building assessment shall be determined (e.g. through a sensitivity analysis) and reported.

11 Calculation of the economic indicators

11.1 Methods for assessing the economic indicators

The costs and incomes shall be calculated initially without applying any discount or escalation rate. This gives the nominal value. The level of aggregation of costs and incomes depends upon the level of detail available.

NOTE For example, contract prices often include the supply, transport and installation of materials and do not disaggregate the prices of these elements.

The assessor should ensure that the aggregated costs include the different cost elements (or income sources) described in Table 1, Table 2 and Table 3.

It is important to identify which of these costs is a recurrent cost and non-recurrent costs and to specify the year used for the reference cost and the year of occurrence of the cost.

Table 1, Table 2 and Table 3 list the main types of costs and incomes to be used, if relevant to a specific project, for economic assessment in accordance with this European Standard.

11.2 Calculation of the discount factor

The discount factor $CF(T)$ shall be calculated using the following formula:

$$CF(T) = \frac{1}{(1+r)^T}$$

where

r = annual real discount rate

T = number of years between the reference date (start of the period covered by the assessment) and the date of onset of the cost

11.3 Net Present Value (NPV), Net Present Cost (NPC)

The NPV is the sum of the discounted future cash flows, both costs and benefits/revenues. Where only costs are included this may be termed Net Present Cost (NPC).

NPV is a standard measure in LCC analyses, used to determine and compare the cost effectiveness of proposed options. It can be applied across the full range of construction investments, covering whole investment programmes, assets, systems, components and operating and maintenance models. The costs and revenues/benefits to be included in each analysis are defined according to its objectives. For example, revenues from recycling of materials or from surplus energy generation are typically included in a LCC analysis of alternative sustainability options.

11.4 Annual Cost and Annual Equivalent Value (AC or AEV)

The AC or AEV is a uniform annual amount that, when totalled over the period of analysis, equals the total net cost of the project taking into account the time value of money over the period. It is used to compare investment options where the natural replacement cycle cannot easily be directly related to the period of analysis. The lowest AEV indicates the lowest cost option.

11.5 Other economic indicators

Additional economic indicators are listed in Annex C and may be used for other aspects of economic assessment which are outside the scope of this European Standard, and therefore these indicators are not intended to be reported.

11.6 Costs and related indicators

Indicators used in this clause represent the costs and incomes associated with the object of assessment during its whole life cycle.

11.7 Calculation methods

The values for each of the above-mentioned indicators may be calculated for each module in the life cycle stages, or may be aggregated.

12 Reporting of the assessment of results

12.1 General information on the assessment

The economic performance of a building represents only one aspect of the contribution to sustainability as presented in ISO 15392 and in the general framework EN 15643-1.

The basis of the assessment is the transparency and traceability of information used for the different options and choices of the assessor during all the calculation process.

The economic performance of buildings can be presented by documents and visual aids. The findings of all results shall be traceable and transparent. This requires that information be presented in sufficient detail to allow the reader to assess the quality of the information.

Annex C contains examples of the scope of the assessment, and of the detailed presentation of data.

Reporting of the assessment shall include (but not be limited to) the following information and/or assumptions regarding:

— purpose of the assessment (intended use and scope);

— identification of building (address, etc.);

— client for assessment;

— name and qualification of the assessor;

— assessment method including version number and reference;

— point of assessment in the building's life cycle;

— period for which the assessment is valid;

— date of assessment;

— statement regarding verification of the assessment;

— name and qualification of the verifier, if verification is applied.

12.2 General information on the object of assessment

The report shall include the following:

a) The functional equivalent assessed:

   1) building type (e.g. office, factory);

   2) relevant technical and functional requirements (e.g. the regulatory and client's specific requirements);

   3) pattern of use (e.g. occupancy);

   4) required service life;

b) The reference study period used for the assessment;

c) It may also include other building information, for example:

5) technical type of building (structural type);

6) year of commissioning;

7) year(s) of refurbishment;

8) for each operational area:

i) design number of building occupants;

ii) design occupancy schedule;

iii) heating, cooling and ventilation system and hot water service system;

iv) lighting system;

v) power and communication systems.

12.3 Statement of boundaries and scenarios used in the assessment

For the building under assessment the relevant assumptions and scenarios in accordance with Clause 8 shall be stated in the documentation.

12.4 Data sources

Data sources, type and quality of data used shall be reported.

12.5 Expression of results

For each module of the life cycle, values shall be reported for all costs (and incomes) that have been determined in the assessment.

If any module contains only partial information, this shall be clearly stated and reasons for omitting this information shall be given.

If a module is excluded, the module shall be stated as MNA (module not assessed) and reasons for omitting this information shall be given.

Incomes arising from the sale of land, exported energy, reuse of building components or systems, recycling of building materials, and energy recovery and other recovery operations beyond the building life cycle (i.e. the system boundary), may be included as information in module D.

Table 4 shows the minimum disaggregation level which is required for inclusion in the assessment report.

The economic performance data may be further disaggregated, for example separating refurbishment from repair and replacement.

Table 4 — Expression of costs and incomes

<table>
<tr><th>Costs and income</th><th>Unit Indicator</th><th colspan="2">Information Modules A
Before use stage</th><th colspan="3">Information Modules B
Use stage</th><th>Information Modules C
End of life stage</th><th>Information Module D
Costs and incomes beyond the system boundary</th></tr>
<tr><td>Non-annual costs</td><td>€(or other currency) /occurrence
Date of occurrence</td><td colspan="2">Pre-construction
(A0) and Construction
(A1-A5)</td><td colspan="3">Maintenance
(B2)
Repair, replacement and refurbishment
(B3, 4 and 5)</td><td>Deconstruction, Transport, Waste processing and Disposal
(C1-C4)</td><td>Re-use
Re-cycling
Recovery Potential</td></tr>
<tr><td>Non-annual Income</td><td>€/occurrence (or other currency)
Date of occurrence</td><td colspan="2"></td><td colspan="3">Use (B1)
Energy related incentives (B6)</td><td></td><td>Re-use
Re-cycling
Recovery Potential
Land sale</td></tr>
<tr><td>Annual recurrent costs</td><td>Ref. Year €/year</td><td colspan="2"></td><td>Use and maintenance
B1 and B2</td><td>Operational energy use
B6</td><td>Operational water use
B7</td><td></td><td></td></tr>
<tr><td>Annual recurrent income</td><td>Ref. Year €/year</td><td></td><td></td><td>Use
(B1)</td><td>Exported energy
(B6)</td><td></td><td></td><td></td></tr>
</table>

12.6 Communication of assessment results

The communication of results of the economic assessment shall be based on and be limited to the report in accordance with 12.5.

The communication from the report may be simplified according to the following rules:

— the communication may be limited to a selection of indicators;

— results shall be presented separately for all the building life cycle stages and for module D;

— within each of the building life cycle stages (see Figure 6 and Figure 7), the results per indicator may be summed provided that values for the indicator are determined for each module within that stage;

— if values have not been determined for all modules of a life cycle stage, the results shall be presented separately for each module of that stage, and those modules for which no values are determined shall be shown as Module Not Assessed (MNA).

NOTE In addition, the results can be presented graphically to assist communication.

13 Verification of results

In order to be verifiable, all information used, options, or decisions taken shall be presented in a transparent manner.

If there is need for verification of the assessment, a verification procedure shall be applied.

The verification shall include (but is not limited to) the following:

— consistency between the purpose of assessment and boundaries and scenarios used;

— traceability of data used;

— consistency with the environmental and social assessments of the building;

— completeness and justification of completeness for the quantification at the building level.

The competence of the verifier shall be stated in the verification procedure.

Annex A
(informative)

Example building description

Figure A.1 illustrates part of a building model presenting different levels of aggregation, from the product level to the building element level.

NOTE The figure does not cover all product and elements embedded in the building.

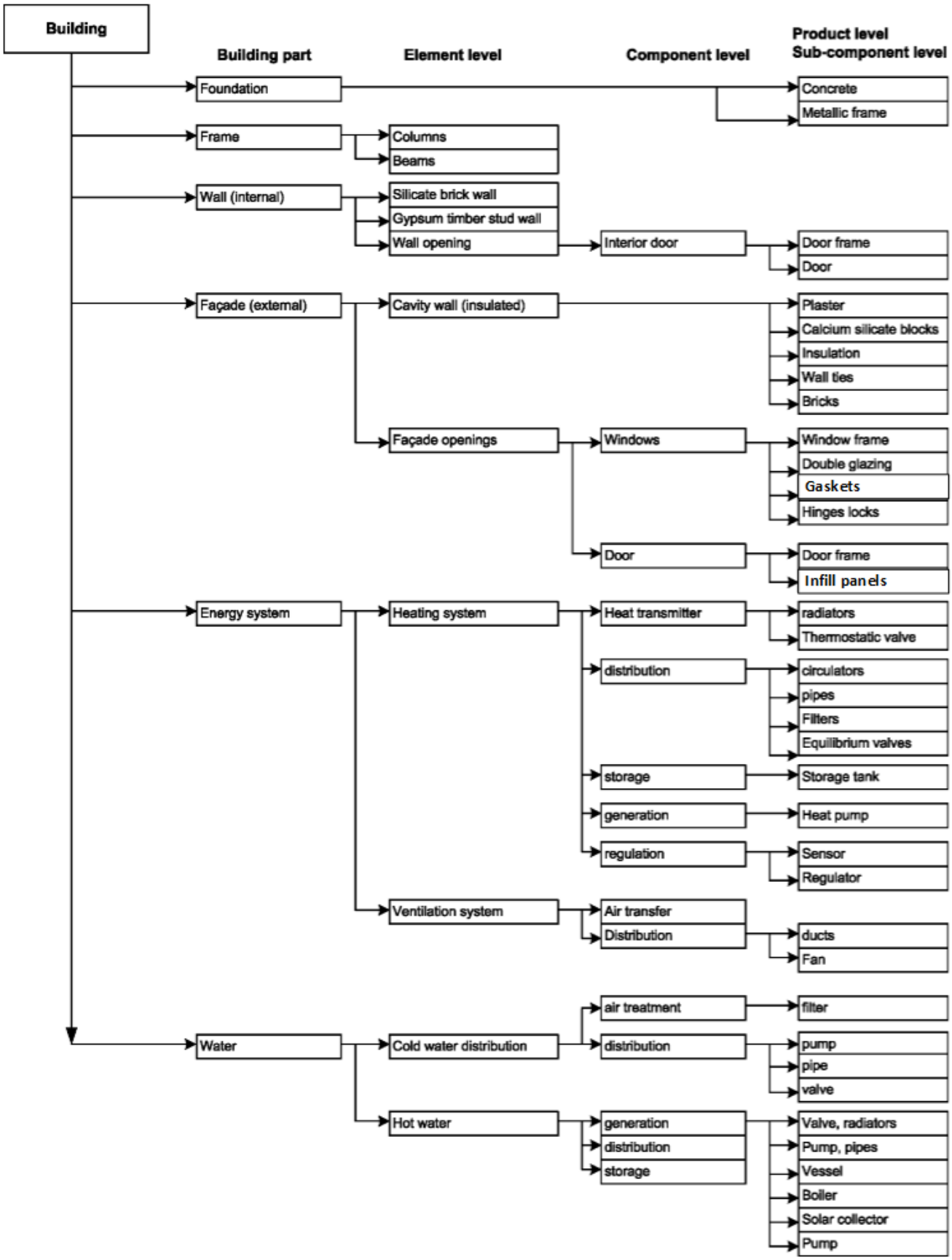


Figure A.1 —Example of a structuring of building information using the different level of aggregation

Annex B
(informative)

Exported energy – Case studies

B.1 General

Annex B provides practical case studies of imported and exported energy, based on the annual energy input and output flows. The following cases illustrate the interpretation principles expressed in 7.4.3.7.

B.2 Case 1

The energy production unit is delivering all of its produced energy to the building and is complementing the imported energy (see Figure B.1).

All economic costs of the unit from design, production, transport, installation (A0-A5), use, maintenance, repair, replacement (B1-B5) and end-of-life (C1-C4) are fully allocated to the building. All economic costs related to the operational energy use of the unit (module B6) are fully allocated to the building.

NOTE This case could be, for example, a fuel-based heating system intended to satisfy the energy demand of the building or for an electricity generator providing electricity to the building which is not connected to the electricity grid.

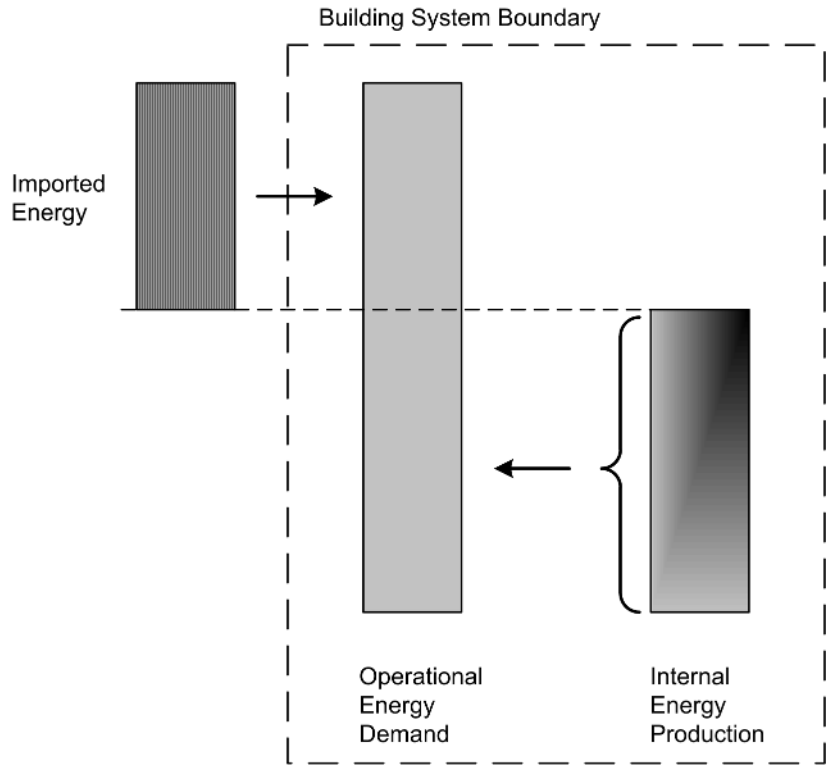


Figure B.1 —Scenario for energy use, supply and import (Case 1)

B.3 Case 2

The energy production unit exports energy that is surplus to the building's needs. No energy is imported (see Figure B.2). The scenario shall specify the amount (annual average) of energy that is exported.

All costs of the energy production unit from design, production, transport, installation (A0-A5), use, maintenance, repair, replacement (B1-B5) and end-of-life (C1-C4) are fully allocated to the building. All economic costs related to the operational energy use of the energy production unit (module B6) are fully allocated to the building.

The costs and income from the exported energy, substituting energy beyond the building system, are reported in module B6.

NOTE This is, for example, the case for a central heating system aiming at satisfying the thermal energy demand of the building and which can also provide thermal energy to surrounding facilities which are not included in the system boundary.

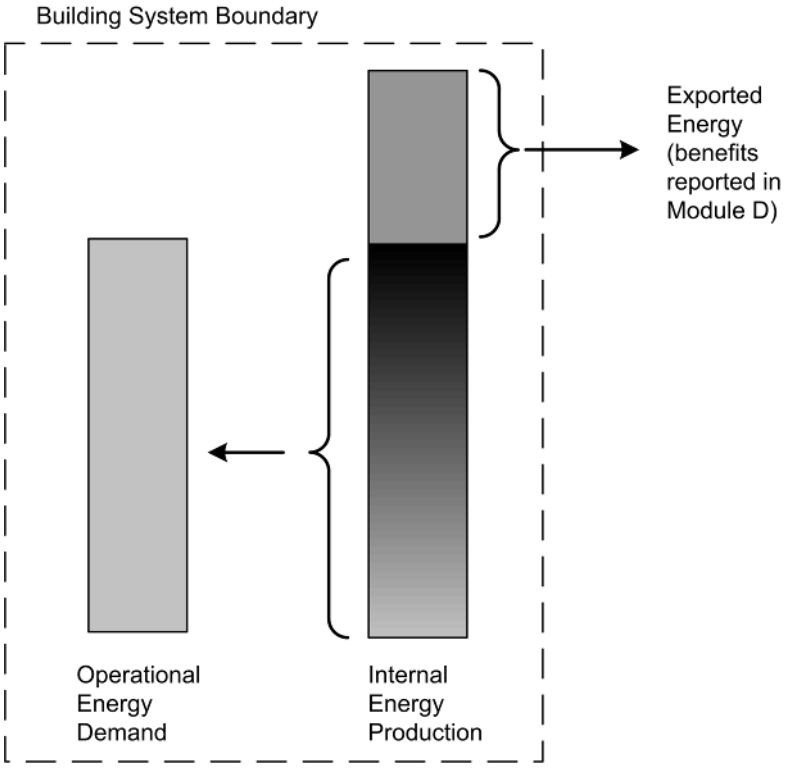


Figure B.2 — Scenario for energy use and export (Case 2)

B.4 Case 3

In addition to energy imported into the system energy is produced on the building site that is used in part for the building and the remainder exported (see Figure B.3).

All economic costs of the unit from design, production, transport, installation (A0-A5), use, maintenance, repair, replacement (B1-B5) and end-of-life (C1-C4) are fully allocated to the building. All economic costs related to the operational energy use of the unit (module B6) are fully allocated to the building.

All economic impacts and aspects of the imported energy are fully allocated to the building and reported in module B6.

The benefits of the exported energy, substituting energy beyond the building system, are reported in module D.

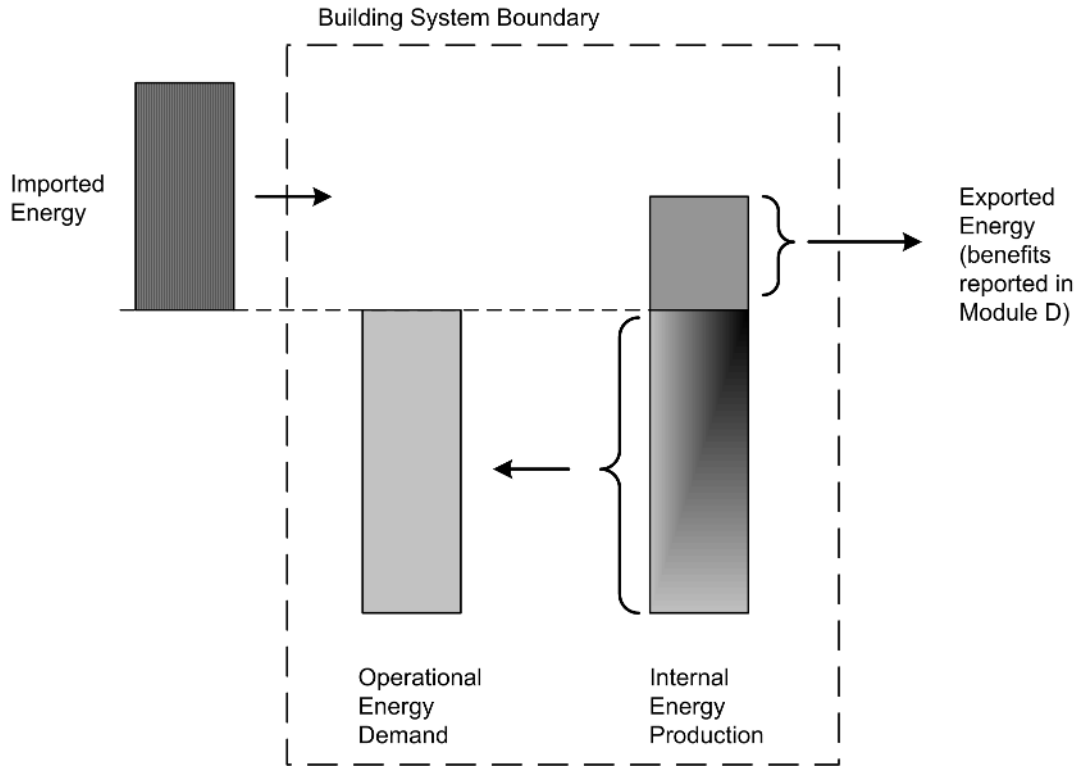


Figure B.3 — Scenario for energy use, supply and export (Case 3)

NOTE This applies to intermittent electricity sources such as photovoltaic cells or wind turbines. Owing to their intermittent nature, only a fraction of the electricity production is used within the building, even if the electricity generated annually is lower than the overall electricity demand of the building.

B.5 Case 4

The energy production unit does not deliver energy for use within the building or system, all site-produced energy is exported and the full energy demand of the building is covered by imported energy (see Figure B.4).

All economic costs of the unit from design, production, transport, installation (A0-A5), use, maintenance, repair, replacement (B1-B5) and end-of-life (C1-C4) are fully allocated to the building. All economic costs related to the operational energy use of the unit (module B6) are fully allocated to the building.

The benefits of the exported energy, substituting energy beyond the building system, are reported in module D.

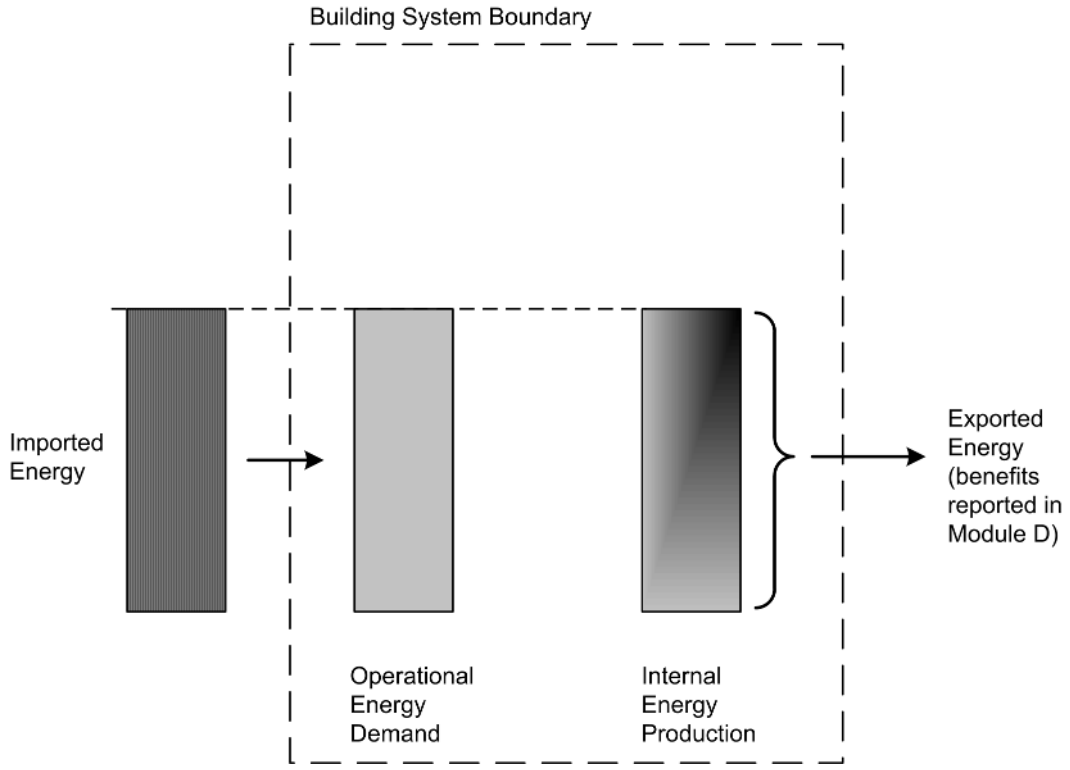


Figure B.4 —Scenario as all site-produced energy is exported

Annex C
(informative)

Additional indicators to assess the economic performance of buildings – Rules for assessment

C.1 General

In addition to the identification and evaluation of Life Cycle Costing (and revenues), there are other ways to describe and evaluate the economic performance of buildings. Since there are no uniform and agreed definitions and rules, these are presented in an informative annex. These indicators are not intended to be reported within Module D.

C.2 Value stability and performance

C.2.1 General

Part of the aim of sustainable development in the field of economics is the preservation of capital. Therefore, there is an interest in preserving the economic value of a building over its life cycle and - if possible - in achieving a positive economic performance. This meets at the same time the objective of minimizing the financial risks.

A distinction is made between these two:

— Value stability in a short-term perspective;

— Value stability and performance in a medium-to long-term perspective.

C.2.2 Value stability in a short-term perspective

To assess the value stability in a short-term perspective the investment costs at the time of completion and handover of the building are compared with the market value/current market price at the time of delivery. The market value is preferably determined based on the income approach. Value stability is achieved when the market value has reached at least the level of investment costs (including land).

NOTE The **Income Approach** is one of three major groups of methodologies, called valuation approaches, used by appraisers. It is particularly common in commercial real estate appraisal and in business appraisal. While there are quite a few acceptable methods under the rubric of the income approach, most of these methods fall into three categories: direct capitalization, discounted cash flow, and gross income multiplier.

C.2.3 Value stability and performance in a medium-to long-term perspective

So far there are no established and accepted methods for assessing and evaluating the value stability and performance over an extended period of time. An orientation to the identification and assessment of the financial risk according to TEGoVA [1)] is possible.

1) http://www.tegova.org/en/p4912f1ead0b2c

http://www.tandfonline.com/doi/abs/10.3846/ijspm.2010.14#

The medium-to long-term value stability and performance will be influenced among others by specific market, location and building characteristics. The object under observation in a sustainability assessment of buildings is the building itself and its site. Therefore, only the building-related contribution to the value stability and performance can be assessed.

This can be done using “consequential” indicators. These are among others:

— **Flexibility and adaptability** of the building to changing user needs to lower the risk of changes in the market;

— **Energy performance** of the building to reduce the risk of energy price changes and to lower the risk of depreciation if a high energy performance becomes the “standard” in the real-estate market (and property rating);

— **Environmental performance** to reduce several risks (e.g. reputation risk) and to lower the risk of depreciation if an environmental performance becomes the “standard” in the real-estate market (and property rating);

— **Adaptability of the building to climate change;**

— **Durability** (see the framework standard EN 15643-4:2012, 3.16).

NOTE It is not certain that sustainable buildings are bound to get a premium in the future, but the “non-sustainable” ones are likely to be affected by reduced rents, higher vacancy rates and other negative effects.

Some of the indicators are already used in a different context for sustainability assessment purposes. However, this is not double counting but a multiple effect.

C.2.4 Additional economic indicators used in ISO 15686-5

The following economic indicators are described in ISO 15686-5 and may be used for other aspects of economic assessment which are outside the scope of this European Standard:

— payback period;

— net savings or net benefit;

— savings to investment ratio;

— adjusted internal rate of return.

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[20] Construction Products Directive (CPD) Guidance Paper F

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[22] TEGoVA, The European Group of Valuers' Associations, http://www.tegova.org/en/p4912f1ead0b2c

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