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Sustainability in building construction — Framework for methods of assessment of the environmental performance of construction works —

Part 1: Buildings

Développement durable dans la construction — Cadre méthodologique de l'évaluation de la performance environnementale des ouvrages de construction —

Partie 1: Bâtiments

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21931-1 was prepared by Technical Committee ISO/TC 59, *Building construction*, Subcommittee SC 17, *Sustainability in building construction*.

This first edition of ISO 21931-1 cancels and replaces ISO/TS 21931-1:2006.

ISO 21931 consists of the following parts, under the general title *Sustainability in building construction — Framework for methods of assessment of the environmental performance of construction works*:

— *Part 1: Buildings*

Civil engineering works (infrastructure) is to form the subject of a part 2.

Introduction

The ability to measure and understand the environmental performance of buildings is essential for communicating their potential environmental impacts and their influence on sustainable development.

This part of ISO 21931 establishes a framework for methods of assessment of the environmental performance of buildings and related external works, which is a central part of the process. Such assessments can be used for benchmarking performance and monitoring progress towards improvement of performance. This part of ISO 21931 does not set benchmarks or levels of performance relative to environmental impacts and aspects.

The development of methods of assessment of the environmental performance of buildings has been ongoing since the early 1990s. This has been prompted by:

a) a recognition of impacts of buildings on the environment;

b) an increased focus on sustainability and sustainable development in the construction sector;

c) a need to meet the market demand for differentiation between buildings, based on measured environmental performance and environmental information;

d) a shift from single performance measures to a more comprehensive set of environmental considerations;

e) a recognition of the benefits of proactive voluntary measures.

The methods of assessment of the environmental performance of buildings provide a basis for demonstrating and communicating the result of efforts to improve environmental performance in construction works. The methods typically establish a means of assessing a broad range of environmental considerations against explicitly declared criteria, and give a summary of environmental performance.

The methods of assessment of the environmental performance of buildings provide:

— a common and verifiable set of references, such that building owners, striving for higher environmental standards, have a means of measuring, evaluating and demonstrating that effort,

— a reference as a common basis by which building owners, design teams, contractors and suppliers can formulate effective strategies in building design and operation, which are intended to improve environmental performance,

— detailed information on the building which is gathered and organized in such a way that it can be used to lower operating, financing and insurance costs, and vacancy rates, and increase marketability,

— a clear description of the factors considered to be the key environmental considerations and their relative importance, thereby assisting the design process.

To achieve the above-mentioned practical goals, methods of assessment of the environmental performance of buildings need to refer to limited criteria and seek a balance between rigour and practicality. Life cycle-based approaches play an increasingly significant role for setting performance criteria within methods of assessment of environmental performance of buildings. However, the collection and maintenance of current data sets for the multitude of building systems and elements might not be practicable. Also, the context of overall building performance is important for considering each environmental criterion.

Considering all of these issues, the purpose of this part of ISO 21931 is to describe the framework and the principles that apply in the assessment of the environmental performance of new and existing buildings and

their related site works, taking into account the various environmental impacts these buildings are likely to have.

This part of ISO 21931 aims to bridge the gap between regional and national methods for the assessment of the environmental performance of buildings, by providing a common framework for their expression.

Practical relevant rules and recommendations concerning methods for the assessment of the environmental performance of buildings, which can exist on either a national or regional basis, can be examined and improved by the use of the framework of assessment, which is the basis of this part of ISO 21931.

An improvement of the environmental performance of a building requires an appropriate operation of the building over its lifetime. In existing buildings, it can be enhanced through the use of an environmental policy and the implementation of an environmental management system.

This part of ISO 21931 is one in a suite of International Standards dealing with sustainability in building construction, which includes ISO/TS 21929-1, ISO 21930 and ISO 15392, along with the terminology of sustainability in building construction (future ISO/TR 21932).

This part of ISO 21931 deals with environmental performance related to environmental impacts and aspects. Social aspects related to the indoor and local outdoor environment are discussed in Annex A.

The relationship among the International Standards is illustrated in Figure 1.

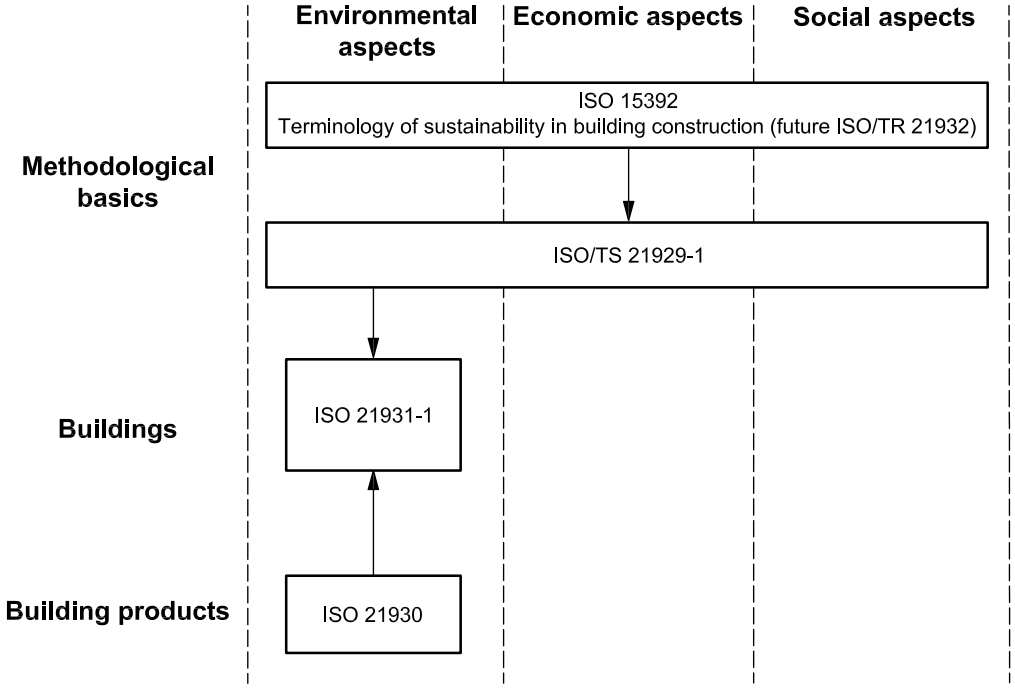


Figure 1 — Suite of related International Standards for sustainability in buildings and construction works

Sustainability in building construction — Framework for methods of assessment of the environmental performance of construction works —

Part 1: Buildings

1 Scope

This part of ISO 21931 provides a general framework for improving the quality and comparability of methods for assessing the environmental performance of buildings and their related external works.

It identifies and describes issues to be taken into account in the development and use of methods of assessment of the environmental performance for new or existing buildings related to their design, construction, operation, maintenance and refurbishment, and in the deconstruction stages.

The object of assessment in this part of ISO 21931 is the building and the external works within its site (curtilage).

This part of ISO 21931 is intended to be used in conjunction with, and following the principles set out in the "ISO 14020 family of International Standards", which includes ISO 14020, ISO 14021, ISO 14024 and ISO 14025, as well as ISO 14040 and ISO 15392. Where deviation occurs, this part of ISO 21931 takes precedence.

This part of ISO 21931 deals only with methods of assessment of environmental performance and excludes methods of assessment of social and economic performance, which are also part of sustainability and sustainable development.

NOTE 1 It is recognized that environmental performance is only one of a number of significant factors in a building's overall performance.

NOTE 2 In many cases, methods of assessment of the environmental performance of buildings include consideration of social aspects related to the indoor and local outdoor environment (see Annex A).

2 Normative references

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

ISO 6707-1, *Building and civil engineering — Vocabulary — Part 1: General terms*

ISO 14025, *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*

ISO 14040:2006, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14050, *Environmental management — Vocabulary*

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

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

ISO 21930:2007, *Sustainability in building construction — Environmental declaration of building products*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6707-1, ISO 14025, ISO 14040, ISO 14050, ISO 15392 and ISO 21930 and the following apply.

NOTE See the terms and definitions in the terminology of sustainability in building construction (future ISO/TR 21932).

3.1
design life
required service life

3.2
downstream process
process (3.11) that is carried out after the designated process in the stream of relevant processes

3.3
environmental aspect
aspect of buildings, part of buildings, **processes** (3.11) or services related to their life cycle that can cause a change to the environment

3.4
environmental impact
change to the environment, whether adverse or beneficial, wholly or partially, resulting from **environmental aspects** (3.3)

NOTE Adapted from ISO 15392:2008, definitions 3.13 and 3.13.2.

3.5
environmental performance
performance of a building related to its **environmental impacts** (3.4) and environmental aspects

NOTE 1 The environmental performance is influenced by all **processes** (3.11) related to the life cycle of the building.

NOTE 2 Environmental performance can be expressed either quantitatively or qualitatively with reference to performance requirements or possibly relative to a scale of values or a benchmark.

3.6
estimated service life
service life that a building or parts of a building 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

[ISO 15686-1:—, definition 4.8]

3.7
functional equivalent
quantified functional requirements and/or technical requirements for a building for use as a reference basis for comparison

1) To be published.

3.8
gate
point at which the building product or material leaves the factory before it becomes an input into another manufacturing **process** (3.11) or before it goes to the distributor, a factory or building site

[ISO 21930:2007, definition 3.6]

3.9
interested party
person or group concerned with or affected by the **environmental performance** (3.5) of a building

3.10
non-renewable resource
resource that exists in a fixed amount that cannot be replenished on a human timescale

[ISO 21930:2007, definition 3.8]

3.11
process
series of operations performed to achieve a desired result

3.12
renewable resource
resource that is grown, naturally replenished or cleansed on a human timescale

EXAMPLES Trees in forests, grasses in grasslands and fertile soil.

NOTE A renewable resource is capable of being exhausted but can last indefinitely with proper stewardship.

[ISO 21930:2007, definition 3.13]

3.13
system boundary
interface between a building and the environment or other product systems

NOTE 1 System boundary defines what is included and what is not included in an assessment.

NOTE 2 Adapted from ISO 14040:2006, definition 3.32.

3.14
transparency
open, comprehensive and understandable presentation of information

[ISO 14040:2006, definition 3.7]

3.15
upstream process
process (3.11) carried out before the designated process in the stream of relevant processes

4 Principles for assessment of the environmental performance of buildings

4.1 General

This clause deals with the principles for the assessment of the environmental performance of buildings that are important for the application of this part of ISO 21931.

The environmental performance of a building is related to its characteristics and functions, where the building is

a) an end-use product and an integrated assembly of products,

b) a place in which to live, work or socialize (a place for living, working or doing other activities), and

c) a system in operation.

Methodologies for the assessment of the environmental performance of buildings and their related external works need to explicitly define the methods used to take account of the environmental impacts and aspects of the building.

4.1.1 A building as an end-use product and an integrated assembly of products

A building physically consists of various elements, such as construction products and components, which are parts of a building and its technical systems. Therefore, a building can be considered as an integrated assembly of construction products, which are manufactured, used and disposed of, according to their service life. It follows that buildings and the choice of construction products used in them take into consideration, and are based on, the project-specific requirements.

For the assessment of the environmental performance that relates to the characteristics of a building as an assembly of components and products, it is necessary to give a clear indication of the system boundary, such that the extent to which the different aspects, parts, processes and services of the building are involved in the assessment is clearly defined.

The environmental performance of a building involves issues that relate to the characteristics of the building, as an end-use product, as well as issues that relate to the characteristics of the building as an integrated assembly of components and products. During use, some products need to be maintained. The environmental performance of a building is directly related to impacts caused by the maintenance of the building components or products during their service life, and also includes consideration of refurbishment and end-of-life scenarios.

Because a building is an assembly of components and products, the environmental impacts of such components and products, which can occur at any time during their life cycle, have relevance for the assessment of environmental performance of the complete building.

The assessment of buildings may utilize environmental product declarations (EPD), as established on the basis of the same product category rules (PCRs), defined in ISO 21930. For the summations of EPD, data shall be derived in accordance with ISO 21930.

NOTE The environmental performance of a building that relates to the characteristics of a building as an assembly of products has relevance to the issues described in ISO 21930.

4.1.2 A building as a place in which to live, work or socialize

Over the use stage, a building provides for its users conditions appropriate for living, working, studying, or undertaking leisure or other social activities.

These conditions are expressed as technical and functional requirements, which include aspects related to the indoor environment of the building. These requirements become fixed when they are prescribed in the client's brief or in the project specification. Indoor environment requirements influence the results of the assessment of environmental performance and, therefore, need to be taken into account in the prescription of the functional equivalent given in 5.8.5.

The user's behaviour has an influence on environmental performance.

Location-related aspects of a building used as a place in which to live, work or socialize may be part of the assessment of the environmental performance of the building. When location-related aspects, such as those resulting from transportation of the users, are considered within the method of assessment, the environmental aspects of the building extend beyond the area of the building site.

NOTE 1 When the method is used for a design stage assessment, scenarios of buildings in operation provide information on the influence of the user behaviour. In the case of existing buildings, monitoring data of buildings in operation can provide relevant information, although in the absence of such data, it is possible to use scenarios as for design stage assessment.

NOTE 2 Methods of assessment of the environmental performance of a building can include consideration of social aspects, such as health and comfort, related to the indoor and local outdoor environment (see Annex A).

4.1.3 A building as a system in operation

Throughout its operation during the use stage, a building provides a number of services to its users, as well as conditions appropriate for living, working, studying, the provision of health care and leisure activities. The provision of these services results in environmental impacts due to input and output flows that are a consequence of the operation of the building services.

The environmental performance of the building depends on the resources, including materials, energy, water, etc., that it uses. When resources are used, emission flows occur, including atmospheric emissions, waste water, waste, etc. In addition to this, a building is linked to infrastructure both upstream and downstream, which requires energy, water and transport, and generates environmental impacts. The impacts related to these links, including those upstream and downstream, should be considered within the defined system boundary (see 5.4).

NOTE For these purposes, life-cycle analysis of energy, water and wastewater services can be used.

4.2 Purpose of assessment

The reasons for the assessment of the environmental performance of a building can vary, depending on the particular circumstances. A method for the assessment of the environmental performance of a building provides a means for the measurement and evaluation of the environmental impacts of a building. Such information may be used to support the decision-making process for a number of different scenarios, such as:

— the procurement of a building;

— the design and construction of a new building;

— improving the operation of an existing building during the operating phase;

— designing for retrofit and refurbishment during the operating phase;

— the deconstruction and disposal of the building at the end of the operating phase;

— the analysis of the environmental performance of an existing building.

Such an assessment may also be used for communicating environmental performance to third parties, the benchmarking of environmental performance and monitoring the progress towards the improvement of performance.

NOTE For examples of the possible relationships between the options listed, the life-cycle stages and the perspective of interested parties, see Annex B.

4.3 Relevance of local contexts

The environmental performance of a building is influenced by the characteristics of the climatic, social, economic and cultural context of the nation, region and site in which the building is located.

Subject to the aims and objectives of the assessment, the environmental performance of a building shall be expressed by absolute values. In addition, relative values may be used alongside the absolute values. Relative values refer to given contexts and should reflect regionally relevant benchmarks, as appropriate (see 5.8.6).

NOTE The characteristics and relevance of local contexts make the co-existence of regional and national methods for the assessment of the environmental performance of buildings possible, provided the methods align with the framework described in this part of ISO 21931.

5 Framework for methods of assessment of environmental performance of buildings

5.1 General

This clause gives minimum requirements and additional recommendations for consideration in the development, understanding, implementation and improvement of the methods of assessment of the environmental performance of buildings.

5.2 Assessment method documentation

The documentation of the assessment method shall identify

— the body responsible for the development and the maintenance of the method,

— details of stakeholder involvement in the development and validation of the method,

— national/regional/organizational means of recognition of the method and/or its accreditation, and

— processes and procedures for the delivery of the assessment (e.g. workflow, training, communication).

The method shall include and the documentation shall clearly describe

— the purpose of the method (5.3),

— the system boundary (5.4),

— a statement of the assumptions and scenarios (5.5),

— a structured list of the issues for assessment (5.6),

— the life-cycle stages of the building covered (5.7),

— the method(s) for the quantification of the environmental performance of the building (5.8),

— all sources of information (generic and specific databases, etc.) (5.9).

— an evaluation and interpretation process (5.10), and

— a report of results of the assessment (5.11).

In addition to the description of the method, statements regarding the assessment-specific assumptions, methods for the quantification and sources of information shall be recorded in the report containing the assessment result.

5.3 Purpose of the method

The documentation of the assessment method shall indicate the intended use, which shall be related to the application of the method and expected use of the assessment result.

NOTE Intended uses can include, for example:

a) the evaluation of options for

   1) procurement of a building;

   2) design and construction of a new building;

   3) the analysis of the environmental performance of an existing building;

   4) improving operation of an existing building;

   5) designing for retrofit and refurbishment during the operating phase;

   6) the deconstruction and disposal at the end of the operating phase;

b) use as the basis for benchmarking;

c) communication to third parties.

5.4 System boundary

The documentation of the assessment method shall indicate the physical scope (e.g. the object of assessment), the temporal scope and energy and mass flow(s) which are considered and not considered in the assessment. If possible, the method of assessment should include the whole building, its services, related external works and its site, for its entire life cycle, including upstream and downstream processes. In practice, however, the system boundary for the assessment is determined by the intended use of the assessment, the users and stakeholders, the stages of the building life cycle to which the method is applied, and the assumptions underlying the assessment.

Methods of assessment of the environmental performance of buildings shall clearly define the system boundaries used. When the assessment is restricted to a part of a building or a part of the life cycle, or if any relevant environmental issue is not addressed, this shall be documented and reasons explained.

Where comparisons are made between the results from different methods of assessment, it shall be ensured that the physical scope, temporal scope and energy and mass flows considered within the system boundary of the assessment methods are the same (see 5.10.2).

5.5 Statement of assumptions and scenarios

The method of assessment shall apply a fixed set of assumptions and scenarios, offer the user a choice between several default assumptions and scenarios or offer the user a free definition of assumptions and scenarios, or any combination thereof.

The documentation of the assessment method shall include statements regarding the general assumptions and scenarios used in the assessment. Building-specific assumptions and scenarios shall be stated in the assessment report (see 5.11).

Wherever possible, relevant information about an assessment of the environmental performance of an existing building should be based on a field survey and measurement.

NOTE 1 At different points in the life of a building project, it is possible for assumptions to be made. For example, at the concept stage, it is possible to find that there is little information of the proposed details of a building, and many

assumptions can be required. As the project progresses, the details become refined and assumptions can be replaced by specific information.

NOTE 2 An assessment of the environmental performance of a building generally requires knowledge of the following (either direct knowledge, assumptions or scenarios):

a) energy use, including type(s) and mix;

b) water consumption;

c) design life and estimated service life of the building;

d) products, including types, quantities, supply chain and logistics, estimated service life;

e) construction process;

f) servicing, maintenance, repair and refurbishment;

g) end of life, including demolition/deconstruction/recovery/recycling/final disposal;

h) occupants' behaviour in the operation stage;

i) building's location and its influence on user transportation;

j) building management operations that affect energy consumption and/or water consumption, waste production, including commissioning of building systems;

k) available infrastructure;

l) land use related to the building site.

5.6 List of issues for assessment

5.6.1 General

The environmental performance of a building can be assessed according to the environmental issues which are of concern to the various interested parties. The issues used to assess the environmental performance of a building should be presented as structured lists in the documentation for the assessment method.

The issues shall include

— environmental impacts (global and local), and

— environmental aspects.

In addition, the issues should include those related to the management processes for construction, delivery, operation and maintenance.

Some items may be excluded from the assessment report when the appropriate reasons are presented in the documentation of assessment method.

NOTE 1 For example, where the issue is already a precondition of law or where the market has already excluded products related to some environmental impact, therefore the risk of having those impacts in construction of a new building is very low.

The list of environmental issues may include both qualitative and quantitative information.

NOTE 2 Annex C illustrates the relationship between environmental aspects, impacts, issues and characteristics of the building.

NOTE 3 The issues listed can be used as the basis of assessment criteria.

5.6.2 Environmental impacts

5.6.2.1 Global and interregional environmental impacts

The environmental impacts that shall be considered and included in the assessment method are

a) climate change, and

b) depletion of the stratospheric ozone layer.

The environmental impacts that shall be considered and included in the assessment method, where information is available, are

— acidification of land and water sources,

— eutrophication, and

— formation of tropospheric ozone (photochemical oxidants).

5.6.2.2 Local environmental impacts

The following environmental impacts on the building site and its local surroundings shall be considered and included in the assessment method:

a) local impacts on biodiversity and ecology (flora and fauna);

b) load on local infrastructure (such as services and sewerage system);

c) change of microclimate;

d) impact on surface drainage.

5.6.3 Environmental aspects

5.6.3.1 General

The following environmental aspects shall be considered and included in the assessment method:

a) use of resources, which shall include the

   1) use of non-renewable primary energy resources,

   2) use of non-renewable material resources,

   3) use of renewable material resources,

   4) use of renewable primary energy, and

   5) consumption of freshwater;

b) production and segregation of waste for disposal, which shall include

   1) hazardous waste, and

   2) non-hazardous waste;

c) land use related to building site.

Consumption of freshwater should include the amount and type of water.

5.6.3.2 Local environmental aspects

The following environmental aspects of the building and its site shall be considered and included in the assessment method:

a) risk and emission to surface water and ground water;

b) risk and emission to soil.

5.6.4 Issues related to the management processes for construction, delivery, operation and maintenance

The environmental performance of a building is not only influenced by the quality of the building itself, but also by the management processes for the construction, delivery, operation and maintenance of the building. The following environmental issues related to the management processes for construction, delivery, operation and maintenance should also be included in the assessment method:

a) waste production and disposal;

b) reuse, recycling, and recovery of the materials;

c) pollution emissions;

d) water use;

e) wastewater treatment;

f) repair, conservation and replacement of products used in the building;

g) conservation and enhancement of the site environment to promote biodiversity;

h) environmental emergency management.

Double-counting with relevant environmental impacts (5.6.2) and aspects (5.6.3) shall be avoided. The management process information should be consistent with, and support the assumptions and scenarios used in, the assessment.

5.6.5 Additional issues

Additional issues may be selected to meet the assessment method objectives and shall be justified and fully described.

5.7 Building life cycle

5.7.1 General

The results of the assessment of the environmental performance of a building are directly influenced by the point of the assessment within the building life cycle and the life-cycle stages addressed. Therefore, methods of assessment of the environmental performance shall clearly document what life-cycle stages are relevant to each environmental issue considered in the method.

The life cycle can be understood as a set of subdivided modules, which can be assessed and combined in different ways.

Figure 2 illustrates a modular structure of the life-cycle stages of a building from the physical point of view. The life cycle of a building may also be looked at from other perspectives, for example, from a project management point of view.

NOTE A building project starts with a consideration of the need for, and functions required of, a building, followed by the decision whether to build a new building or refurbish an existing building, and then proceeds through the contractual arrangements for procurement, design and specification, acquisition of land (if needed) and materials, construction, handover for fit-out and use.

5.7.2 Prior to handover

As shown in Figure 2, the stages before the handover of the building include the following modules:

a) production, including

   1) raw material supply, and

   2) manufacturing of products including transport and all upstream processes from cradle to gate;

b) construction process, including

   1) transport to the building site, and

   2) building installation/construction.

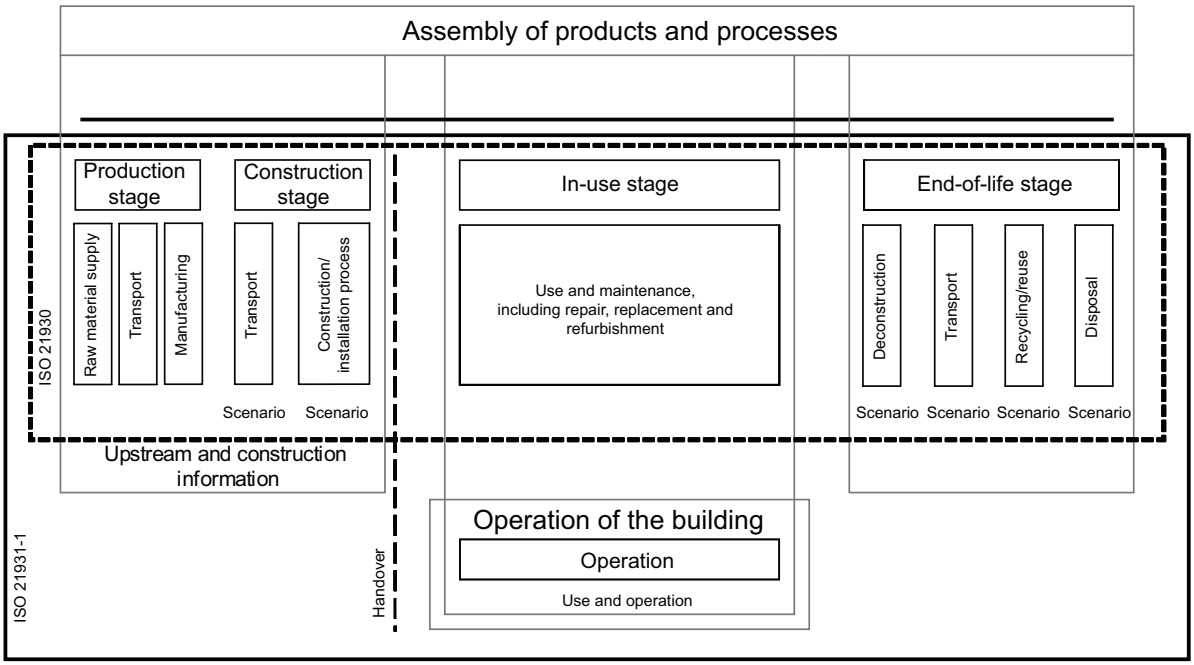


Figure 2 — Modular structure of the life-cycle stages of a building from the physical point of view

5.7.3 Stage following handover

After the handover of the building, the in-use stage modules include:

a) use and maintenance, including

   1) repair and replacement (including upstream and downstream processes), and

   2) refurbishment (including upstream and downstream processes);

b) operation of the building, including directly building related

1) energy use,

2) water use, and

3) waste treatment/disposal.

5.7.4 End-of-life stage

The end-of-life stage modules, include:

a) deconstruction;

b) transport;

c) recycling/reuse;

d) disposal.

All life-cycle stages shall be considered in the assessment. When some stages are not considered or are excluded from the assessment, the reasons for such omission or exclusion shall be clearly explained in the methodology documentation. The assessment report shall state which life-cycle stages are included and which life-cycle stages are excluded.

NOTE Table D.1 shows the relationship of environmental issues to the different stages of the life cycle of a building and identifies those issues to be included in the assessment method, as given in 5.6.

5.8 Methods for quantification of environmental performance of buildings

5.8.1 General

The measurement of the environmental performance of a building requires indicators for the environmental issues selected (see 5.6). Indicators may be qualitative or quantitative.

Methods for quantification of the environmental performance of a building are composed of a methodology to

— measure the environmental performance by specific issues, and

— aggregate the results of measurement of the environmental performance from multiple issues.

Qualitative environmental performance can be expressed in a quantitative way by several means, such as rating or scoring. The evaluation of qualitative environmental performance, which has no direct means for quantification, can be made by consensus or by agreement.

5.8.2 Data quality

The quality of data used for the assessment of the environmental performance of a building influences the results. Where available, the assessment shall use data specific to the building under consideration. If such data are not available, generic data appropriate to the building from reference documents may be used. Where EPD data are used, the data shall comply with ISO 21930. Other quantitative data shall comply with scientific and engineering principles.

NOTE Data used in the assessment of the environmental performance of a building can include:

— data related to and describing the building and its life cycle,

— data related to products and services used,

— reference data, and

— data related to converting building activity and processes into environmental impacts.

Where possible, the assessment should provide guidance on how uncertainty in data can be tested and managed through the use of sensitivity analysis (for a given range of possible values) and/or probabilistic analysis (where there is a well-understood distribution of possible values).

All data used shall be verifiable.

5.8.3 Traceability and transparency

Information regarding the assessment method and result of the assessment shall be transparent and traceable. Transparency encompasses the presentation of information in a manner that is open, comprehensive and understandable.

Methods for the assessment of the environmental performance of buildings shall clearly indicate the way in which the results have been derived in order to make it possible to trace them back to the original data. This implies that the method of assessment shall indicate the way in which the method was verified and validated and ensure consistency of the results of assessment by providing traceability of the measuring process.

5.8.4 Double-counting

Double-counting of environmental impacts shall be avoided in order to prevent distortion of the assessment results.

NOTE When one action or measure has several effects, it can be said to have a ‘multiple-effect'. For example, avoidance of the use of CFCs has the effect of preventing ozone layer depletion as well as global warming. Assessment of multiple-effect is different from double-counting.

5.8.5 Functional equivalent

The functional equivalent is the reference parameter in the determination of environmental performance and is instrumental in the quantification of building performance and of users' requirements.

A building or a part of a building can have a number of possible functions. The function or functions that serve as the basis for the assessment shall be specified.

The functional equivalent, expressed in terms of performance or occupancy for which a building or section of a building is designed, is used as the basis for quantification of the environmental performance of a building and shall include, but is not necessarily limited to,

a) type/use of building (office, factory, etc.),

b) occupancy (period and pattern of use), and

c) design life (service life required by clients).

In addition, the functional equivalent of a building may take account of various user requirements.

5.8.6 Reference levels

Reference levels and a scale of values can be used in the quantification of indicators within the assessment method. Reference levels shall be documented and justified.

NOTE The reference level and scale of values can be related to building codes/regulations, user requirements and evaluation of conditions in the area where the building is located.

Quantitative information on the environmental performance may be referred to as a predefined baseline. In such a case, the reason or basis for setting the baseline shall be clearly documented.

5.8.7 Aggregation

The assessed environmental performance relating to a specific category of environmental issue (5.6) may be aggregated from the values of multiple category indicators. Aggregation methodologies shall, where appropriate, use conversion factors that comply with scientific or engineering principles.

NOTE Weighting can be used if such conversion factors are not available (see 5.8.8).

The method used to aggregate the results of measurement of environmental performance by multiple category indicators shall be clearly stated.

5.8.8 Weighting

An assessment method that uses aggregated indicators for the assessment results either implicitly or explicitly includes a weighting system. The underlying process that supports weighting shall be based on the differences in the relative importance of category indicators, and shall be documented.

The weighting system can vary according to national, regional or local contexts and conditions, and should provide a method for addressing such variances, which shall be documented and justified. Both the explicit and implicit weighting shall be explained and explicit weighting factors shall be listed in the assessment method documentation.

5.9 Sources of information

The sources of information that can be used in the assessment shall be clearly indicated in the documentation of the assessment method and shall be accessible to the relevant and responsible parties using the assessment.

The sources of the data shall be indicated, whether measurements, qualitative judgments, general data from reference documents or calculated values.

The sources of information may include generic as well as specific databases. Sources of information may include, but are not limited to,

a) checklists and questionnaires,

b) design documentation,

c) environmental product declaration(s),

d) life-cycle inventories,

e) static or dynamic models of building characteristics (e.g. thermal, acoustic), and

f) various types of measurement (resource use, concentrations, etc.)

5.10 Evaluation of assessment results

5.10.1 General

The assessment of the environmental performance of a building produces a set of qualitative and/or quantitative results. These results can be evaluated using a process of examination through ranking and making comparisons with predetermined benchmarks, reference levels and/or scales of value. The evaluation shall be documented in the report (see 5.11) and explained.

In addition to full assessment results, where representative single scores or descriptors are used to support the evaluation of the environmental performance of a building, the methods to aggregate the indicators shall be clearly documented in order to assure traceability (see 5.8.7 and 5.8.8).

The environmental performance of an assessed building shall be expressed by numerical presentation. In addition, graphical presentations of environmental performance may provide simplified presentation, but great care should be taken to avoid misrepresentation of results.

5.10.2 Comparability of the results

Comparability of the results of assessment of the environmental performance of a building is particularly critical when different buildings or parts of a building are being assessed using a single method. To ensure that such comparisons are made on a common basis, the functional equivalent of the buildings (or parts) shall be the same. The primary purpose of a functional equivalent is to provide a basis to ensure comparability of the environmental assessment results of different buildings.

Where comparisons are made between the results from different methods of assessment of a single building, the physical scope, temporal scope and energy and mass flows considered within the system boundary of the assessment methods shall be the same.

5.11 Assessment report

The report regarding the environmental performance of a building may be presented as documents and visual aids. The findings of all results shall be traceable and transparent.

The assessment report shall include, but not be limited to, the following information and/or assumptions regarding:

a) general information:

   1) purpose of the assessment;

   2) identification of building (address, etc.);

   3) client for assessment;

   4) assessor;

   5) assessment method, including version number and reference;

   6) time of assessment in the building's life cycle;

   7) life-cycle stages covered in the assessment (see 5.7);

   8) period for which the assessment is valid;

   9) date of assessment;

10) sources of information used in the assessment;

11) year of construction of building;

12) year(s) of refurbishment of building;

b) building:

1) functional equivalent (see 5.8.5);

2) general description of building;

c) assumptions and data limitations.

The report shall include details on assumptions made according to 5.5, and should document data quality issues as required in 5.8.2.

d) Result.

The report shall include the results for the issues listed in 5.6, including reasons for any information specifically excluded.

e) Evaluation.

The report shall include the result of the evaluation process described in 5.10. Information on the methods for quantifying results shall be described.

f) Statement.

A statement shall be given indicating that the assessment has been carried out using a method that is in accordance with this part of ISO 21931.

Annex A
(informative)

Consideration of social aspects, such as health and comfort, related to the indoor and local outdoor environment

A.1 In many cases, methods of assessment of the environmental performance of buildings include consideration of social aspects related to the indoor and local outdoor environment. Over the building's life cycle, the indoor and local outdoor environments impact on the well-being, health, comfort and quality of life of the users of the building, such as occupants, site workers and maintenance staff, as well as neighbours.

A.2 When the assessment method includes consideration of social aspects related to the indoor environment in the use stage, the following issues should be considered and included, where relevant:

a) indoor air conditions (e.g. effectiveness of ventilation, concentration of hazardous substances and odour conditions);

b) hygro-thermal conditions (e.g. air temperature and humidity);

c) visual conditions (e.g. glare, access to daylight and exterior views, and quality of light);

d) acoustic conditions;

e) characteristics of water;

f) intensity of electromagnetic fields;

g) radon concentration;

h) presence of mould.

NOTE For information relevant to indoor air quality, see ISO 16814.

A.3 When the assessment method includes consideration of social aspects related to the local outdoor environment, the following issues should be considered and included, where relevant:

— wind loads;

— noise;

— shading or glare on neighbouring property;

— odours.

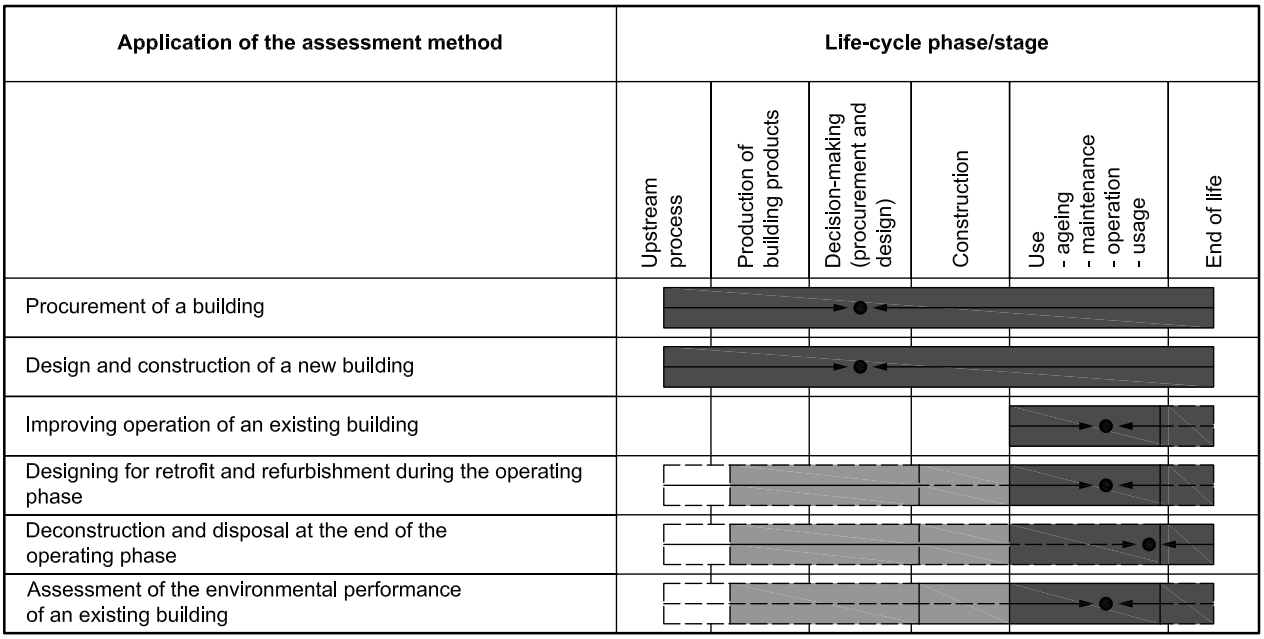
Annex B
(informative)

Extent and application of the assessment method

B.1 In order to understand and correctly interpret the results of an assessment, it is important to declare which stages of the building life cycle have been taken into account for the assessment.

Figures B.1, B.2 and B.3 illustrate how the extent of an assessment can vary depending on the intended use and on the recipients of the results, as well as on the building life-cycle stages within which the methods are applied.

B.2 Figure B.1 shows the extent of the information that can be required from stages across the life cycle (represented by a rectangular bar) for points of time (represented by the black dot) in the life cycle at which assessments may be carried out.

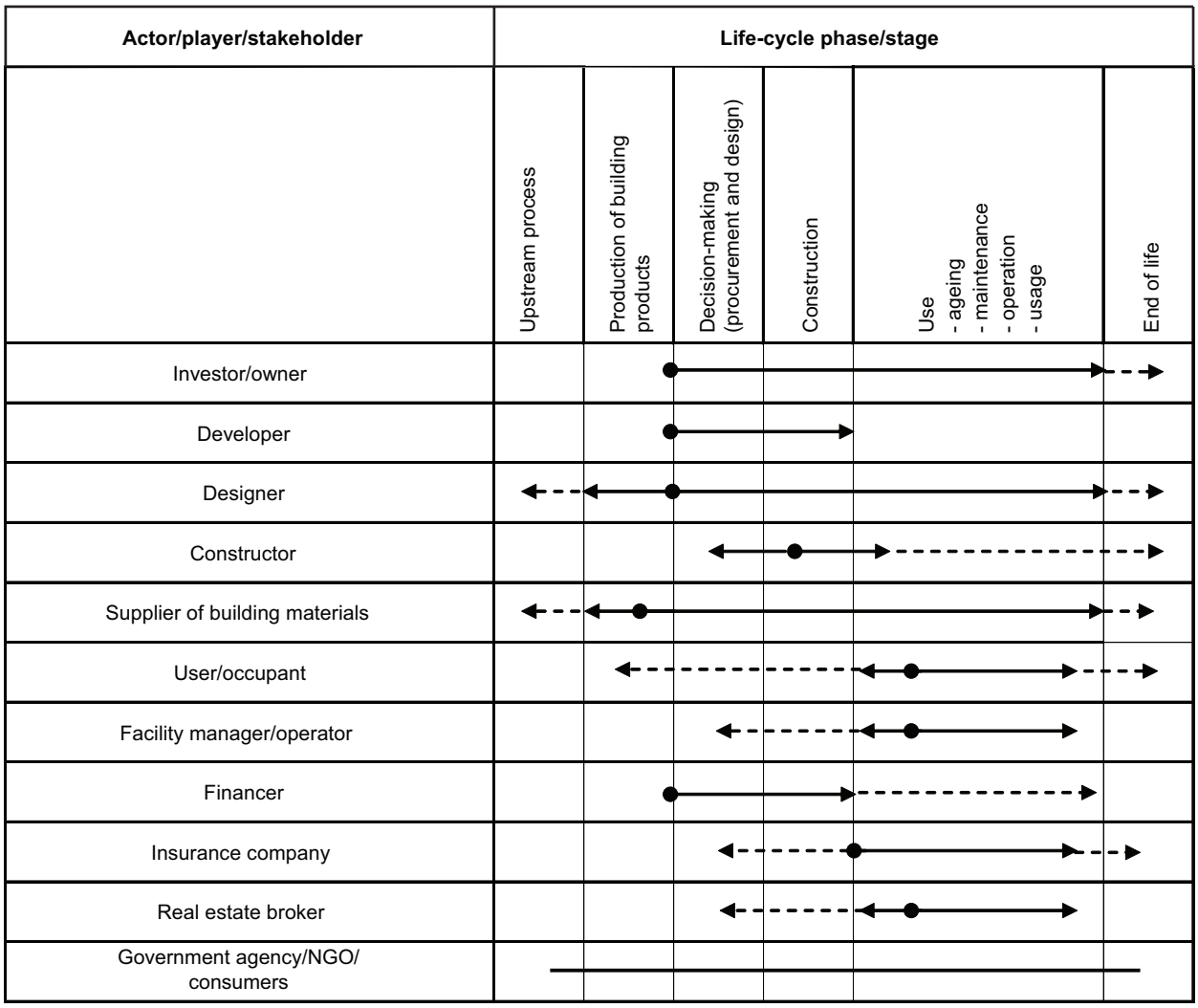


Key

- the extent of the information collected
- the focus of the assessment
- the point in time of the assessment
- the life-cycle stages considered
- the conceptual area or area of action
- the limits of amounts of data considered

Figure B.1 — Relationship between application cases and life-cycle stage

B.3 Figure B.2 shows the points in time within the life cycle (represented by the black dots) at which the various interested parties may conduct assessments or are interested in assessment results. Additionally, it shows which stages of the building life cycle are usually directly included in the interested parties' considerations (the continuous line) and also within a broader perspective, the stages that should be considered (the dashed lines).



Key

- ● point in time within the life cycle
- ——→ life-cycle stages included in the interested parties' considerations
- - - → life-cycle stages that should be considered

Figure B.2 — Examples of range of parties interested in life-cycle stage(s)

B.4 Figure B.3 shows examples of the potential application and/or purpose(s) of assessment methods, depending on users.

<table>
<tr><th rowspan="2">Possible users of the assessment information</th><th colspan="4">Application or purpose (project stages)</th></tr>
<tr><th>Strategic planning and schematic design</th><th>Detailed design and construction</th><th>Operation, including repair and maintenance</th><th>Deconstruction</th></tr>
<tr><td>— Client
— Designer
— Constructor
— Supplier
— Governmental agency</td><td colspan="2">Methods for assessing the design of a building:
— comparison of possible design alternatives
— assessment against target values
— communication between client and designers</td><td></td><td></td></tr>
<tr><td>— Owner
— Facility manager
— Building manager and operator
— Occupant
— Developer
— Real estate broker
— Investor
— Governmental Agency
— Neighbour</td><td></td><td colspan="2">Methods for assessing and rating an existing building:
communication between interested parties for investment in the building</td><td></td></tr>
<tr><td>— Owner
— Designer
— Building manager and operator
— Occupant
— Governmental Agency
— Neighbour</td><td></td><td></td><td colspan="2">Methods for assessing building operation:
— communication between interested parties for building operation
— continuous improvement of operation</td></tr>
</table>

Figure B.3 — Examples of the potential application and/or purposes of assessment methods depending on users

Annex C
(informative)

Relationships between environmental aspects, impacts, issues and characteristics of the building

C.1 Environmental aspects, impacts and other issues are not independent concepts. This annex is intended to visually show how they interact with each other and the main cause-and-effect relationships. The aim is to clarify what types of results are given by particular assessment methods, in order to avoid confusion or double-counting.

C.2 Building environmental aspects represent what is consumed and produced by the building and its site over its life cycle, typically expressed in terms of energy and mass flows, but also often in terms of qualitative data. These aspects are caused by the physical characteristics of the building and its site. These characteristics are also the departure point of the cause-and-effect chains and relate in certain respects to the building environmental aspects (see Figures C.1 and C.2).

C.3 Figure C.1 shows in a simplified way the cause-and-effect chains, using the concepts in Figure C.2.

C.4 The left-hand side of Figure C.2 shows how characteristics relate to environmental aspects. The thermal properties of the components of the building envelope, the size and orientation of windows, the boiler efficiency and the embodied energy in the bearing structure are examples of characteristics. Corresponding aspects are mainly consumption of primary energy and emissions into the air.

C.5 The environmental aspects can produce impacts on the environment, which can be adverse or beneficial. For instance, emissions into the air, due to the variety of pollutants, contribute to several environmental impacts. The central part of Figure C.2 shows interactions between aspects and impacts.

C.6 Methods of assessment of the environmental performance of a building can include consideration of social aspects, such as health and comfort, related to the indoor and local outdoor environment (see Annex A). The characteristics of the building interact with the indoor and outdoor conditions, which can have impacts on the indoor environment (in terms of comfort conditions and indoor air quality) and on the local environment (at the local scale). This is shown on the right-hand side of Figure C.2, even though direct links between characteristics and these two types of issues are not explicitly represented.

Environmental impacts and social aspects related to indoor and local outdoor environments do not interact with each other.

NOTE The links implied in the conceptual matrix shown in Figure C.2 are not exhaustive.

C.7 The management processes, through adequate organization, actions and decisions taken or led by the actors involved at the different stages of the building project, aim to optimize the design, construction and/or operation, in order to improve the environmental performance of the building. The management processes influence the characteristics of the building and the assessment results (in terms of aspects, impacts and issues), although the cause-and-effect relationships are of a different nature, because they are organizational and not physical. Management processes can influence all items.

For example, proper training can help maintenance staff understand and use building energy management systems (BEMS), potentially resulting in energy savings, while ensuring good comfort levels for the indoor environment. Adequate information and checking on the construction site can lead to a better segregation of waste and better valuation of the economic value of this waste. Awareness, through education, of building users can help to reduce water consumption.

On the other hand, and to a limited extent, the building characteristics and the assessment results can lead to the adoption of certain management processes which would help maintain, or even improve, the environmental performance.

The relevance and effectiveness of the management processes can constitute, in themselves, an assessment result, from an organizational point of view.

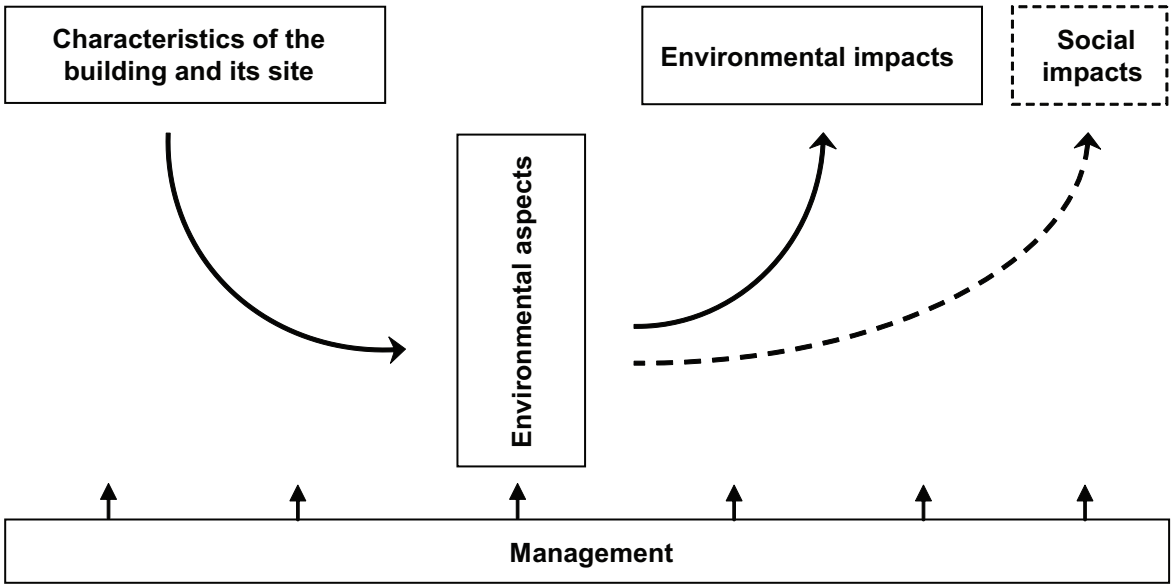


Figure C.1 — Cause-and-effect chains

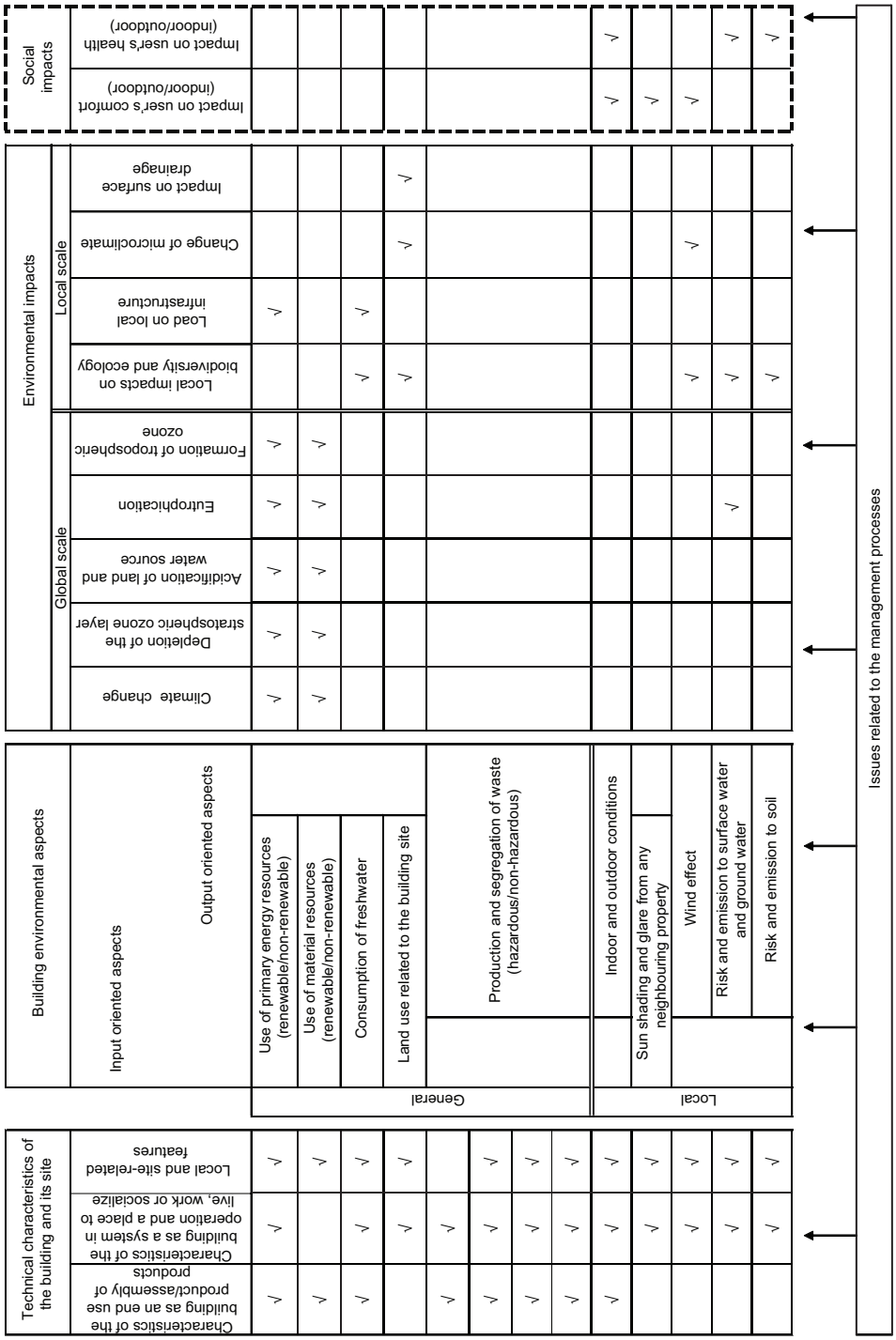


Figure C.2 — Schematic matrix of the relationships between environmental aspects, impacts and characteristics

Annex D
(informative)

Graphical illustration of correlation and mapping of environmental issues to different life-cycle stages

D.1 Although the assessment of the environmental performance of buildings considers all stages in the building's life cycle, not all of the issues of concern (see 5.6) are relevant at every stage within that life cycle (see 5.7). Therefore, the issues of concern given in 5.6 only need to be taken into account at the point in the assessment which addresses the stages for which they are relevant.

D.2 Table D.1 exemplifies the relationship of specific environmental issues to different stages of the life cycle of a building and identifies those to be included in the assessment method according to 5.6. The use of this type of illustration can help to clarify the system boundary of the assessment method and therefore improve the transparency.

NOTE 1 Alternative method(s) can be used to illustrate the relationships, if any, between the environmental issue(s) and life-cycle stage(s).

NOTE 2 Social aspects, such as health and comfort, related to the indoor and local outdoor environment are only relevant when the assessment method includes consideration of such aspects (see Annex A).

Table D.1 — Relationship of specific environmental issues to different stages of the life cycle of a building

Sub-clause	Issue for assessment	Life-cycle stages of a building (physical)																
		Product stage			Construction process stage		In-use stage								End of life stage			
		Raw material supply	Transport	Manufacturing	Transport	Construction process	Use (user-oriented)	Use (building-oriented)	Operation (energy)	Operation (water, waste, etc.)	Maintenance	Repair	Replacement	Refurbishment	Deconstruction	Transport	Recycling/reuse	Disposal
5.6.2	**Environmental impact**																	
5.6.2.1	**Global**																	
M	Climate change	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Depletion of stratospheric ozone layer	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
MI	Acidification of land	MI	MI	MI	MI	MI			MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
MI	Acidification of water sources	MI	MI	MI	MI	MI			MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
MI	Eutrophication	MI	MI	MI	MI	MI			MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
MI	Formation of photochemicals, oxidants	MI	MI	MI	MI	MI			MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
5.6.2.2	**Local**																	
M	Impact on biodiversity and ecology					M		M	M	M	M	M	M	M	M			
M	Load on infrastructure						M		M	M								
M	Change of microclimate							M										
M	Impact on surface drainage							M		M								
5.6.3	**Environmental aspects**																	
5.6.3.1	**General**																	
M	Use of non-ren. primary energy resources	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Use of non-ren. material resources	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Use of renewable material resources	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Use of renewable primary energy resources	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Consumption of freshwater	M	M	M	M	M	M		M	M	M	M	M	M	M	M	M	M
M	Hazardous waste	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Non-hazardous waste	M	M	M	M	M			M	M	M	M	M	M	M	M	M	M
M	Land use related to building site							M										
5.6.3.2	**Local**																	
M	Sun shading and glare							M										
M	Wind effect							M										
M	Risk and emissions to surface water					M		M	M	M	M	M	M	M	M			
M	Risk and emissions to ground water					M		M	M	M	M	M	M	M	M			
M	Risk and emissions to soil					M		M	M	M	M	M	M	M	M			
5.6.4	**Management process**																	
V	Process quality for construction					V												
V	Process quality for operation								V	V								
V	Process quality for maintenance										V	V	V	V				
V	Waste production and disposal					V	V			V	V	V	V	V	V			V
V	Reuse, recycling, recovery of material					V		V	V	V	V	V	V	V	V		V	
V	Pollution emissions					V				V	V	V	V	V	V			
V	Water use					V	V											
V	Waste water treatment									V								
V	Repair, conservation, replacement of products used in the building											V	V	V				
V	Conservation of site environment to promote diversity					V				V	V	V	V	V	V			
V	Environmental energy management					V	V	V	V	V	V	V	V	V	V			
Consideration of social aspects, such as health and comfort, related to the indoor and outdoor local environment																		
Annex A issues should be included where relevant	**Indoor environment**																	
	Indoor air conditions							A										
	Hygro-thermal conditions							A										
	Visual conditions						A											
	Acoustic conditions						A											
	Characteristics of water									A								
	Intensity of electromagnetic fields							A										
	Radon concentration							A										
	Presence of mould							A										
	Local outdoor environment																	
	Wind load							A										
	Noise					A		A										
	Odour							A										
	Sun shading and glare					A		A										

A voluntary, additional.
M mandatory.
MI mandatory, where information is available.
V voluntary.

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