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CONVENZIONE TRA IL MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE ED IL POLITECNICO DI MILANO DEL 24 MARZO 2014 PER L'ATTUAZIONE DELLE METODOLOGIE DI CALCOLO DELL'IMPRONTA DI CARBONIO E DI COMPENSAZIONE DELLE EMISSIONI DI CO_2 DI EXPO 2015

D.1.1.a Methodological guidelines for the LCA of temporary buildings in mega events

Dipartimento di Energia

Methodological guidelines for the LCA of temporary buildings in mega events

Table of contents

1 General introduction 6

2 Standard references 6

3 Purpose of the assessment 7

4 Description of the object of assessment 8

4.1 Definition of temporary building 8

4.2 Specification of the building characteristics 9

5 Functional unit or declared unit 9

5.1 Reference study period 10

5.2 Required service life 10

6 System boundaries 11

6.1 Physical 11

6.2 Life Cycle Stages 11

6.2.1 FIRST USE (during the mega event) 14

6.2.2 $A_1$1 Raw material supply 14

6.2.3 $A_1$2 Transport 14

6.2.4 $A_1$3 Manufacturing 14

6.2.5 $A_1$4 Transport to and from the site 14

6.2.6 $A_1$5 Construction and installation 15

6.2.7 $B_1$1 Installed products in use 16

6.2.8 $B_1$2 Maintenance 16

6.2.9 B13-5 Repair-Replacement-Refurbishment 16

6.2.10 B16 Energy use to operate building integrated technical systems 16

6.2.11 $B_1$7 Operational water use by building integrated technical systems 19

6.2.12 $C_1$1 Deconstruction or demolition after the first use 19

6.2.13 $C_1$2 Transport 20

6.2.14 $C_1$3 Waste processing for recovery or recycling 20

6.2.15 $C_1$4 Waste disposal 20

6.2.16 D_1 Benefits and loads beyond the system boundary 21

6.2.17 SECOND USE (beyond the mega event) 22

6.2.18 $A_2$1-3 Raw material supply- Transport-Manufacturing 22

6.2.19 $A_2$4 Transport to and from the site 22

6.2.20 $A_2$5 Construction and installation 23

6.2.21 $B_2$1 Installed products in use 23
6.2.22 $B_2$2 Maintenance 23
6.2.23 $B_2$3 Repair 24
6.2.24 $B_2$4-5 Replacement-Refurbishment 24
6.2.25 $B_2$6-7 Energy use to operate building integrated technical systems and Operational water use by building integrated technical systems 24
6.2.26 $C_2$1 End of life: Deconstruction and demolition 24
6.2.27 $C_2$2-4 Transport- Waste processing for recovery or recycling-Waste disposal 24
6.2.28 D_2 Benefits and loads beyond the system boundary 25
6.3 Specifications of different boundary settings 25
6.3.1 Geographical boundaries 25
6.3.2 Time boundaries 25
6.3.3 Boundaries to and from nature 25
6.3.4 Other system boundaries 25
7 Cut-off rules 25
8 Allocation rules 26
9 Exclusion 26
10 Data collection and building information 27
11 Scenarios for defining the building life cycle 30
11.1 Scenarios for the product stage (Modules A1 to A3) 31
11.2 Scenarios for the construction process stage (Modules A4-A5) 31
11.3 Scenarios for Use stage (modules B1 to B7) 32
11.4 Scenarios for the end of life stage (Modules C1 to C4) 33
12 Data quality requirement 33
12.1 Rules for using EPD data 34
12.2 Rules for using generic data 34
13 Environmental impacts and aspects and related indicators 35
13.1 Indicators describing environmental impacts 35
13.2 Indicators describing resource use 35
13.3 Indicators describing additional environmental information 36
14 Reporting the assessment results 36
14.1 General information on the assessment 36
14.2 General information on the object of assessment 36
14.3 Statement of boundaries and scenarios used in the assessment 37
14.4 Data sources 37

14.5 List of indicators used for assessment and expression of results 37
14.6 List of PCR documents 38

1 General introduction

Considering that in a global world mega events are more frequent and that for the organization of the exhibition area a significant amount of materials are necessary, the effort to reduce the environmental impacts related to temporary buildings is very important. The temporary nature of the event requires a special attention to the strategies for the management of the temporary structure at the end of the event.

The Italian Environmental Ministry, on the occasion of Expo 2015, has expressed interest for the definition of a tool to evaluate the environmental impacts of the temporary buildings in mega events, that could be used for the identification of the materials and technological solutions with lower impacts or for the post event scenario.

Of course LCA could be considered a useful support to define strategies and to support decision for lowering the environmental impacts.

The aim of this document is to provide rules for the assessment of the environmental performance of temporary buildings in mega events.

2 Standard references

This is a document following the international standards and PCRs:

- ISO 14001: 2004 *Environmental management systems*
- ISO 14040: 2006 *LCA - Principles and procedures*
- ISO 14044: 2006 *LCA - Requirements and guidelines*
- ISO 14025: 2006 *Type III environmental declarations*
- ISO 21930: 2007 *Environmental declaration of building products*
- ISO 15392: 2008 *Sustainability in Building Construction – General Principles*
- ISO 20121:2012 *Event sustainability management systems -- Requirements with guidance for use*
- ISO 14046: 2014 *Environmental management — Water footprint — Principles, requirements and guidelines*
- EN 15603: 2008 *Energy performance of buildings – Overall energy use and definition of energy ratings*
- EN 15643-1: 2010 *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 15804:2012 *Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products*
- EN 15978:2011 *Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method*
- PCR UN CPC 387 *Prefabricated Buildings* (version 1.1 dated 2014-02-10, published by the International EPD® System)
- PCR UN CPC 531 *Buildings* (version 1.0 dated 2014-02-26, published by the International EPD® System)
- IBU PCR for Building related products and services – Part A Calculation Rules for the LCA and requirements on the project report

This document specifies further and additional minimum requirements on LCA studies of temporary buildings in mega events, defined below, complementary to the above mentioned general requirement documents. This document aims towards compliance with the European standards EN 15804 (Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products) and EN 15978 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method).

The approach to the assessment covers all stages of the building life cycle and is based on data obtained from Environmental Product Declarations (EPD), their "information modules" (EN 15804) and other information necessary and relevant for carrying out the assessment. The assessment includes all building related construction products, processes and services, used over the life cycle of the building.

3 Purpose of the assessment

The purpose of the assessment is defined by the goal, the scope and the intended use of the assessment.

The goal of the assessment is to quantify the environmental performance of the temporary building (object of assessment) by means of the collection of data and compilation of environmental information. In order to calculate the environmental performance of the building in terms of environmental impacts and aspects (according to the rules and requirements described in the following paragraphs).

The scope and intended use of the assessment shall be defined and documented.

The target group could be the mega event organization and/or the LCA practitioner involved in the LCA assessment of the temporary buildings.

The scope of the assessment is represented by what is included in the assessment with respect to the specifications of the object, i.e. the temporary building, to the quantification of the building and its life cycle, to the type of data. In particular, the scope and the intended use determine the level of detail required of the environmental information, and of other data used in the calculations. However, the calculation method remains the same.

Depending on the context, the intended use of the assessment may include the following alternatives:

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

   - comparisons of the environmental performance of different design options for temporary buildings (e.g. alternative materials, products, technical solutions);
   - comparisons of the environmental performance of the different scenarios post-event of the temporary building (e.g. demolition and reconstruction, relocation and reuse of the building in another place, on site refunctionalization of the building);
   - identification of the potential for environmental performance improvements;

b) declaring performance with respect to legal requirements or for acquiring access to incentives (e.g. Green Public Procurement, minimum requirement in a tender);

c) documenting the environmental performance of a building for use in, for example:

   - certification/labeling of the building (e.g. LEED, EPD of the building);

- declaring environmental performance (e.g. award for sustainability of the organizer of the mega event);
- marketing;

d) support for policy development.

LCA could be developed at different stages of the building life process and therefore the degree of detail in the data collection and the level of detail between hypothetical assumptions and monitoring of the construction may affect the results.

For this reason the phase in which the LCA is developed shall be stated (*ex ante or ex post*).

In case the LCA (or EPD) is prepared in advanced, it is strongly recommended to monitor the data (consumption of energy etc.) during the use phase or at least before the dismantling phase.

If the mega event organizer requires the development of an LCA during the design phase of the temporary buildings, to support the design and material choices, it could be recommended to update the LCA at the end of construction, by monitoring the changes from the initial project to the as-built and analyse and justify all the differences between initial assumptions and actual consumptions and emissions. This approach could be considered a strategic vision and a KPI (key performance indicator) of the quality of the project.

4 Description of the object of assessment

4.1 Definition of temporary building

Temporary buildings for mega events are buildings with a short service life strictly related to the event duration (e.g. Expo events typically last for 6 months, Olympic games for three-four weeks).

With the aim of the reduction of environmental impacts, it is clearly unsustainable designing disposable temporary buildings with a short service life; so the strategies for the extension after the first use in the mega event were considered of great importance. Instead of designing a temporary service life, the temporary nature should be designed as the possibility of extending the constructed object to more uses, expanding its service life.

In this perspective, the temporary nature of the buildings related to mega events can be defined as:

- temporary function (with the refunctionalization of the structure for a new use at the end of the event);
- temporary location (with the disassembly and reassembly of the entire structure or of its parts separately elsewhere at the end of the event);
- temporary life (with the demolition at the end of the event and waste treatment without reuse of the building parts).

In the first two cases, the temporary nature of the building shall be a requirement in the design phase, an upstream objective of the project, since it requires the project to deal with the functionality of the second life and with technical characteristics that allow the reuse.

The possible scenarios at the end of the first use (after the event) of the temporary building are:

- reuse of the whole building for a similar/compatible use (refunctionalization without modification) in the same place;
- reuse of the whole building for the same use in another place (relocation);
- reuse of the whole building for a different use (refunctionalization with modification) in the same place;
- reuse of the whole building for a different use (refunctionalization with modification) in another place (relocation);
- disassembly of the building and reuse of the divided building components for the same use;
- disassembly of the building and reuse of the divided building components for other use;
- demolition of the building and disposal/energy recovery/recycling of building materials.

Partial reuse is also possible, with a mix of the previous scenarios.

4.2 Specification of the building characteristics

A building can vary in shape, size and function, which affects how it is built and what requirements it must meet.

A building can be built on site, built on site with prefabricated parts or be entirely prefabricated.

The dimensions of the building and its main characteristics shall be declared in the LCA:

- number of storeys,
- the storey height,
- net floor area (living spaces), ancillary spaces area,
- gross floor area,
- gross conditioned volume (or gross internal volume, when there is no conditioning system),
- perimeter surface of the heated (internal) volumes,
- shape factor (S/V).

Also the weight and dimensions of the main building components (structure, walls, roof, windows) shall be described in the LCA.

Other specifications are voluntary.

5 Functional unit or declared unit

The functional unit (or functional equivalent) shall be declared and shall include the relevant technical and functional characteristics of the building (e.g. the regulatory and client's specific requirements), the reference study period and the required service life of the building, the type of use (e.g. office, exhibition), the pattern of use (e.g. occupancy).

A common reference unit shall be used to present the result of the indicators of the environmental assessment relative to the functional equivalent. To allow different possible uses, the results shall be expressed:

- per the entire building,
- per m^2 per year (related to net floor area),
- per m^3 per year (related to gross heated or refrigerated volume).

LCA results shall be reported according to the EN 15804 modules but also dividing the impacts between first use and second use. For the impacts not specifically related with one of the two use (for example the impacts related to the production of the building components reused), the impacts shall be divided considering the time of use and the time for construction-deconstruction.

EXAMPLE 1 In case of reuse of the material structure, if the first use of the temporary building related to the mega event is of six month during the mega event and three months for the construction and three months for the disassembly, the impacts related to the mega event are 1/10 of the total impacts of the building components reused and the impacts related to the second use post-event are 9/10 of the total impacts of the building components reused.

The LCA shall follow a "cradle to grave" approach, i.e. including all life cycle stages of the building, with a modular approach in the presentation of results (see Figure 1).

The object of the assessment is a temporary building with a first use related to the mega event and a second use after the mega event: the service life of the building is extended to the end of the second use.

Comparisons should only be made between buildings with the same function (in the first use and in the second use). A description of the type of use and pattern of use shall be declared also for the second use, specifying in the scenarios if it is necessary a refunctionalization of the building.

5.1 Reference study period

Assessment shall be carried out on the basis of a chosen reference study period, the same for all the assessments, so as to ensure comparability of the results. The reference study period shall be of 10 years. The reference study period corresponds to the required service life of the building (see 4.2). According to EN 15978, if the reference study period is longer than the service life of the temporary building, scenarios 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 full value of impacts and aspects for both the first use (during the event) and the second use (after the event) shall be taken into account.

5.2 Required service life

Temporary buildings shall cover a Required Service Life (ReqSL) of 10 years (according to Eurocode, the structural lifetime for temporary buildings shall be of 10 years), considering the first use during the mega event and defining a second use after the mega event.

If the temporary building (as a whole or divided in its components) is reused after the mega event, its service life is extended to the period of reuse.

If the temporary building is not reused after the first use, the production of another temporary buildings (with the same characteristics) shall be considered to cover the Required Service Life.

EXAMPLE 1 If the temporary building is not reused after the six month of the first use during the mega event, the production of another temporary building (with the same characteristics) shall be considered to cover the others 9.5 years of the Required Service Life.

6 System boundaries

6.1 Physical

The system boundary includes the building in all its parts, the building-integrated technical system and the building related furniture, fixtures and fittings. It includes also the surrounding area of the building (and related paving, facility, green, etc.) during the first use.

The surrounding area of the building is excluded in the second use due to the fact that probably the area on which the building will be located during the second use is not already known.

The LCA of the building shall include the building structure (such as structural frame and foundations, beams, columns, slabs, stairs, etc.), the building envelope (such as external walls, windows, roof, etc.), the internal partitions (such as internal walls, doors, ceiling, flooring, etc.). In addition, the facilities required for the building's function to be met shall be included: the system of water supply and drainage, sanitary systems, heating and water heating, cooling, ventilation, electrical systems and elevators. All energy generating units located within the building's site shall be included in the assessment: these energy units may generate energy both from renewable sources (e.g. photovoltaic cells, wind mills, solar thermal panels, ground or air source type heat pumps) and from non-renewable energy sources (gas boilers, CHP (Combined Heat Power), fuel cells, heat pumps). No distinction is made between energy production units that are part of the building fabric and energy production units that are not part of the building fabric: for example, 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.

Furnishings not building related, such as kitchen fixtures, bathroom fittings, etc., and appliances, such as entertainment electronics, washing machines, refrigerators, cooking appliances, etc., shall not be included in the system boundaries.

System boundaries shall be not less than the EN 15804 representation.

6.2 Life Cycle Stages

The core process of assessment is the building. The assessment includes all the upstream and downstream processes needed to establish and maintain the function(s) of the building, in the first use and in the second use.

Figure 1 describes the system boundary and the different stages of the life cycle of the temporary building. The processes are divided into information modules (e.g. A1-A3, A4-A5) according to the "modularity principle" of EN 15978:2011. The organisation of the different modules used for the assessment of the building corresponds to the modular structure of information from EPD for construction products, processes and services according to EN 15804.

The environmental information shall be given for each module, and not only as an aggregated value (with the exception of Module A1-A3). The LCA of the building shall cover all modules in the stages A to C. Module D is voluntary and beyond the system boundaries.

The Module numbers are in compliance with the standard EN 15978:2011, but doubled to be referred to the first use and the second use. So, the reference "$_1$ " means first use (related to the mega event) and the reference "$_2$" means second use (beyond the mega event). For example, "A_2 1-3 " refers to the product stage of building products necessary to the second use of the building beyond the mega event.

Please note that this is a general description and that not all processes are relevant for every type of temporary building. Not all the type of temporary buildings (see 3.1) cover all stages of the life cycle, so not all modules must always be considered.

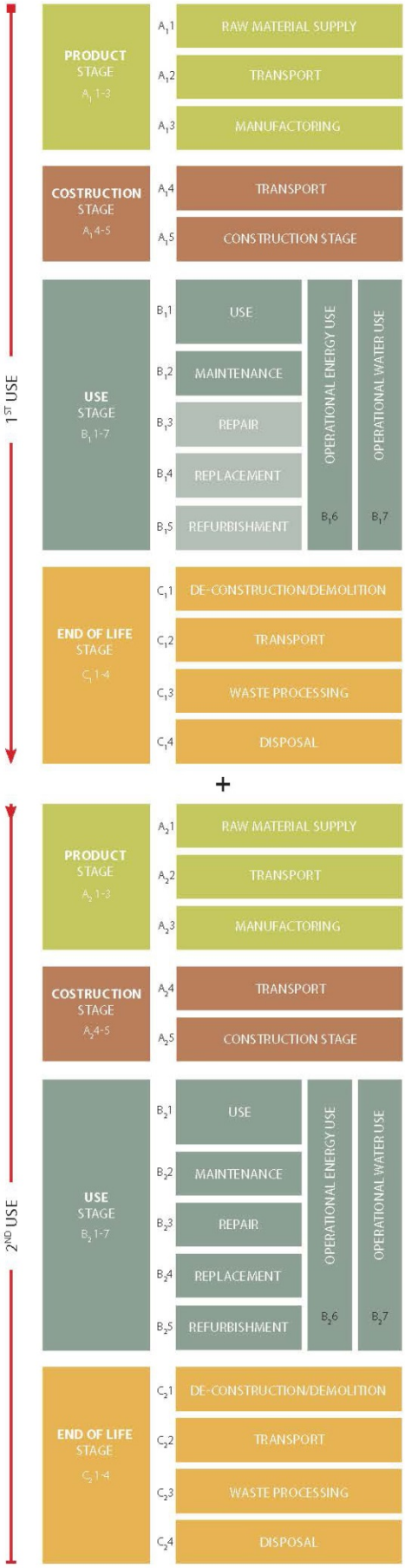

Figure 1 Building life cycle system boundaries, illustrated with EN 15978:2011 as reference

6.2.1 FIRST USE (during the mega event)

6.2.2 $A_1$1 Raw material supply

The boundary for this module shall include:

- extraction and processing of raw materials (e.g. mining processes), production and processing of biomass (e.g. agricultural or forestry operations), processing of secondary materials from a previous product systems (e.g. steel recycling) but not including those processes that are part of the waste processing in the previous product system, reuse of products or materials from a previous product system;
- generation of electricity, steam and heat from the primary sources of energy, including extraction, refining and transportation of fuels;
- energy recovery and recycling processes of (and other recovery processes from) secondary fuels, but not including those processes that are part of waste processing in the previous product system.

6.2.3 $A_1$2 Transport

The boundary for this module shall include:

- transportation to the factory where raw materials are processed (external transportation up to the factory gate) and internal transports.

6.2.4 $A_1$3 Manufacturing

The boundary for this module shall include:

- production of auxiliary and ancillary materials or semi-finished or products or components;
- manufacturing of products and co-products;
- production of packaging material;
- management of waste from the manufacturing, processing up to the end-of-waste state or disposal of final residues including any packaging not leaving the factory gate with the product;
- in case that the manufacturing incorporate (at the same site) recycling process of any purchased recycled material and the transport from the recycling process to where the material is used;
- in the case of prefabricated buildings, assembly at plant of building parts or of the whole building.

The energy used in raw material extraction and manufacturing to both primary energy and the energy that comes from energy recovery (waste, residues, etc.) are included in the inventory. In the case of energy from energy recovery, the processes related to waste management shall not be included.

6.2.5 $A_1$4 Transport to and from the site

The boundary for this module shall include:

- transport of materials, products, services and equipment from the factory gate to the building site, including any transport to the intermediate storage and distribution;
- in the case of prefabricated buildings (ready for construction), transport of building parts or of the whole building (considering the volume and not the mass);
- transport of construction equipment (cranes, scaffolding, etc.) to and from the site;
- all impacts and aspects related to losses due to the transportation (i.e. production, transport and waste management of the products and materials that are damaged or otherwise lost during transportation).

Transport of persons to and from the site shall not be included.

The return of the empty means of transport from the building site to the plant shall be considered.

NOTE Where construction equipment is often moved from one building site to the next, due to the building activity of a contractor, the average distance is taken into account. For hired equipment the actual distance for the transport to and from the building site is taken into account.

6.2.6 A_15 Construction and installation

The boundary for this module shall include 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 production and transformation of a product;
- provision of heating, cooling, ventilation, humidity control etc. during the construction process;
- installation of the products into the building at the site, including ancillary materials not counted in the LCA/EPD of the products, e.g. releasing agents in formworks for concrete, formworks discarded at the end of the project, water use for cooling of the construction machinery or on-site cleaning;
- wastage of products (i.e. additional production processes to compensate for the loss of wastage of products, transport and waste management of the products and materials that are damaged or otherwise lost during transportation, construction and installation process);
- waste management processes of other wastes generated on the construction site, including all processes (e.g. transportation from the building site) until final disposal or until end of waste state is reached;
- waste processing of the waste from product packaging up to the end-of-waste state or disposal of final residues;
- production, transportation and waste management of products and materials lost during the construction and installation process.

Additional information on control, check and test shall be part of the A_15 phase and shall be considered, if the LCA is developed during or after the construction phase of the building. Data collection shall be done during the construction phase.

6.2.7 $B_1$1 Installed products in use

The boundary for this module shall include emissions related to the building's normal uses that are not covered by the Modules $B_1$2-$B_1$7. Continuous emissions from materials in the building are included here, for example release of substances from the facade, roof, floor covering and other surfaces (interior or exterior) emitted to air (indoor air quality), soil or water. These aspects shall be reported separately.

NOTE The assessment of these aspects follows the standards from CEN/TC 351.

6.2.8 $B_1$2 Maintenance

Due to the short time of the first use of temporary building (mega events last less than 1 year), the maintenance activities that shall be considered are only the ones related to cleaning.

The boundary of maintenance shall include:

- daily scheduled cleaning servicing;
- all cleaning processes of the interior and exterior of the building and of the systems;
- the production and transportation of the components and ancillary products used for cleaning;
- transportation of any waste from cleaning processes;
- the end-of-life processes of any waste from cleaning process, including the ancillary materials.

Additional information on maintenance for early failures shall be considered, if the LCA is developed during or after the construction phase of the building. Data collection shall be done during the construction phase.

6.2.9 B13-5 Repair-Replacement-Refurbishment

The modules B3 Repair, B4 Replacement, B5 Refurbishment, considered in the EN 15978:2011, are not included because the period of time of the first use of temporary buildings in mega events typically is shorter than 1 year, so it is supposed that there is no need of repair, replacement and refurbishment.

6.2.10 B16 Energy use to operate building integrated technical systems

The system boundaries for this module shall include the energy used in the operating phase by the technical systems that are integrated into the building, together with its associated processing and transportation of any waste arising on site from the use of energy.

The energy use in the building refers to the activity and processes as presented in EN 15603. The calculation method used for heating and cooling energy shall however be specified. Moreover, if semi-steady methods have been used, supplementary information on energy needs calculated by dynamic method should be reported. 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.

The integrated building technical systems are installed technical equipment supporting operation of a building including:

- heating, cooling, humidification/de-humidification, ventilation;
- lighting;
- domestic hot water;

- auxiliary energy used for pumps, lifts, escalators, control and automation;
- other systems (e.g. lifts, escalators, safety and security installation and communication systems).

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 separately, including the environmental information associated with such energy consumption.

Aspects related to the production, transportation and installation of equipment required to supply energy to the building shall be assigned to modules $A_1$1-$A_1$5. Energy use during maintenance, repair, replacement or refurbishment activities for the equipment shall be assigned to modules $B_1$2-$B_1$5. Aspects related to the waste processing and final disposal of equipment shall be assigned to modules $C_1$1-$C_1$4. Additional environmental benefits and loads resulting from the exported energy shall be reported in module D.

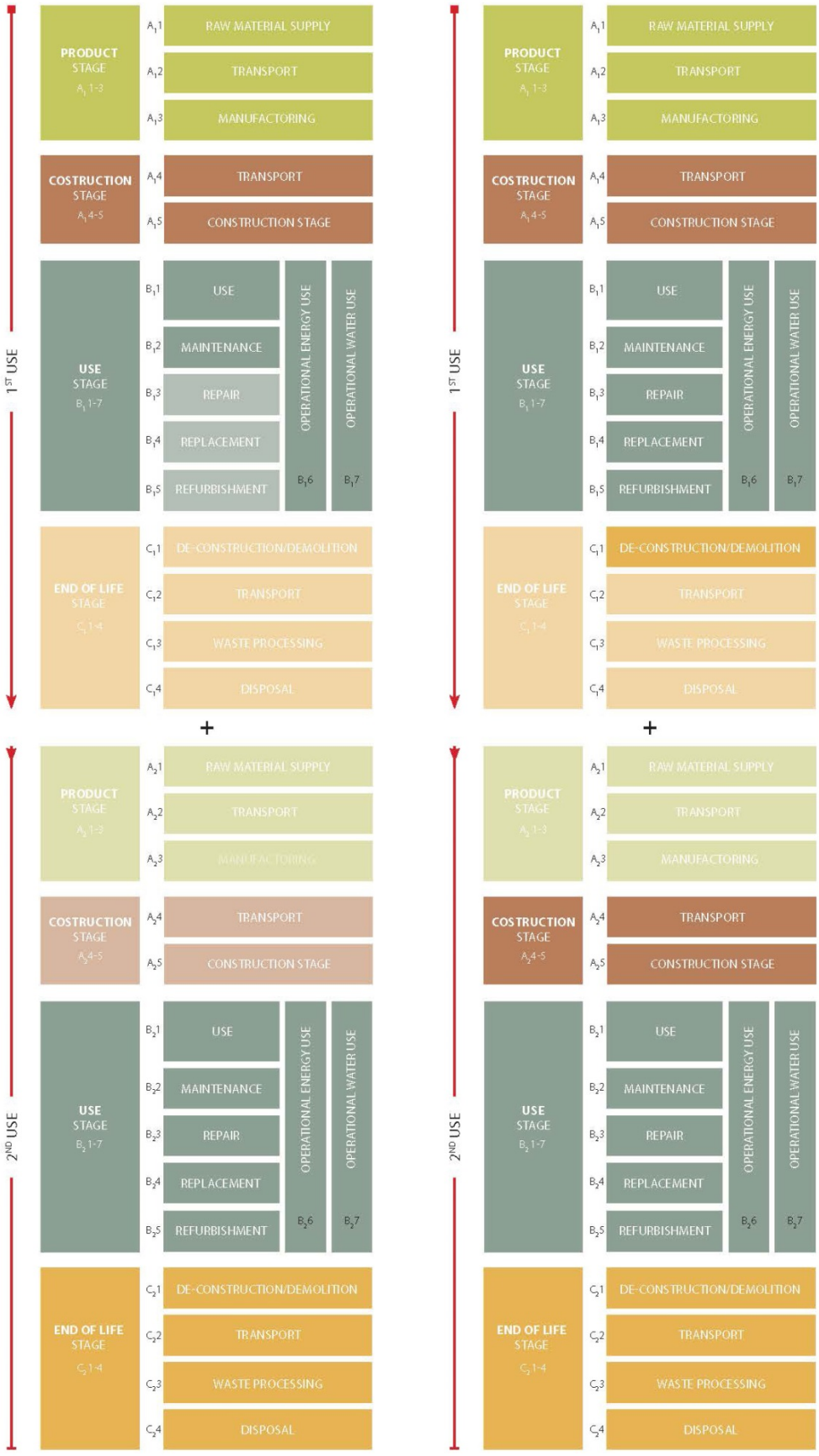

Figure 2 Examples of building life cycle system boundaries and phases that can be omitted (transparency) in the case of temporary building completely reused on site without replacement (on the left) and in the case of building completely reused elsewhere (disassembled and reassembled) without replacement (on the right).

6.2.11 $B_1$7 Operational water use by building integrated technical systems

The boundary of this module shall include all water used and its treatment (pre- and post-use) during the normal operation of the building (related to the integrated building technical system, excluding during maintenance processes), together with its associated environmental aspects and impacts considering the life cycle of water (including production and transportation and waste water treatment). The module covers the period from the handover of the building to when the building is deconstructed or demolished.

This module 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;
- security, fire safety and internal transport;
- 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.

Aspects related to the production, transportation, maintenance and disposal of equipment required to supply water to the building would be covered within modules $B_1$2-$B_1$5.

Any details concerning the water sources, quality parameters and/or characteristics, geographical location of water used or affected, temporal aspects of water use, e.g. time of use and release if relevant residence time occurs within the system boundaries shall be stated in accordance with ISO 14046: 2014.

6.2.12 $C_1$1 Deconstruction or demolition after the first use

At the end of the mega event, the deconstruction, disassembly dismantling and/or demolition of the temporary building shall be considered, including initial on-site sorting of the materials. 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.

At this point, the building's demolition or deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled.

Only if the building at the end of event is reused on the same site, deconstruction and demolition activities shall not be counted (unless it is necessary to repair or replace damaged or deteriorated parts).

The subsequent modules $C_1$2-$C_1$3-$C_1$4 and D_1 shall be considered only if the scenario at the end of the event (at the end of the first use) provides for the total or partial demolition of the building and the demolition waste are conferred to the sorting plant or landfill. They shall also be considered in the other cases, for those parts of the work that are not reused and are conferred to the sorting plant or landfill (e.g. foundations).

If the building is completely reused on site without replacement of materials and without integration of new materials, the modules $C_1$1-$C_1$2-$C_1$3-$C_1$4-D_1 and $A_2$1-$A_2$2-$A_2$3-$A_2$4-$A_2$5 shall not be considered, unless for those components that should be modified or treated (e.g. cleaning), and the assessment continues from the modules $A_2$4-$A_2$5 (see figure 2).

If the building is completely reused elsewhere (disassembled and reassembled) without replacement of materials and without integration of new materials, the modules $C_1$2-$C_1$3-$C_1$4-D_1 and $A_2$1-$A_2$2-$A_2$3 shall not be considered, unless for the components that should be modified or treated (e.g. cleaning) or replaced (e.g. foundations), and the assessment continues from the modules $A_2$4-$A_2$5 (see figure 2).

In all the cases with partial replacement of materials, the modules $C_1$2-$C_1$3-$C_1$4-D_1 shall be considered for those materials that are demolished and transferred to the sorting plant or landfill and in $A_2$1-$A_2$2-$A_2$3 shall be considered the replacement of these parts.

6.2.13 $C_1$2 Transport

For all the materials and components of the temporary building that, at the end of the event (first use), are demolished and conferred to the sorting plant or landfill, all transports to final disposal of the discarded materials and products and/or until the end-of-waste state is reached (e.g. to a recycling site) shall be considered. This includes transport to and from possible intermediate storage/processing locations (e.g. to a sorting plant).

Materials and components intended for reuse are excluded (see 5.2.18).

6.2.14 $C_1$3 Waste processing for recovery or recycling

For all the materials and components of the temporary building that, at the end of the event (first use), are demolished and conferred to the sorting plant or landfill, waste processing should be considered, including collection of waste fractions from the deconstruction and waste processing of material flows intended for recycling and energy recovery, i.e. waste processing until the end-of-waste stage is reached.

Materials and components intended for reuse are excluded (see 5.2.18).

Materials for recycling or energy recovery processing shall be modelled as the elementary techno-sphere flows in the inventory. Materials for energy recovery are identified based on the efficiency of energy recovery, with a rate of 60% or higher, without prejudice to existing legislation (EN 15978). Materials from which energy is recovered with an efficiency rate below 60% are not considered materials for energy recovery (but for incineration, from which the environmental loads are declared in module $C_1$4).

NOTE 1. Processing after the end-of-waste stage is reached, in order to replace primary materials or fuels (as secondary materials or fuels) in another product system, are considered beyond the building's system boundaries and are assigned to module D_1.

NOTE 2. Materials can only be considered as materials for energy recovery if they have reached the end-of-waste state.

6.2.15 $C_1$4 Waste disposal

This module covers possible post-transportation treatment of all materials and components of the temporary building that, at the end of the event (first use), are demolished and conferred to landfill. Waste

disposal includes physical pre-treatment of waste for final disposal and management of the disposal site. This module quantifies all environmental loads resulting from final disposal of materials, e.g. neutralisation, incineration (with or without utilization of energy) and landfilling (with or without utilization of landfill gases).

For some end-of-life processes such as land-filling, emissions can occur after the time period of the assessment. As a rule, a time period of 100 years is considered appropriate for such long-term processes.

Environmental loads from waste disposal are considered part of the building's product system, according to the "polluter pays principle". If the waste disposal process generates energy such as heat and power (e.g. from waste incineration), the potential benefits from utilization of such energy in the next product system (i.e. exported energy) are assigned to Module D_1.

6.2.16 D_1 Benefits and loads beyond the system boundary

Materials for recycling or energy recovery (secondary materials or fuels) are considered as potential resources outside the building's system boundaries that may substitute the production of other materials or fuels (e.g. primary materials or fuels). This module indicates the potential benefits of avoided future use of primary materials and fuels, or a mixture of primary and secondary materials and fuels, while taking into account the loads associated with the recycling and recovery processes outside the system boundaries. Module D is therefore not an actual part of the building's product system but an information module to increase transparency and to acknowledge the "design for reuse and recycling" concept.

Components for reuse shall be considered in module $A_2$1-3.

Module D quantifies the net environmental benefits or loads resulting from reuse, recycling and energy recovery resulting from the net flows of materials and exported energy exiting the system boundary.

Module D provides information to help with transparency on the benefits and loads of processes beyond the system boundary of the object of assessment.

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 impacts may be calculated and shall be based on:

- average existing technology;
- current practice;
- net impacts.

Net impacts are the impacts connected to the recycling process which substitutes primary production, minus the impacts producing the substituted primary product. For closed loop recycling only the net material flow exiting the system is used as the basis for calculating the avoided impacts.

NOTE 1 "Net" also means that we have to subtract input of secondary material (A) from output of secondary material in order to calculate net impact.

Technical rules for calculation of benefits could be applicable according to the PCR developed.

6.2.17 SECOND USE (beyond the mega event)

6.2.18 $A_2$1-3 Raw material supply- Transport-Manufacturing

In these modules all flows of materials and energy that are necessary to "integrate" or "reconstruct" the building for the second use beyond the mega event shall be considered (by the same rules of the modules $A_1$1-3).

Depending on scenarios such flows can be:

- if the building, at the end of the event, is completely demolished and the materials are landfilled, all flows (energy and materials) needed to "rebuild" a building that meet the new use shall be considered (adding again the modules $A_1$1-3 and any supplementary materials needed for the new function, to make the building suitable for a second use);
- if the building at the end of the event is reused, the flows relating to any supplementary materials required for example in relation to a possible new location (e.g. foundations), the adequacy with respect to the change of function (e.g. insulating materials to improve the thermal performance of the building), the integration of the missing parts in the case of partial reuse of components or replacement of broken/deteriorated components after the first use, etc. shall be considered.

In the case where the reuse beyond the mega event concerns only components or parts of the building (and not the entire building), aimed also at different locations, the "reconstruction" of the building to the second use shall be considered, considering again all flows (energy and materials) of the modules $A_1$1-3 as if a new building covers the second use, and subtracting the components and parts of work that are reused, even if in different buildings from the reference one (as if they were " avoided flows"). If the components are reused for different uses, less qualified (downcycling), it is necessary to count the actual product avoided (e.g. re-use of a beam of laminated wood as a bench, subtract impacts avoided as if it were a solid wood).

In the case of reuse of components unaltered compared to the first use, these modules shall not be considered, unless the components should be modified or treated (e.g. cleaning).

6.2.19 $A_2$4 Transport to and from the site

In this module should be considered (by the same rules of the module $A_1$4) transports necessary for the second use of the building beyond the mega event.

Depending on scenarios such transport can be:

- if the building at the end of the event is completely demolished and the materials were landfilled, all transports shall be considered again using data from the module $A_1$4 (as the place of relocation is not a hypothesis of the project, it can be considered the same site of the mega event);
- if the building at the end of the event is reused on the same site, new transport are not calculated;
- if the building at the end of the event is dismantled and relocated elsewhere, the transports of all components of the building from the site of the first use to the site of the second use shall be considered.

In case of reusing of the components separately, in different buildings with different locations, for the evaluation the transports from the site of the first use to the site of the second use shall be counted, adopting different actual distances (if known) or one relative distance considering the building into which

most of the materials are reused, "as if" it merges together all the components in a single building. If no distance of the new use is known, a distance of 100 km can alternatively be assumed. Any different assumption shall be justified.

In all cases, even the transport of any supplementary materials shall be counted (e.g. new foundation in the case of relocation elsewhere, or supplementary materials for the refunctionalisation or for the replacement of damaged parts).

6.2.20 $A_2$5 Construction and installation

In this module should be considered (by the same rules of the module $A_1$5) flows of energy and materials necessary for any reconstruction for the second use of the building beyond the mega event.

Depending on the scenarios:

- if the building is reused on site, only activities related to refunctionalisation, to make the building suitable for a second use, shall be considered;
- if the building is rebuilt or relocated, all construction activities, including those related to refunctionalisation, shall be considered.

6.2.21 $B_2$1 Installed products in use

The boundary for this module shall include emissions related to the building's normal uses that are not covered by the Modules $B_2$2-$B_2$7. Continuous emissions from materials in the building are included here, for example release of substances from the facade, roof, floor covering and other surfaces (interior or exterior) emitted to air (indoor air quality), soil or water. These aspects shall be reported separately.

NOTE The assessment of these aspects follow the standards from CEN/TC 351.

6.2.22 $B_2$2 Maintenance

Maintenance covers the combination of all typically planned technical and associated administrative activities and actions during the service life to maintain the building or its parts in a state in which it can perform its required functional and technical performance, as well as preserve the aesthetic qualities of the product. This will include:

- scheduled maintenance that is required in the daily work of building operations, including on-going maintenance of the property;
- preventative and regular maintenance activity such as cleaning and the planned servicing, replacement or mending of worn, damaged or degraded parts;
- the production and transportation of the components and ancillary products used for maintenance;
- all cleaning processes of the interior and exterior of the building;
- transportation of any waste from maintenance processes or from maintenance related transportation
- the end-of-life processes of any waste from transportation and the maintenance process, including any part of the component and ancillary materials removed

6.2.23 $B_2$3 Repair

The module “repair” refers to measures that are not typically scheduled during the lifetime of the building. The module covers a combination of all technical and associated administrative actions during the service life associated with a typically not planned corrective, responsive or reactive treatment of a part of the building to return it to an acceptable condition in which it can perform its required functional and technical performance, as well as preserve the aesthetic qualities of the product. This includes:

- corrective and preventive handling of a product or installation when it is broken or out of order, so that the required function and performance is achieved;
- replacement of a faulty/broken component or part due to damage/injury;
- the production of the repaired part of a component and of ancillary products used for repair;
- the transportation of the repaired part of component and of ancillary products, including production impacts and aspects of any losses of material during transportation;
- the repair process of the repaired part of component and ancillary products;
- transportation of any waste from repair processes or from repair related transportation;
- the end-of-life processes of any waste from transportation and the repair process, including any part of the component and ancillary materials removed.

6.2.24 $B_2$4-5 Replacement-Refurbishment

The modules B4 Replacement and B5 Refurbishment, considered in the EN 15978:2011, are not included because the reference study period and the required service life of temporary buildings is 10 years, so there is no need of replacement and refurbishment.

6.2.25 $B_2$6-7 Energy use to operate building integrated technical systems and Operational water use by building integrated technical systems

The rules related to these modules are the same of modules $B_1$6-$B_1$7.

Aspects related to the production, transportation and installation of equipment required to supply energy to the building shall be assigned to modules $A_2$1-$A_2$5. Energy use during maintenance, repair, replacement or refurbishment activities for the equipment shall be assigned to modules $B_2$2-$B_2$5. Aspects related to the waste processing and final disposal of equipment shall be assigned to modules $C_2$1-$C_2$4.

6.2.26 $C_2$1 End of life: Deconstruction and demolition

The end-of-life stage of a building starts when the building is decommissioned and is not intended to have any further use. 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.

At this point, the building’s demolition/deconstruction may be considered as a multi-output process that provides a source of materials, products and building elements that are to be discarded, recovered, recycled.

6.2.27 $C_2$2-4 Transport- Waste processing for recovery or recycling-Waste disposal

The rules related to these modules are the same of modules $C_1$2-$C_1$4.

6.2.28 D_2 Benefits and loads beyond the system boundary

The rules related to this module are the same of module D_1.

6.3 Specifications of different boundary settings

6.3.1 Geographical boundaries

LCI data shall be representative for the actual production processes and representative for the country or region where the respective process is taking place. In rare cases where no other information is available, global data, e.g. average global values, may be used.

For waste generated during the construction and demolition phases, waste management statistics from the country in question shall be used.

6.3.2 Time boundaries

Data shall be based on data that represent the current situation. Data sets used for calculations shall have been updated within the last 10 years for generic data and within the last 5 years for producer specific data.

6.3.3 Boundaries to and from nature

System boundaries to and from nature are jointly described by so-called elementary flows. Boundaries to nature are defined as flows of material and energy resources from nature into the system. Emissions to air, water and soil cross the system boundary when they are emitted from or leaving the product system. The inclusion of resource flows from nature to the technosphere corresponds to resource use and explorative impact, and on the output side emissions and resource consumption.

In the ideal case, all withdrawals from nature and emissions related to building (within the system boundaries) shall be included in the life cycle inventory. A flow that cannot be traced back to a natural recipient is regulated by data quality requirements.

Waste to landfills is modelled to achieve elementary flows in a foreseeable time perspective.

6.3.4 Other system boundaries

The following system boundaries are applied on production equipment and employees:

- Environmental impacts of infrastructure, construction, production equipment, and tools that are not directly consumed in the production process should not be accounted for in the life cycle inventory.
- Employee-related activities such as transport to and from work should not be included.

7 Cut-off rules

All inflows and outflows for which there are data shall be included in the calculations. If data are not available, conservative assumptions with generic data may be used. All such assumptions shall be documented.

If insufficient data or data gaps occur for a unit process, not more than 1% of the total energy consumption and 1% of the total mass input may be omitted from each unit process. For each information module, or aggregated information modules (A1-3, A4-5, B1-B7 and C1-C4), not more than 5% of material and energy input flows may be excluded, in accordance with EN 15804 (Section 6.3.5). Conservative assumptions in combination with plausibility considerations and expert judgment can be used to demonstrate compliance with these criteria. A special emphasis must be placed on material and energy flows that are known to have a large impact.

8 Allocation rules

Allocation is partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems. In many industrial processes more than one product is generated in the production process (multi-output process) and one outflow from a process may be generated from several input materials (multi-input process). These processes are said multifunctional.

As a general rule, allocation should be avoided as far as possible by collection of product-specific data. If allocation cannot be avoided, the sum of the allocated inputs and outputs of a unit process shall be equal to the unallocated inputs and outputs of the unit process.

The inputs and outputs must be allocated to the different products according to clearly stated procedures that shall be documented and explained.

The initial allocation step includes dividing up the multifunctional process (or product system) in sub-processes (or sub-systems); the inputs and outputs of the process (or product system) should be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system. Where physical relationship alone cannot be established or used as the basis for allocation, the inputs should be allocated between the products and functions in a way that reflects other relationships between them. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.

A second way to avoid allocation is by expanding the product system to include the additional functions related to the co-products; however, this strategy is not allowed by all programme operators.

The allocation principles stated above also applies to reuse and recycling situations. In accordance with UNI EN 15804:2012, the end-of-life system boundary of the construction product system is set where outputs of the system under study, e.g. materials, products or construction elements, have reached the end-of-waste state. Therefore, waste processing of the material flows (e.g. undergoing recovery or recycling processes) during any module of the product system (e.g. during the production stage, use stage or end-of-life stage) are included up to the system boundary of the respective module.

9 Exclusion

All the excluded processes shall be listed.

The LCA is building related, so all the infrastructures (streets, bridge, railways etc.) are excluded.

The area surrounding the building (and related paving, facility, green) shall be considered in the first use, but is excluded in the second use (due to the fact that probably the area on which the building will be located during the second use is not already known).

Furnishings not building related, such as kitchen fixtures, bathroom fittings, etc., and appliances, such as entertainment electronics, washing machines, refrigerators, cooking appliances, etc., shall not be included in the system boundaries.

10 Data collection and building information

The data collection start with the quantification of the mass and energy flows building-related (technosphere flows). This quantification should be organised in a structured way.

To facilitate the quantification, 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 (energy, water).

The choice of the level of details depends on the goal and scope (and intended use) of the assessment and of the availability of data at the time the assessment is carried out (concept design, detailed design, procurement/tender, construction and handover, use). The source of data (e.g. design drawings, bill of quantities, invoices, and actual data by monitoring) shall be declared. Assessments should be made using data and information that most precisely represents the object of assessment and the time of the assessment.

This information may be given in different forms:

- aggregated data, either for the object of assessment as a whole (e.g. volume, height, floor area, energy consumption, water consumption) or for major components (e.g. walls, floors, roofs);
- product/material specific data for components (e.g. bricks, plaster, flooring, windows, fixtures and finishes).

Furthermore, the information, whether it is detailed or aggregated, can be:

- generic data (from literature, from typical current practice);
- average data (from statistical assumptions, from databases) or collective data (e.g. EPD for a type or a category of similar products);
- specific data, calculated (e.g. design drawings, bill of quantities, information that is specific to the manufacturers' components and/or products used in the construction, etc.) for the actual products and components used or directly measured information (e.g. for utilities and services, energy, water demand, waste, etc.) as built and operated.

The quantification of the building parts and of the energy consumption shall be specific data. For related processes, when it is impossible the collection of specific data, averaged and generic data can be used. All these aspects shall be declared.

The quantification of the building parts shall include:

- foundations;
- bearing structure (e.g. frame, beams, columns, load-bearing elements, slabs);
- staircase(s);
- external walls;
- windows;
- roof;
- internal walls;
- doors;
- flooring;
- ceiling;
- technical systems.

The technical systems shall include (if present):

- 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;
- water treatment systems.

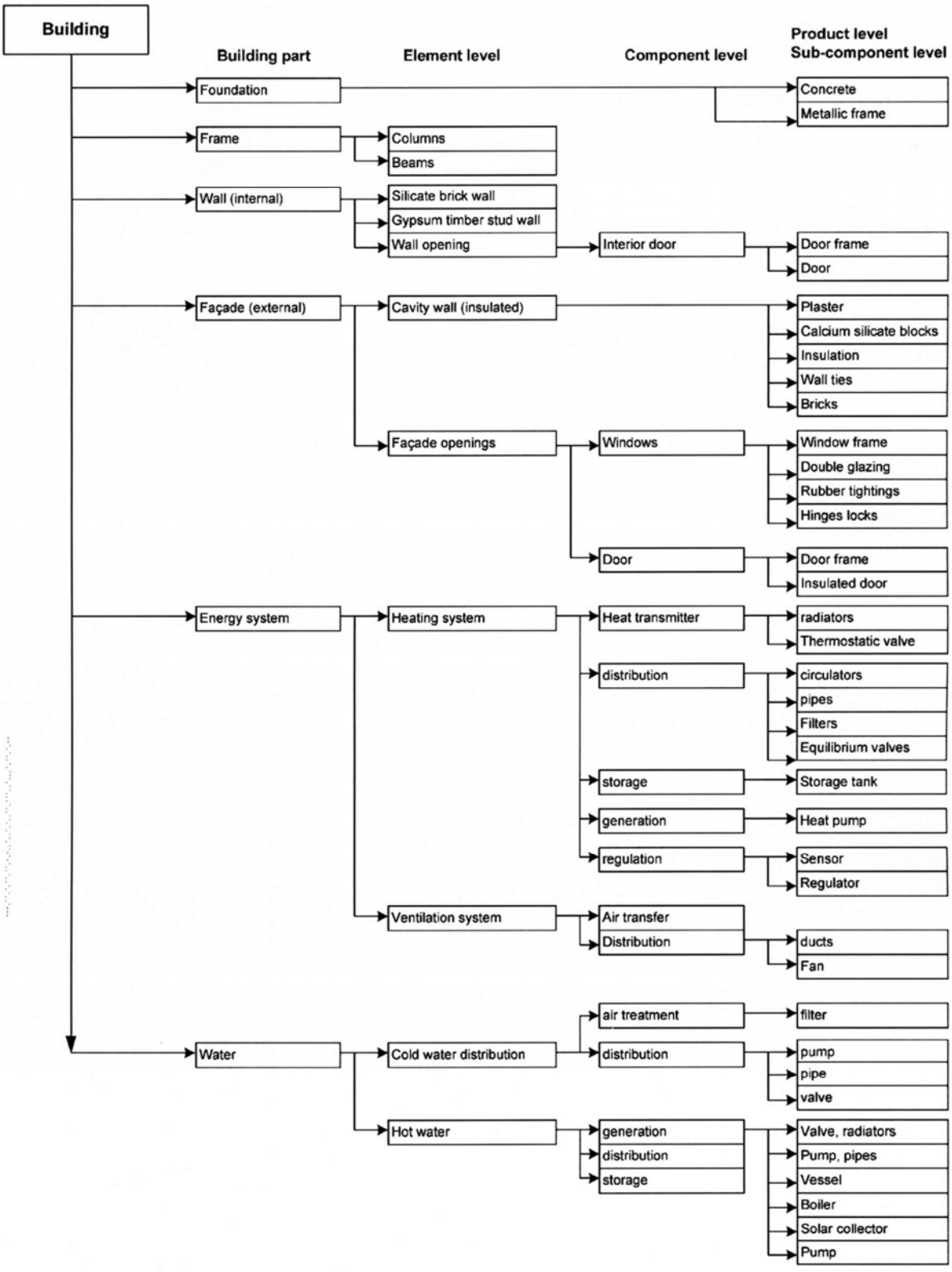

Figura 2. Example of a structuring building information using different level of aggregation, source: EN 15978:2011.

Additional technical information provided by the manufacturer of the product (e.g. for transportation given in tonnes.km and losses that occur during the construction phase) shall be used for completion of the assessment.

The quantification of the impacts and aspects of operational energy is a direct result of the calculation of the energy used during the use stage of the building according to EN 15603 and shall be derived from the EPD, if available, of the different energy carriers or LCA databases. The 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.

NOTE Values of the environmental indicators derived from LCA methodology may differ from the conversion factors presented in EN 15603 and EN 15217 for primary energy and CO_2 emission.

11 Scenarios for defining the building life cycle

To provide the complete description of the object of assessment, time-related characteristics of the building need to be added to the physical description of the building (e.g. reference study period, service life, replacement period, working hours, pattern of use). This requires the development and use of appropriate scenarios representing assumptions (or, where known, real information) that can be applied to modules related to construction, first use, eventual deconstruction-construction, second use and end-of-life stages (modules $A_1$4 to $C_2$4) of the object of assessment. If information on module D is communicated in a building assessment, scenarios are required to be defined at the building level, to model loads and benefits for recycling and energy recovery.

Information modules available from EPD shall be reviewed in order to determine if they are representative of the assessed building. If only “cradle to gate” EPD or “cradle to gate EPD with options” are available, information shall be added to complete all “cradle to grave” modules. In order to provide full transparency, any change of, or adaptation from, the given information modules shall be reported.

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.

Sources of information shall be documented. It should be clear from the assessment report whether information/data has been:

- assumed, from generic or average data (e.g. from the literature or statistical data),
- estimated or calculated, from specific data (e.g. through the design drawings, bill of quantities, through documentation or interviews to manufacturers, builders or contractors),
- based on actual measurement (e.g. during the construction process, collecting the invoices paid by the construction company or the building site reports with the accurate description of the construction operations and the amount of the materials consumed, compiled by each subcontractor).

Scenarios should also distinguish and make clear when they relate to specific functions undertaken within the building (e.g. scenarios for lighting energy used in an exhibition hall or energy and water use associated with the use of a restaurant).

11.1 Scenarios for the product stage (Modules A1 to A3)

Specific or representative EPD, in accordance with the requirements of EN 15804, for the product which is used in the building shall be used.

When no EPD is available, scenarios for products shall be clearly defined from cradle to gate modules according to EN 15804. This includes any products, construction assembly of pre-fabricated products or any combination of these.

11.2 Scenarios for the construction process stage (Modules A4-A5)

Scenarios for transport shall specify for any category of materials or products, the type of transport used, distances travelled and fuel consumption required for their movement from the factory to the site. When specific data are not available, the type of transport and transport distance should be defined as representative to actual conditions on the market.

Environmental information for the construction process stage shall be collected on site and related to:

- ancillary materials for installation, specified by material [kg or other units as appropriate]
- water use in [m^3]
- other resource use [kg]
- quantitative description of energy type and consumption during the installation process [kWh or MJ]
- wastage of materials on the building site before waste processing, generated by the product's installation, specified by type [kg]
- output materials, specified by type, as result of waste processing at the building site e.g. of collection for recycling, for energy recovery, disposal (specified by route) [kg]
- direct emissions from installation to ambient air, soil and water [kg].

When no information for the construction process are available, because the LCA is conducted before the beginning or after the end of the construction process (the contractors rarely can provide information about the consumptions of the building site activities), estimated data from specific information of the construction activities or generic data assumed from literature can be used.

Scenarios for the construction process stage cover the period from the factory gate of the different construction products to the practical completion of the construction work. The scenarios shall be defined for any elementary operation described within the boundaries of the construction stage.

EXAMPLE 1 The scenarios specify the assumptions or adaptation made to the EPD of construction products with respect to the application technology of their installation (based on technical information of producers): mechanically fixed, glued, welded. It includes the specifications or assumptions on the energy use, water use and waste generated in the application process if not given or if not directly applicable for the building scenario. It also includes information on energy use required for on-site equipment (e.g. cranes, vacuum equipment, scissor lifts, scaffolding elevators, heating, cooling).

EXAMPLE 2 The scenarios specify the assumptions for temporary works, as temporary stabilisation or supporting structures for neighbouring buildings, temporary pumps for groundwater, fences, etc. used during the construction stage.

11.3 Scenarios for Use stage (modules B1 to B7)

The building scenarios for the use stage shall describe all activities with a relevant environmental impact arising from the operation of the building, including the building systems and building management activities associated with the object of assessment.

Scenarios should be based on the existing regulations, client's requirements, accepted code of practice, statistical data.

Scenarios for the energy use shall be obtained from EN 15603 or energy certification. The assessment of energy use may be based on alternative methods for energy modelling and scenarios for the pattern of use, which shall be described and documented. If additional energy uses are included, the scenarios attached to these additional energy uses (process) 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. The scenario for the energy use shall specify per energy carrier the imported energy used to satisfy the specified demand (e.g. electricity, natural gas, district heating) 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).

The scenarios for the water use should be based on statistical data, normative data, or on real-life data where available. These scenarios shall also take into account and justify any reduction of potable water use through the use of the rainwater harvesting, water recycling and/or other sources. These amounts may be reported separately as additional information.

The cleaning, maintenance and repair scenarios for all major items of plant, machinery, windows, wall and flooring finishes shall be described. These scenarios shall take into account the following:

- client requirements (as expressed in the brief);
- requirements issued from EN 15804;
- manufacturers' information;
- pattern of use.

Information for the maintenance/repair process stages to be collected are:

- maintenance/repair process description, e.g. cleaning, inspection activities;
- maintenance/repair cycle [number per RSL or year];
- ancillary materials for maintenance/repair, e.g. cleaning agent/lubrificant, specify materials [kg/cycle];
- wastage material during maintenance/repair, specify materials [kg];
- net fresh water consumption during maintenance/repair [m^3];
- energy input during maintenance/repair, e.g. vacuum cleaning or crane activity and energy carrier type e.g. electricity, and amount, if applicable and relevant [kWh].

The scenario shall define the internal and external conditions for the object of assessment. These conditions influence the impacts related to the characteristics of the products in their application (e.g. release of substances into the environment depends on pattern of use, humidity, air velocity, and temperature).

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

The scenarios for dismantling and deconstruction shall be restricted to the on-site process and activities. The collection of data related to deconstruction/demolition shall be specified by type:

- kg collected separately
- kg collected with mixed construction waste

Scenarios for transport shall specify for any category of materials or products, the type of transport used, distances travelled and fuel consumption required for their movement from the site for disposal or to the system boundary for materials leaving the system for reuse, recycling and energy recovery.

The scenarios for waste processing shall describe all 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 scenarios shall be based only on solutions and technologies that have been proven to be economically and technically viable.

To define the scenarios for waste treatment, construction waste shall be specified by type:

- kg for re-use
- kg for recycling
- kg for energy recovery
- kg product or material for final deposition.

12 Data quality requirement

As a general rule, specific data shall always be used if available. Generic data may be used if specific data is lacking.

For example, for the production modules, it is preferable to use manufacturer's average or specific data if available from e.g. an approved EPD, but if specific data is lacking, generic data (e.g. commercial databases and free databases) can be used.

Specific data is mandatory to be used for the quantification of the building components and materials.

Specific data are, for example site specific data gathered from the sites where specific processes are carried out or data gathered from the actual construction site where building-specific processes are carried out, and data from other parts of the life cycle traced to the specific building system under study, e.g. materials or electricity provided from a contracted supplier being able to provide data for the actual delivered services, transportation taking place based on the actual fuel consumption and related emissions etc. Specific data for a building refers to data collected by the developer of the LCA as strictly related to the specific building. Specific data can be based on selected generic databases where for instance the travel distance, specific travel means and fuel consumption account for the specific data information.

Generic data are data from commonly available data sources (e.g. commercial databases and free databases), which are allowed to be used to substitute specific data. Selected generic data can aim to represent specific processes.

Any data used should preferably represent average values for a specific year. However, the way these data are being generated could vary e.g. over time, and in such cases they should have the form of a representative annual average value for a specified reference period.

It should be clear from the assessment report whether information/data has been assumed, estimated or calculated, or is based on actual measurement. Sources of information shall be documented.

12.1 Rules for using EPD data

If a specific or representative EPD in accordance with the requirements of EN 15804 is available for the product which is used in the building, no amendment shall be made to the product stage information module (A1 to A3).

If no such EPD is available or the EPD is not complete for the product which is used in the building, the product stage information modules (A1 to A3) of available generic (not specific) EPD or a data set of a similar product may be used and adapted to create a new data set to reflect the actual situation as closely as possible. Such a data set shall be made only on the basis of suitably reliable and accurate information available for products.

In making such adaptations, assumptions shall not simply default to the best case but shall conservatively represent a realistic condition. Data referring to contractors supplying main building components should be asked for from the contractor as specific data, as well as infrastructure, if relevant.

EPD information can be available on an aggregated level for a building part, for a building element, for a building component, or on the level of the product or material, depending on availability of information. The scenarios and system boundaries of the data used should be consistent at the building level and shall be relevant to the building that is the object of assessment.

The results for A1-A2-A3 can be declared as a single aggregated information module A1-3.

12.2 Rules for using generic data

For allowing the use of generic data, selected prescribed characteristics for precision, completeness and representative-ness must be fulfilled and demonstrated such as:

- data should be as current as possible, so validation of the data shall not be older than 10 years;
- 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 environmental impacts associated with other generic data (not in compliance with the requirements listed above) must however not exceed 10% of the building's overall environmental impacts.

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

13 Environmental impacts and aspects and related indicators

13.1 Indicators describing environmental impacts

The environmental information on impacts shall be expressed with the impact category indicators of LCIA, using characterisation factors according to EN 15804 and EN 15978. These predetermined indicators shall be included in the assessment as follows:

Indicator	**Unit (expressed per functional unit or per declared unit)**
Abiotic depletion potential (ADP-elements) for non fossil resources	kg Sb equiv
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ, net calorific value
Acidification potential of soil and water, AP;	kg SO_2 equiv
Depletion potential of the stratospheric ozone layer, ODP;	kg CFC 11 equiv
Global warming potential, GWP;	kg CO_2 equiv
Eutrophication potential, EP;	kg $(PO_4)^3$- equiv
Formation potential of tropospheric ozone, POCP;	kg Ethene equiv

13.2 Indicators describing resource use

The following environmental indicators apply data based on input flows of the LCI. They describe use of renewable and non-renewable primary energy and water resources. They shall be included in the assessment as follows:

Impact Category	**Unit (expressed per functional unit or per declared unit)**
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of not renewable primary energy excluding not renewable primary energy resources used as raw materials	MJ, net calorific value
Use of not renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of not renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of not renewable secondary fuels	MJ, net calorific value
Net use of fresh water	m^3

13.3 Indicators describing additional environmental information

The indicators describing waste categories and output flows derived from scenarios and LCI shall be included in the assessment as follows:

Indicators describing waste categories:

Parameter	**Unit (expressed per functional unit or per declared unit)**
Hazardous waste disposed	kg
Not hazardous waste disposed	kg
Radioactive waste disposed	kg

Indicators describing the output flows leaving the system:

Parameter	**Unit (expressed per functional unit or per declared unit)**
Components for re-use	kg
Materials for recycling	kg
Materials for energy recovery	kg
Exported energy	MJ per energy carrier

14 Reporting the assessment results

14.1 General information on the assessment

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

The environmental 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.

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;
- 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.

14.2 General information on the object of assessment

a) Functional equivalent:

- building type (e.g. office, exhibition hall);
- relevant technical and functional requirements (e.g. the regulatory and client's specific requirements);
- pattern of use (e.g. occupancy)
- required service life;

b) Reference study period;

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

- technical type of building (structural type);
- year of commissioning;
- design number of building occupants;
- design occupancy schedule;
- heating, cooling and ventilation system and hot water service system;
- lighting system;
- power and communication systems.

14.3 Statement of boundaries and scenarios used in the assessment

For the building under assessment the relevant assumptions and scenarios shall be stated in the documentation.

14.4 Data sources

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

14.5 List of indicators used for assessment and expression of results

The results of the environmental assessment of the building shall be reported and presented as structured list, according to the scenarios used for the assessment.

For each module of the life cycle, values shall be reported at least for all the mandatory indicators.

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

Indicators that have not been determined shall be reported as INA (Indicator Not Assessed) 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.

The results for impacts and aspects resulting from reuse, recycling 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.

14.6 List of PCR documents

A list of existing PCRs on materials, components and systems of relevance for temporary buildings should be reported by specifying the programme operator which has developed the documents.

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