Life Cycle Assessment of Composite Decking Systems

Prepared for:

fiberon®

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Prepared by:
Dr. Gerard Mansell | Life Cycle Practitioner
Life Cycle Services
+1.510.452.8000
gmansell@scsglobalservices.com

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1 General aspects

This report presents the findings of the Life Cycle Assessment (LCA) conducted by SCS Global Services (SCS) of composite decking systems manufactured by Fiberon at the company's production facilities in New London, North Carolina and Meridian, Idaho. The products are constructed from virgin and recycled polyethylene, PVC, recycled wood, and various additives sand pigments. This study includes six (6) product lines, for use in various commercial and residential applications.

The LCA study scope, methodology, data sources, assumptions, and limitations, used to calculate final indicator results developed for the EPDs are described in this report. The scope is 'cradle-to-gate with options' including the following life cycle stages: raw material extraction and processing; transport to manufacturer; product manufacturing, including packaging, and product disposal.

This report is provided to aid in understanding the life cycle impacts for the Fiberon products for the category indicators specified by the PCR. The intended audience for this technical LCA report includes Fiberon, the EPD verifier, and other LCA practitioners or technical audiences with which Fiberon chooses to share the report. The results of the study are not intended for use in comparative assertions. This report has been critically reviewed by an external LCA expert, independent of the project for conformance to ISO 14044 and the PCR.

2 Goal of the study

The goals of the study include two primary objectives:

1. To assess the potential environmental impacts, using category indicators specified by the PCR, for the products over their life cycle – raw material extraction and processing, material transport, product manufacturing, including packaging, and product disposal
2. To serve as the basis of preparing an Environmental Product Declaration (EPD), conformant to the ISO 21930[1] (the PCR), ISO 14025[2] and ISO 14044[3].

Life Cycle Impact Assessment (LCIA) results are reported using the indicators prescribed by the Product Category Rules (the PCR) including the TRACI 2.1[4] characterization methodology. It should be noted that the PCR does not require reporting of all environmentally relevant impacts, such as impacts to ecosystems, key species habitats, or water resources.

The scope of the assessment includes the products described in Table 1.

Table 1. Fiberon products included in the LCA study.

Product Name	Product Description
Concordia (Symmetry & Horizon) Sanctuary ArmorGuard/Veranda Good Life (Escapes & Weekender) Perspective	Fiberon® composite decking is manufactured using a co-extrusion process, combining wood fiber and polyethylene (PE) into the board core, and a polyethylene (PE) capstock. Both the core and capstock are inclusive of additives for color, weathering resistance and specific performance characteristics. Fiberon composite decking is intended for use as exterior walking surfaces, including decking, stair treads, and ramps.
Paramount PVC	Fiberon PVC composite decking is manufactured using a co-extrusion process, combining a cellular PVC core and a PVC capstock. Both the core and capstock are inclusive of additives for color, weathering resistance and specific performance characteristics. Fiberon composite decking is intended for use as exterior walking surfaces, including decking, stair treads, and ramps.

[1] ISO 21930:2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services
[2] ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures
[3] ISO 14044: 2006/Amd 1:2017/Amd 2:2020 Environmental Management – Life cycle assessment – Requirements and guidelines.
[4] Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Dr. Bare, J., https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci.

3 Scope of the study

3.1 Function, declared unit and reference flows

The LCA scope of this study is "cradle-to-gate with options", including raw material extraction, processing of raw materials, material transport, product and packaging manufacture and product end-of-life. Resource consumption, emissions and wastes and their associated potential environmental impacts are calculated for the composite decking system products upstream of the manufacturing facilities in New London, North Carolina and Meridian, Idaho. Impact results for the products are calculated as a production weighted average across the manufacturing facilities.

The Fiberon Composite Decking System products provide the primary function of exterior decking. According to ISO 14044, the functional unit is "the quantified performance of a product system, for use as a reference unit." As the scope of the study is cradle-to-gate with options, a declared unit is used in lieu of a functional unit. For the present assessment, a declared unit of 1 square meter of decking surface is defined. The declared unit and reference flow for the products are summarized in Table 2.

Table 2. Declared unit and reference flows for the Fiberon products.

Product Name	Declared Unit	Reference flow (kg/m^2)
Concordia (Symmetry & Horizon)	1 m^2 of decking system with a thickness of 23.2 mm	22.7
Sanctuary	1 m^2 of decking system with a thickness of 23.2 mm	22.5
Armor Guard/Veranda	1 m^2 of decking system with a thickness of 23.5 mm	21.5
Good Life	1 m^2 of decking system with a thickness of 23.5 mm	20.7
Perspective	1 m^2 of decking system with a thickness of 22.4 mm	22.8
Paramount PVC	1 m^2 of decking system with a thickness of 24.6 mm	15.5

Sample images of the Fiberon products included in the LCA are shown in Figure 1.

Figure 1. Representative product images for Fiberon Composite Decking System products included in the LCA scope.

3.2 System description

General description of the system

The scope of the LCA study is "cradle-to-gate with options", including raw material extraction, processing of raw materials, material transport, product manufacture, including packaging, and end-of-life. Resource consumption, emissions and wastes and their associated potential environmental impacts are calculated for the composite decking system products upstream of Fiberon's manufacturing facilities. The product systems are modeled based on information provided by the manufacturer for the product, including packaging, and secondary data from life cycle databases.

The product systems studied in this LCA include Fiberon's composite decking system products manufactured at the company's production facilities in New London, NC and Meridian, ID. The products are constructed from virgin and recycled polyethylene, PVC, recycled wood, additives and pigments sourced from various local and regional suppliers. Recycled polyethylene plastic used in the manufacture of the products is supplied by a recycling facility in New London, NC owned and operated by the manufacturer.

Electricity use at the manufacturer's facilities is modeled based on the regional electricity supply mix for the appropriate eGRID subregion. Electricity and resources (e.g., natural gas) used at the manufacturing facility are allocated to the products based on annual production data for 2019.

Geographical coverage

The Fiberon composite decking system products are manufactured at the company's facilities in North Carolina and Idaho. Electricity use at the manufacturing facility is modeled using inventory datasets for the regional electricity grids. Disposal processes are modeled based on regional statistics for North America as specified by the PCR. Environmental impact category indicators are reported based on the U.S. EPA's TRACI 2.1 characterization methodology.

Time coverage

Manufacturer-supplied data (primary data) are based on annual production for calendar year 2019.

3.3 System boundaries

Initial inclusion and exclusion rules for unit processes and flows

The product system under study includes the production of all the components shown in Table 5 (Section 4.2), as well as product disposal at end-of-life (see Figure 2). The system boundaries include all unit processes contributing measurably to category indicator results for those category indicators specified in the PCR.

All inputs and outputs relevant to the production of products were included in the LCA calculations. According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. In the present study, all known materials and processes were included in the life cycle inventory.

Consistent with PCR requirements, processes excluded from the system boundary include the following:

- Construction activities, capital equipment, and infrastructure
- Maintenance and operation of capital equipment
- Personnel travel and resource use

The deletion of these processes is permitted since it is not expected to significantly change the overall conclusions of the study.

The life cycle stages included in the study, according to the module definitions of the PCR, are shown in Table 3. A flow diagram of the product system, including system boundaries, is provided in Figure 2.

Table 3. The modules and unit processes included in the scope for the Fiberon products.

Module	Module description from the PCR	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Extraction and processing of raw materials for the composite decking system components.
A2	Transport (to the manufacturer)	Transport of component materials to the manufacturing facilities
A3	Manufacturing, including ancillary material production	Manufacturing of products and packaging (incl. upstream unit processes*)
A4	Transport (to the building site)	Module Not Declared
A5	Construction-installation process	Module Not Declared
B1	Product use	Module Not Declared
B2	Product maintenance	Module Not Declared
B3	Product repair	Module Not Declared
B4	Product replacement	Module Not Declared
B5	Product refurbishment	Module Not Declared
B6	Operational energy use by technical building systems	Module Not Declared
B7	Operational water uses by technical building systems	Module Not Declared
C1	Deconstruction, demolition	Demolition of the product is accomplished using hand tools with no associated emissions and negligible impacts
C2	Transport (to waste processing)	Transport of the product to waste treatment at end-of-life
C3	Waste processing for reuse, recovery and/or recycling	The products are disposed of by landfilling or incineration which require no waste processing
C4	Disposal	Disposal of the product in a municipal landfill or incineration
D	Reuse-recovery-recycling potential	Module Not Declared

**This includes unit processes involved in the generation of electricity, and production of material input (e.g., adhesives and pigments).*

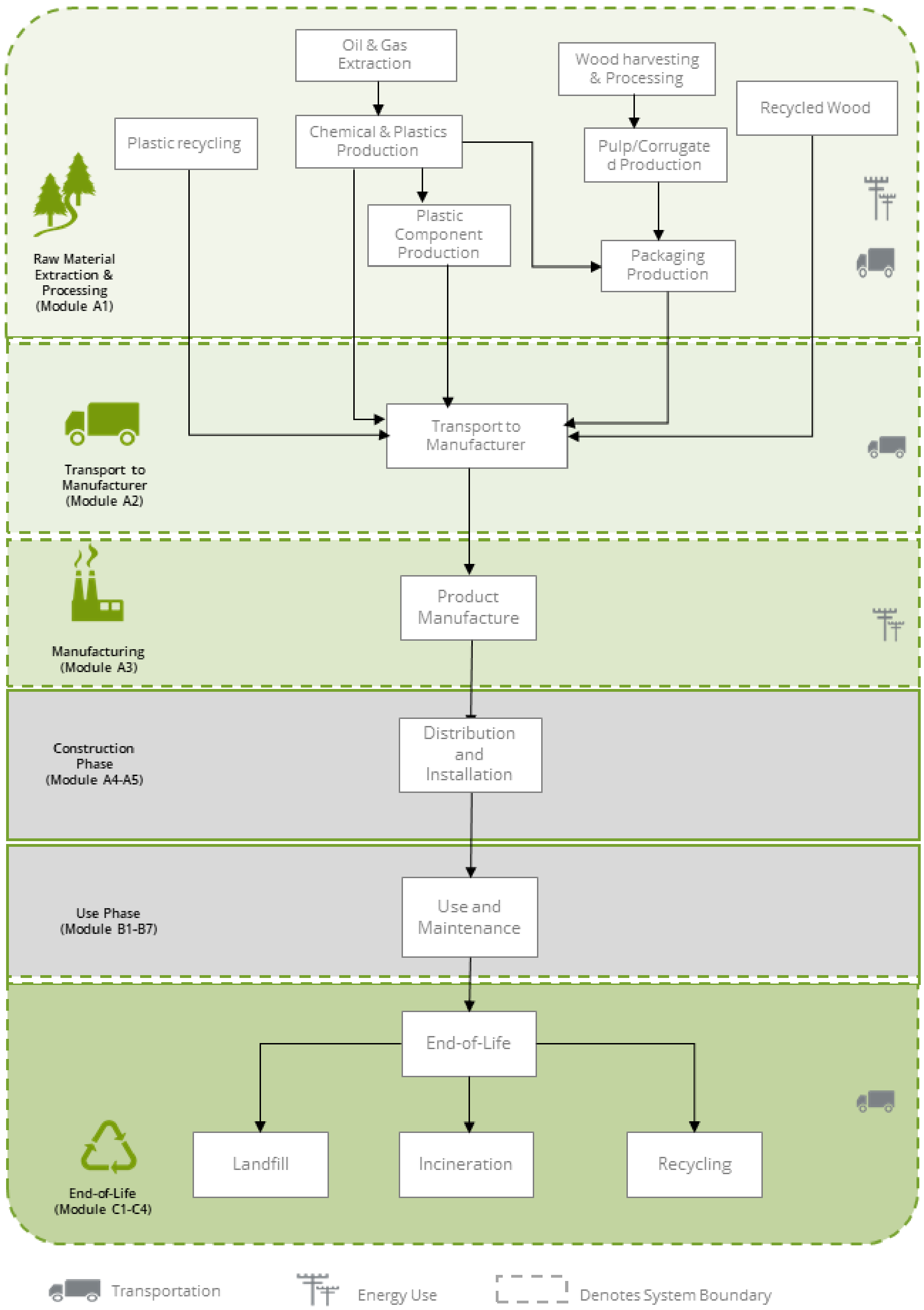

Figure 2. Flow diagram and system boundaries for the life cycle of the Fiberon products.

Allocation procedures

This study follows the allocation guidelines of ISO 14044, and sought to minimize the use of allocation wherever possible. The PCR require primary data for allocation based on physical relationships (e.g., volume, energy content, or mass-based relationships). Alternatively, economic allocation may be applied. The secondary databases used for the product system (discussed below) apply allocation based primarily on physical relationships.

Resource use at the Fiberon facilities (e.g., water and energy) was allocated to the product based on the product mass as a fraction of the total facility production volume (i.e., mass-based allocation). Electricity use at the manufacturing facilities was modeled using ecoinvent inventory datasets for the applicable eGRID sub-regional electricity grid.

Recycled materials were allocated using the recycled content allocation method (also known as the 100-0 cut off method). Using the recycled content allocation approach, system inputs with recycled content do not receive any burden from the previous life cycle other than reprocessing of the waste material. At end-of-life, materials which are recycled leave the system boundaries with no additional burden.

Impacts from transportation were allocated based on the mass of material and distance transported.

3.4 Equivalence of compared systems

The results presented are not intended for use in comparative assertions.

3.5 Initial data quality requirements

One of the primary goals of the study is to produce an LCA and EPD for the Fiberon composite decking system products; as such, the overarching data quality requirements are to enable a reliable assessment of the indicator results for all reported impact categories, with data quality sufficient as to identify the key unit processes, differentiated by overall contribution to final results. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results.

A data quality assessment is provided in Section 4 of this report, according to the requirements of the PCR, and considers all of the following data quality requirments as noted in ISO 14044 Section 4.2.3.6.

- Time-related coverage of the data (age, minimum collection period);
- Geographical coverage;
- Technological coverage (specific technologies or technology mixes that should be used);
- Precision (measure of the variability of the data values for each data expressed);
- Completeness: Percentage of flow that is measured or estimated;
- Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest;
- Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;

- Reproducibility: qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study;
- Sources of the data; and
- Uncertainty of the information (e.g., data, models and assumptions).

3.6 General assumptions

The assessment relied on a number of assumptions related to material composition, processing, and use and maintenance. The major assumptions used in the assessment are described below.

- The Fiber Composite manufacturing facilities are located in New London, North Carolina and Meridian, Idaho. Ecoinvent inventory datasets for the appropriate eGRID energy grid mix were used to model resource use and emissions from electricity use at the manufacturing facilities.
- Electricity and resource use at the production facilities was allocated to the composite decking system products based on product mass utilizing production data for calendar year 2019 provided by the manufacturer.
- Primary data for upstream component fabrication were not available. Representative data from the Ecoinvent LCI databases were utilized as appropriate.
- Specific data to estimate the disposition of the product at end-of-life were unavailable. The study assumes no recycling of the product occurs at end-of-life. Assumptions regarding landfilling and incineration rates for the product materials are based on regional statistics regarding municipal solid waste generation.

3.7 Data types and sources

The life cycle inventory (LCI) of each unit process comprises material and energy inputs, emissions, and wastes. Primary data, as well as datasets from commercial LCI database are used to model each unit process within the product system and include data quantifying the elementary and technology flows necessary to calculate environmental impacts in the LCIA phase. These include the following general types of data:

- Inputs from nature: biotic and abiotic resources;
- Inputs from the technosphere: ancillary materials, services such as waste management and transport, energy inputs, etc.; and,
- Outputs to nature: emission to air, water and soil.

To the extent available, primary data are used for foreground processes (e.g., product manufacturing), while background processes are modeled using secondary data sourced from the Ecoinvent[5] LCI databases.

3.8 Sensitivity analysis for refining the system boundaries

Sensitivity analyses are conducted to evaluate the impact of various modeling assumptions on indicator results. For the present study, the impacts due to the choice of resource allocation methodology is investigated in a sensitivity analysis. The results of the analysis are presented and discussed in Section 5.3.

3.9 Life cycle impact assessment

Mandatory elements

The LCA conforms to ISO 14040/44 and ISO 21930 (the PCR). Impact category indicators are estimated using the TRACI 2.1 characterization factors. The impact indicators considered for the assessment include:

- Potential for Global Warming
- Acidification Potential
- Eutrophication Potential
- Smog Formation Potential
- Ozone Depletion Potential
- Fossil Fuel Depletion Potential

Note that for global warming calculations, the TRACI 2.1 global warming calculations are based on IPCC 2007. Note also that the TRACI characterization method does not include biogenic carbon uptake or biomass CO_2 emissions. Based on the component materials of the product and production processes, there are no impacts associated with land-use changes, nor are environmental impacts associated with carbonation relevant for the product system. The impact category indicators included in the assessment are described below.

[5] Ecoinvent Centre (2020) Ecoinvent data from v3.7. Swiss Center for Life Cycle Inventories, Dübendorf, 2020. http://www.Ecoinvent.org

Category Indicator	Units	Impact Category and Environmental Mechanism
Global Warming Potential (GWP)	kg CO_2 eq.	Anthropogenic emissions of greenhouse gases and short-lived climate forcers have led to increased radiative forcing, which has in turn increased the global mean temperature by 0.8°C since pre-industrial times. This is projected to increase to 1.5°C by 2035, 2.0°C by 2050, and 4.0°C by 2100. As global mean temperatures continue to climb, global climate change will result. Some of the predicted impacts include reductions in food and food supplies, water supplies, and sea level rise.
Ozone Layer Depletion (ODP)	kg CFC-11 eq.	Emissions of ozone depleting substances such as chlorofluorocarbons contribute to a thinning of the stratospheric ozone layer. This can lead to increased cases of skin cancer, and effects on crops, other plants, marine life, and human-built materials. All chlorinated and brominated compounds stable enough to reach the stratosphere can have an effect. CFCs, halons and HCFCs are the major causes of ozone depletion. Damage to the ozone layer reduces its ability to prevent ultraviolet (UV) light entering the earth's atmosphere, increasing the amount of carcinogenic UVB light reaching the earth's surface. Due to the international ban on ozone depleting chemicals, the stratospheric ozone layer has begun to recover; U.S. EPA projects that the ozone layer will recover within about 50 years.
Smog Formation Potential (SFP)	kg O_3 eq	Photochemical ozone, also called "ground level ozone", is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. If ozone concentrations reach above certain critical thresholds, health effects in humans can result, including bronchitis, asthma, and emphysema. The impact category depends largely on the amounts of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds).
Acidification (AP)	kg SO_2 eq.	Acidification is the increasing concentration of hydrogen ion (H^+) within the local environmental and occurs as a result of adding acids such as nitric acid and sulfuric acids into the environment. Acid precursor emissions transport in the atmosphere and deposit as acids. These acids may deposit in soils which are sensitive, or insensitive, to the increased acid burden; sensitivity can depend on a number of factors. In acid-sensitive soils, the deposition can decrease the soil pH (acidification) and increase the mobility of heavy metals in the environment, such as aluminum. This acidification can affect the pH of local soils and freshwater bodies, by increasing local hydrogen ion concentrations, causing endpoints such as tree die-offs and dead lakes. Emissions of sulfur dioxide and nitrogen oxides from the combustion of fossil fuels have been the greatest contributor to acid rain.
Eutrophication (EP)	kg N eq.	Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. In some regions, emissions of excess nutrients (including phosphorus and nitrogen) into water can lead to increased algal blooms. These blooms can reach such a severity that waterways become choked, with no other plant life able to establish itself. If algal blooms are intense enough, the decaying algae consumes dissolved oxygen in the water column starving other organisms of needed oxygen. Whereas phosphorous is mainly responsible for eutrophication in freshwater systems, nitrogen is mainly responsible for eutrophication in ocean water bodies. Emissions of ammonia, nitrates, nitrogen oxides and phosphorous to air or water all have an impact on eutrophication.

Category Indicator	Units	Impact Category and Environmental Mechanism
Fossil Fuel Depletion (FFD)	MJ surplus	This impact category reflects the relative abundance and depletion of feedstock reserves resulting from the net consumption of fossil energy resources used for electric power generation, operations and transport, and for incorporation into materials such as plastics. This indicator considers the amount of resources used for the function under study, the availability of economically recoverable reserves, the degree to which such resources may be replenished, the relative efficiency of power generation systems and fuel systems, and whether the resource is available for reuse at end of life (e.g., recycling). All fossil fuel resources which are consumed in a non-renewable fashion are included.

The PCR requires that several other parameters be reported in EPD, including resource use, waste categories and output flows, and other environmental information. Many of these additional parameters seek to classify resources and materials with respect to their use as raw materials for the product. While the LCA model tracks the input of these elementary flows, the model does not explicitly track whether those energy flows are used to generate energy (e.g., natural gas-based electricity) or used in a product (e.g., fossil-based plastics). In such cases, and when the parameters cannot be estimated by other means (e.g., from primary material content and/or resource use data), these parameters are reported herein, and in the EPD, as "*Indicator not assessed (INA).*"

Elementary flows were reviewed for resources which are considered renewable on a human time scale. Elementary flows related to land occupation were not included. In addition, water consumption was not included since this flow is reported separately. As the products do not contain significant amounts of bio-based materials, biogenic carbon emissions and removals are not declared.

In light of the above discussion, the additional parameters were assessed using the following methods:

- *Use of renewable primary energy excluding renewable primary energy resources used as raw materials (RPR_E).* This parameter is estimated as the total consumption of renewable primary energy renewable resources minus the primary energy resources used as raw materials.
- *Use of renewable primary energy resources used as raw materials (RPR_M).* Although no classification scheme is available in openLCA for this parameter, based on the material content of the product, no component materials contribute to this parameter.
- *Use of non-renewable primary energy resources used as raw materials ($NRPR_E$).* No classification scheme is available in openLCA for energy resources used as raw materials. *Indicator not assessed*
- *Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials ($NRPR_M$).* No classification scheme is available in openLCA for energy resources used as raw materials. *Indicator not assessed.*
- *Use of secondary material (SM).* There are some recycled materials used as components of the products and this is reported as use of secondary materials in the product system.

- *Use of renewable and nonrenewable secondary fuels (RSF/NRSF).* The main consumption of any secondary fuel in the product system is the combustion of municipal solid waste, used to generate electricity in some regions. In the U.S., municipal solid waste incineration accounts for less than 2% of total electricity generation. This parameter is assumed negligible for the current assessment.
- *Net use of fresh water (FW).* Net use of fresh water (consumption) is included in the Ecoinvent datasets used for the modeling and are reported for all modules. Water consumption includes evaporation, transpiration, product integration and discharge into a different drainage basin or the sea.
- *Hazardous waste disposed (HWD).* All flows of hazardous waste included in the full LCI and other data sources were aggregated into a single result for total hazardous waste disposal.
- *Non-hazardous waste disposed (NHWD).* This includes all wastes produced across all life cycle stages included in the study scope. Flows of non-hazardous waste included in the full LCI were also aggregated into a single result for total non-hazardous waste disposal.
- *Radioactive wastes disposed (HLRW/ILLRW).* All flows of radioactive wastes included in the full LCI and other data sources were classified and reported as low-level and high-level radioactive.
- *Components for re-use (CRU).* There are no components of the product which can be reused, or recycled, at the end of the reference service lifetime and this parameter is reported as zero.
- *Materials for recycling (MR).* This parameter, as reported, includes recycled materials of the product at end-of-life based on the recycling rates used for the assessment (Section 2.17).
- *Materials for energy recovery (MER). T*he production of materials for energy recovery crossing the system boundaries is negligible.
- *Recovered energy (RE).* The recovered energy crossing the system boundaries is negligible.
- *Exported energy (EE).* The exported energy crossing the system boundaries is negligible.

All results are calculated with the OpenLCA 1.10 model using primary and secondary inventory data as described below.

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment[6]. The interpretation included the use of evaluation and sensitivity checks to steer the iterative process during the assessment, and a final evaluation including completeness, sensitivity, and consistency checks, at the end of the study.

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[6] European Joint Research Commission. International Reference Life Cycle Data System handbook. *General guide for Life Cycle Assessment – Detailed Guidance.* © European Union, 2010.

Value Choices and Optional Elements

The study avoids the use of value choices in the assessment, as described in ISO 14044, such as normalization, weighting or grouping of indicator results. The study also includes a data quality assessment, considered optional under ISO 14044.

3.10 Calculation methods

The LCIA and inventory results were calculated based on the TRACI 2.1 characterization methodoloys using the openLCA v1.10 model with primary and secondary data as described in Section 4.

3.11 Limitations of the study

As a result of the choice of study scope and LCIA methodologies used, there were several important study limitations which should be understood to ensure an appropriate interpretation of results. None of these limitations were judged to have significant relevance to final indicator results and were deemed acceptable limitations.

Limitations in the Study Scope

- Energy resource use and emissions at the Fiberon manufacturing facilities were reported separately for electricity and fuel consumption. Resource use and emissions were allocated to the product based on the mass of the product as a fraction of the total facility production (i.e., mass-based allocation).
- Lacking detailed supplier information, much of the upstream raw materials extraction and processing could not be modeled with actual process information. Representative data from the Ecoinvent LCI databases were utilized as appropriate.
- Specific data to estimate the disposition of the product at end-of-life were unavailable. Assumptions for end-of-life are based on regional statistics regarding landfilling and incineration of municipal solid waste .

Limitations in Life Cycle Impact Assessment Phase

There are several important limitations in the LCIA methodologies used, which are based upon the requirements of the PCR. These limitations are described below.

There may be additional impacts relevant to the production of the products at the manufacturing facilities. Some of these omitted impact categories are listed in Table 4. This list is not exhaustive; there may be other impact categories which are not included.

Table 4. Impact categories omitted from the LCIA of the Fiberon products.

Impact Categories	Impact Categories
Terrestrial Biome Disturbance	Hazardous Environmental Contaminant Exposure Risks
Freshwater Biome Disturbance	$PM_{2.5}$ Exposures
Wetland Biome Disturbance	Hazardous Ambient Air Contaminant Exposure Risks
Loss of Key Species	Hazardous Food and Water Contaminant Exposure Risks
Arctic Climate Change	Risks from Radioactive Wastes
Ocean Acidification	-

It should also be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.

Limitations in Results for Other Parameters

The PCR allows for the results for several inventory flows related to construction products to be reported as “other parameters”. These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted considering this limitation.

3.12 Type of critical review

This LCA report has been critically reviewed by an external LCA expert not involved with the execution of this study, in conformance with ISO 14044, following ISO 14071.

4 Life Cycle Inventory

4.1 Data Requirements

The life cycle inventory (LCI) of each unit process comprises those material and energy inputs, emissions, wastes, and product outputs associated with the operation. Environmental flows from the LCI modeling are used to calculate environmental impacts in the Life Cycle Impact Assessment (LCIA) phase, discussed in Section 5. According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. In the present study, except as noted, all known materials and processes were included in the life cycle inventory.

This study included several key data requirements:

- Functional description of the products, using the requirements of the PCR;
- Material composition of the products and packaging;
- Primary data for Fiberon's manufacturing operations, including energy use and waste generation;
- Primary data for Fiberon's recycling operations, including energy use and waste generation;
- Representative inventory data for many unit processes, using secondary data from the Ecoinvent[7] life cycle databases, with a prioritization for data with the highest degree of representativeness of the actual material or process; and
- Transportation data for material suppliers.

4.2 Primary data

Primary data for the material composition of the products, manufacturing electricity use and waste generation were provided by the manufacturer via completed Data Request Forms (DRFs). Primary data, including electricity and resource use, were also provided for Fiberon's recycling operations at the New London facility. The primary data used to model the product systems considered in the assessment are described below.

Product Composition

The product system studied in this LCA includes the cradle-to-gate impacts of the Fiberon composite decking system products described above and shown in Figure 2. The products are virgin and recycled polyethylene, PVC, recycled wood and various additives and pigments.

Table summarizes the component by weight and material for the products and product packaging data. Also presented are the material components as a percent of total mass.

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[7] Ecoinvent v3.7 2020. Swiss Center for Life Cycle Inventories, 2020 http://www.ecoinvent.org

Table 5. Material component summary for the Fiberon products by mass in kg/m^2 and as a percentage of total mass.

Material	Concordia (Symmetry & Horizon)	Sanctuary	Armor Guard /Veranda	Good Life	Perspective	Paramount PVC
Product						
Polyethylene	7.73	7.31	7.32	6.92	7.03	0.00
	34%	32%	34%	33%	31%	0%
PVC	2.39	2.44	2.12	2.21	2.74	14.6
	11%	11%	9.9%	11%	12%	94%
Wood	11.8	11.8	11.3	10.7	11.7	0.00
	52%	53%	53%	52%	51%	0%
Other	0.751	0.953	0.740	0.871	1.31	0.887
	3.3%	4.2%	3.4%	4.2%	5.7%	5.7%
Product Total	**22.7**	**22.5**	**21.5**	**20.7**	**22.8**	**15.5**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**
Packaging						
Plastic	$6.09x10^{-2}$	$6.09x10^{-2}$	$6.09x10^{-2}$	$6.09x10^{-2}$	$6.09x10^{-2}$	$6.09x10^{-2}$
	10%	10%	10%	10%	10%	10%
Corrugated	0.543	0.543	0.543	0.543	0.543	0.543
	90%	90%	90%	90%	90%	90%
Packaging Total	**0.604**	**0.604**	**0.604**	**0.604**	**0.604**	**0.604**
	100%	**100%**	**100%**	**100%**	**100%**	**100%**

In conformance with the PCR, product materials were reviewed for the presence of any toxic or hazardous chemicals. Based on a review of the product components provided by the manufacturer, no regulated chemicals were identified in the product or product components.

Manufacturing

The products are manufactured at the Fiberon facilities in New London, NC and Meridian, ID. The manufacturer provided primary data for their annual production, resource use and elecricity consumption and waste generation at the facilities. Electricity consumption is modeled using Ecoinvent datasets for the SRVC (New London) and NWPP (Meridian) eGRID[8] electricity grid mixes.

Transportation

Transportation for the LCA model is based on data for transport from the component manufacturer (1st tier supplier) to the Fiberon manufacturing facilities for fabrication. Transportation data for 2nd tier suppliers (material supplier to component manufacturer) are based on data embedded in the representative LCI datasets. Based on distances and transport modes from multiple suppliers, weighted transport distances, in ton-km, for upstream raw materials are estimated for modeling the product system.

[8] Emissions & Generation Resource Integrated Database (eGRID). https://www.epa.gov/egrid

Product End-of-Life

No specific data are available regarding the recycling rate of materials in the product at end-of-life. Although some component materials of the product are recyclable, the form of the final product makes separation and recovery of these materials impractical. Therefore, the products are assumed to be landfilled or incinerated at end-of-life. Based on regional statistics for municipal solid waste disposal[9], 80% of the product materials are assumed landfilled and 20% incinerated

Transportation for end-of-life scenarios was modeled using the EPA WARM model[10] assumption of 20 miles (~32 km), from the point of product use to a landfill, material recovery center, or waste incinerator. Ecoinvent datasets are used to model the impacts associated with incineration and landfilling, which does not include energy recovery from landfill gas. The end-of-life disposal scenario parameters are summarized in Table 6.

Table 6. End-of-life disposal scenario parameters for the Fiberon products.

Parameter		Concordia (Symmetry & Horizon)	Sanctuary	ArmorGuard/ Veranda/Protect	Good Life	Perspective	Paramount PVC
Assumptions for scenario development		80% Landfill 20% Incineration	80% Landfill 20% Incineration	80% Landfill 20% Incineration	80% Landfill 20% Incineration	80% Landfill 20% Incineration	80% Landfill 20% Incineration
Collection process							
	Collected with mixed construction waste (kg)	22.7	22.5	21.5	20.7	22.8	15.5
	Recovery	n/a	n/a	n/a	n/a	n/a	n/a
Disposal	Recycled (kg)	0.00	0.00	0.00	0.00	0.00	0.00
	Landfill (kg)	18.2	18.0	17.2	16.5	18.2	12.4
	Incineration (kg)	4.54	4.51	4.30	4.13	4.56	3.10
Removals of biogenic carbon (kg CO_2 eq)[1]		21.7	21.7	20.8	19.6	21.5	0.00

[1]Excludes Packaging

4.3 Secondary data sources

Secondary data are sourced from the Ecoinvent[11] LCI database with a bias towards the most recent and representative data. The specific datasets used for the modeling are summarized below.

4.4 Summary of data sources

Unit processes were developed within the OpenLCA v1.10 LCI model, drawing upon data from multiple sources. Primary data were provided by Fiberon for their manufacturing facilities in addition to supplier

[9] Product Category Rules for Building-Related Products and Services. Part A: Life Cycle Assessment Calculation Rules and Report Requirements. UL Environment. UL 10010. Version 3.2. 2018

[10] "WARM Model Transportation Research - Draft." Memorandum from ICF Consulting to United States Environmental Protection Agency. September 7, 2004. http://epa.gov/epawaste/conserve/tools/warm/SWMGHGreport.html#background

[11] Ecoinvent Centre (2020) Ecoinvent data from v3.7. Swiss Center for Life Cycle Inventories, Dübendorf, 2020 http://www.Ecoinvent.org

locations and transport modes for the product component materials. The principal source of secondary LCI data is the Ecoinvent database. Detailed descriptions of unit processes can be found in the accompanying documentation. The datasets shown in Table 7 are used in the LCA model to represent the manufacture of the composite decking products.

Table 7. LCI datasets and associated databases used to model material production and processing.

Component	Dataset	Data Source	Publication Date
PRODUCT			
Polyethylene			
Recycled PE	Recycled PE	Primary data	2020
HDPE	polyethylene production, high density, granulate | polyethylene, high density, granulate | Cutoff, S/RoW	EI v3.7	2020
Polyvinyl Chloride			
PVC	polyvinylchloride production, bulk polymerisation | polyvinylchloride, bulk polymerised | Cutoff, S/RoW	EI v3.7	2020
Wood			
Recycled Wood Trim/Wood Chips	n/a	n/a	n/a
Other			
Additives & Colorants	Polyethylene grafted with maleic anhydride	EI v3.7	2020
	Ethylene-methacrylic acid copolymer	EI v3.7	2020
	polydimethylsiloxane production | polydimethylsiloxane | Cutoff, S/GLO	EI v3.7	2020
	limestone production, crushed, washed | limestone, crushed, washed | Cutoff, S/RoW	EI v3.7	2020
	zinc oxide production | zinc oxide | Cutoff, S/RoW	EI v3.7	2020
	chemical production, organic | chemical, organic | Cutoff, S/GLO	EI v3.7	2020
PACKAGING			
Cardboard	containerboard production, linerboard, testliner | containerboard, linerboard | Cutoff, S/RoW	EI v3.7	2020
Packaging Film	packaging film production, low density polyethylene | packaging film, low density polyethylene | Cutoff, S/RoW	EI v3.7	2020
TRANSPORT			
Road transport	market for transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, S/RoW	EI v3.7	2020
RESOURCES			
Grid electricity	Electricity, medium voltage, per kWh - NWPP/NWPP	EI v3.7; eGRID	2020; 2018
	Electricity, medium voltage, per kWh - SRVC/SRVC	EI v3.7; eGRID	2020; 2018
Heat – natural gas	market group for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, S/GLO	EI v3.7	2020
Heat – propane	heat production, propane, at industrial furnace >100kW | heat, district or industrial, other than natural gas | Cutoff, S/RoW	EI v3.7	2020

4.5 Data Quality Assessment

The data quality assessment addresses the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 5 years old (typically 2016). All of the data used represented an average of at least one year's worth of data collection, and up to three years in some cases. Manufacturer-supplied data (primary data) are based on annual production for 2019.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Electricity use for product manufacture is modeled using representative data for the US. Surrogate data used in the assessment are representative of global or European operations. Data representative of European operations are considered sufficiently similar to actual processes. Data representing product disposal are based on regional statistics.
Technology Coverage: Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations. Representative fabrication datasets, specific to the type of material, are used to represent the actual processes, as appropriate.
Precision: Measure of the variability of the data values for each data expressed	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results.
Completeness: Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of the decking system products. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used; with a bias towards Ecoinvent v3.7 data where available. Different portions of the product life cycle are equally considered.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners. All assumptions, models, and data sources are documented.
Sources of the Data: Description of all primary and secondary data sources	Energy use data at Fiberon's manufacturing facilities represents an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. For secondary LCI data, Ecoinvent v3.7 LCI data are used.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products and packaging is low. Actual supplier data for upstream operations were not available and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

4.6 Life cycle inventory results

Environmental flows from the LCI modeling are used to calculate environmental impacts in the Life Cycle Impact Assessment (LCIA) phase, discussed in Section 5.

The resource use and emissions from each step of the product life cycle are summed to obtain the life cycle inventory results. Table 8 and Table 9 summarize the results for additional parameters (energy and waste flows) as specified in the PCR. The LCIA and inventory flow results were calculated using the OpenLCA model and summarized for the declared unit from cradle-to-gate and product disposal. Where necessary, the lower heating value is used for energy flow calculations

Life cycle inventory results were reviewed for completeness, consistency and representativeness. Overall, with respect to those impact categories assessed, the inventory was considered consistent and generally representative of the system processes as the same types of data sources are used throughout, primarily from the manufacturer, as well as the Ecoinvent life cycle inventory database. As noted previously, all known processes and materials of the product system are included in the inventory.

Table 8. Resource use for the Fiberon products. Results are shown for per declared unit for each product from cradle-to-gate plus end-of-life. Results reported in MJ are calculated using lower heating values.

Product	Unit	Concordia (Symmetry & Horizon)	Sanctuary	Armor Guard/Veranda	Good Life	Perspective	Paramount PVC
Renewable primary resources used as energy carrier	MJ	34.2	34.2	32.2	31.2	23.0	41.0
Renewable primary resources used as material	MJ	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable primary resources used as energy carrier	MJ	INA	INA	INA	INA	INA	INA
Non-renewable primary resources used as material	MJ	INA	INA	INA	INA	INA	INA
Use of secondary materials	kg	21.3	20.2	19.3	21.5	2.17	21.3
Renewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Non-renewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Net use of fresh water	**m^3**	1.37	1.27	1.26	1.75	4.21	1.37

INA = Indicator not assessed | Neg. = Negligible

Table 9. Waste flows for the Fiberon products. Results are shown for per functional unit for each product from cradle-to-gate plus end-of-life. Results reported in MJ are calculated using lower heating values.

Product	Unit	Concordia (Symmetry & Horizon)	Sanctuary	Armor Guard/Veranda	Good Life	Perspective	Paramount PVC
Hazardous waste disposed	kg	2.72×10^{-4}	2.51×10^{-4}	2.51×10^{-4}	3.05×10^{-4}	6.90×10^{-4}	2.72×10^{-4}
Non-hazardous waste disposed	kg	25.2	23.7	23.0	26.0	20.7	25.2
High-level radioactive waste	kg	2.37×10^{-4}	2.22×10^{-4}	2.15×10^{-4}	3.38×10^{-4}	3.09×10^{-4}	2.37×10^{-4}
Intermediate/low-level radioactive waste	kg	1.61×10^{-3}	1.47×10^{-3}	1.45×10^{-3}	2.20×10^{-3}	1.95×10^{-3}	1.61×10^{-3}
Components for reuse	kg	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling	kg	0.00	0.00	0.00	0.00	0.00	0.00
Materials for energy recovery	kg	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Recovered/Exported excess energy	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

Neg. = Negligible

5 Life Cycle Impact Assessment

5.1 General approach

LCIA Methodology

From the LCI data, impact assessment results are calculated. The choice of methods and indicators used in the assessment are based on the requirements of the PCR. It should be noted that the LCIA results presented below are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Furthermore, the environmental relevance of LCIA results are not affected by LCI functional unit calculation, system wide averaging, aggregation and allocation.

Indicator calculations

Impact category indicators are estimated using the TRACI 2.1 characterization method, as described above (Section 3.10). TRACI 2.1 is a midpoint oriented LCIA methodology which takes the life cycle inventory data and estimates potential environmental impacts.

It should be noted that the indicators prescribed by the PCR do not represent all categories of potential environmental and human health impact associated with the life cycle of the flooring products, and this represents a general limitation of the LCA study. Additionally, these indicators have no “environmental relevance,” as defined in the ISO-14044 §4.4.2.2.2, 4.4.2.2.4, and 4.4.5, with the exception of the “Potential for Global Warming” indicator, which has low environmental relevance. That is, these “potential” results may or may not have any relationship to actual impacts occurring.

5.2 LCIA results

Category impact indicators are summarized for the Fiberon products in Table 10. Results are presented per declared unit from cradle-to-gate and end-of-life.

Table 10. Life Cycle Impact Assessment results for the Fiberon products. Results are shown per declared unit from cradle-to-gate plus end-of-life.

Product	Unit	Concordia (Symmetry & Horizon)	Sanctuary	Armor Guard/Veranda	Good Life	Perspective	Paramount PVC
Global warming	kg CO_2 eq	27.8	27.2	25.9	25.5	28.5	54.7
Ozone depletion	kg CFC-11 eq	4.66×10^{-3}	4.68×10^{-3}	4.47×10^{-3}	4.31×10^{-3}	4.90×10^{-3}	2.03×10^{-5}
Acidification	kg SO_2 eq	9.82×10^{-2}	9.78×10^{-2}	9.09×10^{-2}	9.06×10^{-2}	0.104	0.201
Eutrophication	kg N eq	0.237	0.235	0.222	0.216	0.238	0.231
Smog	kg O_3 eq	1.45	1.43	1.35	1.33	1.48	2.71
Fossil fuel depletion	MJ eq.	39.3	36.2	36.2	36.1	37.7	125

5.3 Impact Indicator Variability

The variability of indicator results was evaluated to determine whether any of the composite decking system products assessed for the EPD could be averaged and reported as a single representative set of results for the product group. Based on the requirements of the PCR, variability of indicator results across the products considered must not exceed +/-10%. An evaluation of the assessment results reveals a single product grouping satisfying the variability criteria can be defined. In particular, all products, with the exception of the Paramount PVC decking, are considered for averaging.

Table 11 presents the average indicator results for the polyethylene decking products, as well as the percent difference from the corresponding average. As shown, the results within each product line considered satisfy the 10% variability requirement of the PCR and can therefore be included as a single set of results in the EPD.

Table 11. TRACI Life Cycle Impact Assessment Results for the Fiberon PE decking system products. Percent difference from average shown for each product model.

Impact Category	Average	Concordia (Symmetry & Horizon)	Sanctuary	Armor Guard/Veranda	Good Life	Perspective
Global warming	27.0	3%	1%	-4%	-5%	6%
Ozone depletion	4.60×10^{-3}	1%	2%	-3%	-6%	6%
Acidification	9.64×10^{-2}	2%	1%	-6%	-6%	8%
Eutrophication	0.229	3%	2%	-3%	-6%	4%
Smog	1.41	3%	1%	-4%	-5%	5%
Fossil fuel depletion	37.1	6%	-2%	-2%	-3%	2%

5.4 LCIA analysis

Contribution analysis

Life cycle modeling of the composite decking system products was divided into distinct life cycle phases, including raw material extraction and processing, product manufacturing, including packaging, and product disposal. A detailed examination of the potential environmental impacts provides some insight into the relative contributions from each of the product's life cycle phases.

The following life cycle phases were included in the contribution analysis:

- *Raw Materials and Processing (Sourcing/Extraction) stage (A1)* – This stage includes extraction of virgin materials and reclamation of non-virgin feedstock. This includes the extraction of all raw materials, including the transport to the manufacturing site. Resource use and emissions associated with both extraction of the raw materials and raw material processing are included.
- *Transport stage (A2)* –The impacts associated with the transport of the processed raw materials to the manufacturing facility are included in this stage.
- *Manufacturing stage (A3)* **–** This stage includes all the relevant manufacturing processes and flows, including the impacts from energy use and emissions at the manufacturing facility. Production of capital goods, infrastructure, manufacturing equipment, and personnel-related activities are not included. This stage also includes the production of the product packaging materials.
- *Disposal stage (C1 - C4)* **–** The end of life stage includes demolition of the products (*C*1), transport of the products to waste treatment facilities (*C2*), waste processing (*C3*) and associated emissions as the product degrades in a landfill or is burned in an incinerator (*C4*). For the products, no emissions are generated during demolition while no waste processing is required for incineration or landfill disposal. Results for these stages (*C1 & C3*) are reported as zero for the product system.

The life cycle stages included in the system boundary for the Fiberon products are summarized below.

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
x	x	x	MND	MND	MND	MND	MND	MND	MND	MND	MND	x	x	x	x	MND

X = Included in system boundary
MND = Module not declared

Category indicator results for the composite decking system products are summarized by life cycle phase in Table 12 through Table 15. Results are presented as an average across all products within each product line satisfying the variability criteria, as discussed in Section 5.3, above.

Impact indicators are displayed graphically by life cycle phase in Figure 3 for the product system from cradle-to-gate plus end-of-life.

With the exception of the Eutrophication Potential indicator, which is dominated by the disposal phase, the contributions to total impact indicators are dominated by the raw material extraction and processing phase. The product manufacturing phase is generally the next highest contributor followed by product disposal. Impact contribution from transport phases are generally less than ~5-10% of the total, depending on the specific indicator considered.

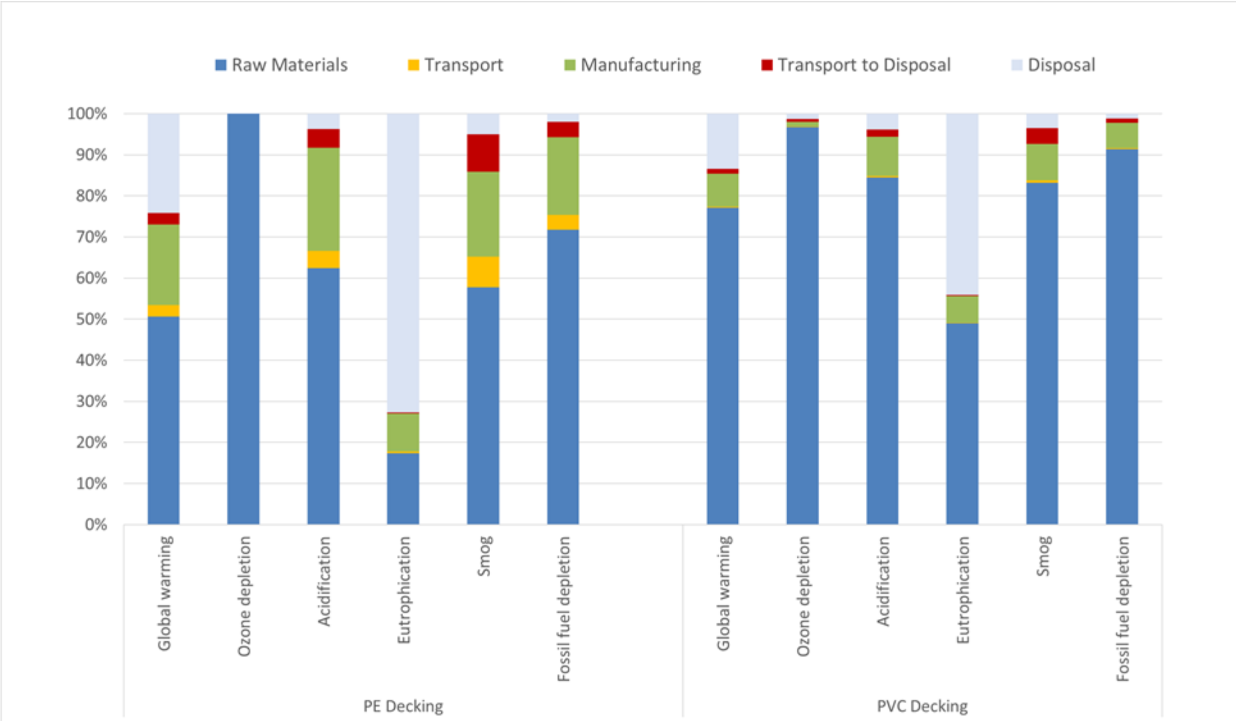

Figure 3. Contribution analysis for the Fiberon products –TRACI 2.1.

Table 12. TRACI Life Cycle Impact Assessment (LCIA) results for the ***PE Composite Decking System*** products. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Impact Category	Unit	Total	Raw Materials	Transport	Manufacturing	Transport to Disposal	Disposal
Global warming	kg CO2 eq	26.8	11.7	0.962	6.07	0.895	7.24
	%	100%	43%	3.6%	23%	3.3%	27%
Acidification	kg SO2 eq	9.55×10^{-2}	5.39×10^{-2}	5.13×10^{-3}	2.79×10^{-2}	5.15×10^{-3}	3.45×10^{-3}
	%	100%	56%	5.4%	29%	5.4%	3.6%
Eutrophication	kg N eq	0.229	3.02×10^{-2}	1.18×10^{-3}	2.20×10^{-2}	6.63×10^{-4}	0.174
	%	100%	13%	0.51%	9.6%	0.29%	76%
Smog	kg O3 eq	1.40	0.715	0.132	0.329	0.146	7.51×10^{-2}
	%	100%	51%	9.5%	24%	10%	5.4%
Ozone depletion	kg CFC-11 eq	4.57×10^{-3}	4.57×10^{-3}	2.17×10^{-7}	3.00×10^{-7}	2.07×10^{-7}	1.02×10^{-7}
	%	100%	100%	0.0047%	0.0066%	0.0045%	0.0022%
Fossil fuel depletion	MJ surplus	37.0	23.1	1.98	9.19	1.85	0.872
	%	100%	62%	5.3%	25%	5%	2.4%

Table 13. Resource use and waste flows for the ***PE Composite Decking System*** products. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits

Parameter	Unit	Total	Raw Materials	Transport	Manufacturing	Transport to Disposal	Disposal
Energy Use							
Use of renewable primary energy	MJ	31.8	12.6	0.189	18.8	$4.59x10^{-2}$	0.240
	%	100%	40%	0.59%	59%	0.14%	0.75%
Use of renewable primary energy resources used as raw materials	MJ	0.00	0.00	1.00	2.00	12.0	14.0
Use of nonrenewable primary energy	MJ	INA	INA	INA	INA	INA	INA
Use of nonrenewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA
Use of secondary materials	kg	20.6	20.6	0.00	0.00	0.00	0.00
	%	100%	100%	0%	0%	0%	0%
Renewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Nonrenewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Use of net fresh water	m3	1.37	0.757	$1.11x10^{-2}$	0.537	$3.94x10^{-3}$	$6.05x10^{-2}$
	-	100%	55%	0.81%	39%	0.29%	4.4%
Waste Flows							
Nonhazardous waste disposed	kg	24.5	4.88	0.604	0.958	$5.82x10^{-2}$	18.0
	%	100%	20%	2.5%	3.9%	0.24%	73%
Hazardous waste disposed	kg	$2.66x10^{-4}$	$1.12x10^{-4}$	$3.82x10^{-5}$	$6.66x10^{-5}$	$3.33x10^{-5}$	$1.51x10^{-5}$
	%	100%	42%	14%	25%	13%	5.7%
High-level radioactive waste	kg	$2.40x10^{-4}$	$1.31x10^{-4}$	$8.76x10^{-7}$	$1.07x10^{-4}$	$2.03x10^{-7}$	$1.00x10^{-6}$
	%	100%	55%	0.36%	45%	0.084%	0.42%
Intermediate and low-level radioactive waste	kg	$1.60x10^{-3}$	$8.10x10^{-4}$	$9.15x10^{-5}$	$5.78x10^{-4}$	$8.71x10^{-5}$	$3.44x10^{-5}$
	%	100%	51%	5.7%	36%	5.4%	2.1%
Use of secondary materials	kg	20.6	20.6	0.00	0.00	0.00	0.00
	%	100%	100%	0%	0%	0%	0%
Materials for recycling	kg	0.00	0.00	0.00	0.00	0.00	0.00
Components for re-use	kg	0.00	0.00	1.00	2.00	12.0	14.0
Materials for energy recovery	kg	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Exported energy	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

Table 14. TRACI Life Cycle Impact Assessment (LCIA) results for the ***PVC Composite Decking System*** products. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Impact Category	Unit	Total	Raw Materials	Transport	Manufacturing	Transport to Disposal	Disposal
Global warming	kg CO2 eq	54.7	42.2	0.141	4.41	0.632	7.33
	%	100%	77%	0.26%	8.1%	1.2%	13%
Acidification	kg SO2 eq	0.201	0.169	6.38×10^{-4}	1.92×10^{-2}	3.64×10^{-3}	7.70×10^{-3}
	%	100%	84%	0.32%	9.6%	1.8%	3.8%
Eutrophication	kg N eq	0.231	0.113	1.56×10^{-4}	1.52×10^{-2}	4.68×10^{-4}	0.102
	%	100%	49%	0.068%	6.6%	0.2%	44%
Smog	kg O3 eq	2.71	2.26	1.54×10^{-2}	0.242	0.103	9.58×10^{-2}
	%	100%	83%	0.57%	8.9%	3.8%	3.5%
Ozone depletion	kg CFC-11 eq	2.03×10^{-5}	1.96×10^{-5}	3.27×10^{-8}	2.31×10^{-7}	1.47×10^{-7}	2.62×10^{-7}
	%	100%	97%	0.16%	1.1%	0.72%	1.3%
Fossil fuel depletion	MJ surplus	125	114	0.298	7.63	1.30	1.50
	%	100%	91%	0.24%	6.1%	1%	1.2%

Table 15. Resource use and waste flows for the ***PVC Composite Decking System*** products. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits

Parameter	Unit	Total	Raw Materials	Transport	Manufacturing	Transport to Disposal	Disposal
Energy Use							
Use of renewable primary energy	MJ	41.0	34.4	$2.35x10^{-2}$	5.61	$3.24x10^{-2}$	0.951
	%	100%	84%	0.057%	14%	0.079%	2.3%
Use of renewable primary energy resources used as raw materials	MJ	0.00	0.00	1.00	2.00	12.0	14.0
Use of nonrenewable primary energy	MJ	INA	INA	INA	INA	INA	INA
Use of nonrenewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA	INA
Use of secondary materials	kg	2.17	2.17	0.00	0.00	0.00	0.00
	%	100%	100%	0%	0%	0%	0%
Renewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Nonrenewable secondary fuel use	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Use of net fresh water	m3	4.21	3.37	$1.48x10^{-3}$	0.508	$2.78x10^{-3}$	0.329
	-	100%	80%	0.035%	12%	0.066%	7.8%
Waste Flows							
Nonhazardous waste disposed	kg	20.7	5.74	$9.99x10^{-2}$	0.615	$4.11x10^{-2}$	14.2
	%	100%	28%	0.48%	3%	0.2%	69%
Hazardous waste disposed	kg	$6.90x10^{-4}$	$5.85x10^{-4}$	$5.54x10^{-6}$	$5.33x10^{-5}$	$2.35x10^{-5}$	$2.30x10^{-5}$
	%	100%	85%	0.8%	7.7%	3.4%	3.3%
High-level radioactive waste	kg	$3.09x10^{-4}$	$1.77x10^{-4}$	$1.10x10^{-7}$	$1.28x10^{-4}$	$1.43x10^{-7}$	$3.48x10^{-6}$
	%	100%	57%	0.036%	42%	0.046%	1.1%
Intermediate and low-level radioactive waste	kg	$1.95x10^{-3}$	$1.13x10^{-3}$	$1.38x10^{-5}$	$6.81x10^{-4}$	$6.16x10^{-5}$	$6.43x10^{-5}$
	%	100%	58%	0.71%	35%	3.2%	3.3%
Use of secondary materials	kg	2.17	2.17	0.00	0.00	0.00	0.00
	%	100%	100%	0%	0%	0%	0%
Materials for recycling	kg	0.00	0.00	0.00	0.00	0.00	0.00
Components for re-use	kg	0.00	0.00	1.00	2.00	12.0	14.0
Materials for energy recovery	kg	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Exported energy	MJ	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.

INA = Indicator not assessed | Neg. = Negligible

Sensitivity analysis

Sensitivity analyses were conducted to evaluate the impact of various modeling assumptions on indicator results. The sensitivity analysis conducted as part of the study is described below. All sensitivity results are presented per declared unit over the cradle-to-gate plus product disposal.

As noted above, energy and resource use for the decking system products was allocated on a mass basis using annual production data for the manufacturing facilities. To evaluate the effect of the allocation used on the estimated impact indicators, the product systems were modeled with a cost-based resource allocation approach using annual sales data and sales price per product.

The results of the sensitivity modeling are presented for the Fiberon products in Table 16 below. Results are shown for the products modeled using cost-based allocation, as well as the percent change from the reference product system. Decreases ranging from minimal (<~8%) to ~25% in the indicator results are obtained, depending on the specific product and impact indicator.

Table 16. Life Cycle Impact Assessment results for cost-based allocation for the composite decking system products. Results are shown per declared unit. Percent change from reference product system is also shown.

Impact Category	Unit	PE Decking	Paramount PVC
Global warming	kg CO2 eq	21.7 (-19.6%)	51.1 (-6.6%)
Acidification	kg SO2 eq	4.60×10^{-3} (0.0%)	2.01×10^{-5} (-0.9%)
Eutrophication	kg N eq	7.16×10^{-2} (-25.7%)	0.185 (-8.0%)
Smog	kg O3 eq	0.211 (-8.0%)	0.220 (-5.0%)
Ozone depletion	kg CFC-11 eq	1.12 (-20.6%)	2.51 (-7.4%)
Fossil fuel depletion	MJ surplus	29.4 (-20.8%)	119 (-4.7%)

End-of-Life Scenarios

As discussed in Section 2.14 above, product disposal at end-of-life included both landfilling and incineration of materials. As per ISO 21930 requirements, impact indicator results are estimated and reported separately for alternative end-of-life scenarios for 100% of each assumed disposal route. The results for the Fiberon products are presented in Table 17 for each disposal scenario and product line.

Table 17. Life Cycle Impact Assessment Results for the Fiberon products by disposal scenario. Results are shown per declared unit.

Impact Category	Unit	PE Decking			PVC Decking		
		100% Recycling	100% Landfill	100% Incineration	100% Recycling	100% Landfill	100% Incineration
Global Warming	kg CO_2 eq	19.7	21.7	48.0	47.3	48.4	79.8
Ozone Depletion	kg CFC11 eq	4.60×10^{-3}	4.60×10^{-3}	4.60×10^{-3}	2.00×10^{-5}	2.01×10^{-5}	2.11×10^{-5}
Acidification	kg SO_2 eq	9.29×10^{-2}	9.51×10^{-2}	0.101	0.193	0.197	0.217
Eutrophication	kg N eq	5.47×10^{-2}	0.270	6.61×10^{-2}	0.129	0.252	0.148
Smog	kg O_3 eq	1.33	1.37	1.53	2.62	2.65	2.97
Fossil fuel depletion	MJ surplus	36.2	37.0	37.6	123	124	129

6 Interpretation

6.1 Preliminary interpretation

Life cycle stage contribution

Results were summarized by life cycle phase for a cradle-to-gate plus end-of-life assessment of the Fiberon Composite Decking System products. The contributions to total impact indicator results are dominated by the raw material extraction and processing stage followed by product manufacturing.

6.2 Evaluation

Completeness check

Life cycle inventory results were reviewed for completeness, consistency and representativeness. Overall, the inventory was considered consistent and generally representative of the product system, with respect to the impact categories assessed. The primary source of data used during the assessment was from the manufacturer, with the remaining derived from the Ecoinvent life cycle inventory database.

Sensitivity check

A sensitivity analysis was conducted to investigate the impacts on estimated indicator results due to assumptions regarding the allocation methodology used in the assessment. The results indicate moderate impact reductions are estimated for the product system when cost-based resource allocation is applied.

6.3 Conclusions, limitations and recommendations

General conclusions

A Life Cycle Impact Assessment of the Fiberon Composite Decking System products was conducted to support the development of an Environmental Product Declaration (EPD) conformant to ISO 14044, ISO 14025 and ISO 21930 (the PCR). Results are reported using the indicators prescribed by the PCR based on the TRACI 2.1 characterization methodology. Impact category indicator results for the product systems considered are presented in Section 5.

Impact category indicator results are summarized by life cycle phase including raw material extraction and processing; transport to manufacturer; product manufacturing, including packaging; and product disposal. Results were evaluated using sensitivity and process contribution analyses.

Excluding product replacements, the contributions to indicator results are dominated by the raw material extraction and processing and product manufacturing phases followed by product disposal. Incorporation of primary data for upstream material components and processing is recommended to improve the overall quality of the assessment.

Limitations

The assessment relied on a number of assumptions and limitations, the most relevant of which are discussed in this report. Most of the upstream raw materials extraction and processing could not be modeled with actual process information. Representative data from Ecoinvent life cycle inventory databases were utilized as appropriate. These datasets were modified to represent the Fiberon product system, where necessary.

It is noted that the LCIA results presented in this report are relative expressions and do not predict impacts on category endpoints, exceedance of thresholds, safety margins, or risks associated with the product system. Impact indicators rely on the use of generic models and potential impacts, and therefore are not able to measure actual environmental impacts. Additionally, the indicators prescribed by the PCR do not represent all categories of potential environmental and human health impacts associated with the life cycle of the assessed products, and this represents a general limitation of the LCA study.

Recommendations

The contribution analysis suggests improvements in the assessment may be realized through collection and incorporation of primary data for the extraction and processing of product components.

APPENDIX 1: ISO 14044 Critical Review Report

Industrial Ecology Consultants

July 6, 2021

Keith Killpack
Manager, LCA Services | SCS Global Services
2000 Powell St., Ste. 600 | Emeryville, CA 94608

Critical Review and Verification Report: Fiberon Composite Decking Systems.

The LCA Practitioner, SCS Global Services, commissioned Industrial Ecology Consultants to perform an external independent critical review and verification of **Composite Decking Systems, July 2, 2021.** SCS Global Services completed the Life Cycle Assessment (LCA) study and respective Environment Product Declaration (EPD) on behalf of the commissioning organization, **Fiber Composites LLC (Fiberon).**

The review of the study and EPD were performed to demonstrate conformance with the following standards, general program instructions, and product category rules:

- International Organization for Standardization. (2000). *Environmental labels and declarations -- General principles* (ISO 14020:2000).
- International Organization for Standardization. (2006). *Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures* (ISO 14025:2006).
- International Organization for Standardization. (2020). *Environmental management -- Life cycle assessment – Principles and framework* (ISO 14040:2006/Amd 1:2020).
- International Organization for Standardization. (2020). *Environmental management -- Life cycle assessment -- Requirements and guidelines* (ISO 14044:2006/Amd 2:2020).
- International Organization for Standardization. (2014). *Environmental management -- Life cycle assessment -- Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006*. (ISO/TS 14071:2014).
- SCS Global Services. (2021). *Program Operator Manual: Type III Environmental Declaration Program.* Version 10-1, revised May 2021.
- International Organization for Standardization. (2017). Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services. (ISO 21930:2017).

The independent third-party critical review and verification was conducted by an external expert per ISO 14044:2006 Section 6.2: Critical review by internal or external expert:

Thomas P. Gloria, Ph.D.
Founder, Chief Sustainability Engineer
Industrial Ecology Consultants

Industrial Ecology Consultants

REVIEW SCOPE

The intent of this review and verification was to provide an external independent third-party critical review of a completed LCA study project report and verification of the respective EPD. The EPD generated from this LCA study was the following:

Fiberon: Composite Decking Systems:

- Concordia (Symmetry & Horizon)
- Sanctuary
- ArmorGuard/Veranda
- Good Life
- Perspective
- Paramount PVC

REVIEW PROCESS

The review and verification involved developing review matrices based on the requirements set forth by the applicable ISO standards and SCS Global Services General Program Instructions (GPIs) as outlined in their Program Operator Manual. The LCA report review and EPD verification covered requirements specified by the PCR, GPIs, and applicable ISO standards.

The LCA study report was reviewed and deemed by this ***independent*** and ***external*** reviewer to conform to the applicable ISO standards, PCRs, and General Program Instructions. This review did not include an assessment of the Life Cycle Inventory (LCI) model, however, it did include a detailed analysis of the individual datasets used to complete the study.

CRITICAL REVIEW & VERIFICATION STATEMENT

Based on the independent verification objectives, the **Life Cycle Assessment of Composite Decking Systems by SCS Global Services on behalf of Fiberon, July 2, 2021,** and the respective EPD, **Composite Decking Systems** were reviewed and verified to be ***in conformance*** with the applicable ISO standards referenced above and SCS Global Services General Program Instructions. The plausibility, quality, and accuracy of the LCA-based data and supporting information are confirmed.

As the External Independent Third-Party Reviewer, I confirm that I have sufficient knowledge and experience of wood, polyethylene, PVC, and decking products, the relevant PCR, ISO standards and the geographical areas intended to generate EPDs to carry out this critical review and verification.

Sincerely,

Thomas P. Gloria, Ph.D.
Founder, Chief Sustainability Engineer
Industrial Ecology Consultants

Critical Review of *Life Cycle Assessment of Composite Decking Systems* According to ISO 14044 & ISO 21930:2017

Prepared for:
Fiberon

Date Completed:
7/2/21

Prepared by:
Thomas Gloria | Life Cycle Practitioner – LCACP-2008-03
Industrial Ecology Consultants
+1.617.553-4929
t.gloria@industrial-ecology.com

SCSglobal SERVICES
Setting the standard for sustainability™
2000 Powell Street, Ste. 600, Emeryville, CA 94608 USA
+1.510.452.8000 main | +1.510.452.8001 fax
www.SCSglobalServices.com

1.0 Introduction

This report contains a summary of the critical review, according to the ISO 14044[1] international standard, of the report titled *Life Cycle Assessment of **Composite Decking Systems***. This report is heretofore referred to as the LCA Report.

The critical review was conducted by an independent life cycle practitioner with no involvement with the execution of the LCA. The critical review assessed the LCA Report for conformance to the ISO 14044:2006 standard. As the intent of the study is to support the development of Environmental Product Declarations (EPDs), the LCA Report was also reviewed for conformance to any additional requirements of the applicable PCR and ISO 21930:2017, as appropriate. This critical review is considered an 'external critical review' under ISO 14044 in conformance with ISO 14071[2].

2.0 Summary of Critical Review by LCA Phase

The original review has found: *4 OFI Editorial* findings. The final review has found: *No outstanding* findings. The following sections summarize the critical review findings by life cycle stage. The checklist used for the critical review is included as an Appendix.

Note that in some instances, a non-conformance finding may apply across multiple LCA study phases while a single issue, or omission, in the LCA Report may result in multiple NCRs.

[1] ISO 14044:2006/Amd 2:2020 Environmental management – Life Cycle Assessment – Requirements and guidelines

[2] ISO/TS 14071:2014 Environmental management — Life cycle assessment — Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006

Appendix: Critical Review Checklist

ISO 14044/ISO 21930 Critical Review Checklist				
Report Title:	Life Cycle Assessment of ***Composite Decking Systems, June 9 2021***		**Finding Type**	**Acronym**
Date LCA Report Received:	June 10, 2021		Verified (Conforms with requirement)	V
Report Author:	Dr. Gerard Mansell, Life Cycle Services, SCS Global Services	**Original (6/9/21)**	149	
		Final (7/2/21)	153	
Reviewer Name:	Thomas Gloria		Opportunity for improvement	OFI
Reviewer Organization:	Industrial Ecology Consultants	**Original (6/9/21)**	4	
		Final (7/2/21)	0	
Date of Review Completed:	7/2/21		Non-conformity with requirement	NCR
Internal Expert?	N/A	**Original (6/9/21)**	0	
		Final (7/2/21)	0	
External Expert?	YES	**SHALL** CLAUSE	PRACTITIONER COMMENT	V COMMENT
Review Panel?	NO	**SHOULD** CLAUSE		NCR/OFI COMMENT

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	4: Methodological Framework for LCA			
4.1 General requirements	**General Requirements**			
	→LCA studies **shall** include the goal and scope definition, inventory analysis, impact assessment and interpretation of results.	V		Requirement met.
	→The requirements and recommendations of this International Standard, with the exception of those provisions regarding impact assessment, also apply to life cycle inventory studies.	V		Requirement met.
	→An LCI study alone **shall** not be used for comparisons intended to be used in comparative assertions intended to be disclosed to the public.	V		Requirement met.
	4.2 Goal and Scope Definition			
4.2.2 Goal of the study	In defining the goal of an LCA, the following items **shall** be unambiguously stated:			
	The intended application	V		Requirement met.
	The reasons for carrying out the study.	V		Requirement met.
	The intended audience.	V		Requirement met.
	Whether the results are intended to be used in comparative assertions intended to be disclosed to the public.	**N/A**		
4.2.3 Scope of the study	**In defining the scope of an LCA, the following items shall be considered and described clearly:**			
	The product system to be studied.	V		Requirement met.
	The functions of the product systems, or in the case of comparative studies, the systems.	V		Requirement met.
	4.2.3.2 The functional unit.			

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	→The scope of an LCA **shall** clearly specify the functions (performance characteristics) of the system being studied.	V		Requirement met.
	→The functional unit **shall** be clearly defined, measurable and consistent with the goal and scope of the study	V		Requirement met.
	→The reference flow **shall** be defined.	V		Requirement met.
	→Comparisons between systems **shall** be made on the basis of the same function(s), quantified by the same functional unit (s) in the form of their reference flows.	V		Requirement met.
	→If additional functions of any of the systems are not taken into account in the comparison of functional unit these omissions **shall** be explained and documented.	V		Requirement met.
	4.2.3.3 The system boundary.			
	→The selection of the system boundary **shall** be consistent with the goal of the study.	V		Requirement met.
	→The criteria used in establishing the system boundary **shall** be identified and explained.	V		Requirement met.
	→Decisions **shall** be made regarding which unit processes to include in the study, and the level of detail to which these unit processes **shall** be studied. Reasons and implications of omitting life cycle stages, processes, inputs or outputs must be clearly stated and explained.	V		Requirement met.
	→The deletion of life cycle stages, processes, inputs, or outputs is permitted only if it does not significantly change the overall conclusions of the study	V		Requirement met.
	→ Each of the unit processes **should** initially describe:			
	(i) Where the unit process begins, in terms of the receipt of raw materials or intermediate products	V		Requirement met.
	(ii) The nature of the transformations and operations that occur as part of the unit process	V		Requirement met.
	(iii) Where the unit process ends, in terms of the destination of the intermediate or final products.	V		Requirement met.
	→The cut-off criteria for initial inclusion of inputs and outputs, the assumptions on which the cut-off criteria are established and its effects on the outcome of the study **shall** be clearly described and assessed.	V		Requirement met.
	Allocation procedures.	V		Requirement met.
	4.2.3.4 LCIA methodology and types of impacts.			
	→The selection of impact categories, category indicators, and characterization models used in the LCIA methodology **shall** be consistent with the goal and scope of the study and considered as described in 4.4.2.2.	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	→An LCIA **shall** be performed using the same methodologies for studies intended to be used in comparative assertions intended to be disclosed to the public. Any differences between these systems regarding these parameters **shall** be identified and reported.	V		Requirement met.
	Interpretation to be used.	V		Requirement met.
	Data requirements.	V		Requirement met.
	Assumptions.	V		Requirement met.
	Value choices and optional elements.	V		Requirement met.
	Limitations.	V		Requirement met.
4.2.3 Scope of the study	**4.2.3.6 Data quality requirements shall be specified to enable the goal and scope of the LCA to be met. It should address the following requirements:**			
	→Time-related coverage, geographical coverage, technology coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, uncertainty of information.	V		Requirement met.
	Comparative assertions intended to be disclosed to the public must address the above requirements.	V		Requirement met.
	→Data quality **should** be characterized by both quantitative and qualitative aspects as well as by methods used to collect and integrate those data	V		Requirement met.
	→Data from specific sites or representative averages **should** be used for those unit processes that contribute the majority of the mass and energy flows in the systems and are considered to have environmentally relevant inputs and outputs.	V		Requirement met.
	→The treatment of missing data shall be documented for each unit process and missing location.			
	(i) A "non-zero" data value that is explained	V		Requirement met.
	(ii) A "zero" data value that is explained	V		Requirement met.
	(iii) A calculated value based on the reported values from unit processes employing a similar technology	V		Requirement met.
	4.2.3.8 Critical review considerations in the scope of the study:			
	(i) Whether a critical review is necessary and how to conduct it.	V		Requirement met.
	(ii) Type of critical review.	V		Requirement met.
	(iii) Who would conduct the review and the level of their expertise. If the study is intended to be used for a comparative assertion intended to be disclosed to the public, interested parties **shall** conduct this evaluation as a critical review.	V		Requirement met.
	Type and format of the report required for the study.	V		Requirement met.
	4.3 Life Cycle Inventory Analysis (LCI)			
Life Cycle Inventory analysis:	**4.3.2.1 Data Collection**			
	→The qualitative and quantitative data for inclusion in the inventory **shall** be collected for each unit process that is included in the system boundary.	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
4.3.2 Collecting Data	→When data have been collected from public sources, the source **shall** be referenced. For those data that may be significant for the conclusions of the study, details about the relevant data collection process, the time when data have been collected, and further information about data quality indicators **shall** be referenced.	V		Requirement met.
	4.3.2.2 Measures taken to reach uniform and consistent understanding of the product systems should include:			
	→Drawing unspecific process flow diagrams that outline all the unit processes to be modelled, including their interrelationships;	V		Requirement met.
	→Describing each unit process in detail with respect to factors influencing inputs and outputs;	V		Requirement met.
	→Listing of flows and relevant data for operating conditions associated with each unit process;	V		Requirement met.
	→Developing a list that specifies the units used;	V		Requirement met.
	→Describing the data collection and calculation techniques needed for all unit processes to be modelled	V		Requirement met.
	→Providing instructions to document clearly any special cases, irregularities or other items associated with the data provided.	V		Requirement met.
Life Cycle Inventory analysis: Calculating Data 4.3.3	**4.3.3.1 Data Calculation**			
	→All calculation procedures **shall** be explicitly documented and all assumptions made **shall** be clearly stated and explained.	V		Requirement met.
	→The same calculation procedures **should** be consistently applied throughout the study.	V		Requirement met.
	→When determining elementary flows associated with production, the actual production mix **should** be used whenever possible.	V		Requirement met.
	→Inputs and outputs related to a combustible material (e.g. oil, gas, or coal) can be transformed into an energy input or output by multiplying them by the relevant heat of combustion.	V		Requirement met.
	4.3.3.2 Validation of data			
	A check on data validity **shall** be conducted during the process of data collection to confirm and provide evidence that the data quality requirements for the intended application have been fulfilled.	V		Requirement met.
	4.3.3.3 Relating data to unit process and functional unit			
	→The quantitative input and output data of the unit process **shall** be calculated in relation to this flow.	V		Requirement met.
	→The calculation **should** result in all system input and output data being referenced to the functional unit.	V		Requirement met.
	→The level of aggregation [of inputs and outputs in the product system] **shall** be consistent with the goal of the study.	V		Requirement met.
	→Data **should** only be aggregated if they are related to equivalent substances and to similar environmental impacts.	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	If more detailed aggregation rules are required, they **should** be explained in the goal and scope definition phase of the study or **should** be left to a subsequent impact assessment phase.	V		Requirement met.
	4.3.3.4 Refining the system boundary			
	→Reflecting the iterative nature of LCA, decisions regarding the data to be included **shall** be based on a sensitivity analysis to determine their significance.	V		Requirement met.
	→The initial system boundary **shall** be revised, as appropriate, in accordance with the cut-off criteria established in the definition of the scope. The results of this refining process and the sensitivity analysis **shall** be documented.	V		Requirement met.
Life Cycle Inventory analysis: 4.3.4 Allocation	**4.3.4.1 Allocation, General**			
	→The inputs and outputs **shall** be allocated to the different products according to clearly stated procedures that **shall** be documented and explained together with the allocation procedure.	V		Requirement met.
	→The sum of the allocated inputs and outputs of a unit process **shall** be equal to the inputs and outputs of the unit process before allocation.	V		Requirement met.
	→Whenever several alternative allocation procedures seem applicable, a sensitivity analysis **shall** be conducted to illustrate the consequences of the departure from the selected approach.	V		Requirement met.
	4.3.4.2 Allocation procedure			
	→ The study **shall** identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below:	V		Requirement met.
	Step 1: Wherever possible, allocation **should** be avoided by 1) dividing the unit process into two or more sub-processes and collecting the input and output data related to these sub-processes; 2) expanding the product system to include the additional functions related to the co-products [...] Step 2: Where allocation cannot be avoided, the inputs and outputs of the system **should** be partitioned between its different products or functions in a way that reflects the underlying physical relationship between them. Step 3: 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 (i.e. economic).	V		Requirement met.
	→ Some outputs may be partly co-products and partly waste. In such cases [...] inputs and outputs **shall** be allocated to the co-products part only.	V		Requirement met.
	→Allocation procedures **shall** be uniformly applied to similar inputs and outputs of the system under consideration.	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	→The inventory is based on material balances between input and output. Allocation procedures **should** approximate as much as possible fundamental input/output relationships and characteristics.	V		Requirement met.
	4.3.4.3 Allocation procedures for reuse and recycling			
	→ Changes in the inherent properties of materials **shall** be taken into account. For the recovery processes between the original and subsequent product system, the system boundary **shall** be identified and explained, ensuring that the allocation principles are observed.	V		Requirement met.
	4.4 Life Cycle Impact Assessment (LCIA)			
Life Cycle Impact Assessment 4.4.1. General	The LCIA phase **shall** be coordinated with other phases of the LCA to take into account the following omissions and sources of uncertainty:			
	→Whether the data quality of the LCI data and results is sufficient to conduct the LCIA in accordance with the study goal and scope definition.	V		Requirement met.
	→Whether the system boundary and data cut-off decisions have been sufficiently reviewed to ensure the availability of LCI results necessary to calculate indicator results for the LCIA.	V		Requirement met.
	→Whether the environmental relevance of the LCIA results is decreased due to the LCI functional unit calculation, system wide averaging, aggregation and allocation.	V		Requirement met.
Life Cycle Impact Assessment 4.4.2. Mandatory Elements of LCIA	**4.4.2.2 Selection of impact categories, category indicators, and characterization models.**			
	4.4.2.2.1 The LCIA phase shall include the following mandatory elements:			
	→Whenever impact categories, category indicators, and characterization models are selected in an LCA, the related information and sources **shall** be referenced.	V		Requirement met.
	→Accurate and descriptive names **shall** be provided for the impact categories and category indicators.	V		Requirement met.
	→The selection of impact categories, category indicators, and characterization models **shall** be both justified and consistent with the goal and scope of the LCA. It **shall** reflect a comprehensive set of environmental issues related to the product system being studied.	V		Requirement met.
	→The environmental mechanism and characterization model that relate the LCI results to the category indicator and provide a basis for characterization factors **shall** be described.	V		Requirement met.
	→The appropriateness of the characterization model used for deriving category indicator in the context of the goal and scope of the study **shall** be described.	V		Requirement met.
	→LCI results other than mass and energy flow data included in the LCA (e.g. land use) **shall** be identified and their relationship to corresponding category indicators **shall** be determined.	V		Requirement met.
	4.4.2.2.2 For each impact category, the necessary components of the LCIA include:			

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	→Identification of the category endpoint(s), characterization model, characterization factors and definition of the category indicator for given category endpoint.	V		Requirement met.
	→Identification of the appropriate LCI results that can be assigned to the impact category, taking into account the chosen category indicator and identified category endpoint(s).	V		Requirement met.
	4.4.2.2.3 In addition to the requirements in 4.4.2.2.1, the following recommendations apply to the selection of impact categories, category indicators, and characterization models:			
	→The impact categories, category indicators, and characterization models **should** be internationally accepted	V		Requirement met.
	→The impact categories **should** represent the aggregated impacts of inputs and outputs of the product system on the category endpoint(s) through the category indicators;	V		Requirement met.
	→Value-choices and assumptions made during the selection of impact categories, category indicators and characterization models **should** be minimized;	V		Requirement met.
	→The impact categories, category indicators and characterization models **should** avoid double counting unless required by the goal and scope definition, for example when the study includes both human health and carcinogenicity;	V		Requirement met.
	The characterization model for each category indicator should be:			
	→ Scientifically and technically valid, and based upon a distinct identifiable environmental mechanism and reproducible empirical observation; the extent to which the characterization model and the characterization factors are scientifically valid **should** be identified;	V		Requirement met.
	→Depending on the environmental mechanism and the goal and scope, spatial and temporal differentiation of the characterization model relating the LCI results to the category indicator **should** be considered.	V		Requirement met.
	→The fate and transport of the substances **should** be part of the characterization model.	V		Requirement met.
	4.4.2.2.4 The environmental relevance of the category indicator or characterization model should be clearly stated in the following terms:			
	(a)The ability of the category indicator to reflect the consequences of the LCI results on the category endpoint(s), at least qualitatively;	V		Requirement met.
	(b) The addition of environmental data or information to the characterization model with respect to the category endpoint(s), including: the condition of the category endpoint(s); the relative magnitude of the assessed change in the category endpoint(s); the spatial aspects, such as area and scale; the temporal aspects; the reversibility of the environmental mechanism; and the	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	uncertainty of the linkages between the category indicators and category endpoints.			
	4.4.2.3 Assignment of LCI results to the selected impact categories (classification).			
	→Assignment of LCI results that are exclusive to one impact category;	V		Requirement met.
	→Identification of LCI results that relate to more than one impact category, including distinction between parallel mechanisms and assignment to serial mechanisms.	V		Requirement met.
	4.4.2.4 Calculation of category indicator results (characterization)			
	→The method of calculating indicator results **shall** be identified and documented, including the value-choices and assumptions made.	V		Requirement met.
	No other recommendations or requirements in Section 4.4.2.4.			
	4.4.2.5 Resulting data after characterization			
	No recommendations or requirements in Section 4.4.2.5.			
4.4.3. Optional elements of LCIA	*No requirements in Section 4.4.3.*			
4.4.4. Additional LCIA data quality	*No recommendations or requirements in Section 4.4.4.*			
4.4.5: LCIA intended to be used in comparative assertions intended to be disclosed to the public	→The comparison **shall** be conducted category indicator by category indicator.	V		Requirement met.
	→An LCIA **shall** not provide the sole basis of comparative assertions intended to be disclosed to the public of overall environmental superiority or equivalence, as additional information will be necessary to overcome the inherent limitations of LCIA.	V		Requirement met.
	→Category indicators intended to be used in comparative assertions intended to be disclosed to the public **should** be internationally accepted.	V		Requirement met.
	→Weighting **shall** not be used.	V		Requirement met.
	→An analysis of results for sensitivity and uncertainty **shall** be conducted for studies intended to be used.	V		Requirement met.
	→Category indicators intended to be used in comparative assertions intended to be disclosed to the public shall, as a minimum, be:			
	(i) Scientifically and technically valid, i.e. using a distinct identifiable environmental mechanism and/or reproducible empirical observation	V		Requirement met.
	(ii) Environmentally relevant, i.e. have sufficiently clear links to the category endpoint(s) including, but not limited to, spatial and temporal characteristics.	V		Requirement met.
	4.5. Life Cycle Interpretation			
Life Cycle Interpretation 4.5.2 Identification of significant issues	→When the results from the LCI and LCIA phases have been found to meet the demands of the goal and scope of the study, the significance of these results **shall** then be determined.	V		Requirement met.
	→All relevant results available at the time **shall** be gathered and consolidated for further analysis, including information on data quality.	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	→The results of the evaluation **should** be presented in a manner that gives the commissioner or any other interested party a clear and understandable view of the outcome of the study.	V		Requirement met.
	→The evaluation **shall** be undertaken in accordance with the goal and scope of the study.	V		Requirement met.
	→During the evaluation, the use of the following three techniques **shall** be considered: completeness check, sensitivity check, consistency check.	V		Requirement met.
	→The results of uncertainty analysis and data quality analysis **should** supplement these checks.	V		Requirement met.
Life Cycle Interpretation 4.5.3. Evaluation.	**4.5.3.2. Completeness check**			
	→ If any relevant information is missing or incomplete, the necessity of such information for satisfying the goal and scope of the LCA **shall** be considered. This finding and its justification **shall** be recorded.	V		Requirement met.
	→If any relevant information, considered necessary for determining the significant issues, is missing or incomplete, the preceding phases (LCI, LCIA) **should** be revisited or, alternatively, the goal and scope definition **should** be adjusted. If the missing information is considered unnecessary, the reason for this **should** be recorded.	V		Requirement met.
	4.5.3.3. Sensitivity check			
	→ The sensitivity check **shall** include the results of the sensitivity analysis and uncertainty analysis, if performed in the preceding phases (LCI, LCIA).	V		Requirement met.
	→When an LCA is intended to be used in a comparative assertion intended to be disclosed to the public, the evaluation element **shall** include interpretative statements based on detailed sensitivity analysis.	V		Requirement met.
	→The inability of a sensitivity check to find significant differences between different studied alternatives does not automatically lead to the conclusion that such differences do not exist. The lack of any significant differences may be the end result of the study.	V		Requirement met.
	→ In a sensitivity check, consideration shall be given to:			
	(i) The issues predetermined by the goal and scope of the study	V		Requirement met.
	(ii) The results from all other phases of the study	V		Requirement met.
	(iii) Expert judgments and previous experiences.	V		Requirement met.
	4.5.3.4. Consistency check.			
	If relevant to the LCA study the following questions shall be addressed:			
	(a) Are differences in data quality along a product system life cycle and between different product systems consistent with the goal and scope of the study?	V		Requirement met.
	(b) Have regional and/or temporal differences, if any, been consistently applied?	V		Requirement met.
	(c)Have allocation rules and the system boundary been consistently applied to all product systems?	V		Requirement met.

ISO 14044 Section 6.1	Specific Requirements. Section #'s refer to ISO 14044	Original Finding (7/2/21)	Final Finding (7/2/21)	Comments
	(d) Have the elements of the impact assessment been consistently applied?	V		Requirement met.
Life Cycle Interpretation 4.5.4. Conclusions, limitations, and recommendations	→Conclusions **shall** be drawn from the study.	V		Requirement met.
	→Recommendations **shall** be based on the final conclusions of the study, and **shall** reflect a logical and reasonable consequence of the conclusions.	V		Requirement met.
	→Whenever appropriate to the goal and scope of the study, specific recommendations to decision-makers **should** be explained.	V		Requirement met.
	→Recommendations **should** relate to the intended application.	V		Requirement met.
	5 Reporting			
5.1 Reporting: General requirements and considerations	→The type and format of the report **shall** be defined in the scope phase of the study.	V		Requirement met.
	→The results and conclusions of the LCA **shall** be completely and accurately reported without bias to the intended audience.	V		Requirement met.
	→The results, data, methods, assumptions and limitations **shall** be transparent and presented in sufficient detail to allow the reader to comprehend the complexities and trade-offs inherent in the LCA.	V		Requirement met.
	→If results of the LCA are communicated to any third party, regardless of the form of communication, then a third-party report shall be prepared and made available (as a reference document) to any third party to whom the communication is made. The following aspects should be considered:			
	(i) LCA Commissioner and practitioner of LCA (internal or external)	V		Requirement met.
	(ii) Date of report requirements of this International Standard	V		Requirement met.
	(iii) Scope of the study (see 5.2c)	V		Requirement met.
	(iv) Life cycle inventory analysis (see 5.2d)	V		Requirement met.
	(V) Life cycle impact assessment (see 5.2e)	V		Requirement met.
	(vi) Life cycle interpretation (see 5.2f)	V		Requirement met.
	(vii) Critical review (see 5.2g)	V		Requirement met.

ISO 21930: 2017	Specific Requirements. Section #'s refer to ISO 21930:2017	Original Finding (1/04/20)	Final Finding (XX/XX/XX)	Comments
	5 General Aspects			
5.1 Objectives of this core PCR	**Product Category**			
	→As the core PCR, this document provides the set of rules, requirements and guidelines that **shall** be applied to the development of an EPD for construction products.	V		Requirement met.
5.2 Product Category	**Life cycle stages and their information modules and module D**			
	→**5.2.1 General** The life cycle of a construction product and a construction works is divided into four life cycle stages, which include a number of information modules (see Figure 2 of ISO 21930). These life cycle stages describe the entire product system of any construction product and the corresponding LCA results are reported according to these life cycle stages in an EPD. The modular set up of the LCA underlying an EPD (see Figure 2 of ISO 21930) allows easy organization and expression of data packages throughout the life cycle of the construction product. This approach requires that the system boundary for each of the life cycle stages, as well as the information modules, included in the EPD are transparent, well defined and applicable to any construction product. The environmental information of an EPD **shall** be subdivided into the four life cycle stages shown in Figure 2. To comply with this document, as a minimum, an EPD **shall** contain the production stage information modules, A1 to A3. All other information modules are optional. In addition, the optional supplementary information (module D) can be included. For construction products that require activity during the use stage information modules B2 to B5, for example, cleaning or refurbishment of parts, the provision of technical information for the relevant module(s) **shall** be mandatory. For construction products that use energy and/or water in the use stage, the provision of technical information for the relevant information module(s) B6 and B7, which are important for the assessment at construction works level, **shall** be mandatory. As an option, supplementary environmental information may also be provided (module D) that addresses potential loads and benefits beyond the system boundary of the product under study. It is important to note that module D is not part of the product system or within the construction works system boundary. NOTE This supplementary information (module D) can be relevant for the consideration of subsequent product systems as it relates to the potential environmental aspects of the net output flows of secondary materials and/or fuels or recovered energy, which might result if the construction product is reused, recycled or recovered in the future.	**N/A**		
	→**5.2.2 Types of EPD with respect to life cycle stages covered** ISO 21930 Requirement (§5.2.2) Types of EPD with respect to life cycle stages covered. An EPD of a construction product provides information modules for the assessment of the environmental performance of buildings (see ISO 21931-1) and civil engineering works. An EPD provides information in a transparent manner to help in the	V		Requirement met.

application of such information to meet the requirements set out in building codes and rating systems that address environmental performance. The information modules (A1 to C4) may be used to combine the environmental impacts from materials, products, components and/or services to an assessment of construction works or a part of such construction works over its complete life cycle or portion thereof. The LCA-based information in an EPD may cover different combinations of information modules, i.e. cover different life cycle stages or parts thereof. There are three types of EPDs: "cradle to gate", "cradle to gate with options" and "cradle to grave". Cradle to gate: Covers the mandatory production stage that includes the following information modules: extraction and upstream production (raw material supply), transport to factory and manufacturing. The LCA results **shall** be reported based on a declared unit. NOTE 1 If an EPD provides additional technical information for one or more information module(s) beyond the factory gate but does not report their impact, then it is a cradle to gate EPD. Cradle to gate with options: Covers the mandatory production stage and optional information modules from the construction stage, use stage and end-of-life stage. The LCA results **shall** be reported based on either a declared unit or functional unit, as appropriate. Optional information modules beyond the gate **shall** be based on scenarios that **shall** be described in the EPD according to 7.1.7.3 to 7.1.7.5. Different approaches and requirements for cradle to gate with options EPDs include the following. — Cradle to construction site: Covers the mandatory production stage (A1 to A3) and transportation to construction site (A4). The LCA result **shall** be reported based on a declared unit. — Cradle to installation: Covers the mandatory production stage (A1 to A3) and both transport to construction site and construction installation on site (A4 and A5). The LCA result **shall** be reported based on a declared unit. — Cradle to gate and maintenance: Covers the mandatory production stage (A1 to A3) and maintenance processes of the product during its service life (B2). The LCA result may be reported based on a declared unit or a functional unit. — Cradle to gate and end-of-life: Covers the mandatory production stage (A1 to A3) and any of the relevant end-of-life information modules of demolition or extraction by de-construction from the construction works (C1), transportation from the construction site to the location for the end-of-life processes (C2), any waste management processes up to the system boundary between product systems, e.g. scrap collection (C3) and/or final deposition of wastes; e.g. deposition of waste on landfill or incineration without energy recovery (C4). The LCA result **shall** be reported based on a declared unit. Cradle to grave: Covers the mandatory production stage (A1 to A3) and all of the information modules from the construction stage (A4 to A5), use stage (B1 to B7) (see Note 2), and end-of-life stage (C1 to C4). The LCA results are reported based on a functional unit. Modules beyond the factory gate **shall** be based on scenarios that **shall** be described in the EPD according to 7.1.7.3 to 7.1.7.5 and **should** contain the values of the predetermined parameters and technical information underlying their quantification.			

	It may also contain only the relevant technical information for further calculation of the environmental performance in the scenarios. If no activity is expected in an information module, then the scenario and assessment of the module **should** reflect this rather than declaring the module not relevant or not applicable for a cradle to grave EPD. Sub-category PCR **should** define default scenarios for all the information modules A4, A5, B1 to B7 and C1 to C4, if it is intended to be used for a cradle to grave EPD. Any mandatory information modules **shall** have the scenarios defined. EPDs declaring information modules with scenarios not defined in the PCR **shall** clearly state the scenario within the EPD. NOTE 2 Information modules can supply information for processes for which there is no EPD available, for example a cleaning process. Any of the three types of EPDs may optionally include information developed under module D to provide supplementary environmental information on the potential loads and benefits of net outflows of secondary material, secondary fuels or recovered energy crossing the system boundary (see 7.1.7.6). Information modules C1 to C4 **shall** be declared when module D is declared.			
	→ISO 21930 Requirement (§5.2.3) Use of scenarios for assessment of information modules beyond the production stage The assessment of information modules beyond the production stage provides manufacturers with an opportunity to demonstrate aspects of product stewardship beyond the supply chain and manufacture of the product. If a comparison of products is required to be conducted at the construction works level (see 5.5), it **shall** consider life cycle stages that occur beyond the production stage within the product system. If a quantitative and/or scenario-based assessment is provided in an EPD for a module beyond the production stage, such information may be applied provided it is relevant to the comparison being made at the construction works level. However, if no appropriate data are provided in the EPD as technical quantitative data and/or information for the assessment of a scenario in an information module, then generic data or new scenarios can be developed within the context of the construction works. For example, if a manufacturer has invested in a packaging and distribution system that minimizes waste and transport impacts for their product, then it may be advantageous to provide technical information or an assessment of the system within information module A4 so that it can be used in a construction works level assessment, rather than using generic information, which may assume increased waste and/or less fuel efficient transport. Some construction products are designed and produced for a specific use in a construction works and the manufacturer might, for example, have control over the transport and installation processes, maintenance, replacement and/or end-of-life processes through a leasing contract or take-back scheme. In these instances, the manufacturer may provide an assessment of the production stage or may wish to provide technical information or an assessment of detailed scenarios for the construction, use and/or	**N/A**		

	end-of-life of the product within the EPD, demonstrating the effect of this product stewardship. NOTE 1 These scenarios could be based, for example, on a specific instance (e.g. transport from the factory to a particular location using the most common vehicle type to determine transport impacts), on the average installation using the average transport distance and mode for the product assessed or the assessment of 100 km of typical transport. NOTE 2 Upstream products can be used as input for other construction products. In such cases, an upstream manufacturer (e.g. of a coating) could deliver useful information for the life cycle stages of the final product, by providing a scenario for the maintenance of a coating, which could be used by the downstream construction product manufacturer within their EPD for the downstream product's maintenance scenario. Alternatively, the upstream manufacturer could choose to provide only the production stage data for the coating.			
	Average EPDs for groups of similar products			
5.3 Average EPDs for groups of similar products	**→ISO 21930 Requirement (§5.3) Average EPDs for groups of similar products** Average EPDs may be derived for similar products from one or more sites of one company or multiple companies using data specific to that product. Average EPDs may also be developed for groups of similar products using averaged environmental performance data. Both these types of average EPDs might significantly reduce the effort associated with producing separate EPDs for similar products. NOTE 1 Products can be considered similar on the basis of materials, manufacturing or function, as relevant to the product category. The larger the variance among the products covered by an average EPD, the less the average represents the intended typical product. The selection of products to be covered in an average EPD **should** be made in such a way that the resulting average EPD is reasonably descriptive for the products covered in the average EPD when considering the use of the average EPD information in an overall assessment of a construction works. Average EPDs, for example EPDs from trade associations, **shall** describe what they represent. This means, as a minimum, providing details on the variation in the composition of the product compared with the average product. Such information **shall** give the user an indication, either qualitatively or quantitatively, of the range of results that are likely for the products covered by the average EPD. See Annex B for examples of average EPDs. When there is a selection of sites or products assessed, the type of average and what it represents **shall** be clearly stated in the EPD. To ensure an average EPD is representative, the information provided in the average EPD and in the LCA report **shall** include, but not be limited to: — a technical description of the average product group (see EXAMPLES 1 to 3); — the number of manufacturing plants included in the EPD; — the names of manufacturing companies or brands or associations; — a description of the relative production representativeness covered by the EPD; — the geographical coverage; — the range of products for which the EPD is relevant;	V		Requirement met.

	— the information on restrictions to the use of the average EPD. In addition, the following information **shall** be provided in the project report in order to be transparent: — description of how the selection of the sites/products was done and how the average was determined; — information on parameters in the LCA having the most influence. EXAMPLE 1 For an average EPD for a declared unit of R-value of a specific type of insulation material, the representativeness of the average EPD could be described by relevant technical properties such as the range of density, thermal conductivity and thickness for which the average EPD is representative. EXAMPLE 2 For an average EPD for a declared unit of 1 m2 of carpet with a given pile mass, the representativeness of the average EPD could be described by relevant technical properties, such as the range of pile mass/m2 as the most influencing parameter. EXAMPLE 3 For an average EPD for declared unit of 1 m2 of insulated steel cladding panel, the representativeness of the average EPD could be described by relevant technical properties such as kg/m2 or thickness of steel and insulation. NOTE 2 Average EPDs are important at the early stages of planning. Apart from this, there is a need for product specific EPDs for the selection/sourcing of particular products. Average EPD may be developed for a group of similar products from the same or different manufacturing plants produced using the same processes and having the same functionality. EXAMPLE 4 An example is a mortar, where the manufacturing is done by mixing different components. Different types of mortar used, for example as a plaster, can vary in their composition while using a limited number of components. In that case, data specific to a typical product can be used. The typical product is modelled and calculated by assuming an average composition taken from the range of the group of similar products. The calculation of the environmental indicators then results in representative values. A sensitivity analysis **should** be conducted on the differences between the similar products in the grouped system. Where an average composition, representative composition or worst-case environmental indicators are used, the products included in an average EPD **shall** not differ in their environmental impact indicators by more than ±10 %. Similar products included in other average EPDs **should** not differ in their environmental impact indicators by more than ±10 %. Where larger impact differences are found for the companies/sites and/or products evaluated, these need to be justified in the project report or the system separated. NOTE 3 An average EPD can provide the impact of an average product, for example, by weighting impacts considering total production volume or a representative sample of the products. For some aspects of technical performance, a conservative estimate of product performance, ensuring adequate technical functionality in the context of the construction works, might be relevant.			
5.4 Use of EPDs for	**5.4 Use of EPDs for construction products**			

construction products	**→ ISO 21930 Requirement (§5.4) Use of EPDs for construction products** The environmental information on construction products is intended mainly for B2B communication and its prime purpose is to provide measurable and verifiable input for the assessment and improvements of the environmental performance of construction works. However, some EPDs may be used in the B2C marketplace and, when doing so, **the user of this document shall follow the provisions of ISO 14025:2006, Clause 9.** The manufacturer, or group of manufacturers, of the construction product is the sole owner of the EPD and is responsible for developing the EPD of the construction product according to the PCR. Only the manufacturer or group of manufacturers is authorized to declare the environmental performance of the construction product using an EPD.	V		Requirement met.
	→ISO 14025 Requirement (§9) Additional requirements for developing Type III environmental declarations for business-to-consumer communication 9.1 General The programme operator **shall** consider the potential audience for any Type III environmental declarations under development. Although it is anticipated that most Type III environmental declarations will be developed for use in business-to-business communication, there may be declarations intended and/or used to provide this type of detailed, quantitative data in business-to-consumer communication. The requirements of 9.2 to 9.4 **shall** apply in addition to those of the other clauses when Type III environmental declarations are intended for, or likely to be used by, consumers. The requirements of 9.2 to 9.4 **shall** also apply when the potential audience for the Type III environmental declaration can be considered to be a consumer as defined in 3.16. 9.2 Provision of information 9.2.1 Content of declaration Type III environmental declarations are complex and require considerable documentation. No part of the required content of the declaration required by the PCR **shall** be omitted or simplified for business-to-consumer communication. Type III environmental declarations **shall** be based on the life cycle of the product, unless – information on specific stages (e.g. the use and end-of-life stages of the product) is not available and reasonable scenarios cannot be modelled, or – these stages may reasonably be expected to be environmentally insignificant. Only under these circumstances can the specific stages be excluded. A statement on omissions **shall** be included in the Type III environmental declaration. Where reasonable scenarios for the specific stages can be modelled, those stages **shall** not be excluded. Assumptions made to create the scenarios **should** be clearly stated in the PCR. 9.2.2 Availability of declaration	V		Requirement met.

	Type III environmental declarations intended for business-to-consumer communication **shall** be available to the consumer at the point of purchase. 9.2.3 Explanatory material When Type III environmental declarations are used for business-to-consumer communication, the organization making the declaration **shall** provide, upon request and at a reasonable cost, extra explanatory material to facilitate consumer understanding of the data in the declaration. The organization making the declaration **shall** publish information allowing a consumer to contact the organization from any area in which the product is sold. Suitable means of contacting the organization may include telephone or other electronic access. Means of obtaining the explanatory material **shall** be clearly stated in the declaration. 9.3 Involvement of interested parties In addition to the requirements of 5.5, the interested parties involved in the development of a Type III environmental declaration or programme for use in business-to-consumer communication **shall** include representatives of both consumer interests and environmental interests. These representatives may be selected by local, national or regional groups, bodies or organizations. The programme operator **shall** be responsible for facilitating this participation. 9.4 Verification Verification required in this International Standard **shall**, in the case of Type III environmental declarations used for business-to-consumer communication, be carried out by a third party (see competence for verifiers in 8.2). When the intended audience for the Type III environmental declaration is a consumer, as defined in 3.16, the declaration **shall** clearly state that the verification was performed by a competent third party.			
5.5 Comparability of EPDs for construction products	**5.5 Comparability of EPDs for construction products**			
	→ISO 21930 Requirement (§5.5) Comparability of EPDs for construction products Comparison of construction products using an EPD **shall** be carried out in the context of the construction works. Consequently, comparison of the environmental performance of construction products using the EPD **shall** consider all the relevant information modules over the full life cycle of the products within the construction works. Such a comparison requires scenarios in the construction works context. **The provisions of ISO 14025:2006, 6.7.2 on comparability shall apply.** Comparisons are possible at the sub-construction works level, for example for assembled systems, components or services for one or more life cycle stages. In all cases of comparing construction products, the principle that the basis for comparison of the assessment is the construction works level **shall** be maintained by ensuring that the same functional requirements are met and: — the products/systems **shall** have the same functional performance; — the comparison is based on the same functional unit; — the environmental performance and technical performance of any excluded elements of the construction works (e.g. assembled systems, components, construction products or construction services) are the same;	N/A		

	— the type and amount of any materials excluded are exactly the same; — any excluded processes and life cycle stages are the same; — equivalent scenarios are used (see Note 2); — the elementary flows related to material inherent properties such as biogenic carbon, the potential to carbonate or the net calorific value of a material, are considered completely and consistently within the scope of comparison; — the influence of the product systems on the use stage of the construction works, including operational aspects and impacts of the construction works, are taken into account or are the same; — module D **shall** not be aggregated with the life cycle information modules A1 to C4 to assess the total impact of the products or construction works being compared, as it is outside the system boundary. It can be taken into consideration as optional supplementary environmental information using equivalent scenarios. NOTE 1 EPD that cannot be considered in a construction works context with equivalent scenarios are not tools to compare construction products and construction services. NOTE 2 The scenarios for information module A5 for two products could be equivalent, as they both model the typical installation of the products and resulting waste management, but not identical, because of, for example, different ancillary material requirements, packaging waste and product wastage generated. The products could show different impacts but could still be compared . The information provided for any comparison **shall** be transparent to allow a clear understanding of the limitations of comparability.			
	→ISO 14025 Requirement (§6.7.2) Requirements for Comparability Comparability of different Type III environmental declarations **shall** be deemed to have been achieved when the following conditions are met. a) The product category definition and description (e.g. function, technical performance and use) are identical. b) The goal and scope definition for the LCA of the product, according to the ISO 14040 series, has the following characteristics: – the functional unit is identical; – the system boundary is equivalent; – the description of data is equivalent; – the criteria for the inclusion of inputs and outputs are identical; – the data quality requirements including coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty are equivalent; – the units are identical. c) For the inventory analysis, – the methods of data collection are equivalent, – the calculation procedures are identical, and – the allocation of material and energy flows and releases is equivalent. d) Impact category selection and calculation rules, if applied, are identical.	N/A		

	e) Predetermined parameters for reporting of LCA data (inventory data categories and impact category indicators) are identical. f) Requirements for provision of additional environmental information, including any methodological requirements (e.g. specifications for hazard and risk assessment) are equivalent. g) Materials and substances to be declared (e.g. information about product content, including specification of materials and substances that can adversely affect human health and/or the environment, in all stages of the life cycle) are equivalent. h) Instructions for producing the data required to create the declaration (LCA, LCI, information modules and additional environmental information) are equivalent. i) Instructions on the content and format of the Type III environmental declaration are equivalent. j) If the declaration is not based on an LCA covering all life cycle stages, information on which stages are not considered is equivalent. k) Period of validity is equivalent. In order to compare Type III environmental declarations based on information modules, either the environmental impacts of omitted life cycle stages of the products **shall** not be significant, or the data of omitted life cycle stages **shall** be identical within the accepted uncertainty of the data.			
5.6 Documenta-tion	**Documentation**			
	→ISO 21930 Requirement (§5.6) Documentation Clause 9 gives the content of an EPD in accordance with this document. The result from an EPD project **shall** be presented as an EPD and a project report. The project report is the systematic and comprehensive summary of the project documentation supporting the verification of an EPD. The project report **shall** record that the LCA-based information and the additional information as declared in the EPD meet the requirements of this document. The project report **shall** contain data and information that is of importance to the data published in the EPD and **shall** meet the requirements of this document and any relevant sub-category PCR used for the EPD development. Special care **shall** be taken to demonstrate, in a transparent manner, how the data and information declared in the EPD were derived from the LCA study and how the RSL was established. **The project report shall be made available to the verifier with the requirements on confidentiality stated in ISO 14025.** The requirements for the project report are given in Clause 10.	V		Requirement met.
	ISO 14025 Requirement (§8.3) Rules for data Confidentiality Product-specific data are often confidential because of – competitive business requirements, – proprietary information covered by intellectual property rights, or – similar legal restrictions. Such confidential data are not required to be made public. The declaration typically only provides data aggregated over all or relevant stages of the life cycle. Business data identified as confidential that is provided for the independent verification process **shall** be kept confidential, in accordance with general programme instructions (see 6.4). If the programme operator determines, based on the verification report, that the data supporting the Type III environmental declaration are inadequate, the declaration **shall** not be published.	N/A		

	Methodological framework			
7.1 Methodological framework	**→ISO 21930 Requirement (§7.1.1): Overarching principles for LCA modelling and calculation** Two main modelling approaches exist for LCA: attributional and consequential. This document follows the attributional LCA approach. The attributional life cycle model depicts the actual or anticipated specific or average supply chain, use and end-of-life scenarios. The consequential life cycle model depicts the anticipated generic supply chain as a consequence of a potentially relevant decision. The attributional and the consequential life cycle models differ with respect to the selection of data and the manner in which co-production processes are considered. In the attributional approach, coproduction processes are allocated based on physical or economic relationships; in the consequential approach, system expansion including avoided processes is applied. The setting of the system boundary for the product system **shall** follow two principles: — The “modularity principle”: Where processes influence the construction product’s environmental performance during its life cycle, they are assigned to the information module of the life cycle stage where they occur; all environmental aspects and potential impacts are declared in the life cycle stage where they can be attributed (see Figure 2). — The “polluter pays principle”: Processes relevant to waste processing are assigned to the product system that generates the waste until the system boundary between product systems is reached.	V		Requirement met.
	→ISO 21930 Requirement (§7.1.2): Functional Unit The functional unit defines the way in which the identified functions and performance characteristics of the product are quantified. The primary purpose of the functional unit is to provide a reference by which product, material and energy flows (input and output data) of a construction product’s LCA results and any other information are normalized to produce data expressed on a common basis. NOTE 1 Comparisons of construction products with the same functional unit follow the rules in 5.5. The functional unit, used as the denominator, provides the basis for the addition of product, material or energy flows and the relevant environmental impacts for any of the life cycle stages and their information modules for the construction product or construction service. The description of the functional unit of a construction product **shall** include, but not be limited to — the quantified function and performance characteristics of the construction product when integrated into a construction works, taking into account the intended use of the product with respect to the functional equivalent of the works, and — the product’s RSL (see 7.1.4), under defined reference in-use conditions or specific in-use conditions. In this way, quantification of both the qualitative and quantitative aspects of the function in relation to end use in a construction works context, for example, “what”, “how much”, “how well” and “for how long” has to be performed. NOTE 2 Guidance on establishing “how well” and “how long” aspects of performance is provided in Annex A. NOTE 3 Guidance on the development of a functional unit is given in ISO 14040:2006, 4.2.2.	**N/A**		

NOTE 4 Guidance on describing in-use conditions is given in ISO 15686-1, ISO 15686-2, ISO 15686-7 and ISO 15686-8. NOTE 5 The functional unit for a product might incorporate aspects of functionality that are not always required for a particular use case of that product. For example, a concrete block can have structural performance functionality, acoustic functionality and thermal functionality, but in a given use case one or more of these functions might not be required. If this is the case, then these aspects of functional unit can be disregarded, if for example, functional unit is being used as the basis for comparison of two or more products for the given use case. EXAMPLE A functional unit can be: a roofing product sufficient to cover 100 m2 of a building, maintain a barrier to water penetration into the building and to include any repair, refurbishment or replacement of replaceable components over a required service life of 50 years.			
→ISO 21930 Requirement (§7.1.3): Declared Unit When the precise function of the product or scenarios at the construction works level is not stated, or is unknown, a declared unit may be used instead of the functional unit. The declared unit provides a reference by which product, material and energy flows (input and output data) of the information module of a construction product's LCA results and any other information are normalized to produce data expressed on a common basis. The declared unit, used as the denominator, provides the basis for the addition of product, material and energy flows attributed to the product and the relevant environmental impacts for EPDs that do not cover the full life cycle (see Figure 2). It **shall** relate to the typical applications of products and their product categories. The declared unit in the EPD **shall** be one of the following: — an item, an assemblage of items, for example, 1 window (dimensions of items **shall** be specified); — mass (kg or metric tonne), for example, 1 000 kg or 1 t of cement; — length (m), for example, 1 m of pipe, 1 m of a beam (dimensions of elements **shall** be specified); — area (m2), for example, 1 m2 of wall elements, 1 m2 of roof elements (dimensions of elements **shall** be specified); — volume (m3), for example, 1 m3 of timber, 1 m3 of ready-mixed concrete. A different unit may be declared for reasons that **shall** be explained and in such cases, information **shall** be provided on how to convert this unit to one or more of the required unit types. EXAMPLE If an EPD for an insulation material is declared in units of thermal resistance, R (m2K/W), in the construction works, then a conversion factor, for example, to 1 kg of material is required. For the development of, for example, transport and disposal scenarios, conversion factors to mass per declared unit **shall** be provided. NOTE Reasons for declaring units other than those listed include the need to use units normally used for design, planning, procurement and sale. The following information is the minimum that **shall** be provided together with the declared unit for the construction product or component: — intended application, where relevant; — statement that comparability of EPDs is limited to those applying a functional unit.	N/A		

→ISO 21930 Requirement (§7.1.5): System Boundary with Nature The system boundary with nature is defined when material flows move from natural systems to the technosphere (i.e. when they are flows caused or influenced by human technological activity) and when emissions are released from the technosphere to the environment. The studied system **should** therefore include all processes in the technosphere which are necessary to provide the function or declared unit of the product. NOTE Biogenic carbon enters the product system during managed agricultural processes or during harvest of biogenic material from natural systems.	V		Requirement met.
→ISO 21930 Requirement (§7.1.6): System Boundary between product systems Product systems can use secondary materials, secondary fuels and recovered energy from previous product systems, and can generate wastes and energy that are recovered to produce secondary materials, secondary fuels and recovered energy for use in subsequent product systems. To ensure that there is no double counting or undercounting of burdens, it is essential that a system boundary between product systems is defined and the same system boundary is used to assign burdens to the appropriate product system for both inputs and outputs from the studied product system. See Table 1 for application of the system boundary between product systems. For input flows to the studied product system, the product system that generates waste is the upstream product system. For output flows from the studied product system, it is the studied product system generating the waste. For input flows to the studied product system, the product system that uses waste, secondary materials or secondary fuels is the studied product system. For output flows used from the studied product system, it is the downstream product system. The setting of the system boundary between products systems **shall** follow the polluter pays principle set out in 7.1.1. A flow **shall** be considered as reaching the system boundary between product systems when it complies with all the following criteria: — the recovered material, product or fuel is commonly used for specific purposes; — a market or demand, identified, for example by a positive economic value, exists for such a recovered material, product or fuel; — the recovered material, product or fuel fulfils the technical requirements for the specific purposes for which it is used and meets the existing legislation and standards applicable to products or secondary fuels. NOTE The “specific purpose” in this context is not restricted to the function of a certain product but can also be applied to a material serving as input to the production process of another product or of energy. As the criteria for the system boundary between product systems relate to common use, demand, economic value, legislation, standards and regulations, it is clear that a particular substance can have a different status in different locations at different points in time. For manufacturers that use wastes, secondary materials and/or secondary fuels as a resource and also produce waste that is recovered in terms of time of data collection and geography of the supply chain for the use of these substances, the current situation **shall** be used to identify the system boundary between product systems. A conservative approach **shall** be used, meaning that if there is uncertainty as to whether a substance has reached the system	V		Requirement met.

boundary between product systems, it **should** be included in the studied product system in the relevant life cycle stage. Additionally, if wastes are used for energy or material recovery and do not have a clearly defined point when they cross the system boundary between product systems in all regions, the most conservative figures **shall** be specified in the communication of the LCA results in information modules A1 to A3 and **shall** include the environmental impacts caused by the emissions including processing, incineration and/or co-incineration of waste (gross figure). For transparency reasons, a net figure can be provided as additional information: — the environmental impacts caused excluding the processing, e.g. incineration of waste (net figure), see Table 1. For the end-of-life stage, any waste treatment or recovery process that occurs before the system boundary between product systems is reached **shall** be included in information module C3 or C4.			
→ISO 21930 Requirement (§7.1.7.1): System boundaries and technical information for scenarios - General The LCA is divided into a number of information modules. When an information module in the LCA is included, it **shall** follow the scope as defined in this clause. The information modules A1, A2 and A3 are based on the actual and representative data of the production process of the product. However, as soon as a construction product leaves the factory gate, the assessment **shall** be based on scenarios and assumptions. The scenarios and assumptions considered depend upon various details including location, type of transport, method of installation and construction, type of construction works, use, maintenance and repair, end-of-life treatment and waste handling. Scenarios and technical information are necessary for the application of EPDs in the assessment of the environmental performance of a building and other types of construction works. Scenarios **shall** be realistic and be representative of one of the most likely alternatives. More than one scenario can be assessed. A scenario **shall** allow users to scale the results to assess realistic options. The scenarios used **shall** be justified in the project report. Scenarios **shall** not include processes or procedures that are not in current use or which have not been demonstrated to be practical. The technical scenario information provided in an EPD **shall** be detailed so as to enable the user of the EPD to assess whether the scenario assumptions are applicable to the context for which the EPD information is to be used. NOTE If two alternative types of recycling are commonly used at the end-of-life, then a scenario for one type, scenarios for each alternative or scenarios for the typical mix plus each alternative could be provided. Only providing the typical mix of two alternatives might not assist in assessing the best option for recycling. Providing a road transport scenario in A4 for 100 km may not be the most likely transport distance but will allow users to scale the results to represent the transport to their particular construction site. Within an EPD, the indicators declared in the individual information modules of a product life cycle (i.e. A1 to A5, B1 to B7, C1 to C4) and the optional supplementary information beyond the life cycle (module D) **shall** not be aggregated in any	V		Requirement met.

	combination of the individual information modules into a total or subtotal of the life cycle stages. As an exception, individual indicators for information modules A1, A2 and A3 may be aggregated to a total for each indicator in the production stage.			
	→ISO 21930 Requirement (§7.1.7.2): A1 to A3, production stage 7.1.7.2.1 General The production stage includes the following three information modules A1 to A3: — A1, extraction and upstream production; — A2, transport to factory; — A3, manufacturing. Information modules A1 to A3 **shall** be included in every EPD. The system boundary with nature **shall** include those technical processes that provide the material and energy inputs into the system and the subsequent manufacturing and transport processes up to the factory gate, as well as the processing of any waste arising from those processes. 7.1.7.2.2 A1, extraction and upstream production The information module "extraction and upstream production" covers raw material extraction and processing, processing of secondary material input (e.g. recycling processes). This includes: — A1 extraction and processing of raw materials (e.g. mining processes) and biomass production and processing (e.g. agricultural or forestry operations), including the production of inputs where they are used; — A1, reuse of products or materials from a previous product system; — A1, processing of secondary materials used as input for manufacturing the product, but not including those processes that are part of the waste processing in the previous product system; — A1, generation of electricity, steam and heat from primary energy resources used for extraction and processing of raw materials, including their extraction, refining and transport; — A1, generation of electricity, steam and heat from secondary fuels, but not including those processes that are part of waste processing in the previous product system to recover secondary fuels; — A1, energy recovery and other recovery processes from secondary fuels, but not including those processes that are part of waste processing in the previous product system; — A1, waste management from manufacturing packaging and manufacturing wastage including transport up to the recycler or disposal. 7.1.7.2.3 A2, transport to factory The information module "transport to factory" covers transport of raw materials and other inputs to the factory and internal transport. 7.1.7.2.4 A3, manufacturing The information module "manufacturing" includes: — A3, production of ancillary materials or pre-products; — A3, generation of electricity, steam and heat from primary energy resources used in manufacturing, including their extraction, refining and transport; — A3, energy recovery and other recovery processes from secondary fuels, but not including those processes that are part of waste processing in the previous product system; — A3, emissions from the combustion of secondary fuels and waste used in the manufacturing process; — A3, manufacturing of products and co-products, including their extraction, manufacturing and transport;	V		Requirement met.

	— A3, manufacturing of packaging, including their extraction, manufacturing and transport; — A3, waste management from manufacturing packaging and manufacturing wastage including transport up to the recycler or disposal. 7.1.7.2.5 Input of secondary materials or recovered energy In the case of input of secondary materials or energy recovered from waste or generated from secondary fuels, the system boundary between the system under study and the previous system (providing the secondary materials and secondary fuels) is set where outputs from the previous system, for example materials, products, construction works elements or energy, reach the system boundary between product systems (see 7.1.7.5). 7.1.7.2.6 Co-products leaving the system Co-products from unit processes leaving the system at the production stage (A1 to A3) **shall** be allocated in accordance with 7.2.5. Loads and benefits from allocated co-products **shall** not be declared in module D (see 7.1.7.6). 7.1.7.2.7 Output of waste The output of waste during this life cycle stage may become a useable output flow, such as a secondary material/fuel or recovered energy, when it has been through a recovery process and complies with the conditions described in the system boundary between product systems (see 7.1.6). These useable output flows **shall** not be considered as co-products but **shall** be considered waste and no allocation to secondary material, secondary fuels or recovered energy **shall** be permitted. As an option, the potential loads and benefits from the net useable output flows from recovery processes may be considered as supplementary information in module D. 7.1.7.2.8 End-of-life scenarios for packaging To support the development of the end-of-life scenarios for packaging at the construction works level where the information module A5 is not declared, data **shall** be provided about any packaging used for the product as specified in 7.1.7.3.			
	→ISO 21930 Requirement (§7.1.7.3): A4 to A5, construction stage 7.1.7.3.1 General The construction stage includes the following two information modules A4 to A5: — A4, transport to site; — A5, installation. Information modules A4 to A5 include provision of all materials, products and energy, as well as waste processing up to the system boundary between product systems or disposal of final residues during the construction stage. They also include all aspects and impacts related to any losses during this construction stage (i.e. production, transport and waste processing and disposal of the lost products and materials). 7.1.7.3.2 A4, transport to site The information module "transport to site" includes: — A4, transportation from the factory gate to the central warehouse or intermediate storage site, if relevant; — A4, transportation to the construction site. Transport distance **should** be as specific as possible. The distance to the construction site may be estimated based on weighted average distance to the market of the product. For the assessment at the construction works level, more complex logistics may have to be considered. 7.1.7.3.3 A5, installation	**N/A**		

	The information module "installation" covers installation of the construction product into any type of construction works. This includes: — A5, wastage of construction products including the production processes (A1 to A3) and transport to site (A4) to account for the material lost from wastage of products; .— A5, waste processing of the waste from product packaging and product wastage including transport during the construction processes up to the system boundary between product systems or disposal of final residues; — A5, installation of the product into the construction works including manufacture and transportation of ancillary materials and any direct use of energy or consumption of freshwater required for installation at the construction site; — A5, installation specific site preparation for the declared product including ancillary materials and waste management if relevant. 7.1.7.3.4 End-of-life scenarios for packaging The information in Table 2 **shall** be provided for all construction products to specify the end-of-life scenarios used for packaging or to support development of the end-of-life scenarios for packaging at the construction works level where the module is not declared. Scenarios **shall** only model processes, for example recycling systems that have been proven to be economically and technically viable. ***Table 2 — A5 product packaging waste***			

Module	Parameter	Unit (expressed per functional unit or per declared unit)	Value
A5 Installation of the product	*Mass of packaging waste Specify by type*	*kg or other unit as appropriate*	
A5 Installation of the product	*GWP based in biogenic carbon content of packaging, specify by type, (where relevant)*	*kg CO2e*	

	→ISO 21930 Requirement (§7.1.7.4): Use Stage 7.1.7.4 Use stage 7.1.7.4.1 General The use stage of the construction works includes information modules covering the period from the handover to when it is deconstructed or demolished. Product level use stage may be vastly different when considered in the context of the construction works since the products will have varying RSLs, encounter differing exposure conditions (with corresponding ESLs) and might be replaced, repaired and maintained several times over the span of the required service life of a construction works. The use stage of the construction product includes the use of construction products, equipment and services in their proper function. It also includes construction product use to protect, conserve, moderate or control a construction works, for example modules describing the impact of any given product upon building operation through integrated technical systems such as heating, cooling, lighting, water supply and internal transport (e.g. provided by lifts and escalators). It also includes product level related maintenance (e.g. cleaning) and repair, both of which can include replacement of replaceable components/parts and refurbishment. It is recognized that it may be difficult to separate all use stage processes and the connected aspects and impacts into these	**N/A**		

	separate modules. However, any deviation from the categorization of aspects and impacts into modules B1 to B5 and B6 to B7 **shall** be reported in a transparent manner and justified. 7.1.7.4.2 B1 to B5, use stage (related to the use of the construction works) 7.1.7.4.2.1 General The use stage of the construction works includes the following five information modules: — B1, use or application of the installed product; — B2, maintenance; — B3, repair; — B4, replacement; — B5, refurbishment. This includes provision and transport of all materials, products and related energy and water use, as well as waste processing up to the system boundary between product systems or disposal of final residues during this part of the use stage. These information modules also include all aspects and impacts related to losses during the use stage (i.e. production, transport and waste processing and disposal of the lost products and materials). 7.1.7.4.2.2 B1, use or application of the installed product In terms of any emissions to the environment not covered by information modules B2 to B7, the information module "use or application of the installed product" covers environmental aspects and impacts connected to the normal (i.e. anticipated) use of products, not including those related to energy and water use, which are dealt with in B6 and B7, for example release of substances from the facade, roof, floor covering, walls and different surfaces (interior or exterior). They are reported as mandatory additional environmental information according to the requirements stated in 8.4 or as optional additional environmental information, for example as described in Annex C. 7.1.7.4.2.3 B2, maintenance The information module "maintenance" covers the combination of all planned technical actions during the reference service life to maintain the construction product installed in a construction works 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 includes: — B2, preventative and regular maintenance activity such as cleaning and the planned servicing replacement of replaceable components or repair of worn, damaged or degraded parts; — B2, production (A1 to A3) of any component and ancillary products used for maintenance, for example cleaning agents; — B2, transportation (A4) of any component and ancillary products used for maintenance; — B2, use of related energy and water, including generation and distribution; — B2, transportation of any waste from maintenance processes or from maintenance related transportation; — B2, end-of-life processes of any waste including transportation and the maintenance process, including any part of the component and ancillary materials removed. Water and energy usage (including production and distribution) required for cleaning, as part of maintenance **shall** be included in this module and not in modules B6 and B7. NOTE 1 Maintenance of a whole section of the construction works as part of a concerted programme is considered as refurbishment.			

	EXAMPLE 1 Painting work on window frames, doors, etc., as well as the annual inspection and maintenance of the (oil or gas) boiler, replacement of filters in the heat recovery or air conditioning system. 7.1.7.4.2.4 B3, repair The module "repair" covers a combination of all technical actions during the service life associated with corrective, responsive or reactive treatment of a construction product or its parts installed in the construction works to return it to an acceptable condition in which it can perform its required functional and technical performance. It also covers the preservation of the aesthetic qualities of the product. At the product level, replacement of a broken component or part due to damage **should** be assigned to "repair", whereas replacement of a whole element due to damage **should** be assigned to the module "replacement" at the construction works level. This includes: — B3, repair process of the repaired part of a component; — B3, production (A1 to A3) of any component and ancillary products used for the repair; — B3, transportation (A4) of any component and ancillary products used for the repair; — B3, use of related energy and water; including generation and distribution; — B3, transportation of any waste from repair processes or from repair related transportation; — B3, end-of-life processes of any waste from transportation and the repair process, including any part of the component and ancillary materials removed. NOTE 2 Repair of a whole section of the construction works as part of a concerted programme is considered as refurbishment. EXAMPLE 2 For a window with broken glass, this includes the production and transportation of new glass and packaging, and all impacts due to the repair process (rubber seal, water for cleaning, etc.) and the end-of-life stage of the glass waste and any related packaging. 7.1.7.4.2.5 B4, replacement The information module "replacement" covers the combination of all technical actions during the service life of the constructions works associated with the return of the construction works to a condition in which it can perform its original required functional or technical performance by replacement of the construction product or construction element. At the product level, "replacement" of a broken component or part due to damage **should** be assigned to "maintenance" (B2) or "repair" (B3), whereas replacement of a whole construction product or construction element due to damage **should** be assigned to "replacement" at the construction works level. This includes: — B4, production (A1 to A3) of any component and ancillary products used for replacement; — B4, transportation (A4) of any component and ancillary products used for replacement; — B4, use of related energy and water, including generation and distribution; — B4, transportation of any waste from replacement processes or from replacement-related transportation; — B4, end of life processes of any waste from transportation and the replacement process, including any part of the component and ancillary materials removed.			

	NOTE 3 Replacement of a whole construction element as part of a concerted replacement programme for the construction works would be considered as "refurbishment". EXAMPLE 3 For a carpet being replaced at the end of its service life, this includes the production and transportation of the new carpet and packaging and all impacts due to the replacement process (adhesive, vacuum cleaning, etc.) and the end-of-life stage of the original carpet, any waste from the installation of the replacement carpet, packaging waste and adhesive. 7.1.7.4.2.6 B5, refurbishment The information module "refurbishment" covers the combination of all technical actions during the service life of a product associated with the return of construction works or their parts to a condition in which it can perform its required functions. Restoration activities **should** be included within refurbishment. This includes: — B5, production (A1 to A3) of any component and ancillary product used for refurbishment; — B5, transportation (A4) of the component and ancillary materials used for refurbishment, including production aspects and impacts of any losses during transportation; — B5, use of related energy and water, including generation and distribution; — B5, transportation of any waste from refurbishment processes or from refurbishment-related transportation; — B5, end-of-life processes of any losses suffered during transportation and the refurbishment process, including the components and ancillary materials removed. NOTE 4 Refurbishment covers a concerted programme of maintenance, repair and/or replacement activity, across a significant part of or the entire service life of the construction product. 7.1.7.4.3 B6 to B7, use stage, information modules related to the operation of the construction works 7.1.7.4.3.1 General The use stage related to the operation of the construction works includes the following two information modules: — B6, operational energy; — B7, operational water use. Information modules B6 to B7 include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the system boundary between product systems or disposal of final residues during this part of the use stage. 7.1.7.4.3.2 B6, operational energy use The information module "operational energy use" covers the operation of integrated technical systems (e.g. operation of heating system and other construction works related installed services). Integrated technical systems are installed technical equipment that support operation of a construction works. This includes technical systems for heating, cooling, ventilation, lighting, domestic hot water and other systems for sanitation, security, fire safety, internal transport, building automation and control and IT communications. This includes generation, distribution and use of energy during the operation of the product (the integrated technical system), together with its associated environmental aspects and impacts including processing and transportation of any waste arising on site from the use of energy.			

	NOTE 5 Use of energy for heating of domestic water is assigned to B6, while consumption of freshwater associated with use of hot water is assigned to B7. If relevant for the product group, aspects related to the production of integrated technical systems equipment **shall** be assigned to information modules A1 to A3, for example radiators, boiler, ventilation system. Aspects related to transportation and installation of integrated technical systems equipment **shall** be assigned to information modules A4 to A5. Energy use and other impacts during maintenance, repair, replacement or refurbishment activities for the equipment **shall** be assigned to information modules B2 to B5. Aspects related to the waste processing and final disposal of equipment **shall** be assigned to information modules C1 to C4. 7.1.7.4.3.3 B7, operational water use The information module "operational water use" covers water use by integrated technical systems during the period from the handover of the construction works to when it is deconstructed or demolished. This includes water use during the operation of the product (the integrated technical system), together with its associated environmental aspects and impacts considering the life cycle of water including production and transportation and waste water treatment.			
	→ISO 21930 Requirement (§7.1.7.5): C1 to C4, end-of-life stage The end-of-life stage of the construction product starts when it is replaced, dismantled or deconstructed from the construction works and does not provide any further functionality. The end-of-life stage includes the following four information modules C1 to C4: — C1, deconstruction/demolition, which includes dismantling or demolition, of the construction product from the construction works and the energy use for this, including initial on-site sorting of the materials; — C2, transportation to waste processing or disposal, which includes the transportation of the discarded construction product as part of the waste processing, for example to a recycling site and transportation of waste, for example to final disposal; — C3, waste processing, which includes, for example collection of waste fractions from the deconstruction, recovery and waste processing of material flows resulting in materials for reuse, secondary materials, secondary fuels or export of recovered energy from the energy recovery from waste with an efficiency of energy recovery of at least 60 %, without prejudice to existing legislation; — C4, disposal of waste which includes physical pre-treatment and management of the disposal site, including provision and transport of all materials, products and related energy and water use. If there are, for example three different recovery and disposal options, the most commonly used one, or all three scenarios, **shall** be declared separately. NOTE 1 A recycling system is not practical if it includes a reference to a return system for which the logistics have not been established. Energy recovery **shall** be based on existing technology and current practice. A scenario based on a typical end-of-life, for example a mix of recovery and disposal options based on a national situation,	V		Requirement met.

	shall only be provided if the scenarios for the separate individual options are also provided. Waste processing **shall** be modelled and the elementary flows **shall** be included in the inventory. When materials have reached the system boundary between product systems, they may be considered as materials for energy recovery provided the energy recovery process has an energy efficiency rate of at least 60 %. Processes where energy is recovered from waste with an efficiency rate below 60 % **shall** be considered as disposal processes and modelled in information module C4. Waste processing **shall** be considered as part of the product system under study. In the case of materials leaving the product system as secondary materials or fuels, processes such as collection and transport before the system boundary between product systems is reached are part of the waste processing of the product system under study. However, after having reached the system boundary between product systems, further processing may be necessary in order to replace primary material or fuel input in another product system. Such processes are considered to be beyond the system boundary, but may be considered in optional module D. NOTE 2 The efficiency with which a secondary fuel is used has no bearing on its status in terms of having crossed the system boundary between product systems. The process of energy recovery from landfill gas **shall** be considered as part of the disposal process in information module C4. Loads and benefits of the recovered energy may be considered in optional module D. Loads (e.g. emissions) from all end-of-life information modules (C1 to C4) **shall** be considered part of the product system under study, according to the "polluter pays principle". The loads associated with the use of secondary fuels **shall** always be part of the product system using the secondary fuel. During the end-of-life stage of the construction product or the construction works, all output from dismantling, deconstruction or demolition, from maintenance, repair, replacement or refurbishing processes, all debris, all construction products, materials or construction elements, etc., are accounted for as part of the studied system. In the case of materials leaving the system as secondary materials or fuels, processes such as collection, transport and waste processing until the system boundary between product systems is reached, are part of current product system under study. The inventory for the end-of-life stage includes all unit operations for the discarded construction product until it is determined to have crossed the system boundary between product systems and becomes a usable material flow for reuse, energy recovery and/or recycling. If the discarded product does not cross the system boundary, it is considered as waste and all waste treatment processes including those of disposal **shall** be assigned to the product system under study. The system boundary between the construction product system and optional module D, which is not a part of the studied product system, is set at the system boundary between the studied product system and any subsequent product systems (see 7.1.6).			
	→ISO 21930 Requirement (§7.1.7.6): Benefits and loads beyond the system boundary in optional supplementary module D	**N/A**		

	Module D is not a life cycle stage like the life cycle stages assessed in information modules A1 to C4. Module D is outside the system boundary of the studied product system and construction works system. Module D is not an allocation approach and does not report impacts that are allocated to other product systems as a result of co-production or recovery processes. Module D provides optional supplementary information about the potential net benefits from reuse, recycling and energy recovery beyond the system boundary of the studied product system. Where relevant, optional supplementary module D information declares potential loads and benefits of secondary material, secondary fuel or recovered energy leaving the product system based on scenarios. Module D information aims at transparency for the resulting potential environmental benefits from reused products, recycled materials, secondary fuels and/or recovered energy leaving a product system and being used in a subsequent product system. Impacts from allocated co-products are not part of module D information (see 7.2.4). The information in module D may contain qualitative technical information, as well as the quantified predetermined LCA-derived parameters. The LCA results from module D **shall** always be reported separately. If module D information is included, the net output flow for all products for reuse, secondary materials, secondary fuels and/or recovered energy leaving a product system is calculated by adding all output flows of the secondary material or fuel or recovered energy and subtracting any input flows of this secondary material or fuel or recovered energy from each information module (e.g. A1 to A5, B1 to B5, C1 to C4) thus arriving at the net output flow of secondary material or fuel or recovered energy from the product system. If module D includes the result from an LCA, the following **shall** be applied. — The potential environmental loads and benefits of the net output flow are calculated by: — identifying the point of substituted functional equivalence where the secondary material or fuel or recovered energy substitutes primary production; — adding the loads associated with any further processing occurring beyond the system boundary that is required to reach the point of substituted functional equivalence; — subtracting the impacts resulting from the substituted production of the product or generation of the energy; — applying a justified correction factor to reflect the difference in functional equivalence where the processed net output flow does not reach the functional equivalence of the substituting process. — In the case of recovered energy, the average production mix **shall** be substituted, for example national average LCI for grid electricity or district heating. In cases where the substituted production primary process is not clear, as a conservative approach, the typical production mix, rather than primary product, **should** be substituted so that the benefit of recovery is not overstated. This is usually the case for electricity and heat generation. — The EPD is developed for construction products and will be part of a construction works that, in reality, will affect the recyclability potential. Even though module D deals with the future (e.g. after end-of-life of the construction product or the construction works), current practice **shall** be used for the scenario setting in order to achieve a verifiable result. If today's			

	average is not available for the quantification of potential benefits or avoided loads, a conservative approach **shall** be used.			
	→ISO 21930 Requirement (§7.1.8): Criteria for the inclusion and exclusion of inputs and outputs The criteria for the exclusion of inputs and outputs (cut-off rules) in the LCA and information modules and any additional information are intended to support an efficient calculation procedure. Cut-off rules **shall** not be applied in order to hide data. Any application of the criteria for the exclusion of inputs and outputs **shall** be documented. When impacts are assessed and reported, the cut-off rules **shall** be based on the environmental impacts related to the respective material flows. The cut-off rules **shall** be justified and documented in the EPD and project report. The following procedure **shall** be followed for the inclusion and exclusion of inputs and outputs. — All inputs and outputs to a (unit) process **shall** be included in the calculation of the pre-set parameters results, for which data are available. Data gaps **shall** be filled by conservative assumptions with average, generic or proxy data. Any assumptions for such choices **shall** be documented. — Particular care **should** be taken to include material and energy flows that are known or suspected to release substances into the air, water or soil in quantities that contribute significantly to any of the pre-set indicators of this document. In cases of insufficient input data or data gaps for a unit process, the cut-off criteria **shall** be 1 % of renewable primary resource (energy), 1 % nonrenewable primary resource (energy) usage, 1 % of the total mass input of that unit process and 1 % of environmental impacts. The total of neglected input flows per module **shall** be a maximum of 5 %of energy usage, mass and environmental impacts. When assumptions are used in combination with plausibility considerations and expert judgement to demonstrate compliance with these criteria, the assumptions **shall** be conservative. — All substances with hazardous and toxic properties that can be of concern for human health and/or the environment **shall** be identified and declared according to normative requirements in standards or regulation applicable in the market for which the EPD is valid, even though the given process unit is under the cut-off criterion of 1 % of the total mass.	V		Requirement met.
	→ISO 21930 Requirement (§7.1.9): Selection of data and data quality requirements Data quality has an influence on the content of an EPD. As a general rule, specific data derived from specific production processes **shall** be the first choice as a basis for calculating an EPD. In addition, the following rules apply. — An EPD describing a specific product **shall** be calculated using specific data for at least the processes over which the manufacturer of the specific product has influence. Generic and proxy data may be used for the processes over which the manufacturer has no influence, for example processes dealing with the production of input commodities, such as raw material extraction or electricity generation, often referred to as upstream data (see Table 3). — An EPD describing a specific product covering all life cycle stages (cradle to grave) may also be calculated using generic and proxy data for some downstream processes, e.g. waste incineration. — An EPD describing products from more than one factory or manufacturer **shall** be calculated using representative average data of the products declared by the EPD (see Table B.1).	V		Requirement met.

<table>
<tr>
<td></td>
<td>— The additional technical information for the development of scenarios of the construction works' life cycle stages shall be specific or specific average information, when an average product is declared.

Table 3 — Application of generic and specific data
<table>
<tr><td>Modules</td><td colspan="2">A1 to A3</td><td>A4 to A5</td><td>B1 to B7</td><td>C1 to C4</td></tr>
<tr><td></td><td>Production of commodities, raw materials</td><td>Product manufacture</td><td>Installation processes</td><td>Use pro-cesses</td><td>End-of-life pro-cesses</td></tr>
<tr><td>Process type</td><td>Upstream processes</td><td>Manu-facturer's processes</td><td colspan="3">Downstream processes</td></tr>
<tr><td>Data type</td><td>Generic data or EPD of upstream processes See also Annex B.</td><td>Manu-facturer's average or specific data See also Annex B.</td><td colspan="3">Scenario based generic data based on technical information given in 7.1.7.3 to 7.1.7.5.</td></tr>
</table>

The quality of the data used to calculate an EPD shall be addressed in the project report (see Clause 10 and ISO 14044:2006, 4.2.3.6). In addition, the following specific requirements apply for construction products.
— Data sets used for calculations shall have been updated within the last 10 years for background data and within the last 5 years for producer-specific (foreground) data; deviations shall be justified.
An EPD can have a period of validity for up to 5 years and it does not have to be recalculated at the end of the period of validity, if the underlying primary and secondary data have not changed significantly (see Clause 11). Thus, it is accepted that data older than 5 years may be used when the validity period of the EPD has been extended according to this document.
— Manufacturer-specific data sets shall be based on average data from 12 consecutive months; deviations shall be justified in the project report.— The time period over which inputs to and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative. A longer time period shall be used if relevant and shall be justified in the project report.
— Emissions from a landfill should be accumulated over 100 years after the material was deposited on or in the landfill.
NOTE Long-term emissions are considered emissions occurring beyond 100 years after the material was deposited on or in the landfill.
— Technological coverage shall reflect the physical reality for the declared product or product group.</td>
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<td>→ISO 21930 Requirement (§7.1.10): Units
SI units shall be used. Basic units are metre (m), kilogram (kg), metric tonne (t) and molecular weight in grams (mol). With the exceptions noted below, all resources are expressed in kg.
Exceptions are:
— the indicators RPRE and NRPRE, which are expressed as kWh or MJ, including renewable energy sources, e.g. hydropower, wind power;
— the indicators RPRM and NRPRM, which are both expressed as kWh or MJ. However, measurement of these materials as inputs, for example in the description of the product's content, are expressed in mass. Primary resources used as energy or material input shall have the same unit;
— water use, which is expressed in m3 (cubic metres);
— temperature, which is expressed in °C;</td>
<td>V</td>
<td></td>
<td>Requirement met.</td>
</tr>
</table>

	— time, which is expressed in practical units depending on the assessment scale: minutes, hours, days, years.			
	Inventory Analysis			
	→ISO 21930 Requirement (§7.2.2): Life Cycle Inventory Analysis – Calculation Procedures The calculation procedures described in ISO 14044 **shall** apply. The same calculation procedures **shall** be applied consistently throughout the study. When transforming the inputs and outputs of combustible material into inputs and outputs of energy, the net calorific value of fuels **shall** be applied according to scientifically based and accepted values specific to the combustible material.	V		Requirement met.
7.2 Inventory Analysis	**→ISO 21930 Requirement (§7.2.4): Life Cycle Inventory Analysis – Principles for allocation for co-products and allocation between product systems situations** When co-products or secondary flows crossing the system boundary are considered in any EPD study, the following principles **shall** be followed. — The inputs and outputs **shall** be allocated to the different products according to clearly stated procedures that **shall** be documented and explained together with the allocation procedure. — For all allocation situations, the sum of the allocated inputs and outputs of a unit process **shall** be equal to the inputs and outputs of the unit process before allocation. This means no double counting or omission of inputs or outputs through allocation is permitted. — Irrespective of the allocation approach chosen for a co-production process or for secondary flows crossing the system boundary between product systems, specific inherent properties of such coproducts or flows, for example calorific content, composition [biogenic carbon content, CaO/Ca(OH)2 content etc.], **shall** not be allocated but always reflect the physical flows. — Allocation to co-products **shall** respect the main purpose of the processes studied, allocating all relevant products and functions appropriately. The purpose of a plant and therefore of the related processes is generally declared in its permit and **shall** be taken into account. Where the revenue from a process is a significant reason for its existence, the proportion of revenue associated with each coproduct **should** be broadly reflected in whichever allocation approach is used for co-products. This is to avoid disproportionate allocation of impacts to co-products. — In situations where it is unclear if an output is a co-product, by-product or a waste, a conservative approach of allocating burdens to the primary product system under consideration **shall** be used. The final disposal of wastes is included in the system boundary of the process that generated them. — Consistent allocation procedures **shall** be uniformly applied to similar inputs and outputs of the system under consideration. For example, the approaches of allocation to co-products or to secondary materials crossing the system boundary between product systems **should** use the same procedure used for co-products or to secondary material flows entering the product system. — Impacts from allocated co-products **shall** not be included in module D. A conservative approach may be used for the assessment of the primary product by not allocating any environmental flows to a	V		Requirement met.

co-product and retaining all impacts within the primary product system. Where a co-product is a relevant input, then the allocation procedure **shall** be followed to understand the impacts that are allocated from the joint co-production process to the co-product. The use of upstream data that do not respect the allocation principles described in this document **shall** be — clearly identified, — subjected to a sensitivity analysis conducted and documented so as to illustrate the likely influence on the results with the upstream data used, — justified in the project report, and — as a minimum, be in line with ISO 14044 allocation rules and attributional LCA.			
→ISO 21930 Requirement (§7.2.5): Life Cycle Inventory Analysis – Allocation for co-products 7.2.5.1 General Most industrial processes produce more than the intended product. Sometimes products are coproduced with other products. As a rule, the material flows between them are not distributed in a simple way. Intermediate products and co-products, which are not required in further processes, leave the product system to become inputs for other product systems. When a unit process produces one or more co-products, which may include by-products, then it is necessary to ascertain the impact associated with the construction product that is the focus of the study. The allocation procedure set out in ISO 14044:2006, 4.3.4 deals with this situation. However, the other co-products from these unit processes can also be used as inputs or as construction products themselves. For this reason, this document has further refined the allocation procedures in ISO 14044 so that the impacts of both studied products and co-products can be calculated using the same procedure. 7.2.5.2 Co-product allocation procedure Co-product allocation **shall** be performed in the order of the following steps: — Identify whether the unit process is a joint co-production process; if each of the co-products can be produced without the other(s) or the ratio of the co-products typically varies in normal production, then it is not a joint co-production process. By-products cannot be avoided and processes producing by-products are therefore joint co-production processes. — If the unit process is not a joint co-production process, then the unit process **should** be subdivided (see 7.2.5.5) into two or more unit processes (one of which represents the studied product) having separate input and output data for each individual unit process. — If the unit process is not a joint co-production process and the unit process **should** be subdivided (see 7.2.5.5) but if respective data are not available, the inventory of the unit process under study **should** be allocated between its different products or functions in a way that reflects the underlying physical relationships between them. — In other cases, such as joint co-production processes, the inventory of the process **should** be allocated between the products and co-products in a way that reflects 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.	V		Requirement met.

— In all other cases, including joint co-production processes, where no relevant underlying physical relationships between the products and co-products can be identified, the inventory of the process **should** be allocated between the products and co-products in a way that reflects the economic value of the co-products when they leave the unit process. The economic value of the co-products may be assessed by considering the proportion of revenue generated by each co-product. The revenue is the price multiplied by the output. For both price and output, representative values **should** be identified (e.g. rolling annual averages). Prices alone are not considered to be the appropriate basis for the decision. NOTE For an example of allocation on a purely economic basis refer to ISO/TR 14049:2012, 7.3.2. Allocation on a purely economic basis **shall** not be used so as to avoid impacts to any co-products that are either produced or used in the manufacture of construction products. 7.2.5.3 Avoiding allocation generally Avoiding allocation is not a type of allocation. However, for the purposes of this document, any approach to assigning impacts to co-products, whether by allocation or by avoiding allocation, **shall** be considered as allocation and **shall** follow the principles for allocation set out in this document. 7.2.5.4 Avoiding allocation by system expansion If there is a need to calculate impact data for both products and co-products, system expansion (the approach of expanding the product system to include the additional functions related to the coproducts) is not considered as an option for avoiding allocation within EPD studies. It **shall** not be used to avoid the allocation of impacts to any co-products which are produced or used in the manufacture of construction products. 7.2.5.5 Allocation by subdivision The LCA study **shall** first identify any unit process that produce more than one product, then determine whether it is possible to divide the unit process into one or more subprocesses that each have a single output. Then separate input and output data related to these individual subprocesses can be collected. Avoiding allocation by subdivision is suitable for unit processes with co-products whose manufacture is not intrinsically linked. This may occur, for instance, when data collection is performed at a given location without going deeper into detail regarding specific processes occurring at that site, for example separate production lines or sequential manufacture of products. For these types of processes, the ratio between the co-products could be significantly altered or only one co-product produced, when required. In such cases, subdivision **shall** not be used and the co-product allocation procedure given in 7.2.5.2 **shall** be used. If a unit process is suitable for subdivision, but the required data are not available, the inputs and outputs of the unit process under study **should** be segregated into its different products or functions in a way that reflects the underlying physical relationships between them, i.e. they **shall** reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system. Such segregation **shall** be described and justified in the project report. Subdivision is more problematic for unit processes where the co-products manufactured are intrinsically linked and are true joint co-products. This is normally the case if the ratio between the coproducts cannot be significantly varied,			

for example, because they are produced from the same input material(s) and co-production is unavoidable.			
→ISO 21930 Requirement (§7.2.6): Allocation between product systems (across the system boundary) The allocation procedure for flows crossing the system boundary between product systems (allocation to recycling) is simple. No burdens are allocated across the system boundary with secondary material, secondary fuel or recovered energy flows arising from waste. There is no allocation across the system boundary between product systems with respect to secondary materials, secondary fuels or recovered energy arising from pre-consumer and post-consumer recycling. Recovery processes carry no allocated burdens and have no impact when they cross the system boundary between product systems and there is no allocation of impacts away from the studied product system to any wastes that are reused, recycled or recovered for use in subsequent product systems. Module D does not show allocated impact and is not a form of allocation as there is no allocation of burdens across the system boundary. Module D is provided as optional and supplementary information that can be used to demonstrate the potential loads and benefits associated with any net outflows of secondary material, secondary fuel or recovered energy crossing the system boundary between product systems. In this document, the rules for allocation are based on the guidance given in ISO 14044:2006, 4.3.4. However, the basic procedures and assumptions used in ISO 14044 have been refined in order to reflect the goal and scope of this document as described in detail below.	V		Requirement met.
→ISO 21930 Requirement (§7.2.7): Accounting of biogenic carbon uptake and emissions during the life cycle Bio-based materials originating from renewable resources (such as wood, linseed oil, cork or bio-based polymers) contain biogenic carbon. The mass flows to and from nature and biogenic carbon removal(s) and emissions throughout the product system **shall** be reported as a flow of biogenic carbon expressed in CO_2 in the LCI. When entering the product system (i.e. a flow to the technosphere from nature), this biogenic carbon flow **shall** be characterized in the LCIA with −1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP, since it represents a removal of carbon that is part of the carbon cycle of bio-based materials. When this bio-based material, partly or as a whole, is converted to emissions, for example, by combustion or biodegradation, it **shall** be accounted for as emitted biogenic CO_2 and other emissions such as biogenic CH_4 in the information module where they occur, depending on the end-of-life scenario. Emissions of biogenic CO_2 **shall** be characterized with +1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP. If a bio-based material containing biogenic carbon leaves the studied product system at the system boundary between product systems in information modules C1 to C4 (or any other information module), this export of bio-based material and associated flow of biogenic carbon is reported as an export of biogenic carbon expressed in CO_2 in the LCI and characterized with +1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP in the respective information module C1 to C4 (or any other information module). Similarly, any import of bio-based material into the product system as secondary fuel or secondary material is reported as an input of biogenic carbon removal(s) expressed in CO_2 in the LCI and **shall** be characterized with −1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP. For wood, biogenic carbon may be	V		Requirement met.

characterized with a −1 kg CO2e/kg CO2 biogenic carbon flow when entering the product system only when the wood originates from sustainably managed forests (see also NOTE 2 in 7.2.11). NOTE 1 The flows of biogenic carbon expressed in CO2 in bio-based materials that are reused, recycled or combusted as the end-of-life scenario will result in zero net contribution to the GWP when the GWP is considered over the whole life cycle (information modules A1 to C4), except for the part of biogenic carbon that is converted to CH4 or other emissions over the life cycle. NOTE 2 This accounting approach is valid for all information modules from A1 to C4. The amount of biogenic carbon contained within bio-based material leaving the product system **shall** be declared as technical scenario information in the module where the material is leaving the product system, irrespective of whether the environmental impacts and aspects of this module are declared. For bio-based packaging material, the quantity of biogenic carbon (expressed in kg CO2) contained within the packaging for the declared unit **shall** be documented in information module A5 as technical scenario information. For construction products, the quantity of removals of biogenic carbon (expressed in kg CO2) within the declared unit of the product (excluding packaging) **shall** be documented at the end-of-life stage in information modules C3/C4 technical scenario information. NOTE 3 The quantity of biogenic carbon contained within packaging and/or product provided as technical scenario information in information module A5 and/or modules C3/C4 will allow the correct calculation of end-of-life scenarios for the packaging and product where the module is not declared or the scenario is not appropriate for a particular construction works level assessment.			
→ISO 21930 Requirement (§7.2.8): Carbonation Carbonation is the reaction of atmospheric carbon dioxide with calcium oxide or calcium hydroxide containing products to form calcium carbonate. NOTE 1 Calcium oxide dissolved in water forms Ca(OH)2 and then reacts with the dissolved CO2. NOTE 2 Products containing calcium oxide or calcium hydroxide include hydrated lime, quick lime, mortars, screeds and all types of concrete. Environmental impacts considered during the production, use and end-of-life stages **shall** include carbonation. NOTE 3 For lime-based products, carbonation is the essential mechanism to gain strength. Carbonation takes place quickly and is complete in the early stage of the service life. The amount of carbon dioxide absorbed will equal the amount of carbon dioxide emitted from the calcium carbonate during lime production. NOTE 4 In the case of concrete, the amount of carbon dioxide absorbed depends upon the concrete surface exposed to air/ground, the concrete strength, the concrete texture and the environment to which it is exposed. Low strength, open textured and thin section concrete will carbonate fully within a few years of manufacture.	**N/A**		

	This process will start immediately after manufacture and be complete in the use stage. High performance, reinforced and fully compacted concrete will carbonate more slowly. Such concretes will not carbonate fully until they are crushed at or after the end-of-life stage. The ability to carbonate is an inherent quality of a material related to the content of calcium oxide or calcium hydroxide. Environmental benefits attributed to carbonation in a product **shall** not be allocated to co-products or secondary materials. The quantification of carbonation as a part of the GWP **shall** be based on recognized methods for the calculation of carbonation and the underlying methodology **shall** be referenced in the project report and results interpreted with respect to uncertainty of calculations. NOTE 5 Examples of recognized methods for calculation of carbonation can be found in the bibliography of this document.			
	→ISO 21930 Requirement (§7.2.9): Accounting of delayed emissions Several methodological approaches have been proposed to address delayed emissions in the quantification of the GWP, for example approaches based on discounting or approaches based on time-dependent characterization factors within a predefined reference study period. Since there is no common acceptance of these approaches, such calculations are not part of the quantification of the GWP. If a manufacturer wishes to declare quantitative or qualitative information on delayed emissions within the EPD, the information **shall** be reported under "Additional environmental information not derived from LCA" (see 9.6) and the underlying methodology **shall** be referenced.	**N/A**		
	→ISO 21930 Requirement (§7.2.10): Inventory indicators describing resource use The declaration of use of renewable and non-renewable primary resources (energy and materials), along with the use of secondary resources (secondary materials, secondary fuels and recovered energy), **shall** be derived from LCI and specified for all information modules. To provide transparency, when declaring the use of primary and secondary resources, the individual inventory indicators **shall** not be combined, aggregated or amalgamated. The following indicators **shall** be included. a) Renewable primary resources used as an energy carrier (fuel), RPRE, are (first use) bio-based materials used as an energy source. Hydropower, solar and wind power used in the technosphere are also included in this indicator. b) Renewable primary resources with energy content used as material, RPRM, are (first use) biobased materials used as materials (e.g. wood, hemp, etc.). c) Non-renewable primary resources used as an energy carrier (fuel), NRPRE, are (first use) materials such as peat, oil, gas, coal, uranium used as an energy source. d) Non-renewable primary resources with energy content used as material, NRPRM, are (first use) primary resources such as oil, gas and coal, used for products (e.g. plastic-based products). e) Secondary materials, SM, are materials recycled from previous use or waste (e.g. scrap metal, broken concrete, broken glass, plastic and wood) that are used as a material input from another product system. These include both renewable and non-renewable resources, with or without energy content, depending on the status of the material when it was originally extracted from the environment. f) Renewable secondary fuels, RSF, are renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy	V		Requirement met.

	source) in another product system (e.g. biomass residue pellets, chipped waste wood). g) Non-renewable secondary fuels, NRSF, are non-renewable materials with energy content that have crossed the system boundary between product systems and are used as fuel input (energy source) in another product system (e.g. processed solvents, shredded tyres). h) Recovered energy, RE, is energy recovered from disposal of waste in previous systems, such as energy recovery from combustion of landfill gas or energy recovered from other systems using energy sources. The quantification on the indicators RPRM and NRPRM is calculated by multiplication of the mass (kg) of the material input (or its components) with the net calorific value (lower heating value) (MJ/kg) of this input (or its components) for each functional or declared unit. The result for each indicator is a value of MJ/functional or declared unit. When the total primary energy is given in LCA tools, the indicators RPRE and NRPRE may be calculated as the difference between the total primary energy used and the primary resources used as raw material for the product. Where a product consists of a mix of renewable and non-renewable primary resources, then the NCV and the mass of each individual input material **should** be considered so that a separate value for renewable and non-renewable resources used as material is provided. NOTE These indicators are about use or inputs of resources into the product system. Outputs of secondary resources and recovered energy are considered as a separate set of indicators. Since no burdens are allocated across the system boundary between product systems with respect to secondary resources and recovered energy, they might not be itemized in the inventory for background datasets. Considering the cut-off criteria (see 7.1.8), such missing data **should** be estimated to calculate these indicators for background data or the lack of inventory **shall** be described in the project report and EPD. These indicators **shall** always be provided for the foreground system according to the cut-off criteria. The abiotic depletion potential for fossil resources (ADPfossil) **shall** be reported. It includes all fossil resource indicators (e.g. coal, oil, fossil gas) used as energy and material.			
	→ISO 21930 Requirement (§7.2.11): Greenhouse gas emissions from land-use change When significant, the greenhouse gases (GHG) emissions occurring as a result of land-use change **shall** be included in the quantification of the GWP. They **should** be assessed in accordance with internationally recognized methods such as the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. This contribution to GWP **shall** be declared separately in the EPD as GWP (land-use change) as additional environmental information, including a short interpretation of the data. The project report **shall** include an interpretation of the results reflecting the influence of data availability and the underlying methodology **shall** be referenced. NOTE 1 The consideration of GHG emissions arising from land-use change is not restricted to biogenic materials, for example in the context of deforestation or conversion of grassland to energy crops, but can also include other materials and	**N/A**		

	processes, for example related to the conversion of land to quarries, infrastructure, production plants, etc. Wood from sustainably managed forests may be accounted for as having zero emissions concerning land-use change. This includes wood products responsibly sourced and certified to the Canadian Standards Association (CSA), Forest Stewardship Council (FSC) and Sustainable Forestry initiative (SFI) Standards, as well as all other standards globally endorsed by the Programme for the Endorsement of Forest Certification International (PEFC International) and the FSC. NOTE 2 The concept of sustainably managed forests is linked but not limited to respective certification schemes. Other evidences such as national reporting under the United Nations Framework Convention on Climate Change (UNFCCC) can be used to identify forests with stable or increasing forest carbon stocks.			
	→ISO 21930 Requirement (§7.2.12): Additional inventory indicators describing emissions and removals of carbon For transparency, the following indicators on the uptake and emissions of CO2 **shall** be separately reported, where relevant and available, if included in the quantification of the GWP: — biogenic CO2, reporting the removals and emissions associated with biogenic carbon content contained within bio-based products, occurring in each module; — biogenic CO2, reporting the removals and emissions associated with biogenic carbon content contained within bio-based packaging, occurring in each module; — CO2 from calcination and carbonation, reporting the emissions and uptake of CO2 from calcination and carbonation occurring in the relevant module; — biogenic CO2, reporting the emissions from combustion of waste from renewable sources used in production processes;— CO2 emissions from combustion of waste from non-renewable sources used in production processes. These indicators enhance the transparency on the different contributions to the GWP in each module.	V		Requirement met.
	→ISO 21930 Requirement (§7.2.13): Inventory indicator describing consumption of freshwater This document uses the consumption (or net use) of freshwater as LCI indicator for declaring water consumption related to a construction product during its life cycle. This indicator **shall** be calculated in compliance with ISO 14046. The use of water, which is not consumed (e.g. water used for river transport, used to power hydroelectric turbines or used as coolant and returned to the original source), **should** not be considered within the indicator. That water which would have been lost from the original, natural system, for example from evaporation of rainwater or from a water body, **should** not be considered within the losses from the technical system studied. Evaporated freshwater is considered consumption unless it is demonstrated otherwise. For each process, the water flows **should** be identified, in terms of volume extracted, volumes discharged and the source or the destination, for example surface water, ground water, sea water. Where tap water (water from the public grid) is used, the water treatment and distribution systems **should** be included as an upstream process, which will have its own resource use and discharges. Similarly, where water is discharged to the sewer, then the sewer and water treatment system **should** be included as a downstream process with its own resource use and discharges.	V		Requirement met.

	Other water flows, for example, water that evaporates or water that is incorporated into the product, **should** ideally be itemized in the process inventory so that a full water balance can be made. For each process, the water consumed is the sum of the water that is lost from a drainage basin. This may be more easily calculated as the sum of water, which evaporates, transpires from biomass as a result of human activity (e.g. irrigation), is incorporated into products or is discharged to a different drainage basin. As previously mentioned, water consumption does not need to account for water that would have been lost from the drainage basin in the natural system before the technical system was implemented. EXAMPLE 1 Rainwater would normally be expected to drain to surface or ground water. If a factory or building is placed on the site, then water could instead be directed to the sewer and could be discharged, after treatment, to the sea, surface or ground water. Water, which is diverted through the water treatment system from its original drainage basin is consumed. If rainwater is used in the building before discharging it into the sewer, then this will be considered no differently than if the water was discharged directly to the sewer. However, if rainwater is used for cleaning and evaporates, then this water is consumed. EXAMPLE 2 For an agricultural process, water that evaporates or transpires from the plants as a result of human activity (irrigation) is considered as consumption. Water such as rainwater, which evaporates or goes to the drainage basin in the same way as if it would, were there was no agricultural process, is not consumption. The assumption is that natural vegetation would have the same effect. EXAMPLE 3 For a quarry, where dewatering takes place, if this water is returned to the same drainage basin it would naturally have drained to, then it is not consumption. If, however, it is used in a process and evaporates, then it is consumption.			
	→ISO 21930 Requirement (§7.2.14): Environmental information describing waste categories and output flows The indicators describing waste categories and other material flows are output flows derived from the LCI. The following waste categories **shall** be declared and specified for all information modules included in the EPD: — hazardous waste disposed, in kg; — non-hazardous waste disposed, in kg; — radioactive waste disposed; — high-level radioactive waste, conditioned, to final repository, in kg or m3; — intermediate- and low-level radioactive waste, conditioned, to final repository, in kg or m3. NOTE 1 Hazardous waste disposed does not include radioactive waste. NOTE 2 High-level radioactive waste, e.g., when generated by electricity production, consists mostly of spent fuel from reactors. NOTE 3 Low- and intermediate-level radioactive wastes, e.g., when generated by electricity production, arise mainly from routine facility maintenance and operations. The following output flow categories **shall** be declared and specified for all information modules included in the EPD: — components for reuse;	V		Requirement met.

— materials for recycling, i.e. secondary material for use in the next product system;
— materials for energy recovery, i.e. secondary fuels for use in the next product system;
— recovered energy exported from the product system.
Table 4 shows how to assign output flows at the construction product's end-of-life to information modules C1-C4 (see also Table 1). Output flows from other information modules **shall** be assigned to the information modules where they occur.

Table 4 — Assignments of output flows at the construction product's end-of-life

Type of flow	Fate	Material specifications	Unit	Exits the system boundary from			Comments
				C1	C3	C4	
Material flows reached the boundary between product systems (see 7.1.6)	Components for reuse[a]	Type 1	kg				Reused components to be declared in C1. If the component needs processing before reuse, then it will be declared in C3.
		Type n	kg				
	Materials for recycling used in the next product system[a]	Type 1	kg				Output of secondary material to be declared in C3. If the material reaches the system boundary between product systems when collected at the construction site, it is declared in C1.
		Type n	kg				
	Material for energy recovery used as secondary fuels in the next prod-uct system[a]	Secondary fuel 1, with NCV	kg				Output of renewable secondary fuels or non-renewable secondary fuels to be declared in C3 (assuming processing in C3 to create secondary fuel). NCV of any net output of secondary fuels to be provided.
		Type n, with NCV	kg				
Material flows have not reached the system boundary between product systems (see 7.1.6) or material converted to energy within the system boundary	Exported energy from waste with energy recovery ≥ 60 % efficiency[a]	Energy Type 1	MJ				Electricity and/or heat from energy recovery processes to be declared in C3. (Waste from energy recovery processes within the system boundary are considered below.)
		Energy Type n	MJ				
	Incineration of waste with energy recovery <60 % efficiency	Waste disposed 1[b]	kg				Waste disposed is the input of waste into the incinerator. Any output of recovered electricity and/or heat from waste incineration to be declared in C4. (Waste generated by incineration processes within the system boundary, see below.)
		Waste disposed n[b]	kg				
		Energy Type 1[a]	MJ				
		Energy Type n[a]	MJ				
	Wastes disposed in landfill and where rele-vant energy recovered from landfill gas	Waste disposed 1[b]	kg				Waste entering landfill to be declared in C4[b].
		Waste disposed n[b]	kg				
		Energy Type 1[a]	MJ				Energy recovered from landfill gas to be declared in C4[a] as exported energy.
		Energy Type n[a]	MJ				

a Potential loads and benefits from net outflows may be considered in module D.
b **Shall** not be considered in module D.

NOTE 4 The indicators in Table 4 are calculated on the net amounts leaving the system boundary if they have crossed the system boundary between product systems, as described in 7.1.7.5.

NOTE 5 The declaration of "components for reuse" and "materials for recycling" fulfils the conditions of 7.1.7.5.

	NOTE 6 The indicator "material for energy recovery" does not include materials for waste incineration. Waste incineration is a method of waste processing and is assigned within the system boundary. Waste incineration plants have a lower energy efficiency rate than power stations using secondary fuels. Materials for energy recovery are based on thermal energy efficiency rate of the power station not less than 60 %. NOTE 7 Recovered energy relates to energy exported from waste incineration and landfill.			
	Impact assessment indicators describing main environmental impacts derived from LCA			
7.3 Impact assessment indicators describing main environmental impacts derived from LCA	**→ISO 21930 Requirement (§7.3): Impact assessment indicators describing main environmental impacts derived from LCA** An EPD developed using this document **shall**, as a minimum, report the set of impact categories stated in Table 5. In order to evaluate and use EPDs at a construction works level in a particular market or geographical location, the life cycle impacts (LCIA) indicators that are reported in the EPD **shall** be based on characterization factors recommended by a programme operator and suitable for the market(s) and geographical location(s) where the EPD is intended to be used. For European-market EPDs developed with this document as the core PCR, the characterization method included in the latest edition of EN 15804 **shall** be used. The EPD results **shall** be developed using one of the relevant, commonly used characterization methods. In the absence of specificity or preference regarding a characterization method, the default references provided in Table 5 **shall** be used. Values reported for GWP are based on accumulated radiative forcing over 100 years. Impact category results may be provided using more than one characterization method including the default references. Results **shall** be reported separately for each method that is used. Impact category results may be reported that are in addition to those minimum results mandated in Table 5 (see also 8.2). Scientifically developed characterization methods **should** be used for these additional indicators. In order to evaluate and use EPDs at a construction works level, the impact categories relevant for that particular market **shall** be used. A sub-category PCR may specify additional impact categories to be reported for a given product group based on market, regulatory and other relevant and applicable factors. ADPelement is optional (see 8.2) as there is great uncertainty related to characterization factors. ADPelement includes all non-renewable material resources (e.g. minerals, uranium, sulphur) used as energy and material resource. NOTE 1 The comparability of EPDs with different impact categories reported is limited (see 5.5). NOTE 2 Characterization factors of the Default International Characterization Method are publicly available on http:// cml .leiden .edu/ software/ data -cmlia .htm NOTE 3 It is considered good practice to identify any LCI data that has no calculated environmental impact within the project report. This can help to identify the need to generate complementary and consistent characterization factors for relevant LCI flows.	V		Requirement met.

Impact category and abbreviation	Default international characterization method	Default North American market characterization method	Default European market characterization method as provided in
Global warming potential (GWP 100)	IPCC[30]	TRACI	EN 15804
Ozone depletion potential (ODP)	WMO[34]	TRACI	EN 15804
Eutrophication potential (EP)	Heijungs et al.[31]	TRACI	EN 15804
Acidification potential (AP)	Hauschild and Wenzel[32]	TRACI	EN 15804
Photochemical oxidant creation potential (POCP)	Goedkoop et al.[41]	TRACI	EN 15804

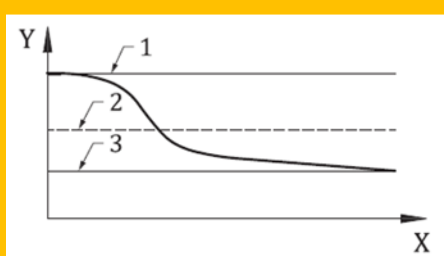
8.1	**Additional Environmental Information - General**			
	→ISO 21930 Requirements (§8.1) Additional Environmental Information - 8.1 General An LCA **should** consider all significant aspects related to the product during its life cycle. Significant environmental aspects that are not covered by the LCA **shall** be reported in the EPD, where relevant, as additional environmental information. Such information may be either qualitative or quantitative information related to the product's life cycle (see ISO 14025:2006, 7.2.3) and **shall** be verifiable and comply with the requirements stated in ISO 14025:2006, 7.2.4. Significant quantitative aspects not currently covered by LCA include measures still under development that may at some time in the future be included in pre-set LCIA indicators as outlined in 8.2. Other significant aspects, whether qualitative or quantitative, are outlined in 8.3. In markets where the emission of dangerous substances are regulated, this information is a mandatory part of additional environmental information as outlined in 8.4.	V		Requirement met.
8.2	**Additional LCA-related environmental information not included in the pre-set LCIA indicators**			
	→ISO 21930 Requirements (§8.2) Additional LCA-related environmental information not included in the pre-set LCIA indicators An EPD based on the core rules according to this document may also address additional environmental information that is not part of the pre-set LCIA indicators. This may include impact categories that are still under development or have high levels of uncertainty that preclude international acceptance pending further development. Such potential LCIA categories **shall** follow the requirements for characterization models given in ISO 14044. The following are examples of such potential impact categories: — abiotic depletion potential for non-fossil mineral resources (ADPelements); — land-use-related impacts, for example on biodiversity and/or soil fertility; — toxicological aspects.	V		Requirement met.

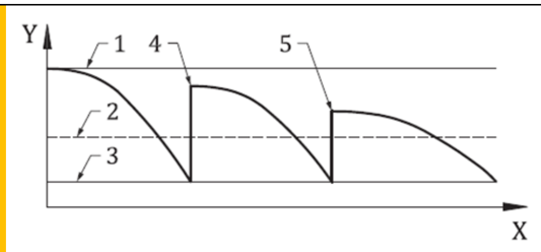
	If such LCIA-type results are included in an EPD, the LCA report and the EPD **shall** include a written discussion of the results, including the limitations related to the LCIA-type methods used. This requirement also applies to the development of sub-category PCR. NOTE 1 The same release scenario of emissions from construction products used here can also be linked to the LCA scenario development in the relevant modules.			
8.3	**Additional environmental information not derived from or related to LCA**			
	→ISO 21930 Requirements (§8.3) Additional environmental information not derived from or related to LCA The environmental information included here may be qualitative with a clarifying text if quantitative methods are not available. Examples of environmental aspects that may be included in the EPD are: — geographical aspects relating to the declared environmental impacts at any stages of the life cycle; — environmentally responsible sourcing; — best environmental practice; — energy use for operating pollution control systems; — toxicity risks or hazards related to human health and/or the environment. NOTE 1 Possible methods for assessing and reporting toxicity risks or hazards related to human health and/or the environment are provided in Annex C. Additional environmental issues are not limited to the above list or an indicator result. ISO 14025:2006, 7.2.3 provides a more detailed list of examples for additional environmental information. This additional information **shall** be verifiable and any document supporting the claims **shall** be made available for the verifier. EXAMPLE 1 The interpretation of the relation between the potential environmental impact(s) and the location of the relevant processes of the product system. EXAMPLE 2 Forestry certification systems (PEFC, SFI or FSC) and responsible mining or quarrying systems (for information relating to environmentally responsible sourcing). EXAMPLE 3 Adherence of the manufacturing organization to ISO 14001, Type I Environmental labels or other environmental labels (for best environmental practice).	V		Requirement met.
8.4	**Mandatory additional environmental information**			
	→ISO 21930 Requirements (§8.4) Mandatory additional environmental information 8.4.1 Content of regulated hazardous substances In any EPD, the declaration of material content of the finished product **shall** list, as a minimum, the substances contained in the construction product that are identified as hazardous according to normative requirements in standards or regulations applicable in the market for which the EPD is valid (see Annex D)..Substances with certain hazardous properties can be of concern for human health and/or the environment. Such substances are identified and subsequently regulated to make sure that the risks associated with these substances are properly controlled.	V		Requirement met. There are no known regulated hazardous substances.

	8.4.2 Release of dangerous substances from construction products In markets where the release of dangerous substances is regulated, such information is a mandatory part of additional information required about health and environmental aspects. The methodology and reporting format **shall** be declared according to standards applicable in the market for which the EPD is valid. Different risk-based methods are available for assessing safety and toxicological performance of construction products, with the intention of reducing release of dangerous substances and even replacing them with less harmful alternatives by applying limit values. Falling below such limit values means that a product is safe to use in the intended use situation. This information may also be provided as labels relevant, and accepted, in specific markets. See Annex C for basic examples of such risk-based approaches applicable for EPDs that include, but are not limited to — emission into indoor air, — emitted gamma radiation or ionizing radiation, and — chemicals released to air or leached to water and soil. When developing sub-category PCR, requirements **shall** be given on the measurement of releases of dangerous substances from construction products, where relevant for the construction product and its application, using harmonized test methods when possible.			
10.	**Project Report**			
	→ISO 21930 Reporting Requirements (§10.1) Project Report - General The manufacturer and/or programme operator **shall** provide the EPD project documentation and the EPD to the verifier. The project documentation contains basic data and supporting information necessary for the EPD project as specified in Clause 7. The project report is the systematic and comprehensive summary of the project documentation supporting the verification of an EPD. The project report **shall** record that the LCA-based information and the additional information as declared in the EPD meet the requirements of this document. The project report **shall** be made available to the verifier with the requirements on confidentiality stated in ISO 14025. The project report is not part of the public communication. The project report **shall** contain any data and information of importance to the results published in the EPD and as required by this document. The report **shall** demonstrate in a transparent way that the data and information declared in the EPD result from the LCA study and how the RSL has been established. NOTE In this context, project means the LCA study on the primary product.	V		Requirement met.
	→ISO 21930 Reporting Requirements (§10.2) LCA-related elements of the project report The results, data, methods, assumptions, limitations and conclusions of the LCA **shall** be completely and accurately reported without bias. They **shall** be reported in a transparent manner and presented in sufficient detail to allow independent verification and to permit an understanding of the complexities	V		Requirement met.

	and trade-offs inherent in the LCA. The report **should** also allow the results and interpretation to be used in support of the data and additional information made available in the respective EPD. The project report **shall** state the following: a) General aspects: — commissioner of the LCA study, internal or external practitioner of the LCA study; — date of report; — statement that the study has been conducted according to the requirements of this document. b) Goal of the study: — reasons for carrying out the study and its intended application and audience, i.e. providing information and data for an EPD for B2B and/or B2C communication. c) Scope of the study: — declared/functional unit, including: — definition, including relevant technical specification(s); — calculation rule for averaging data, for example when the declared/functional unit is defined for: — a group of similar products produced by different suppliers, or — the same product produced at different production sites. — system boundary according to the modular approach as outlined in Figure 2 including: — omissions of life cycle stages, processes or data needs; — quantification of energy and material inputs and outputs, taking into account how plant-level data are allocated to the declared products; — assumptions about electricity production and other relevant background data. — cut-off criteria for initial inclusion of inputs and outputs, including: — description of the application of cut-off criteria and assumptions; — list of excluded processes. d) LCI: — qualitative/quantitative description of unit processes necessary to model the life cycle stages of the declared unit, taking into account the provisions of ISO 14025 regarding data confidentiality, — sources of generic or proxy data or literature used to conduct the LCA; — validation of data and discussion considering the dimensions of data quality set out in ISO 14044:2006, 4.2.3.6 including: — data quality assessment, — treatment of missing data; — allocation principles and procedures including: — documentation and justification of allocation procedures, — uniform application of allocation procedures. e) LCIA: — the LCIA procedures, calculations and results of the study; — the relationship of the LCIA results to the LCI results; — reference to all characterization models, characterization factors and methods used, as defined in this document; — a statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceedance of thresholds, safety margins or risks. f) Life cycle interpretation: — the results; — assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related;			

	— data quality assessment; — full transparency in terms of value-choices, rationales and expert judgements.			
	ISO 21930 Reporting Requirements (§10.3) Rules for data confidentiality Product-specific data are very often confidential because of — competitive business issues, — intellectual property rights, or — similar legal restrictions. It is not a requirement to make such confidential data publicly available. Confidential business data provided for the independent verification process **shall** be kept confidential upon request of the body supplying the data and with the approval of the programme operator, in accordance with programme operational rules; see ISO 14025:2006, 8.3.	N/A		
	→ISO 21930 Reporting Requirements (§10.4) Data availability for verification The project report **shall** include any documentation on additional environmental information declared in the EPD as required in this document. Such documentation on additional environmental information may include, for example as copies or references: — laboratory results or measurements for the content declaration; — laboratory results or measurement of functional or technical performance; — documentation on declared technical information on life cycle stages that have not been considered in the LCA of the construction product and that will be used for the assessment of construction works (e.g. transport distances, RSL according to Annex A, energy consumption during use, cleaning cycles, etc.); — laboratory results or measurements for the declaration of emissions to indoor air, soil and water during the product's use stage.	N/A		
	→ISO 21930 Reporting Requirements (§10.5) Documentation on additional environmental information To facilitate verification, it is considered good practice to make the following information available to the verifier, taking into account data confidentiality: — analysis of material and energy flows to justify their inclusion or exclusion; — quantitative description of unit processes that are defined to model processes and life cycle stages of the declared unit; — attribution of process and life cycle data to datasets of an LCI database (if used); — LCIA results per modules of unit processes, for example structured according to life cycle stages; — LCIA results per production plant or product, if average data are declared from several plants or for a range of similar products; — in the case where an EPD is declared as an average environmental performance for a number of products, a statement to that effect **shall** be included in the declaration according to Annex B. This **shall** be provided together with the information required in 5.3; — documentation that substantiates the percentages or figures used for the calculations in the end-of-life scenario; — documentation that substantiates the percentages and figures (number of cycles, prices, etc.) used for the calculations in the allocation procedure, if it differs from this core PCR.	N/A		
Annex A	**Annex A RSL & ESL Guidance**			

→ISO 21930 Requirements (§Annex A) Requirements and guidance on the RSL and ESL A RSL can only be determined for a cradle to grave EPD or a cradle to gate EPD with options where modules A1 to A5 and B1 to B5 have been provided. If the service life is declared, then the following principles **shall** apply. — The RSL of a product can be based upon empirical, probabilistic, statistical, deemed to satisfy or research (scientific) data and **shall** always take into account the intended use (description of use); see ISO 15686-1, ISO 15686–2, ISO 15686–7 and ISO 15686–8. This basis **shall** be reported in the EPD. — A manufacturer providing the RSL for a product **shall** take into account and describe in the EPD the intended use, declared functional performance and the scenario(s). Considering the specific in-use conditions linked to the scenario(s) defined, the estimated service life **shall** be transparent to allow for verification. A declared RSL **shall** be related to the declared functional technical performance and to any maintenance or repair necessary to provide the declared performance during the declared RSL or provided ESL. The declared technical performance may be based on specifications for determination or calculation of this performance given in the relevant product standards. These performances may be defined as initial, average or minimum levels. See Figures A.1 and A.2. NOTE 1 The declared technical performance could be the input for calculations beyond this document. However, the outcome, in terms of RSL, will be input for the requirements in this document. NOTE 2 The manufacturer or producer of the construction product cannot be held responsible for the actual design of the construction works, the use and application of the product, the environment, workmanship or use. EXAMPLE The thermal performance of a window, insulation, a heating boiler, etc., will impact on the energy use of the building in the use stage. This energy use, its emissions and waste contribute to the environmental aspects and impacts of the building in the use stage. The RSL of the window, insulation, the heating boiler, etc., are linked to the product's performance in order to provide consistency in the calculation model.  Key X RSL Y functional performance 1 initial 2 average 3 minimum Figure A.1 — Type of declared technical and functional performance and RSL	**N/A**		



Key
X RSL
Y technical and functional performance
1 initial
2 average
3 minimum
4 maintenance or repair
5 maintenance or repair
Figure A.2 — Type of declared technical and functional performance, repair or maintenance during RSL

The RSL is dependent on the properties of the product and reference in-use conditions. These conditions **shall** be declared together with a RSL and it **shall** be stated that the RSL only applies to these reference in-use conditions.
The description of the technical and functional performance of a product is required for the technical specification of a construction product. The reference in-use conditions for achieving the declared technical and functional performance and the declared RSL **shall** include the following, where relevant:
— RSL expressed in years;
— declared product properties (at the gate) and those of any finishes, etc.;
— design application parameters (if instructed by the manufacturer), including references to any appropriate requirements and application codes;
— an assumed quality of work;
— external environment (for outdoor applications), e.g. weathering, pollutants, UV and wind exposure, construction works orientation, shading, temperature;
— internal environment (for indoor applications), e.g. temperature, moisture, chemical exposure;
— usage conditions, e.g. frequency of use, mechanical exposure;
— maintenance, e.g. required frequency, type and quality and replacement of replaceable components.
The RSL of a construction product (e.g. a window) declared in an EPD is dependent on the service life of its individual components (handle, hinge, etc.) and may be determined by the component with the lowest service life. It also depends on whether the single components of the construction element are replaceable or repairable.
RSL data is normally based on direct testing or both direct and indirect data acquisition (see ISO 15686-2, ISO 15686-8 and ISO/TS 15686-9). Direct data acquisition may be based on:
— field exposure;
— inspection of construction works and their components;
— experimental construction works;
— in-use exposure.
In some cases, for products for which direct data are not available, indirect methods may be used for establishing RSLs:
— correlated to data for existing products of a similar type with similar functions having similar use and exposure conditions;

	— comparative data obtained by testing the products of a similar type and similar function for similar uses and exposure conditions, in accordance with product test standards. NOTE 3 ISO/TS 15686-9 refers to procedures that can be divided into two groups, direct and indirect tests. Direct testing: the achievement of a certain level of performance in a test of a particular property is recognized as being direct evidence of the maximum period of useful life expected as defined by the manufacturer (e.g. abrasion, fatigue, closing and impact tests). Indirect (proxy) testing: the measurement of "proxy" characteristics that can be correlated to actual performance and hence service life (e.g. porosity for freeze-thaw resistance and hardness for abrasion resistance). Tests may be either: — natural weathering/ageing tests, which either give a direct indication of service life (e.g. corrosion tests) or enable normal performance tests to be carried out after treatment, thus allowing the likely degradation under in-use conditions to be determined, or — accelerated weathering/ageing tests, in which the normal ageing process is speeded up to reduce the duration of the test. Care is needed to ensure that degradation mechanisms are just accelerated and not significantly altered in such tests. Tests may be long-term or short-term or a combination of both. Long-term tests may include: a) field exposure; b) exposure in experimental construction works. Short-term tests may include: a) accelerated short-term tests; b) short-term in-use exposures.			
Editorial Comments	**Editorial Comments**			
	pp. 3,4 - Table 1 – many of the descriptions are marketing hype vs. physical and functional information. Remove any hyperbolic or non-scientific terminology such as "eco-friendly" and "The good life just got better".	OFI	V	Product descriptions revised
	p. 3 – update ISO 14044 reference: ISO 14044: 2006/Amd 1:2017/Amd 2:2020 Environmental Management – Life cycle assessment – Requirements and Guidelines.	OFI	V	Reference updated
	p. 3 – update TRACI URL: https://www.epa.gov/chemical-research/tool-reduction-and-assessment-chemicals-and-other-environmental-impacts-traci	OFI	V	Reference updated
	p. 18 – Move title "Product End of Life" to the next page.	OFI	V	Pagination corrected