SCS Global Services
Final Report

Life Cycle Assessment of Industry-Wide Cold Formed Steel Products

Prepared for:

SFIA
STEEL FRAMING INDUSTRY ASSOCIATION

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Prepared by:
Tess Garvey | Life Cycle Assessment Practitioner
Life Cycle Services
+1.510.495.6059
tgarvey@SCSglobalServices.com

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Table of Contents

1. General Objective and Description

This report presents the findings of the Life Cycle Assessment (LCA) conducted by SCS Global Services (SCS) of cold formed steel products (henceforth referred to as "CFS products"), falling under the AISI Standards S220 and S240 categorization. This LCA addresses the environmental aspects and potential environmental impacts throughout a product's life cycle. Descriptions of the CFS products included in the LCA scope are provided in Table 1.

Table 1. Products included in the LCA scope.

Product	Description
CFS products	Cold-formed steel studs, track, joists, rafters, straps, and trusses are made from coated steel that meets the requirements of AISI Standards S220 and S240 and complies with the SFIA Code Compliance Certification Program. The steel for the stud and track sections is produced in North America using a mix of both BOF (Basic Oxygen Furnace) and EAF (Electric Arc Furnace) steel making processes.

2. Goal of the Study

This report presents the findings of the Life Cycle Assessment (LCA) conducted by SCS Global Services (SCS) for the Steel Framing Industry Association (SFIA). The scope of products in this EPD includes structural and nonstructural framing components for walls, floors, and roofs composed of hot-dipped galvanized cold-formed steel members, and flat straps used for bracing. A non-exhaustive list of cold-formed steel members include C-shape studs, joists, rafters, or truss components; channel and furring; and angle or L-headers. The products modeled in this study are manufactured in ten facilities across North America.

The goals of the study include two primary objectives:

1. To assess the potential environmental impacts, use of resources, and generation of waste for the CFS products from cradle-to-gate – extraction of raw materials and processing, including all activities necessary for the production of steel products.
2. To serve as the basis for preparing an Industry-wide Environmental Product Declaration (EPD) conformant to the UL Product Category Rule for Designated Steel Construction Products[1] (henceforth referred to as "the PCR"), which is consistent and complies with ISO-21930[2], ISO-14025[3], ISO-14040[4], and ISO-14044[5].

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[1] Product Category Rule for Building-Related Products and Services. Part B: Designated Steel Construction Product EPD Requirements. UL. August 31, 2020.

[2] ISO-21930: 2007 Sustainability in building construction – Environmental declaration of building products

[3] ISO-14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures

[4] ISO-14040: 2006/AMD 1:2020 Environmental management – Life cycle assessment – Principles and framework

[5] ISO-14044: 2006/AMD 1:2017/AMD 2:2020 Environmental management – Life Cycle Assessment – Requirements and guidelines

Life Cycle Impact Assessment (LCIA) results are reported using the indicators prescribed by the PCR and based on TRACI 2.1 characterization methodologies. 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 LCA study scope, methodology, data sources, assumptions, and limitations, used to calculate final indicator results developed for the EPD are described in this report. The following life cycle stages are included: raw material extraction and processing; transport to manufacturer; and stud and track manufacture.

The intended audience for this technical LCA report includes SFIA, the critical reviewer, the EPD verifier, and other LCA practitioners or technical audiences with which SFIA choses to share the report. The report is intended for business to business (B2B) communication. Results presented are not intended for use in comparative assertions. This report has been critically reviewed by an external LCA practitioner independent of the project for conformance to the PCR, ISO 14044 and ISO 21930:2017.

3. Study Parameters

3.1 Functions of the Product System and Function Unit

The CFS products can be used in a variety of applications for interior wall, exterior wall, roof and floor framing. In accordance with the PCR, a declared unit is used in lieu of the functional unit as this LCA study does not cover the complete life cycle. The declared unit is one metric ton of steel products. The CFS products are manufactured from the same materials, in the same facilities and using the same machinery, and so the products are considered under the same product category. The reference flow for the modeling of this system is one metric ton of products.

Table 2. Declared unit for the assessed CFS products.

Parameter	CFS product	Unit
Declared unit	1	metric ton
Density	7,769 to 7,849	kg/m^3

Example images of the CFS products included in the LCA are shown in Figure 1.

Figure 1. Example product images for CFS products

3.2 System Boundary

The system under study includes the extraction of raw materials and processing, including all activities and transport necessary for the production of steel product at the member manufacturing facilities. The cradle-to-gate system boundary includes all unit processes contributing measurably to the category indicator results and is represented by the product stage, which is comprised of three information modules (A1-A3), in accordance with the PCR.

The information module approach (described in ISO 21930 and EN 15804:2012[6]) has been adopted by the PCR to define the product life cycle stages and is described relative to the LCA study in Table 3. The deletion of life cycle stages, processes, inputs, or outputs is permitted since it is not expected to significantly change the overall conclusions of the study.

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[6] EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

Table 3. Life cycle stages included in the system boundary. MND = Module Not Declared.

Module	Module description from the PCR	Included in System Boundary
A1	Raw material extraction and processing, including all activities necessary for the reprocessing steel scrap, including but not limited to the recovery or extraction and processing of feedstock materials. This stage also includes BOF and EAF Steelmaking.	✓
A2	Transportation from primary production to CFS product forming facilities	✓
A3	Manufacture of CFS products and packaging materials.	✓
A4	Transport (to the building site)	MND
A5	Construction-installation process	MND
B1-B5	Use stage, including maintenance, repair, replacement, and refurbishment	MND
B6	Operational energy use	MND
B7	Operational water use	MND
C1	Deconstruction, demolition	MND
C2	Transport (to waste processing)	MND
C3	Waste processing	MND
C4	Disposal	MND
D	Reuse-recovery-recycling potential	MND

The major individual unit processes that make up each module of the product stage are shown in Figure 2.

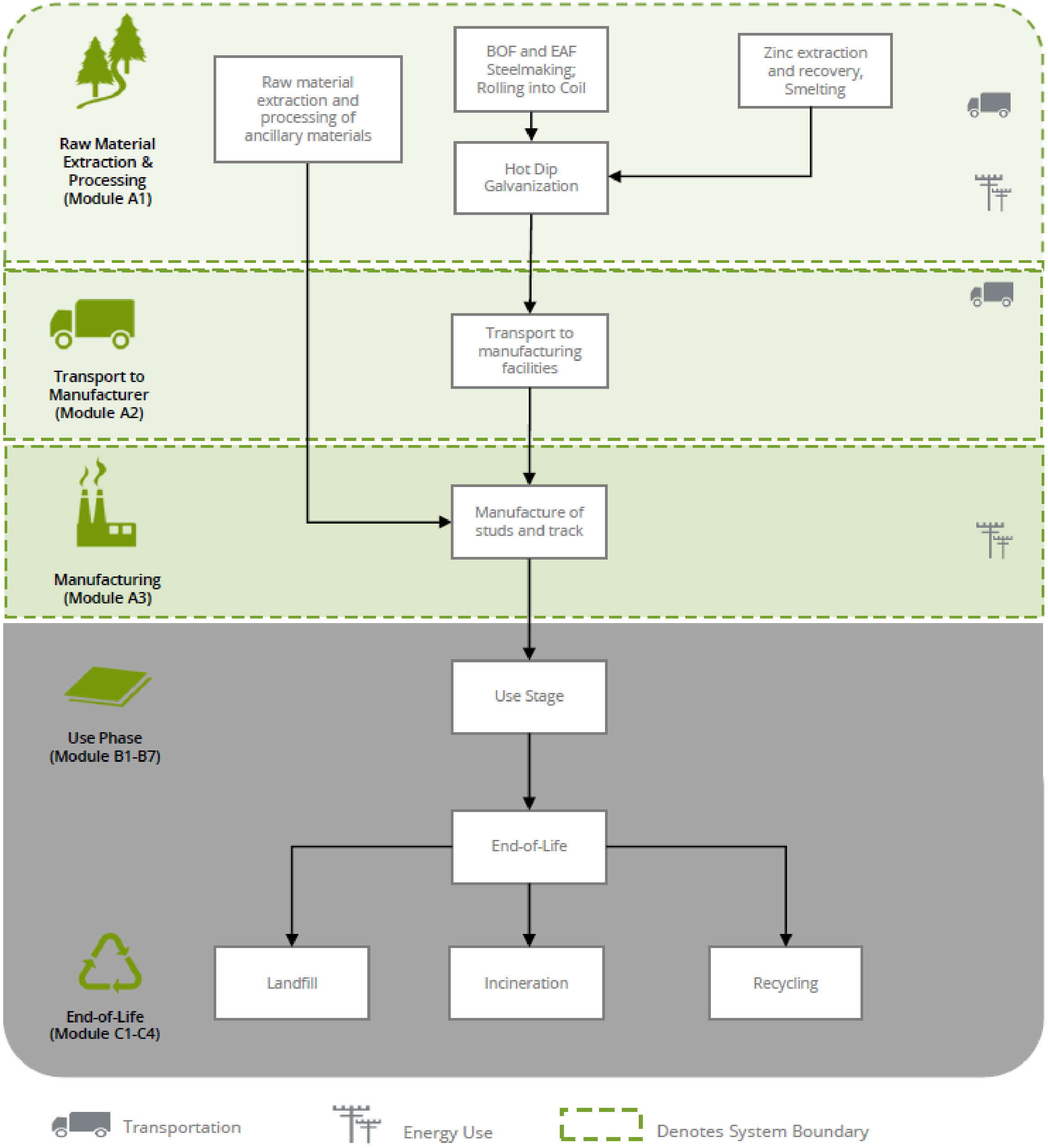

Figure 1. Flow diagram representing the major processes in the product stage of CFS products.

3.3 Product Descriptions

The CFS products in this study are used in various framing applications. The facilities produce CFS products conformant with AISI Standards S220 and S240 and complies with the SFIA Code Compliance Certification Program. The products fall under the UNSPSC classifications: 05 40 00 Cold-formed Metal Framing and 09 22 16 Nonstructural Metal Framing.

3.4 Product Composition

Based on the mass of steel from the LCI report for steelmaking[7], the HDG used contains less than 1% of zinc and over 99% steel.

3.5 The Product System Under Study

The cold formed steel products included in this study are manufactured by ten companies in their respective facilities throughout North America from hot dip galvanized steel (HDG). Galvanized steel coil is unloaded onto an uncoiler, slit, fed into a rollformer in which an oil-based lubricant may be applied. In the rollformer the studs, track and other accessories are formed. The products are packaged using wood or plastic banding, plastic sheeting, and wood and lumber products.

The HDG is produced in steelmaking facilities using both basic oxygen furnace (BOF) and electric arc furnace (EAF) steelmaking across North America. The transport of materials to the manufacturing facilities is based on primary data on the transport distance and mode of transport for steel transported to the manufacturing facilities.

Primary data for CFS products manufacturing was collected from each of the ten companies for one of their manufacturing facilities. The facilities were chosen based on their geographical representativeness. The facilities are located in the following eGRID subregions: CAMX, NWPP, ERCT, RMPA, SRSO, SRVC, FRCC, RFCM and RFCW. The electricity supply mixes for the manufacturing facilities are modeled using ecoinvent electricity grid and modified for the eGRID subregions. The electricity for the one facility located in Mexico was modeled using national ecoinvent electricity dataset without modification. Electricity and resource use at the manufacturing facilities is allocated to the CFS products based on product mass.

Data for steelmaking is taken from the Sphera report on Steelmaking in North America[8], produced for AISI.

3.6 Data Requirements

The LCA study included several key data requests:

- Product density,
- Product material composition,

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[7] Sphera, 2020, “Life Cycle Inventories of North American Steel Products.”
[8] Ibid.

- Resource use (e.g., electricity, natural gas, water, etc.), waste/co-products generation, and emissions released at the CFS products manufacturing facilities,
- Production data for the manufacturing facilities,
- Primary data for CFS products manufacturing facilities,
- Scrap rate for manufacturing of CFS products, and
- Representative inventory data for several unit processes with a preference for data from the Ecoinvent[9] life cycle database.

3.7 Allocation Procedures

This study follows the allocation guidelines of ISO 14044 and allocation rules specified in the PCR and minimized the use of allocation wherever possible.

With respect to the steel scrap, the 100-0 recycled content approach is used in which the recycled material bears only the burden of any processing from waste material.

Mass allocation was deemed the most accurate and reproducible way of calculating the energy and material requirements for the manufacture of the CFS products. Primary data for resource use (e.g., electricity, natural gas, water), wastes, and emissions released, are allocated on a mass-basis as a fraction of total annual production. The data taken from the Sphera report are all those which use physical (mass-based) allocation of the co-products. Some datasets used within the Sphera report are taken from GaBi and may use system expansion.

The transportation from steel producer to the CFS product manufacturing facilties is based on primary data provided by the manufacturers, including modes, distances, and amount of steel transported. Transportation was allocated on the basis of the mass and distance the material was transported.

3.8 LCIA Methodology and Interpretation Used

LCIA methodologies are used to relate the LCI results to the associated environmental impacts, where the LCI results are classified within impact categories, each with a category indicator. The choice of methods and indicators used in the assessment are based on the requirements of ISO 14044 and the relevant 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

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[9] Ecoinvent v3.7.1 Weidema, B.P.; Bauer, Ch.; Hischier, R.; Mutel, Ch.; Nemecek, T.; Reinhard, J.; Vadenbo, C.O.; Wernet, G, 2020, The ecoinvent database: Overview and methodology, Data quality guideline for the ecoinvent database version 3, www.ecoinvent.org

with the product system. Additionally, the environmental relevance of LCIA results is not affected by LCI functional unit calculation, system wide averaging, aggregation and allocation.

Within LCIA, two approaches of characterization may occur along the environmental pathway of an impact indicator: midpoint approach and endpoint approach. Characterization at the midpoint level models the impact using an indicator located somewhere along the methodology mechanism prior to the endpoint categories; while characterization at the endpoint level requires modeling through to the endpoint categories described by the areas of protection (primarily ecosystem quality, human health and resources). In addition to differences according to environmental modeling approach (midpoint and endpoint), other differences among LCIA methodologies include the number of impact categories, and substances, covered by each methodology, as well as temporal and geographic variations in characterization data used. In the current study, impact category indicators are estimated using the TRACI 2.1[10] characterization methodologies.

TRACI (Tool for the Reduction and Assessment of Chemical and other environmental Impacts) is a midpoint-oriented methodology developed by the US Environmental Protection Agency (US EPA), with the aim of assisting in the impact assessment of process designs and achieving pollution prevention. The midpoint impact categories considered in the methodology include: Ozone depletion, global warming, smog formation, acidification, eutrophication, human health cancer, human health non cancer, human health criteria pollutants, eco-toxicity, and fossil fuel depletion. The impact categories were selected and characterized based on the data and information from the U.S. EPA. No weighting method is embedded in the methodology. The regional validity for the methodology impact categories is appropriate to US, although global impact categories. such as ozone layer depletion and global warming, are also considered.

The LCA conforms to ISO 14040/44 and the UL Product Category Rule for the category of Designated Steel Construction Products. Impact category indicators are estimated using TRACI 2.1 characterization factors. The impact indicators considered for the assessment include:

- Potential for Global Warming,
- Acidification Potential,
- Eutrophication Potential,
- Photochemical Ozone (Smog) Creation Potential,
- Ozone Depletion Potential,
- Fossil Fuel Depletion Potential[11],

Note that for global warming calculations, the TRACI 2.1 global warming characterization factors are based on IPCC 2007. Note also that this characterization method does not include biogenic carbon uptake or biomass CO_2 emissions. Based on the component materials of the product and production

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[10] Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Dr. Bare, J., http://www.epa.gov/nrmrl/std/traci/traci.html

[11] TRACI 2.1 only

processes, there are no impacts associated with land-use changes, nor are environmental impacts associated with carbonation relevant for the product system. Biogenic carbon uptake and biomass CO_2 emissions are not relevant for the product system.

The impact category indicators included in the assessment are described below in Table 4

Table 4. Description of impact categories.

Category Indicator	Units	Impact Category and Environmental Mechanism
Global Warming Potential of GHGs over 100 years (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.[12]
Ozone Layer Depletion (ODP Steady State) (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. Chlorofluorocarbons (CFCs), halons and hydrochlorofluorocarbons (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.
Photochemical Oxidant Creation Potential (POCP)	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), sulphur 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 sulphuric 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 sulphur 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.

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[12] Stocker, T.F., et al. 2013: Technical Summary. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Category Indicator	Units	Impact Category and Environmental Mechanism
		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.
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 takes into account 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.
Abiotic Depletion (elements) (ADPE)	kg Sb eq	This impact category refers to the consumption of non-biological resources such as minerals and metals. The value of the abiotic resource consumption of a substance is a measure of the scarcity of a substance and depends on the amount of resources and the extraction rate. The indicator is calculated as the amount of resources that are depleted and measured in antimony equivalents for mineral depletion.
Abiotic Depletion (fossil fuels) (ADPF)	MJ	This impact category refers to the consumption of fossil fuels and uranium. It is calculated as the amount of resources that are depleted and measured in equivalent MJ of fossil fuels.

The PCR requires that several other parameters be reported in the 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.

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).* Since there is no classification scheme available in openLCA 1.10 to account for this parameter, it is estimated using the CED methodology available in openLCA, which accounts for renewable energy resources in background and foreground processes.

- *Use of renewable primary energy resources used as raw materials (RPR_M).* Although no classification scheme is available in openLCA 1.10 for energy resources used as raw materials, this parameter can be estimated based on the material content of the product materials and packaging.
- *Use of non-renewable primary energy resources used as raw materials ($NRPR_E$).* Since there is no classification scheme available in openLCA 1.10 to account for this parameter, it is estimated using the CED methodology available in openLCA, which accounts for nonrenewable primary energy resources in background and foreground processes.
- *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 1.10 for energy resources used as raw materials. This indicator is based on the material contact of the product and packaging.
- *Use of secondary material (SM).* The product contains steel scrap and this is a measure of the use of scrap in the product.
- *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 reported as negligible (neg.).
- *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 evaporation, transpiration, product integration and discharge into a different drainage basin or the sea. Use of FW is calculated from life cycle inventory flows.
- *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. The parameter is calculated the flows in Table 5. Waste classification is consistent with geographical region of North America (NA) (RCRA).

Table 5. The flows of hazardous waste aggregated into the result for the parameter of "hazardous waste disposed".

Flow Name	Flow Name
Volume occupied, underground deposit	Oil separator sludge
Asbestos	Oil waste
Bilge oil	Refinery sludge
Chemical waste, inert	Waste, from incinerator
Chemical waste, regulated	Waste, toxic
Chemical waste, unspecified	Welding dust
Electrostatic filter dust	-

- *Non-hazardous waste disposed (NHWD).* This includes all wastes produced across all life cycle stages included in the study scope. The parameter is calculated using the method for "Bulk waste" classification from the EDIP/UMIP 1997 LCIA methodology. 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 wastes as summarized in Table **Table** 6.

Table 6. Classification of radioactive waste flows.

Intermediate and Low Level Waste Flows (ILLRW)	High Level Waste Flows (HLRW)
Volume occupied, final repository for low-active radioactive waste*	Volume occupied, final repository for radioactive waste*
Waste, nuclear, low and medium active**	Waste, nuclear, high active**
Waste, nuclear, unspecified	-
Radioactive waste	-
Radioactive tailings	-

**The mass of radioactive waste was calculated using the conversion factor of 416.67 kilograms per cubic meter of volume in final repository, based on data from Ecoinvent v2.2.*[13]
***Converted from cubic meters of nuclear waste to kilograms using a mass of 19,000 kilograms per cubic meter of waste, the density of uranium. In North America, 93% of spent fuel is uranium, and most of the remainder is fission products of similar density.*[14]

- *Components for re-use (CRU).* There are no components of the product which can be re-used at end of life.
- *Materials for recycling (MR).* No materials for recycling are produced at the manufacturing facility. This category consists of the packaging materials sent for recycling.
- *Materials for energy recovery (MER).* The production of materials for energy recovery crossing the system boundaries is negligible.
- *Recovered energy (RE).* The recovered energy is energy recovered from the disposal of waste in previous systems. The RE crossing the system boundaries is negligible.

Additionally, the PCR requires the calculation of carbon emissions and removals. The biogenic carbon included in the product system are attributed to the wood and cardboard packaging.

- *Biogenic carbon removal from product is from recycled wood wastes at manufacturers.*
- *Biogenic carbon emission from product is zero.*
- *Biogenic carbon removal from packaging is from wood and lumber used to package the CFS products.*
- *Biogenic carbon emission from packaging is zero.*

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[13] Nuclear spent fuel, in conditioning, at plant/CH U. Ecoinvent v2.2. 2010.
[14] What is Nuclear? *What is nuclear waste?* Retrieved on 5/26/16 from http://www.whatisnuclear.com/articles/waste.html

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

The interpretation phase conforms to ISO 14044 with further guidance from the ILCD General Guide for Life Cycle Assessment[15]. 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.

3.9 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 includes a data quality assessment, considered optional under ISO-14044 and required by the PCR.

3.10 Cut-off Criteria

The cut-off criteria for including or excluding materials, energy, and emissions data from the study are in accordance with the PCR and are listed below.

- All inputs and outputs to a unit process are included in the LCA calculation for which data are available. Any data gaps are filled with representative data. Assumptions used for filling data gaps are documented in the LCA report.
- Where there is a data gap or insufficient data, criteria for exclusion of inputs and outputs is 1% of primary energy usage (renewable and non-renewable energy) and 1% on a mass basis for the specific unit process. The maximum criteria for exclusion of inputs and outputs is 5% of primary energy usage and mass across all modules included in the LCA.
- If a flow meets the above criteria for exclusion but is considered to have a significant potential environmental impact, it is included.

3.11 Limitations

As a result of the choice of study scope and LCIA methodologies used, there are several important study limitations which should be understood to ensure an appropriate interpretation of results, as described below.

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

Limitations in the Study Scope

Primary data on HDG were not obtained by SCS Global from suppliers. The results for A1 were taken from a life cycle inventory of HDG produced in the US, developed by Sphera under contract with AISI. Most of the datasets used in the Sphera report are taken from GaBi and some of these background datasets may use system expansion. Without access to the raw data, it would be impossible to remodel the A1 data without system expansion.

Comparison of the environmental performance of products should be based on the product's use in a building, considering the complete life cycle. Results that do not consider the complete building context are inappropriate for comparing construction products. As the scope of this LCA is the production of steel construction products, and does not include impacts on the building, indicator results presented in this LCA cannot be compared directly to another material type, unless these products have equivalent use phase impacts and identical effects on the whole building.

The results presented should be considered in the context of operational impacts from the function of the integrated whole building system. When the building lifetime is taken into account, the impacts resulting from the production of these steel products can range from small, to significant, due to the nearly limitless number of building designs possible. These impacts from the operational phase of a whole building are not the subject of this study but should be considered when interpreting results.

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 CFS products at the manufacturing facilities. Some of these omitted impact categories are listed in Table 7. This list is not exhaustive; there may be other impact categories which are not included.

Table 7. Impact categories omitted from the LCIA of the CFS products

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

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 requires that results for several inventory flows related to construction products are to be reported as "other parameters". These are aggregated inventory flows, and do not characterize any potential impact; results should be interpreted taking into account this limitation.

For some of these parameters, i.e. NWHD, HWD, HLRW, and ILRW, insufficient information was provided in the Sphera report for steelmaking using BOF and EAF production routes. For these parameters only, secondary datasets from ecoinvent for BOF and EAF steelmaking were used, and HDG production from steel slab was modeled using the Sphera LCI for HDG production.

3.12 Data Quality Requirements

One of the primary goals of the study is to produce an industry-wide EPD for the Steel Framing Industry Association; 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.

3.13 Type of Critical Review

This LCA report has been critically reviewed by a 3rd party independent LCA expert not involved with the execution of this study, in conformance with ISO 14044. This critical review is considered an 'external' critical review.

4. Life Cycle Modeling

The life cycle inventory (LCI) of each unit process comprises material and energy inputs, emissions, co-products, and wastes. Data sources for these inventories include primary data as well as secondary data from the Ecoinvent database. Environmental flows from the LCI modeling are used to calculate environmental impacts in the LCIA phase. Where necessary, the lower heating value is used for energy flow calculations.

In the present study, except as noted, all known materials and processes were included in the inventory.

4.1 Assumptions

The assessment relied on several assumptions, described below.

- Representative inventory data were used to reflect the energy mix for electricity use. Supply mixes were modeled based on U.S. EPA eGRID subregions, in which the manufacturing facilities are located.
- Impacts of the system were allocated to co-products during steelmaking (slag, baghouse and millscale) based on mass.
- Representative inventory data for raw materials and ancillary materials were modeled with unit process data taken from Ecoinvent. The datasets utilized for the CFS products manufacture are provided in Section 4.4
- Disposal of manufacturing waste is modeled based for solid and hazardous waste generation and disposal in the United States, as specified in the PCR. Specifically, 80% of non-hazardous wastes are disposed in landfill and 20% incinerated. Transportation for end-of-life scenarios was modeled using the EPA WARM model 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.

4.2 Co-products

The datasets used in the inventory model are provided in Section 4.4. Impacts are allocated to the co-products based on mass.

4.3 Transportation

The transportation from primary producer of raw materials to the manufacturing facilities are based on primary data provided by the manufacturing companies, and includes both truck, rail and ship transportation.

4.4 Data Sources

Unit processes were developed within openLCA v1.10 software. For steel production, the life cycle inventory for HDG were taken from the AISI report. Where primary upstream data were unavailable, secondary data were used. Secondary datasets with the greatest degree of representativeness were chosen. The principal source of secondary LCI data is Ecoinventv3.7.1[16] database. Detailed descriptions of unit processes can be found in the accompanying documentation. The LCI datasets used in the LCA model to represent unit processes in the cradle-to-gate LCA are provided in Table 8 below.

Table 8. LCI datasets and associated databases used to model the product system for cold formed steel products.

Flow	Dataset	Data Source	Publication Date
Raw Materials			
Water	market for tap water | tap water | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Solvent	market for solvent, organic | solvent, organic | Cutoff, U - GLO	Ecoinventv3.7.1	2020
Argon gas	market for argon, liquid | argon, liquid | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Lubricating oil	market for lubricating oil | lubricating oil | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Packaging			
Corrugated box board	corrugated board box production | corrugated board box | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Wood pallets	EUR-flat pallet production | EUR-flat pallet | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Metal banding	metal working, average for steel product manufacturing | metal working, average for steel product manufacturing | Cutoff, U – RoW market for steel, low-alloyed | steel, low-alloyed | Cutoff, U - GLO	Ecoinventv3.7.1	2020
Plastic/ polypropylene banding	textile production, non woven polypropylene, spun bond | textile, non-woven polypropylene | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Electricity/Heat			
Electricity	electricity, medium voltage, modifieid for egrid Subregions electricity voltage transformation from high to medium voltage | electricity, medium voltage | Cutoff, U - MX	Ecoinventv3.7.1 egrid 2018v2	2020, 2018
Propane	market for propane | propane | Cutoff, U	Ecoinventv3.7.1	2020
Heavy fuel oil	market for heavy fuel oil | heavy fuel oil | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Natural gas	market for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Transportation			
Rail	market for transport, freight train | transport, freight train | Cutoff, U - US	Ecoinventv3.7.1	2020
Road	transport, freight, lorry 7.5-16 metric ton, EURO4 | transport, freight, lorry 7.5-16 metric ton, EURO4 | Cutoff, U - RoW	Ecoinventv3.7.1	2020
Ship	transport, freight, sea, container ship | transport, freight, sea, container ship | Cutoff, U - GLO	Ecoinventv3.7.1	2020

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[16] Ecoinvent Centre (2020) Ecoinvent data from v3.7.1. Swiss Center for Life Cycle Inventories, Dübendorf, 2020 http://www.Ecoinvent.org

4.5 Data Quality Assessment

The data quality assessment is discussed in Table 9 below for each of the data quality parameters.

Table 9. Data Quality Assessment

Data Quality Parameter	Parameter Description	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 10 years old (typically 2018 or more recent). All of the data used represented an average of at least one year's worth of data collection. 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. Actual processes for upstream operations are primarily North American. Surrogate data used in the assessment are representative of North American 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.
Precision	Measure of the variability of the data values for each data expressed (e.g. variance)	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 CFS 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 (i.e. geographical coverage, time period and technology coverage)	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 for modules A2 and A3. Data sources of similar quality and age are used with a bias towards Ecoinvent v3.7.1 data where available. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the wastes produced is based on assumptions of current average practices in the United States. Consistency of the A1 module is limited by the background report on HDG production.
Reproducibility	Qualitative assessment of the extent to which information about the methodology and	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.

Data Quality Parameter	Parameter Description	Data Quality Discussion
	data values would allow an independent practitioner to reproduce the results reported in the study	
Sources of the Data	Description of all primary and secondary data sources	Primary data representing materials use, energy use, emissions and waste generation at the manufacturing facilities represent 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. The Ecoinvent database is used for secondary LCI datasets. Secondary data for HDG steel production in North America was obtained from the Sphera LCA report produced for AISI.
Uncertainty of the Information	Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the CFS products is low. Actual supplier data for upstream operations was not available for suppliers and the study relied upon the use of the life cycle inventory developed by Sphera. This inventory and other datasets used 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 LCI Results

The resource use and emissions from each step of the product life cycle are summed to obtain the life cycle inventory results. Table 10 summarizes the results for additional parameters (energy and waste flows) as specified in the PCR (see Section 2.7) for the North American market. The LCIA and inventory flow results were calculated using the openLCA 1.10 model and summarized for one metric ton of CFS product. 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 10. Resource use and wastes results for the declared unit of the CFS products. All values are rounded to three significant digits. Results representing energy flows are calculated using lower heating (i.e., net calorific) values.

Parameter	Unit	1 MT CFS product
Resource use		
Use of renewable primary energy excluding renewable primary energy resources used as raw materials (RPR$_E$)	MJ	5,260
Use of renewable primary energy resources used as raw materials (RPR$_M$)	MJ	1,270
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials (NRPR$_E$)	MJ	28,700
Use of non-renewable primary energy resources used as raw materials (NRPR$_M$)	MJ	626
Use of secondary material (SM)	ton	361
Use of renewable secondary fuels (RSF)	MJ	0.00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00
Use of net fresh water (FW)	m^3	3.57x10^4
Waste and outflows		
Non-hazardous waste disposed (NHWD)	kg	29.1*
Hazardous waste disposed (HWD)	kg	0.238*
High-level Radioactive waste disposed (HLRW)	kg	6.24x10^{-3*}
Radioactive waste disposed (ILLRW)	kg	0.0431*
Components for re-use (CRU)	kg	0.00
Materials for recycling (MR)	kg	186
Materials for energy recovery (MER)	kg	0.00
Exported energy (EE)	MJ	Neg.
Biogenic carbon		
Biogenic carbon removal from product	kg	-0.0559
Biogenic carbon emission from product	kg	0.0
Biogenic carbon removal from packaging	kg	157
Biogenic carbon emission from packaging	kg	0.0

INA = Indicator not assessed
*calculated using ecoinvent datasets for steel slab production

5. Life Cycle Impact Assessment

5.1 Overview

Category impact indicator results using TRACI 2.1 are presented in Table 11, below, using the required characterization methods in the PCR, discussed in Section 3.8. Impact category indicators are estimated using the TRACI 2.1 characterization methodologies. Statistical information and distribution can be found in Appendix Table A2.

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 product, 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. The potential environmental impacts are presented by information module (A1-A3), described in Section 3.2, providing some insight into the relative contributions for the product systems under study.

Table 11. LCIA results for the declared unit of the CFS products. All values are rounded to three significant digits. Values below indicator results show the percent contribution of each life cycle module to the result for each impact category.

Impact Category (Units)	Total (A1-A3)	A1	A2	A3
		Upstream Steel and Component Production	Transport to Manufacturer	The CFS products Manufacture
TRACI				
Global Warming Potential (kg CO_2 eq)	2,440	2,220	84.4	135
	100%	91.0%	3.46%	5.55%
Acidifcation Potential (kg SO_2 eq)	5.58	4.45	0.500	0.628
	100%	79.8%	8.96%	11.3%
Eutrophication Potential (kg N eq)	0.810	0.270	0.107	0.433
	100%	33.4%	13.3%	53.4%
Smog Formation Potential (kg O_3 eq)	101	77.1	13.3	10.6
	100%	76.3%	13.2%	10.5%
Ozone Depletion Potential (kg CFC-11 eq)	3.37x10^{-5}	6.02x10^{-7}	1.88x10^{-5}	1.43x10^{-5}
	100%	1.79%	55.8%	42.5%
Fossil Fuel Depletion (MJ eq)	26,800	26,300	171	292
	100%	98.3%	0.638%	1.09%

5.2 Contribution Analysis

Life cycle modeling of the CFS product was divided into distinct life cycle phases, including raw material extraction and processing, product manufacturing, delivery and installation, product use and maintenance, and 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, BOF and EAF steelmaking, and rolling, pickling and hot dip galvanization. Included within this stage is transport between upstream manufacturers. Resource use and emissions associated with both extraction of the raw materials and product component manufacturing are included.
- *Transport stage (A2)* –The impacts associated with the transport of the processed raw materials and steel to the manufacturing facility are included in this stage.
- *Manufacturing stage (A3)* **–** This stage includes all the relevant manufacturing processes and flows for the CFS products, including the impacts from energy use and emissions at the manufacturing facilities. Production of capital goods, infrastructure, manufacturing equipment, and personnel-related activities are not included. This stage does not includes the production of packaging materials.

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

Product			**Construction Process**		**Use**							**End-of-life**				**Benefits and loads beyond the system boundary**
A1	A2	A3	A4	A5	B1	B1	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	MND	MND	MND	MND	MND

X = Included in system boundary
MND = Module not declared

Category indicator results for the products are summarized by life cycle phase in Appendix A. Impact indicators are displayed graphically by life cycle phase in Figure 3 using the TRACI methodology for the declared unit of 1 metric ton. The main contributions to indicator results for many of the impact category indicators assessed occur from either the steel production phase (A1) or by the CFS product manufacturing phase (*A3*).

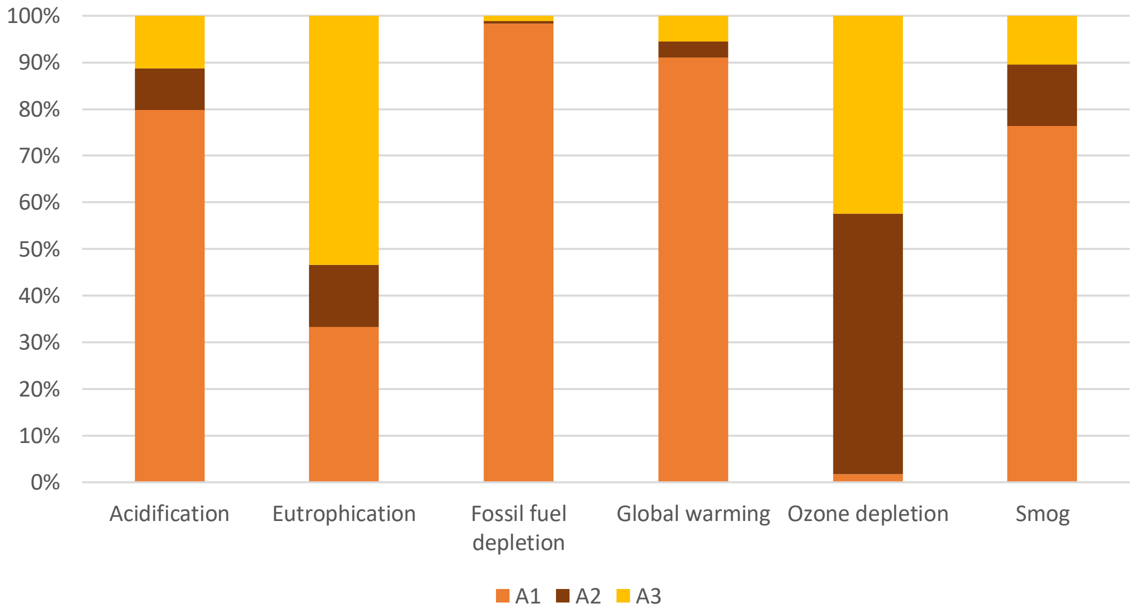

Figure 3. Contribution analysis for industry-wide CFS products life cycle using TRACI 2.1.

5.3 Sensitivity Analysis

Sensitivity analyses are conducted to evaluate the impact of various modeling assumptions on indicator results, including assumptions regarding co-products and the products which they displace. The sensitivitiy presented here compares the difference in impact results were every manufacturing facility to use the minimum electricity on a per ton product basis. The range of electricity used in kWh/ton product produced ranged from 10-100 kWh per metric ton of steel stud or track. To see the potential impact reductions from improved energy efficiency, all facilities were modeled as using 10 kWh/ton product produced.

The results of the sensitivity modeling are presented for the CFS products in Table 13 below. Results are presented as the percent difference from the baseline scenario. The impact indicator results in this sensitivity are generally negative, indicating that reduced electricity use has some potential to reduce overall production impacts, specifically for eutrophication and ozone depletion potentials. Other impact categories were impacted less than 1%.

Table 14. Life Cycle Impact Assessment Results for the CFS products produced using the minimum electricity per ton product at the stud and track manufacturing facility. Results are presented as the percent difference from the reference scenario for 1 MT of stud and track.

Impact Category	Sensitivity Impact Result from Minimum Electricity Use	% Difference from Base Case A2
TRACI 2.1		
GWP (kg CO_2 eq)	2426	-0.61%
AP (kg SO_2 eq)	5.53	-0.83%
EP (kg N eq)	0.750	-7.47%
SFP (kg O_3 eq)	100	-0.48%
ODP (kg CFC-11 eq)	3.26×10^{-5}	-3.21%
FFD (MJ eq)	26,800	-0.06%

6. Life Cycle Interpretation

Significant Issues

Per ISO 14044, one of the steps in the Interpretation phase is the identification of significant issues. The purpose of this step is to identify the assumptions, methodological decisions, unit processes, and other aspects, which influence the results of the assessment.

Generally speaking, for the product systems and indicators included in this study, the contribution to impacts from the production of HDG steel (A1), and in some cases the CFS products (A3). In most cases, the smallest contributing life cycle phase is the transportation of materials to the CFS product manufacturing facilities (A2).

Completeness Check

For Modules A1, A2 and A3, there was sufficient documentation available for a completeness check. The completeness of modules A2 and A3 are very high. Data for Modules A2 and A3 are based on primary data from the manufacturers, covering all major production processes. The most significant gaps occur in module A1, for which all the relevant impact results were available and the life cycle energy and water use flows were available. However, a complete life cycle inventory was not available. Using the ecoinvent datasets for BOF and EAF steelmaking is considered sufficiently representative to calculate the waste flows, NHWD, HWD, HLRW, and ILRW.

There may be additional emissions not accounted for in the inventory data used to represent these intermediate flows, mainly based on secondary datasets from Europe and North America. However, when considering the entire steel product life cycle, these omissions are negligible in scale in comparison to final results.

Sensitivity Analysis

As part of an iterative process, sensitivity checks to the key assumptions, methodological choices, data uncertainties, parameters, inventory data, and characterization data were performed.

The key aspects of the study, to which final results could be tested and results are sensitive, include:

- The smallest relative electricity use (kWh/ton) seen among the ten facilities was applied across all facilities to determine the potential for impact reductions within the A3 module.
- The LCIA methodology used, considering both the impact categories included and characterization factors used.

Consistency Check

Throughout all stages of this LCA under SCS' control, methodological choices and practices were consistent with ISO 14044 and the PCR. The background data used in A1 was based on the GaBi database which may use system expansion in some of its background datasets. System expansion is not allowed per ISO 21930:2017 and the PCR, but the model was unable to be recreated without the full LCI data.

7. Conclusions

An industry-wide life cycle assessment of cold formed steel products was conducted to support the preparation of an industry wide Environmental Product Declaration (EPD) based on the PCR. The LCIA results were assessed relative to the production of one (1) metric ton of CFS product and the impact category indicator results are presented in Section 6.

The indicator results for the CFS products, when considered across all life cycle stages, indicate that upstream steel production is the most significant contributor to results (Module A1), accounting for 33-99% of the total impacts across all category indicators. The exception to this was ozone depletion, for which the Sphera results reported a negative ODP for steelmaking.

Recommendations

Steel production in A1, and electricity consumption within A3 at the manufacture of the CFS product are the dominating factors for potential environmental impacts of the product system. More detailed data from the steel mills would improve accuracy of the results and the ability to evaluate the sensitivity of results to the most impactful life cycle stage, A1.

Appendix A: Life Cycle Contribution Analysis

The following impact indicators, specified by the PCR, are reported below:

TRACI 2.1 Impact Category	Unit
Global Warming Potential (GWP)	kg CO_2 eq
Ozone Depletion Potential (ODP)	kg CFC 11 eq
Acidification Potential (AP)	kg SO_2 eq
Eutrophication Potential (EP)	kg N eq
Smog Formation Potential (SFP)	kg O_3 eq
Fossil Fuel Depletion Potential (ADPfossil)	MJ Surplus, LHV

The following inventory parameters, specified by the PCR, are also reported.

Resources	Unit	Waste and Outflows	Unit
RPRE: Renewable primary resources used as energy carrier (fuel)	MJ, LHV	HWD: Hazardous waste disposed	kg
RPRM: Renewable primary resources with energy content used as material	MJ, LHV	NHWD: Non-hazardous waste disposed	kg
NRPRE: Non-renewable primary resources used as an energy carrier (fuel)	MJ, LHV	HLRW: High-level radioactive waste, conditioned, to final repository	kg
NRPRM: Non-renewable primary resources with energy content used as material	MJ, LHV	ILLRW: Intermediate- and low-level radioactive waste, conditioned, to final repository	kg
SM: Secondary materials	MJ, LHV	CRU: Components for re-use	kg
RSF: Renewable secondary fuels	MJ, LHV	MR: Materials for recycling	kg
NRSF: Non-renewable secondary fuels	MJ, LHV	MER: Materials for energy recovery	kg
RE: Recovered energy	MJ, LHV	EE: Recovered energy exported from the product system	MJ, LHV
FW: Use of net freshwater resources	m_3	-	-

Table A1. Life Cycle Impact Assessment (LCIA) results per metric ton of the CFS products across manufacturers, and percent contribution by life cycle stage. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Impact Category	Life cycle stage			
	Total	A1	A2	A3
TRACI 2.1				
GWP (kg CO_2 eq)	2440	2220	84.4	135
	100%	91.0%	3.46%	5.55%
AP (kg SO_2 eq)	5.58	4.45	0.500	0.628
	100%	79.8%	8.96%	11.3%
EP (kg N eq)	0.81	0.270	0.107	0.433
	100%	33.4%	13.3%	53.4%
SFP (kg O_3 eq)	101	77.1	13.3	10.6
	100%	76.3%	13.2%	10.5%
ODP (kg CFC-11 eq)	$3.37x10^{-5}$	$6.02x10^{-7}$	$1.88x10^{-5}$	$1.43x10^{-5}$
	100%	1.79%	55.8%	42.5%
FFD (MJ eq)	26,800	26,300	171	292
	100%	98.3%	0.638%	1.09%

Table A2. Statistical Information and Distribution for Life Cycle Impact Assessment (LCIA) results per metric ton of CFS product across manufacturers. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Impact Category	Average	Median	Minimum	Maximum
TRACI 2.1				
GWP (kg CO_2 eq)	2,380	2,380	2,250	2,610
AP (kg SO_2 eq)	5.21	5.07	4.55	6.39
EP (kg N eq)	0.621	0.538	0.369	1.43
SFP (kg O_3 eq)	93.5	89.4	78.4	112.5
ODP (kg CFC-11 eq)	$2.88x10^{-5}$	$2.71x10^{-5}$	$5.80x10^{-6}$	$6.01x10^{-5}$
FFD (MJ eq)	26,600	26,600	26,400	27,100

Table A3. Resource use and waste flows per metric ton of CFS product across manufacturers, and percent contribution by life cycle stage. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.

Parameter	Total	A1	A2	A3
Resources				
RPRE (MJ)	5,260	1,450	11.5	3,800
	100%	27.5%	0.218%	72.2%
RPRM (MJ)	1,270	0.00	0.00	1,273
	100%	0.0%	0.0%	100%
NRPRE (MJ)	28,700	26,400	632	1,700
NRPRM (MJ)	626	0.0	0.0	626
SM (MT)	361	361	0	0
	100%	100%	0%	0%
RSF/NRSF (MJ)	0.00	0.00	0.00	0.00
RE (MJ)	0.00	0.00	0.00	0.00
FW (m3)	$3.57\text{x}10^{4}$	$3.57\text{x}10^{4}$	0.332	24.0
	100%	99.9%	0.000931%	0.0672%
Wastes				
HWD (kg)*	0.238	0.230	$1.77\text{x}10^{-3}$	$2.40\text{x}10^{-3}$
	100%	98.2%	0.757%	1.02%
NHWD (kg)*	736	685	21.7	29.1
	100%	93.1%	2.96%	3.95%
HLRW (kg)*	$6.24\text{x}10^{-3}$	$5.72\text{x}10^{-3}$	$5.24\text{x}10^{-5}$	$4.64\text{x}10^{-4}$
	100%	91.7%	0.841%	7.44%
ILLRW (kg)*	$4.31\text{x}10^{-2}$	$3.38\text{x}10^{-2}$	$4.29\text{x}10^{-3}$	$5.06\text{x}10^{-3}$
	100%	78.3%	9.96%	11.7%
CRU (kg)	0.00	0.00	0.00	0.00
MR (kg)	186	134	0.00	51.7
	100%	72.2%	0.0%	27.8%
MER (kg)	0.00	0.00	0.00	0.00
EE (MJ)	Neg.	Neg.	Neg.	Neg.

Neg. = Negligible

*Calculated using secondary data for A1 through hot rolling. Pickling, cold rolling and hot dip galvanization modeled using Sphera report.

Appendix B: ISO 14044 Critical Review

Industrial Ecology Consultants

May 28, 2021

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

Verification Report: Steel Framing Industry Association

The LCA Practitioner, SCS Global Services, commissioned Industrial Ecology Consultants to perform an external independent verification of **industry-wide cold formed steel products.** SCS Global Services completed the Life Cycle Assessment (LCA) study and respective Environment Product Declaration (EPD) on behalf of the commissioning organization, the **Steel Framing Industry Association (SFIA)**.

The review of the study was 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. (2019). *Program Operator Manual: Type III Environmental Declaration Program*. Version 10-0, revised April 2019.
- UL Environment. (2018). *Product Category Rules for Building-Related Products and Services in: Brazil, China, Europe, India, Japan, Korea, North America, and South East Asia – Part A: Life Cycle Assessment Calculation Rules and Report Requirements*. UL 10010 v3.2, December.
- UL Environment. (2020). *Product Category Rule (PCR) Guidance for Building-Related Products and Services – Part B: Designated Steel Construction Product EPD Requirements*. UL 10010-34 v2.0, August.

The independent third-party 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 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:

SFIA – Cold-formed Steel Framing

REVIEW PROCESS

The review and verification involved developing review matrices based on the requirements set forth by the applicable ISO standards, UL Environment Part A and Part B product category rules, and SCS Global Services General Program Instructions (GPIs). The LCA report and review of the EPD covered identified 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.

VERIFICATION STATEMENT

Based on the independent verification objectives, the **Life Cycle Assessment of Industry-Wide Cold Formed Steel Products, May 28, 2021 prepared for SFIA by SCS Global Services,** and the respective EPD: **SFIA – Cold-formed Steel Framing**, were reviewed and verified to be ***in conformance*** with the applicable ISO standards referenced above, the UL Environment PCRs, 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 steel framing products, the relevant PCR, ISO standards and the geographical areas intended to generate EPDs to carry out this verification.

Sincerely,

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

Independent Review of LCA study of Steel Construction Products

PCR for Building-Related Products and Services - Part A: Calculation Rules for the LCA and Requirements, UL v.3.2, Part B: Building-Related Products and Services: Steel Construction Product EPD Requirements UL 10010-34 v.2.0, ISO14025, ISO14040/44 AMD1/AMD2, ISO 21930, EN 15804

Date: 5/28/21	Doc.: **Life Cycle Assessment of Industry-Wide Cold Formed Steel Products**, May 28, 2021, prepared by SCS Global on behalf of the Steel Framing Industry Association (SFIA)
Reviewer:	Thomas Gloria, Ph.D., Industrial Ecology Consultants LCACP ID: 2008-03

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
Review of Supporting LCA Study					
			Are the methods used to carry out the study consistent with the ISO 14040/14044 standards and with the applicable PCR?		
TE1			**PCR Specific Part A (§2):** ***LCA PROJECT REPORT CONTENT, STRUCTURE, AND ACCESSIBILITY*** *The project report must document any data and information of importance to the results published in the EPD and as required by this document.*	Requirement met.	
TE2			**PCR Specific Part A (§2):** ***LCA PROJECT REPORT CONTENT, STRUCTURE, AND ACCESSIBILITY*** *The project report must support that the LCA-based information and the additional information as declared in the EPD meet the requirements of this set of rules. Particular care shall be given to provide comprehensive explanations regarding how the information declared in the EPD arises from the LCA and how – if declared – the reference service life (RSL) was established.* *The structure of the project report shall follow the structure of this standard based on ISO 21930 and EN 15804. See ISO 21930 Section 10 for detailed requirements of the project report.* *The project report must be accessible to the verifier under the conditions of confidentiality (see ISO 14025 and ISO 21930).* *In conformance with ISO 21930, Section 10.2, the results, data, methods, assumptions, limitations and conclusions of the project report shall be completely and accurately reported without bias. All elements of the project report shall be reported in a transparent manner with enough detail to allow independent verification and permit an understanding of the complexities 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 is not part of the public communication.* ***Section 10.2 of ISO 21930:*** *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:*	Requirement met.	

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			— 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.*		

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			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.*		
TE3			**ISO Requirement (§4.1):** *General Requirements - LCA studies shall include the goal and scope definition, inventory analysis, impact assessment and interpretation of results.*	Requirement met.	
TE4			**ISO Requirement (§4.1):** *General Requirements - LCI studies shall include definition of the goal and scope, inventory analysis and interpretation of results. The requirements and recommendations of this International Standard, with the exception of those provisions regarding impact assessment, also apply to life cycle inventory studies.*	Requirement met.	
TE5			**ISO Requirement (§4.1):** *General Requirements - An LCI study alone shall not be used for comparisons intended to be used in comparative assertions intended to be disclosed to the public.*	N/A	
TE6			**ISO Reporting Requirements (§5.1) and (§5.1.1):** *General Requirements and Considerations - The type and format of the report shall be defined in the scope phase of the study.* *The results and conclusions of the LCA shall be completely and accurately reported without bias to the intended audience. 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. The report shall also allow the results and interpretation to be used in a manner consistent with the goals of the study.*	Requirement met.	
TE7			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance When results of the LCA are to be communicated to any third party (i.e. interested party other than the commissioner or the practitioner of the study), regardless of the form of communication, a third-party report shall be prepared.* *The third-party report can be based on study documentation that contains confidential information that may not be included in the third-party report.*	Requirement met.	
TE8			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance The third-party report constitutes a reference document and shall be made available to any third party to whom the communication is made.*	Requirement met.	
TE9			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance The third-party report shall cover the following aspects:*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			a) General aspects: *1) LCA commissioner, practitioner of LCA (internal or external);* *2) date of report;* *3) statement that the study has been conducted according to the requirements of this International Standard (ISO 14044).*		
TE10			**PCR Specific Part A (§2.1):** *General Information* *The project report must contain the following general information:* *→ the client commissioning the Life Cycle Assessment, internal or external Life Cycle analysts* *→ the report date* *→ indications that the Life Cycle Assessment was performed in agreement with the requirements of these Product Category Rules with reference to EN 15804 and ISO 21930.*	Requirement met.	
TE11			**PCR Specific Part A (§2.1):** *General Information* *The UNSPSC code and the appropriate Construction Specifications Institute (CSI) / Constructions Specifications Canadian (CSC) classification shall be identified for the product category covered by the Part B PCR.*	Provide the UNSPSC, or CSI or CSC codes.	UNSPSC codes added to product description (Section 3.3) **Acknowledged**
TE12			**ISO Requirement (§4.2.1):** *Goal and Scope Definition General – The goal and scope of an LCA shall be clearly defined and shall be consistent with the intended application. Due to the iterative nature of LCA, the scope may have to be refined during the study.*	Requirement met.	
TE13			**ISO Requirement (§4.2.2):** *Goal of the study – In defining the goal of an LCA, the following items shall be unambiguously stated:* *– the intended application;* *– the reasons for carrying out the study:* *– the intended audience, i.e. to whom the results of the study are intended to be communicated:* *– whether the results are intended to be used in comparative assertions intended to be disclosed to the public.*	Requirement met.	
TE14			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* ***b) Goal of the study****:* *1) reasons for carrying out the study;* *2) its intended applications;* *3) the target audiences;* *4) statement as to whether the study intends to support comparative assertions intended to be disclosed to the public.*	Requirement met.	
TE15			**PCR Specific Part A (§2.2):** *Goal of the study* *The study goal must be outlined in the project report, including the following:* * Reasons for performing the study*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			☐ *Intended use* ☐ *Target group, i.e. whether the information and data for an EPD is intended for business-to-business (B2B) and/or business-to-consumer (B2C) communication.* *[ISO 21930, Section 5.4]: "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."* ISO 14025:2006, Claus 9: ***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***		

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			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.*		
TE16			**ISO Requirement (§4.2.3.1): *Scope of the study - General***. *In defining the scope of an LCA, the following items shall be considered and clearly described:* *– the product system to be studied;* *– the functions of the product system or, in the case of comparative studies, the systems;* *– the functional unit;*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			– the system boundary; *– allocation procedures;* *– LCIA methodology and types of impacts;* *– interpretation to be used;* *– data requirements;* *– assumptions;* *– value choices and optional elements;* *– limitations;* *– data quality requirements;* *– type of critical review, if any;* *– type and format of the report required for the study.* *In some cases, the goal and scope of the study may be revised due to unforeseen limitations, constraints or as a result of additional information. Such modifications, together with their justification, should be documented.*		
TE17			**ISO Requirement (§4.2.3.2):** ***Scope of the study - Function and functional unit*** *The scope of an LCA shall clearly specify the functions (performance characteristics) of the system being studied. The functional unit shall be consistent with the goal and scope of the study. One of the primary purposes of a functional unit is to provide a reference to which the input and output data are normalized (in a mathematical sense). Therefore, the functional unit shall be clearly defined and measurable.* *Having chosen the functional unit, the reference flow shall be defined.* *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. If additional functions of any of the systems are not taken into account in the comparison of functional units, then these omissions shall be explained and documented. As an alternative, systems associated with the delivery of this function may be added to the boundary of the other system to make the systems more comparable. In these cases, the processes selected shall be explained and documented.*	Requirement met, in this case the Declared Unit.	
TE18			**ISO Requirement (§4.2.3.3.1):** ***Scope of the study - System boundary*** *The system boundary determines which unit processes shall be included within the LCA. The selection of the system boundary shall be consistent with the goal of the study. The criteria used in establishing the system boundary shall be identified and explained.* *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.*	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			The deletion of life cycle stages, processes, inputs or outputs is only permitted if it does not significantly change the overall conclusions of the study. Any decisions to omit life cycle stages, processes, inputs or outputs shall be clearly stated, and the reasons and implications for their omission shall be explained. *Decisions shall also be made regarding which inputs and outputs shall be included and the level of detail of the LCA shall be clearly stated.*		
TE19			**ISO Requirement (§4.2.3.3.2):** ***Scope of the study - System boundary*** *It is helpful to describe the system using a process flow diagram showing the unit processes and their inter-relationships. Each of the unit processes should be initially described to define:* *– where the unit process begins, in terms of the receipt of raw materials or intermediate products,* *– the nature of the transformations and operations that occur as part of the unit process, and* *– where the unit process ends, in terms of the destination of the intermediate or final products.* *Ideally, the product system should be modelled in such a manner that inputs and outputs at its boundary are elementary and product flows. It is an iterative process to identify the inputs and outputs that should be traced to the environment, i.e. to identify which unit processes producing the inputs (or which unit processes receiving the outputs) should be included in the product system under study. The initial identification is made using available data. Inputs and outputs should be more fully identified after additional data are collected during the course of the study, and then subjected to a sensitivity analysis (see 4.3.3.4).* *For material inputs, the analysis begins with an initial selection of inputs to be studied. This selection should be based on an identification of the inputs associated with each of the unit processes to be modelled. This effort may be undertaken with data collected from specific sites or from published sources. The goal is to identify the significant inputs associated with each of the unit processes.* *Energy inputs and outputs shall be treated as any other input or output to an LCA. The various types of energy inputs and outputs shall include inputs and outputs relevant for the production and delivery of fuels, feedstock energy and process energy used within the system being modelled.*	Requirement met.	
TE20			**ISO Requirement (§4.2.3.3.3):** ***Scope of the study – Cut-off Criteria*** *The cut-off criteria for initial inclusion of inputs and outputs and the assumptions on which the cut-off criteria are established shall be clearly*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			described. The effect on the outcome of the study of the cut-off criteria selected shall also be assessed and described in the final report. *Several cut-off criteria are used in LCA practice to decide which inputs are to be included in the assessment, such as mass, energy and environmental significance. Making the initial identification of inputs based on mass contribution alone may result in important inputs being omitted from the study. Accordingly, energy and environmental significance should also be used as cut-off criteria in this process.* *a)* ***Mass****: an appropriate decision, when using mass as a criterion, would require the inclusion in the study of all inputs that cumulatively contribute more than a defined percentage to the mass input of the product system being modelled.* *b)* ***Energy****: similarly, an appropriate decision, when using energy as a criterion, would require the inclusion in the study of those inputs that cumulatively contribute more than a defined percentage of the product system's energy inputs.* *c)* ***Environmental significance****: decisions on cut-off criteria should be made to include inputs that contribute more than an additional defined amount of the estimated quantity of individual data of the product system that are specially selected because of environmental relevance.* *Similar cut-off criteria may also be used to identify which outputs should be traced to the environment, e.g. by including final waste treatment processes.* *Where the study is intended to be used in comparative assertions intended to be disclosed to the public, the final sensitivity analysis of the inputs and outputs data shall include the mass, energy and environmental significance criteria so that all inputs that cumulatively contribute more than a defined amount (e.g. percentage) to the total are included in the study.* *All of the selected inputs identified through this process should be modelled as elementary flows.* *It should be decided which inputs and outputs data have to be traced to other product systems, including flows subject to allocation. The system should be described in sufficient detail and clarity to allow another practitioner to duplicate the inventory analysis.*		

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
TE21			**ISO Requirement (§4.2.3.4): *Scope of the study – LCIA methodology and types of impacts*** *It shall be determined which impact categories, category indicators and characterization models are included within the LCA study. The selection of impact categories, category indicators and characterization models used in the LCIA methodology shall be consistent with the goal of the study and considered as described in 4.4.2.2.*	Requirement met.	
TE22			**ISO Requirement (§4.2.3.6): *Scope of the study – Data quality requirements*** ***4.2.3.6.1*** *Data quality requirements shall be specified to enable the goal and scope of the LCA to be met.* ***4.2.3.6.2*** *The data quality requirements should address the following:* *a) time-related coverage: age of data and the minimum length of time over which data should be collected;* *b) geographical coverage: geographical area from which data for unit processes should be collected to satisfy the goal of the study;* *c) technology coverage: specific technology or technology mix;* *d) precision: measure of the variability of the data values for each data expressed (e.g. variance);* *e) completeness: percentage of flow that is measured or estimated;* *f) representativeness: qualitative assessment of the degree to which the data set reflects the true population of interest (i.e. geographical coverage, time period and technology coverage);* *g) consistency: qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis;* *h) 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;* *i) sources of the data;* *j) uncertainty of the information (e.g. data, models and assumptions).* *Where a study is intended to be used in comparative assertions intended to be disclosed to the public, the data quality requirements stated in a) to j) above* ***shall*** *be addressed.* ***4.2.3.6.3*** *The treatment of missing data shall be documented. For each unit process and for each reporting location where missing data are identified, the treatment of the missing data and data gaps should result in* *– a “non-zero” data value that is explained,*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			– a "zero" data value if explained, or *– a calculated value based on the reported values from unit processes employing similar technology.*		
TE23			**ISO Requirement (§4.2.3.7):** ***Scope of the study – Comparisons between systems*** *In a comparative study, the equivalence of the systems being compared shall be evaluated before interpreting the results. Consequently, the scope of the study shall be defined in such a way that the systems can be compared. Systems shall be compared using the same functional unit and equivalent methodological considerations, such as performance, system boundary, data quality, allocation procedures, decision rules on evaluating inputs, and outputs and impact assessment. Any differences between systems regarding these parameters shall be identified and reported. 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.* *A life cycle impact assessment shall be performed for studies intended to be used in comparative assertions intended to be disclosed to the public.*	Requirement met.	
TE24			**ISO Requirement (§4.2.3.8):** ***Scope of the study – Critical review considerations*** *The scope of the study shall define* *– whether a critical review is necessary and, if so, how to conduct it,* *– the type of critical review needed (see Clause 6), and* *– who would conduct the review, and their level of expertise.*	Requirement met.	
TE25			**ISO Reporting Requirements (§5.2)** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* ***c) Scope of the study:*** *1) function, including* *i) statement of performance characteristics, and* *ii) any omission of additional functions in comparisons;* *2) functional unit, including* *i) consistency with goal and scope,* *ii) definition,* *iii) result of performance measurement;* *3) system boundary, including* *i) omissions of life cycle stages, processes or data needs,* *ii) quantification of energy and material inputs and outputs, and* *iii) assumptions about electricity production;* *4) cut-off criteria for initial inclusion of inputs and output, including* *i) description of cut-off criteria and assumptions,* *ii) effect of selection on results,*	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			iii) inclusion of mass, energy and environmental cut-off criteria.		
TE26			**PCR Specific Part A (§2.3):** *Methodological Framework* *The LCA shall follow an attributional approach as outlined in ISO 21930 Section 7.1.1.* *ISO 21930 Section 7.1.1:* ***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.*	Requirement met. Note: It is recognized that the foreground data used in this study related to North American (NA) steel production used the physical allocation approach. The LCA practitioner (SCS Global) made their best effort to ensure that background datasets also avoided a system expansion approach. However, the LCA practitioner (Sphera) could not guarantee that the background data of the NA steel data set also avoided system expansion. Typical sources for additional system expansion credits may include the alloys associated with steel making. Material inputs listed in Table D-4 of the Shera NA Steel were examined for any occurrences of system expansion. None were found.	
TE27			**PCR Specific Part A (§2.4):** *Scope of the study – Declared/Functional Unit* *The Life Cycle Assessment of the construction product must be calculated for a declared or functional unit as specified in the relevant sub-category PCR for the product group, in conformance with EN 15804 and ISO 21930 Section 7.1.2.* *The selected declared or functional unit must be documented in the project report. In addition, a mass conversion factor of the declared unit shall be indicated.*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			ISO 21930 Section 7.1.2: ***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.* *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,*		

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			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.*		
TE28			**PCR Specific Part B (§3.1):** ***3.1. DECLARED UNIT*** *A declared unit shall be applied if the precise function of the product is not stated or not known. The declared unit shall be one (1) metric ton and optionally one (1) short ton for steel construction products. Conversion factors (e.g. density, thickness, surface area, etc.) shall be provided in order to allow the users to conduct further calculations (e.g. transport impacts).* *Environmental Impact results based on a declared unit of a steel product do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted. See Section 5.1 for additional EPD comparability guidelines.*	Requirement met.	
TE29			**PCR Specific Part A (§2.5):** *Product averages for EPDs.* *Averaging of products may significantly reduce EPD development efforts by allowing manufacturers to use one LCA for multiple products and should be considered during the PCR development. Two types of product averages are allowed using this PCR; industry average EPDs and product-specific averages.* *The range of products included in an EPD shall be justified in the context of EPD application; i.e. what the EPD represents. It is crucial that the reasoning be explained and the average reported value can be understood. For example, if a single product is made using a single process, but contains variance of recycled content (different for different locations), an EPD can represent the product as an average of the virgin and recycled material content given the rationale is fully explained. An average is also appropriate in the case of products demonstrating a wide range of variation based on selection of materials serving the same function, such as choice of upholstery fabric on a seat chair cushion.* *Further guidance and clarification for calculating and reporting product averages may be provided by the relevant Part B PCR and shall be followed.*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
TE30			**PCR Specific Part A (§2.5.1):** *Industry Average EPD.* *The method for creating an industry-average EPD shall be described. To ensure an industry average EPD is representative, the information provided in the average EPD and in the LCA report shall include the requirements in ISO 21930 Section 5.3.* *Note: Include how a sufficient statistical representation is achieved, how geographic location is assessed, and how the average is weighted to insure sufficient representation so as to avoid bias. A quantitative assessment of primary dataset variability, including mean, median, standard deviation, and best fitting probability distribution function shall be included.* *The method of dataset averaging shall be described (i.e., horizontal or vertical averaging) and justified. The justification shall consider if data is more appropriately represented by standalone gate-to-gate processes (horizontal averaging) versus capturing the flow of goods within a facility(ies) (vertical averaging).* *A qualitative assessment shall be provided within the EPD that estimates percent representation of industry and percent geographical region representation, the median reference flow units (e.g. weight, area, volume), and other contributing sources of variation (e.g. operational capacity, grid mix.)* *ISO 21930 Section 5.3:* ***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.*	*Requirement met.*	

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			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;* *— 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.*		

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			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.*		
TE31			**PCR Specific Part A (§2.5.2):** *Product Specific EPD* *The method for creating a company specific individual product/product group EPD shall be described, including the method for determining a weighted average across products based on production volume. If a product is manufactured at different production sites, the sites shall be indicated and method for determining the weighted average shall also be described.*	N/A	

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Note: Products of similar specifications and utilized for the same application(s) may be grouped and reported as an average declared product in the same EPD provided that 1) the products included in the grouping differ by no more than ±10 % for any environmental impact indicator and 2) the weighted coefficient of variation across all products shall be less than or equal to 20% for any impact category with the exception of Ozone Depletion Potential (ODP). If the weighted coefficient of variation is 20% or greater for any impact category with the exception of ODP, each product shall be shown separately. Quantitative justification should be provided in the LCA that substantiates the reported average declared product.		
TE32			**PCR Specific Part A (§2.6):** *Product Description* *The declared product must be described with regards to its technical and functional specifications.* *[ISO 21930, section 6.3]: "The product group covered by a sub-category PCR shall be described unambiguously.* *The definition may consider product functionality (e.g. conveyance of materials through pipes), typical production processes (e.g. mining or oil refinery) or applications (e.g. for use in cold climates).* *If there is potential ambiguity in the product sub-category, the description shall also state which products are not covered by the sub-category Part B PCR."*	Requirement met.	
TE33			**PCR Specific Part A (§2.7):** *Product Application The designated application(s) for the referenced product(s) shall be specified/described.*	Requirement met.	
TE34			**PCR Specific Part A (§2.8):** *System Boundaries* *The system boundaries of the LCA and EPD shall follow the modular structure in line with ISO 21930 Section 5.2.1 and EN 15804 Section 6.2. This PCR encourages, when possible, EPDs that are cradle to grave in scope (Modules A1-C4) but also recognizes EPDs that are cradle to gate (Modules A1-A3) and cradle to gate with optional modules as being in scope.* *The environmental information of an EPD shall be subdivided into four life cycle stages per Figure 1: Production (Modules A1-A3); Construction (Modules A4-A5); Use (Modules B1-B7); and EOL (Modules C1-C4). Only the declaration of the Production modules, A1-A3, is re-quired for conformance with ISO 21930 or EN 15804. The declaration of other life cycle modules is optional, unless specifically addressed in a sub-category Part B, with the exception of Module C (see Section 2.8.4.5). 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.*	Requirement met.	

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			Any omissions of life cycle stages, processes or data shall be documented and justified in the LCA and EPD. *For construction products requiring activity or use of energy and/or water during the use stage, technical information for the relevant information modules (B2 to B5 or B6 and/or B7, respectively) is required per ISO 21930, Section 5.2.1.* *When a product EPD only includes Module A (Production stage), the following information regarding intended use of the product shall be provided as additional information:* ☐ *Other products not included in assessment needed for product to serve intended function in the construction work* ☐ *Anticipated replacement cycle of product in the construction work context* ☐ *Intended use* *Supplementary environmental information may also be provided in module D that addresses potential loads and benefits beyond the product system boundary.*		
TE35			**PCR Specific Part A (§2.8.1):** *Types of EPDs* *Per ISO 21930, Section 5.2.2 "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". See Figure 1 for the information modules included in each type of EPD.*	Requirement met.	
TE36			**PCR Specific Part B (§3.2.1):** *System Boundary - General* *The type of EPD shall be specified as cradle to gate or cradle to gate with options (end of life). The modules considered shall be described in brief in the EPD and justified in the LCA as per "System boundaries" outlined in Part A, Section 2.8. It should be apparent as to what processes are considered in what modules per the module descriptions in Part A, Section 2.8. Any relevant aspects or impacts not included in an information module shall be supported with relevant additional environmental information and the omissions shall be justified. Module D is not an information module and shall be reported separately if included in the EPD.* *Capital goods and infrastructure flows shall be excluded from the product system boundary.*	Requirement met.	
TE37			**PCR Specific Part B (§3.2.2):** *System Boundary – Module D*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Module D reports the potential benefit or burden from the displacement of primary materials and/or fuels associated with recycling and recovery at end-of-life. When optional Module D is reported in an EPD, the EPD shall explicitly describe the methodology used to calculate the reported values, including the LCI of scrap used in calculations, and shall address any uncertainty or comparability issues relative to these values. If Module D is reported, the EPD shall include the following paragraph: ***Interpreting the Results in Module D****: The values in Module D include a recognition of the benefits or impacts related to steel recycling which occur at the end of the product's service life. The rate of steel recycling and related processes will evolve over time. The results included in Module D attempt to capture future benefits, or impacts, but are based on a methodology that uses current industry-average data reflecting current processes.*		
TE38			**PCR Specific Part A (§2.8.2):** *Reference Service Life and Building Estimated Service Life* *The indication of the RSL is required for EPDs covering the complete use stage (modules B1-B7), or if a use stage scenario is described, which refers to the lifetime of the product. If no use stage modules are declared, and no use stage scenario which refers to the lifetime of the product is described, the indication of the RSL is voluntary. Refer to ISO 21930 Section 7.1.4 for more information.* *The RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer. If primary data to support declaration are unavailable, a default RSL of 75 years may be assumed for the product category system (if applicable; described as part of the functional unit or reported under additional environmental information, if all life cycle stages are not declared) unless the sub-category Part B PCR indicates otherwise, or if otherwise stated and substantiated. When reporting the number of replacements necessary to fulfil the required performance and functionality over the construction works Estimated Ser-vice Life (ESL), fractional values shall be rounded up to the nearest tenth. An assumed ESL of 75 years shall be used for the construction works life.* *The RSL shall refer to the declared technical and functional performance of the product. A standard life expectancy based on the prescribed method or default of 75 years shall be used, with the option of any deviation allowed only if justified in writing, publicly available for review, and posted for publication. When reported, the RSL shall be established in line with all of the specific*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			rules in North American (NA) product standards and shall also consider, but not necessarily adhere to, the ISO 15686-1, -2, -7 and -8 standards. Where information is available for deriving the RSL from NA product standards, such data has priority. This PCR acknowledges product manufacturers cannot be held responsible for the actual design of the construction works, use and application of the product, environment, or workmanship. *The assumptions upon which the designated RSL is based and for which the RSL exclusively applies shall be provided in project report. Influences on ageing, when applied, shall be in accordance with the state of the art.*		
TE39			**PCR Specific Part A (§2.8.3):** *System Boundary with Nature and Between Product Systems* *System boundaries with nature and between product systems shall be defined, calculated and reported according to ISO 21930 sections 7.1.5 and 7.1.6.* *ISO 21930 Section 7.1.5:* ***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.* ***7.1.6 System boundary between products 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*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			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 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).*		

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			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.*		
TE40			**PCR Specific Part A (§2.8.4):** *System Boundaries and Scenarios 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.”* *Specific requirements for scenarios and assumptions shall follow ISO 21930 Section 7.1.7.1, and additional requirements may be provided in the sub-category Part B PCR.* *[ISO 21930, Section 7.1.7.1]: “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 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.”* *[EN 15804, Section 6.3.8]: “Scenarios shall support the calculation of information modules covering processes that deal with any one or all of the life cycle stages of the construction product except for the required modules A1 to A3; scenarios shall support the assessment of the environmental performance of a building in its life cycle stages “construction, use stage, end-of-life” [...].* *Scenarios shall be provided only for the environmental assessment. A scenario shall be based on relevant technical information. With the help of the scenario, the predetermined parameters of the EPD are derived by applying the calculation rules given in this standard.*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			A scenario shall be realistic and representative of one of the most probable alternatives. (If there are, e.g. three different applications, the most representative one, or all three scenarios shall be declared). Scenarios shall not include processes or procedures that are not in cur-rent use or which have not been demonstrated to be practical. *EXAMPLE 1: A recycling system is not practical if it includes a reference to a return system for which the logistics have not been established.* *EXAMPLE 2: Energy recovery needs to be based on existing technology and current practice.* *For EPDs that declare optional information modules, the additional technical information related to the scenarios underlying these modules is required."* *If an optional module declares the life cycle, the relevant technical information, e.g. recycling or reuse rates, must be documented in the project report with reference to the respective literary source."*		
TE41			**PCR Specific Part A (§2.8.4.1):** *A1-A3, Product Stage, Information Modules [ISO 21930 Section 7.1.7.2, supplemented with EN 15804 Section 6.2.2]: "The product stage includes:* *A1 Extraction and upstream production;* *A2 Transport to the 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. All materials, products and energy, as well as processing up to the system boundary between product systems1 or disposal of final residues during the product stage shall be provided. For a detailed description of what shall be included in modules A1-A3, refer to ISO 21930 Sections 7.1.7.2.2 – 7.1.7.2.4.*	Requirement met.	
TE42			**PCR Specific Part A (§2.8.4.1):** *[ISO 21930 Section 7.1.7.1 and EN 15804 Section 6.2.2]: "Modules A1, A2 and A3 may be declared as an aggregated Module A1-3."*	Requirement met.	
TE43			**PCR Specific Part A (§2.8.4.1):** *A1-A3, Product Stage, Information Modules The flows crossing into the system at the A1-A3 boundary are determined as follows:* ☐ *Production waste that is recycled without any modification of the material inherent characteristics (i.e. closed-loop or open-loop considered closed loop)*	Requirement met.	

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(1) Com-ment Type & No.	(2) Page No.	(3) Para/ Fig/ Tbl/ Note	(4) ISO/PCR Requirement	(5) Comment (justification for change)/Proposed change	(6) Decisions on each comment submitted
			can be considered as recycled within Modules A1-A3. This is only possible up to the volume that was used as input in production. *Heat and power from energy recovery of production waste in Modules A1-A3 can be considered closed-loop within Module A1-A3 if they are used at the same quality with-in Modules A1-A3 and only to the maximum amount in MJ as is required of the respective energy quality in MJ during production (assumption: overall manufacturing, A1-A3, considered as a module).*		
TE44			**PCR Specific Part A (§2.8.4.1):** *A1-A3, Product Stage, Information Modules* *If an allocation procedure different from co-product allocation is chosen for flows that reach the system at the boundary A1-A3, or datasets are chosen where allocation procedures are unknown, this procedure has to be justified or clarified as a dataset limitation. Ideally, datasets should be used that clarify allocation procedures. The resulting material and energy flows are to be described transparently in the project report with regard to the amounts of materials and energy within Module A1-A3.*	Requirement met.	
TE45			**PCR Specific Part A (§2.8.4.1.1):** *Coproducts leaving the system* *[ISO 21930 Section 7.1.7.2.6, supplemented with EN 15804 Section 6.3.4.2]: "Co-products from unit processes leaving the system at the production stage (A1-A3) shall be allocated in accordance with ISO 21930 Section 7.2.5. Loads and benefits from allocated co-products shall not be declared in Module D." (See Section 2.8.4.6 of this standard.)*	Requirement met.	
TE46			**PCR Specific Part A (§2.8.4.1.1):** *Outputs of waste* *ISO 21930 and EN 15804 have different approaches on the treatment of waste, as provided below. For the purposes of this standard, the approach detailed in ISO 21930 shall be used unless an EPD requires explicit conformance with EN 15804.* *ISO 21930 Section 7.1.7.2.7: "The output of waste during [the Production] 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 ISO 21930 Section 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."* *While loads and benefits from allocated co-products shall not be declared in Module D, waste recovered as a useable output flows may be considered from recovery processes and included as supplementary information in module D.*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			EN 15804 Section 6.4.3.2: "Flows leaving the system at the end-of-waste2 boundary of the production stage (A1 -A3) shall be allocated as co-products. *The output of waste during this life cycle stage may reach the end-of-waste state3 when it complies with the conditions described in EN 15804 Section 6.3.4.5, end-of-life stage. They are then allocated as co-products as EN 15804 Section 6.4.3.2."*		
TE47			**PCR Specific Part A (§2.8.4.2):** *A4-A5, Construction stage, Information modules* *[ISO 21930 Section 7.1.7.3.1, supplemented with EN 15804 Section 6.2.3]: "The construction process 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 process stage (i.e. production, transport and waste processing and disposal of the lost products and materials)."* *When a product is sold as a system, e.g. as a package including the installation materials, then the entire production of all components and product residues that might occur in A5 are to be declared in A1-A3. The transport of the system to the site is to be declared in A4. The installation inclusive waste treatment is to be declared in A5.* *[ISO 21930 Sections 7.1.7.3.2 – 7.1.7.3.3, supplemented with EN 15804 Section 6.3.4.3]: "The construction stage includes the optional information modules for:* *A4 Transportation from the factory gate to central warehouse or intermediate storage site, if relevant* *A4 Transportation to the construction site* *A4-A5 Storage of products, including heating, cooling, humidity control, etc.* *A5 Construction product waste (additional production and transport processes to compensate for the loss of product waste)* *A5 Waste processing of product packaging waste and product waste during the construction process up to the system boundary between product systems or disposal of final residues* *A5 Product installation into the construction works, including the manufacturing and transport of ancillary materials, direct energy use, and freshwater consumption required for installation*	N/A	

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Com-ment Type & No.</th><th>(2)
Page No.</th><th>(3)
Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th></tr>
<tr><td></td><td></td><td></td><td><i>A5 Site preparation required for product installation, including ancillary materials and waste management
Transport distances 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.
If no specific information for the efficiency of waste incineration plants (R1 value; see Section 2.8.7) of the incineration plant is available, it is assumed that packaging materials (and potential product waste from the installation process) are treated thermally in a plant with R1<0.6. Thus, the combustion process (loads) for the packaging is to be declared in Module A5, the resulting benefits in Module D.
The information in from ISO 21930 Section 7.1.7.3.4 shall be included, as below: “The information in [the following table] 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.</i>
<table>
<tr><th><i>Module</i></th><th><i>Parameter</i></th><th><i>Unit (expressed per functional unit or per declared unit)</i></th><th><i>Value</i></th></tr>
<tr><td><i>A5 Installation of the product</i></td><td><i>Mass of packaging waste Specify by type</i></td><td><i>kg or other unit as appropriate</i></td><td></td></tr>
<tr><td><i>A5 Installation of the product</i></td><td><i>GWP based in biogenic carbon content of packaging, specify by type, (where relevant)</i></td><td><i>kg CO_2e</i></td><td></td></tr>
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<tr><td>TE48</td><td></td><td></td><td>PCR Specific Part A (§2.8.4.3): <i>B1-B5, Use stage information modules</i>

<i>[ISO 21930 Section 7.1.7.4.1] “The use stage of the construction works includes information modules covering the period from the handover to when it is deconstructed or demolished. The 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.”
“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.”</i></td><td>N/A</td><td></td></tr>
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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			[ISO 21930 Section 7.1.7.4.2 and similarly EN 15804 Section 6.2.4]: "The use stage of the construction works includes the following five information modules: *B1 Use or application of the installed product* *B2 Maintenance (preventative and regular maintenance activities required for product function and technical performance, e.g. cleaning);* *B3 Repair (corrective, responsive, or reactive treatment of a product or its parts (e.g. a broken component), including preservation of aesthetic qualities);* *B4 Replacement (required when an entire product needs to be replaced, instead of a repairing a broken part or component);* *B5 Refurbishment (required to return a product to its functional condition during its service life, i.e. restoration).* *This includes provision and transportation of all materials, products and related energy and water use, as well as waste processing up to 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 the losses during this part of the use stage (i.e. production, transport, waste processing and disposal of the lost products and materials)."* *The B1 - B5 use stage information modules shall be covered according to ISO 21930 Section 7.1.7.4.2 and EN 15804 Section 6.3.4.4. Additional required assumptions for these in-formation modules may be included in a sub-category Part B PCR.*		
TE49			**PCR Specific Part A (§2.8.4.4):** *B6-B7, Use stage information modules relating to the operation of the building* *[ISO 21930 Section 7.1.7.4.3.1 and similarly EN 15804 Section 6.2.5]: "The use stage relating to the operation of the construction products includes the following two information modules:* *B6 Operational energy use (e.g. operation of a heating system and other technical construction works-related installed services);* *B7 Operational water use;* *Information modules 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."* *B6 - B7 use stage information modules shall be covered according to ISO 21930 Sections 7.1.7.4.3.2 - 7.1.7.4.3.3 and EN 15804 Section 6.3.4.4.3.*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
TE50			**PCR Specific Part A (§2.8.4.5):** *C1-C4 End-of-Life stage information modules* *The declaration of Module C is required in an EPD unless either of the following conditions are met4:* *1. Life cycle data for end-of-life is included and broken out separately in the LCA project report, in addition to one of the following:* ☐ *Recycling is directly controlled or supported by manufacturer, OR* ☐ *Landfill generic data per the product category is used, and has been standardized for comparability.* *OR* *2. A qualitative statement is provided in the LCA and EPD describing the typical end-of-life treatment of the product, including:* ☐ *Typical end-of-life scenarios are outlined* ☐ *Recycling is reported as average or product specific recycling rates and standard re-porting procedures are outlined, such as manufacturer take-back programs* ☐ *Biogenic carbon content/potential for decay is addressed* *The end-of-life information modules are as follows, and should be covered per ISO 21930 Section 7.1.7.5 and EN 15804 Section 6.2.6:* *C1 Deconstruction/Demolition (includes dismantling or demolition of the product from the site and the required energy to do this, including on-site material sorting)* *C2 Transportation to waste processing or disposal* *C3 Waste processing (includes collection of waste from deconstruction, recovery, and waste processing of material flows resulting in materials for reuse, secondary materials, secondary fuels, or export of energy recovered from waste with an efficiency of at least 60%, regardless of existing legislation)* *C4 Disposal of waste* *It is important to note that if there are, for example, three different recovery and disposal options for a product system, the most commonly used one, or all three scenarios, shall be declared separately. Also, per ISO 21930 Section 7.1.7.5, "A scenario based on a typical end-of-life, for example a mix of recovery and disposal options based on a national situation, shall only be provided if the scenarios for the separate individual options are also provided."* *A sub-category Part B PCR may provide additional requirements regarding product disposal pathway assumptions beyond what is provided in Section 2.8.5.*	N/A	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			The end-of-life system boundary of the construction product system to Module D is set where outputs, i.e. secondary materials or fuels, have reached system boundary between product systems or disposal of final residues.		
TE51			**PCR Specific Part A (§2.8.4.6):** *Benefits and loads beyond the product system boundary, information Module D* *[ISO 21930 Section 7.1.7.6] "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."* *Unless specified otherwise in a sub-category Part B PCR, Module D may be included in an LCA and EPD, and the results shall conform with ISO 21930 Section 7.1.7.6 and EN 15804 Section 6.3.4.6 as well as the requirements below. Specifically, per ISO 21930 Section 7.1.7.6, "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 re-covered energy from the product system." When reporting Module D results, the potential environmental loads and benefits shall be reported separately. When reporting Module D, the following non-emission specific quantitative and qualitative data shall also be included, but is not limited to:* ☐ *Recycled content* ☐ *Percent recyclability* ☐ *Reuse and recovery opportunities* ☐ *Mass of recyclable materials*	N/A	
TE52			**PCR Specific Part A (§2.8.5):** *Disposal Pathways by Region* *The following disposal pathways for the product shall be used by region or country unless justified otherwise or specified differently in the sub-category Part B PCR. Results for each of the individual options shall also be separately reported, as required by ISO 21930 Section 7.1.7.5 (i.e., if results are presented of a scenario that includes landfill, recycling, and incineration, then*	Requirement met.	

<table>
<tr><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th><th>(5)</th><th>(6)</th></tr>
<tr><th>Com-ment Type & No.</th><th>Page No.</th><th>Para/ Fig/ Tbl/ Note</th><th>ISO/PCR Requirement</th><th>Comment (justification for change)/Proposed change</th><th>Decisions on each comment submitted</th></tr>
<tr><td></td><td></td><td></td><td>

results must also be presented separately for 100% landfill, 100% recycling, and 100% incineration).

Table 1. Product Disposal Assumptions by Region

<table>
<tr><th>Country/Region</th><th>Material</th><th>Recycling Rate</th><th>Landfill Rate</th><th>Incineration Rate</th></tr>
<tr><td>Brazil[1]</td><td>All</td><td>0%</td><td>100%</td><td>0%</td></tr>
<tr><td>Canada</td><td>All metals</td><td>85%</td><td>15%</td><td>0%</td></tr>
<tr><td></td><td>Other materials</td><td>7%</td><td>93%</td><td>0%</td></tr>
<tr><td>China[3]</td><td>All</td><td>5%</td><td>95%</td><td>0%</td></tr>
<tr><td>EU</td><td>All</td><td>50%</td><td>37%</td><td>13%</td></tr>
<tr><td>India</td><td>All</td><td>0%</td><td>100%</td><td>0%</td></tr>
<tr><td>Japan</td><td>All</td><td>53%</td><td>4%</td><td>43%</td></tr>
<tr><td>Korea</td><td>All</td><td>83.9%</td><td>9.4%</td><td>6.1%</td></tr>
<tr><td>United States</td><td>All metals</td><td>85%</td><td>15%</td><td>0%</td></tr>
<tr><td></td><td>Other materials</td><td>0%</td><td>100%</td><td>0%</td></tr>
<tr><td>South East Asia - Malaysia</td><td>Concrete and aggregate</td><td>68%</td><td>32%</td><td>0%</td></tr>
<tr><td></td><td>Wood</td><td>4%</td><td>96%</td><td>0%</td></tr>
<tr><td></td><td>Others</td><td>0%</td><td>100%</td><td>0%</td></tr>
<tr><td>South East Asia – Singapore</td><td>All</td><td>94%</td><td>6%</td><td>0%</td></tr>
<tr><td>South East Asia – Other</td><td>All</td><td>5%</td><td>95%</td><td>0%</td></tr>
</table>

</td><td></td><td></td></tr>
<tr><td>TE53</td><td></td><td></td><td>

PCR Specific Part A (§2.8.5): *Disposal Pathways by Region*

The following disposal pathways shall be used for the product packaging unless justified otherwise or specified differently in the sub-category PCR.

Table 2. Packaging Disposal Assumptions by Region

</td><td>N/A</td><td></td></tr>
</table>

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**

Country/Region	***Material Type***	***Recycling Rate***	***Landfill Rate***	***Incineration Rate***
Brazil[13]	*Plastic*	*13.5%*	*86.5%*	*0%*
	Metals	*70%*	*30%*	*0%*
	Glass	*2.4%*	*97.6%*	*0%*
	Pulp (cardboard, paper)	*13.1%*	*86.9%*	*0%*
	Wood	*51.4%*	*48.6%*	*0%*
Canada	*Plastics*	*78%*	*22%*	*0%*
	Other materials	*20%*	*80%*	*0%*
China	*Plastics*	*25%*	*56%*	*19%*
	Metals	*20%*	*80%*	*0%*
EU20	*Plastic*	*40.3%*	*28.7%*	*31.0%*
	Metals	*76.2%*	*23.3%*	*0.5%*
	Glass	*73.2%*	*26.7%*	*0.1%*
	Pulp (cardboard, paper)	*82.8%*	*9.4%*	*7.8%*
	Wood	*39.8%*	*34.5%*	*25.7%*
India	*All*	*10%*	*90%*	*0%*
Japan	*Metals*	*98%*	*2%*	*0%*
	Other materials	*21%*	*1%*	*78%*
Korea	*All*	*83.9%*	*9.4%*	*6.1%*
United States	*Plastics*	*15%*	*68%*	*17%*
	Metals	*57%*	*34%*	*9%*
	Pulp (cardboard, paper)	*75%*	*20%*	*5%*

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Com-ment Type & No.</th><th>(2)
Page No.</th><th>(3)
Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th></tr>
<tr><td>TE54</td><td></td><td></td><td>

PCR Specific Part A (§2.8.6): *Waste Classification by Region*
The following relevant legislation references shall be used by region or country:
Table 3. Waste classification by region

<table>
<tr><th><i>Country/Region</i></th><th><i>Legislation</i></th></tr>
<tr><td><i>Brazil</i></td><td><i>Annex 1-A to 1-C of the CONAMA Resolution no 23, from December 12, 1996, unless they do not present any characteristics listed in Annex II of the same legislation.</i>
<i>Annex 10-A and 10-B of the CONAMA Resolution no 235, from January 7, 1998</i></td></tr>
<tr><td><i>China</i></td><td><i>List of Toxic Chemicals Severely Restricted on the Import and Export in China (Circular No. 65 [2005])</i>
<i>Measures for the Administration of Restricted Use of Hazardous Substances in Electrical and Electronic Products (Circular No. 32 [2016])</i></td></tr>
<tr><td><i>Europe</i></td><td><i>REACH Substances of Very High Concern</i></td></tr>
<tr><td><i>India</i></td><td><i>REACH Substances of Very High Concern</i></td></tr>
<tr><td><i>Japan</i></td><td><i>Hazardous wastes defined by the Basel Law are as follows:</i>
<i>A. The following materials which are exported or imported for the disposal operations listed in Annex IV of the Basel Convention.</i>
<i>1. Materials listed in Annex I of the Convention and having one or more hazardous characteristics listed in Annex III of the Convention;</i>
<i>2. Materials listed in Annex II of the Convention;</i>
<i>3. Materials to be notified to the Secretariat of the Convention by the Government of Japan through the designation by the Cabinet Order in accordance with Section 1 or 2 of Article 3 of the Convention; and</i>
<i>4. Materials informed by the Secretariat of the Convention in accordance with Section 3 of Article 3 of the Convention.</i>
<i>B. Materials, exportation, importation, transportation (including storage) and disposal of which must be regulated based on bilateral, multilateral or regional agreements or arrangements defined in Article 11 of the Convention.</i></td></tr>
<tr><td><i>Korea</i></td><td><i>Waste Control Act with some regulation under the Act on the Promotion of Saving and Recycling of Resources.</i></td></tr>
<tr><td><i>North America</i></td><td><i>Resource Conservation and Recovery Act (RCRA), Subtitle 3</i></td></tr>
<tr><td><i>Southeast Asia</i></td><td><i>REACH Substances of Very High Concern</i></td></tr>
</table>

</td><td>State waste classification is consistent with geographical region of North America (NA).</td><td>Statement added to section 3.8
Acknowledged</td></tr>
</table>

(1)	(2)	(3)	(4)	(5)	(6)
Comment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
TE55			**PCR Specific Part A (§2.8.7):** *Incineration Efficiency* *If data are available, the efficiency of waste incineration plants (R1) shall be calculated in accordance with Annex II of the EU waste directive as follows:* $R1\,WIP = ((Epe \times 2{,}6 + Eph{,}use \times 1{,}1) - (Ef + Ei)) / (0{,}97 \times (Ew + Ef))$ Epe *means annual energy produced as electricity* (GJ/a) $Eph{,}use$ *means annual energy produced as heat for commercial use* (GJ/a) Ef *means annual energy input into the system from fuels contributing to the production of steam* (GJ/a) Ei *means annual energy imported excluding* Ew *and* Ef (GJ/a) Ew *means annual energy contained in the treated waste calculated using the net calorific value of the waste* (GJ/a) *0,97 is a factor accounting for energy losses due to bottom ash and radiation WIP waste incineration plant* *In summary, three different cases of modelling thermal recycling of waste should be modelled and declared can be distinguished:* *Thermal treatment of waste, i.e. the waste flow has not reached the end of the waste status before combustion, and the incineration plant has a R1-value <0.6: the environmental loads of waste processing and incineration processes are declared as a waste disposal process in Module C4. Produced net energy due to treatment of waste is declared as exported energy in C4 and the benefits of the generated net energy is declared in Module D.* *Energy Recovery, i.e. the waste flow has not reached the end of waste status before combustion, and the incineration plant has a R1 value> 0.6: the environmental impact of waste processing and incineration processes are declared as energy recovery in C.3, the produced net energy is declared as exported energy in C3 and the associated benefits of the generated net energy is declared in Module D.* *Energetic use of a secondary fuel, i.e. the waste flow has reached the end of waste status prior to the combustion or thermal energy recovery process. This qualifies the material flow at the system boundary as a secondary fuel and the criteria of the R1 value is not applicable: the environmental impacts of any waste treatment of the future secondary fuel are accounted in C3, the*	Requirement met. Incineration based on GaBi models.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			material flow is declared as a material for energy recovery in C3, and the benefits associated with the generated net energy are declared in Module D. *NOTE: The default assumption shall be thermal treatment of waste unless the proper justification can be provided for other methods with supporting documentation.*		
TE56			**PCR Specific Part A (§2.8.8):** *Power Mix* *The following applies as regards selecting the power mix:* □ *At production facilities in the US, regionally specific grid mix data on electricity shall be based on EPA's eGRID database. Preference should be given to subnational consumption mixes that account for power trade between these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used.* □ *At production facilities in Canada, province specific grid mix data on electricity shall be based on StatCan statistics. Alternatively, production mixes of the two continental interconnections (East, West) may be used.* □ *At production facilities in China, region specific grid mix data on electricity shall be based on grid mixes of the State Grid Corporation of China (SGCC) or the China Southern Power Grid (CSG), depending on the provider of the facility.* □ *At production facilities in Brazil, India, Indonesia, Japan, Korea, Malaysia, or Thailand, country-specific grid mixes shall be based on IEA/OECD statistics.* □ *At production facilities outside of the countries listed above, comparable country-specific or region-specific processes shall be used provided they comply with the current state of the art.* □ *At production facilities in several countries, the applicable power mixes shall be assessed specifically for each country or combined weighted by production volumes in the respective countries.* □ *If "green" power is used, it must not be reported in inventory or impact assessment results in the LCA and EPD; results must specify the original grid source used for production. However, if there is a transparent path, such as in the EU (Guarantee of Origin), where chain of custody of green power can be traced by kwh and origin (not just CO2e attributes), these results may be reported separately with an explanatory note stating how the green power is used in the calculations. Certificates must be available for the entire period of EPD validity. If certificates cannot be provided for the full 5 years when issuing the EPD, the program operator must request the certificates for the preceding five (5) years in order to extend the Declaration.*	Requirement met.	

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Com-ment Type & No.</th><th>(2)
Page No.</th><th>(3)
Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th></tr>
<tr><td>TE57</td><td></td><td></td><td>PCR Specific Part A (§2.8.9): <i>CO2 Certificates</i>
<i>CO2 certificates shall not be included in the Life Cycle Assessment but may be reported separately, apart from LCA results. The following CO2 certificates may be recognized:</i>
☐ <i>Clean Development Mechanism (CDM) Gold Standard</i>
☐ <i>Gold Standard Verified Emission Reduction (VER)</i>
☐ <i>Voluntary Carbon Standard</i>
☐ <i>Verified Emission Reduction (VER)</i>

<i>Other certificates can be considered if they comply with the criteria on which this selection is based.</i>

<i>Owing to the fact that the EPDs are always valid for a period of five (5) years, the manufacturer must provide evidence of discontinuation of CO2 pollution rights in order to obtain recognition.</i>

<i>CO2 credits shall be specified separately and not reported in inventory or impact assessment results. There shall be clear delineation between the product life cycle impacts and then any carbon offsets or credits used to mitigate this impact.</i></td><td>N/A</td><td></td></tr>
<tr><td>TE58</td><td></td><td></td><td>PCR Specific Part A (§4.12) Specific Part B (§3.10): <i>Units</i>
<i>The International System of Units (SI units) required for all LCA results. Other units commonly used in a regional market may be optionally included in addition to the required SI units.</i>

<i>TABLE 12. MANDATORY CONVERSION FACTORS TO BE USED IF REPORTING IN IMPERIAL UNITS</i>
<table>
<tr><th><i>Convert from</i></th><th><i>To</i></th><th><i>Multiply by</i></th></tr>
<tr><td><i>square meter</i> (m^2)</td><td><i>Square foot</i> (ft^2)</td><td><i>10.76391</i></td></tr>
<tr><td><i>kilogram (kg)</i></td><td><i>Pound (lb)</i></td><td><i>2.204622</i></td></tr>
<tr><td><i>Mega joule (MJ)</i></td><td><i>British Thermal Unit (BTU)</i></td><td><i>947.8170</i></td></tr>
<tr><td><i>degree Celsius (°C)</i></td><td><i>degree Fahrenheit (°F)</i></td><td><i>t/°C = (t/°F - 32)/1.8</i></td></tr>
<tr><td><i>cubic meter (m3)</i></td><td><i>cubic foot (ft3)</i></td><td><i>35.31466</i></td></tr>
</table>

<i>SI units are required for all LCA results. Other units commonly used in a regional market may be optionally included in addition to the required SI units; refer to Part A, Section 4.12 for additional guidance. Three significant figures</i></td><td>Requirement met.</td><td></td></tr>
</table>

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			should be adopted for all results. The number of significant digits shall be appropriate and consistent. **Part B (§3.10):** *Units* *SI units are required for all LCA results. Other units commonly used in a regional market may be optionally included in addition to the required SI units*		
TE59			**PCR Specific Part B (§3.9):** *Estimates and Assumptions* *Key assumptions and estimates in throughout Section 3 and 4 should be included in the LCA and EPD.*	Requirement met.	
TE60			**PCR Specific Part A (§2.9) Part B (§3.4):** *Cut-off Rules* *[ISO 21930 Section 7.1.8 supplemented with EN 15804 Section 6.3.5]: "Criteria for the exclusion of inputs and outputs (cut-off rules) in the Life Cycle Assessment and information modules and any additional information are intended to support an efficient calculation procedure. They shall not be applied in order to hide data. Any application of the criteria for the exclusion of inputs and outputs shall be documented."* *The procedure detailed in ISO 21930, Section 7.1.8 shall be followed for the exclusion of inputs and outputs.* *Application of the cut-off criteria shall be documented in the project report:* *Description of the application of cut-off criteria and assumptions* *List of processes not taken into consideration.* **Part B (§3.4):** *Cut-off rules as specified per Part A, Section 2.9 shall be used and documented. All known mass and energy flows shall be reported. No known flows should be deliberately excluded.*	Requirement met.	
TE61			**PCR Specific Part A (§3.1):** *Life Cycle Inventory Analysis –* ***DATA SELECTION, COLLECTION, AND DATA QUALITY*** *The requirements detailed in ISO 21930 Sections 7.1.9, 7.2.1, and 7.2.2 and EN 15804 Sections 6.3.6, 6.4.1, and 6.4.2 shall apply to the selection and collection of data used to calculate an LCA and report an EPD.* *Manufacturer specific data shall be no more than five years old.* *The data selection and collection procedures shall be documented in the project report.* *Primary data shall be collected for every process in the product system under the control of the organization developing the LCA. Primary data shall be collected using either direct measurement or facility personnel's best engineering estimates based on actual production if measurements are not*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			available. The method of collection shall be specified for each process in the LCA report. *The specified secondary sources should have temporal, geographic, and technological coverage appropriate to the scope of the product category. The system boundaries of the secondary sources should be equivalent and reference flows should be adaptable to the product system specified in the PCR. Allocation procedures used in the specified secondary sources should be appropriate for the product category.* *For industry-average EPDs, data shall be collected from participants in a consistent manner. All data sources shall be specified, including database and year of publication (reference).* *Secondary data sources from regions other than the primary market may be used only if primary market data are unavailable in any commercial database. The substitute source shall be documented.* *LCA models used to generate results for an EPD are encouraged to use unit process data sets (as opposed to system process data sets) so that the modeler may edit the underlying data in pursuit of optimizing the representativeness of the data set to the product system.*		
TE62			**PCR Specific Part A (§3.1):** *Life Cycle Inventory Analysis –**DATA SELECTION, COLLECTION, AND DATA QUALITY*** *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 shall apply to EPDs in accordance with this PCR:* *[ISO 21930 Section 7.1.9, supplemented with EN 15804 Section 6.3.7]:* *"The quality of the data used to calculate an EPD shall be addressed in the project report (see ISO 21930 Section 7.1.9, EN 15804 Clause 8, and ISO 14044 Section 4.2.3.6). In addition the following specific requirements apply for construction products:* *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*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**

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 following table).

Modules	**A1 to A3**		**A4 to A5**	**B1 to B7**	**C1 to C4**
	Production of commodities, raw materials	Product manufacture	Installation processes	Use processes	End-of-life processes
Process type	Upstream processes	Manufacturer's processes	Downstream processes		
Data type	Generic data or EPD of upstream processes See also [ISO 21930] Annex B	Manufacturer's average or specific data See also [ISO 21930] Annex B	Scenario based generic data based on technical information given in [ISO 21930] 7.1.7.3 to 7.1.7.5		

- *Data shall be as current as possible. Data sets used for calculations shall have been updated within the last ten (10) years for background data and within the last five (5) years for producer-specific (foreground) data33. Deviations shall be justified.*

- *Manufacturer-specific data sets shall be based on 12 consecutive months of averaged data; deviations shall be justified in the project report. If future production conditions are to be incorporated at the time of generating the EPD, the following shall apply to Processes which do not have an influence on the manufacturing process (e.g. procurement of green electricity) may be integrated in the Declaration. For green electricity, this means that the Declaration may not be issued until such a time as procurement takes place and is verified by contract.*

o For processes which have an influence on manufacturing processes (e.g. new furnace), data must be available over a certain period of time which

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			provides a representative set of data for the new process. This need not be a full year; 3-4 months often suffices in this case. *[ISO 21930 Section 7.1.9, supplemented with EN 15804 Section 6.3.7]:* *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. o NOTE Long-term emissions are considered emissions occurring beyond 100 years after the material was deposited on or in the landfill.* *The technological coverage shall reflect the physical reality for the declared product or product group;* *Generic data: Guidance for the selection and use of generic data is provided in CEN/TR 15941. Generic data shall be checked for plausibility.* *Data sets shall be complete according to the system boundaries and criteria for the exclusion of inputs and outputs (see EN 15804 Section 6.3.5).*		
TE63			**ISO Requirement (§4.3.2.1):** *Life Cycle Inventory Analysis – Collecting Data* *The qualitative and quantitative data for inclusion in the inventory shall be collected for each unit process that is included within the system boundary. The collected data, whether measured, calculated or estimated, are utilized to quantify the inputs and outputs of a unit process.* *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. If such data do not meet the data quality requirements, this shall be stated.* *To decrease the risk of misunderstandings (e.g. resulting in double counting when validating or reusing the data collected), a description of each unit process shall be recorded.* *Since data collection may span several reporting locations and published references, measures should be taken to reach uniform and consistent understanding of the product systems to be modelled.*	Requirement met.	
TE64			**ISO Requirement (§4.3.3.1):** ***Life Cycle Inventory Analysis – Calculating Data - General***	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			All calculation procedures shall be explicitly documented and the assumptions made shall be clearly stated and explained. The same calculation procedures should be consistently applied throughout the study. *When determining the elementary flows associated with production, the actual production mix should be used whenever possible, in order to reflect the various types of resources that are consumed. As an example, for the production and delivery of electricity, account shall be taken of the electricity mix, the efficiencies of fuel combustion, conversion, transmission and distribution losses.* *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. In this case, it shall be reported whether the higher heating value or the lower heating value is used.* *Several operational steps are needed for data calculation. These are described in 4.3.3.2 to 4.3.3.4 and 4.3.4.*		
TE65			**ISO Requirement (§4.3.3.2):** ***Life Cycle Inventory Analysis – Calculating Data – 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.* *Validation may involve establishing, for example, mass balances, energy balances and/or comparative analyses of release factors. As each unit process obeys the laws of conservation of mass and energy, mass and energy balances provide a useful check on the validity of a unit process description. Obvious anomalies in the data resulting from such validation procedures require alternative data that comply with the data selection as established according to 4.2.3.5.*	Requirement met.	
TE66			**ISO Requirement (§4.3.3.3):** ***Life Cycle Inventory Analysis – Calculating Data – Relating Data to Unit Processes and Functional Unit*** *An appropriate flow shall be determined for each unit process. The quantitative input and output data of the unit process shall be calculated in relation to this flow.*	Requirement met.	
TE67			**ISO Requirement (§4.3.3.4):** ***Life Cycle Inventory Analysis – Calculating Data – Refining the system boundary***	N/A – Boundary set by PCR	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Reflecting the iterative nature of LCA, decisions regarding the data to be included shall be based on a sensitivity analysis to determine their significance, thereby verifying the initial analysis outlined in 4.2.3.3. 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. *The sensitivity analysis may result in* *– exclusion of life cycle stages or unit processes when lack of significance can be shown by the sensitivity analysis,* *– exclusion of inputs and outputs that lack significance to the results of the study, or* *– inclusion of new unit processes, inputs and outputs that are shown to be significant in the sensitivity analysis.* *This analysis serves to limit the subsequent data handling to those input and output data that are determined* *to be significant to the goal of the LCA.*		
TE68			**ISO Requirement (§4.3.4.1): *Life Cycle Inventory Analysis – Calculating Data – 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.* *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.* *Whenever several alternative allocation procedures seem applicable, a sensitivity analysis shall be conducted to illustrate the consequences of the departure from the selected approach.*	Requirement met.	
TE69			**ISO Requirement (§4.3.4.2): *Life Cycle Inventory Analysis – Calculating Data – Allocation Procedures*** *The study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below.* *a) **Step 1**: Wherever possible, allocation should be avoided by* *1) dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or* *2) expanding the product system to include the additional functions related to the co-products, taking into account the requirements of 4.2.3.3.* *b) **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 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.*	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			c) ***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. For example, input and output data might be allocated between co-products in proportion to the economic value of the products.* *Some outputs may be partly co-products and partly waste. In such cases, it is necessary to identify the ratio between co-products and waste since the inputs and outputs shall be allocated to the co-products part only.* *Allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration. For example, if allocation is made to usable products (e.g. intermediate or discarded products)* *leaving the system, then the allocation procedure shall be similar to the allocation procedure used for such products entering the system.* *The inventory is based on material balances between input and output. Allocation procedures should therefore approximate as much as possible such fundamental input/output relationships and characteristics.*		
TE70			**ISO Requirement (§4.3.4.3):** *Life Cycle Inventory Analysis – Calculating Data – Allocation Procedures – resuse and recycling* *4.3.4.3.1 The allocation principles and procedures in 4.3.4.1 and 4.3.4.2 also apply to reuse and recycling situations.* *Changes in the inherent properties of materials shall be taken into account. In addition, particularly 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 as described in 4.3.4.2.* *4.3.4.3.2 However, in these situations, additional elaboration is needed for the following reasons:* *– reuse and recycling (as well as composting, energy recovery and other processes that can be assimilated to reuse/recycling) may imply that the inputs and outputs associated with unit processes for extraction and processing of raw materials and final disposal of products are to be shared by more than one product system;* *– reuse and recycling may change the inherent properties of materials in subsequent use;* *– specific care should be taken when defining system boundary with regard to recovery processes.* *4.3.4.3.3 Several allocation procedures are applicable for reuse and recycling. The application of some procedures is outlined conceptually in Figure 2 and is*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			distinguished in the following to illustrate how the above constraints can be addressed. *a) A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. However, the first use of virgin materials in applicable open-loop product systems may follow an open-loop allocation procedure outlined in b).* *b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.* *4.3.4.3.4 The allocation procedures for the shared unit processes mentioned in 4.3.4.3 should use, as the basis for allocation, if feasible, the following order:* *– physical properties (e.g. mass);* *– economic value (e.g. market value of the scrap material or recycled material in relation to market value of primary material); or* *– the number of subsequent uses of the recycled material (see ISO/TR 14049).*		
TE71			**ISO Reporting Requirement (§5.2):** *Additional Requirements and Guidance* *The third-party report shall cover the following aspects:* *d)* ***Life cycle inventory analysis****:* *1) data collection procedures;* *2) qualitative and quantitative description of unit processes;* *3) sources of published literature;* *4) calculation procedures;* *5) validation of data, including* *i) data quality assessment, and* *ii) treatment of missing data;* *6) sensitivity analysis for refining the system boundary;* *7) allocation principles and procedures, including* *i) documentation and justification of allocation procedures, and* *ii) uniform application of allocation procedures.*	Requirement met.	
TE72			**PCR Specific Part A (§3.1.1) Part B (§3.5) Part B (§3.6):** *Life Cycle Inventory Analysis – Data Quality Evaluation.* *An evaluation of data quality, including temporal, geographical, technological representativeness, and completeness, shall be included in the project report. If the data quality assessment gives sufficient reason to believe that any of the employed generic material or process LCI data is not representative of the*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			product(s) under study and may introduce error to the reported impact category results, then a reasonable effort shall be made by the declaring organization to improve the data quality either by 1) collecting primary data on the material or process in question from suppliers or process operators, 2) developing LCI data based on other data sources like scientific literature, equipment specs, or trade publications, or 3) assessing whether more representative LCI data is available from any of the sources listed in Section 3.1.2. If none of these options is viable within given constraints, the source and nature of the expected error shall be documented in the project report and a disclaimer should be added to the EPD that the reported values are likely an over- or under-estimate of potential environmental burdens. **Part B (§3.5):** *Data sources shall be documented per Part A, Section 3.1.* *All steel datasets shall be the most recent, representative, regional-average datasets published by AISI or Worldsteel, unless data is available from the specific steel supplier for the construction product covered by the EPD. Any deviation from the requirements of ISO 21930:2017 (e.g. physical allocation for co-products) in background datasets shall be justified and described.* *In situations where secondary data is used to represent a key unit process, secondary data shall include a regionally appropriate electricity supply mix.* **Part B (§3.6):** *An evaluation shall be provided regarding data quality, including temporal, geographical, technological representativeness, and completeness and shall follow the requirements outlined in Part A, Section 3.1.1.*		
TE73			**PCR Specific Part A (§3.1.2) Part B (§3.7):** *Life Cycle Inventory Analysis – Background Data.* *Until pre-verified generic data sets are available as per EN 15804 and CEN/TR 15941, the following rules shall apply for selecting the background data base:* *As a general rule, consistent background data should be used in order to ensure comparability of results.* *The following databases may be used:* *o NREL US LCI / LCA Digital Commons (https://www.lcacommons.gov)* *o European/International Life Cycle Database (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm)* *o GaBi (http://www.gabi-software.com/databases)* *o ecoinvent (www.ecoinvent.ch)* *o WorldSteel database (https://www.worldsteel.org/steel-by-topic/life-cyclethinking.html)* *o eBalance (http://support.ike-global.com/downebalancefree)* *o AusLCI (http://www.auslci.com.au/)*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			o Agri-footprint (http://www.agri-footprint.com/) ▯ *A third party verified ISO 14040/44 conforming report shall be available for all secondary data sets with the exception of the databases listed above (either at the unit process level or in aggregate) that contribute to more than two-thirds (67%) of total impact to any of the required impact categories identified by the applicable PCR.* *The project report shall:* ▯ *Indicate the data sets used and sources (e.g., name of database, literary source), including the year for which the data set is representative* ▯ *Document the representativeness of data sets used* ▯ *Document the treatment of missing data* ▯ *Evaluate data quality* **Part B (§3.7):** *The period under review and ensuing averages shall be documented.*		
TE74			**PCR Specific Part A (§3.2):** *Life Cycle Inventory Analysis – Calculation Procedures* *Calculation procedures described in ISO 14044 and referenced in ISO 21930 Section 7.2.2 and EN 15804 Section 6.4.2 shall apply. All calculation procedures shall be applied consistently throughout the LCA.* *When transforming the inputs and outputs of combustible materials into energy, the lower caloric value of fuels (LHV) shall be applied according to scientifically based and accepted values specific to the combustible material.* ***ISO 21930*** ***7.2.2 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.* ***EN 15804*** ***6.4.2 Calculation procedures***	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			The calculation procedures described in EN 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.		
TE75			**PCR Specific Part A (§3.3):** *Life Cycle Inventory Analysis – Allocation Procedures – coproducts and between product systems* *Allocation procedures for co-products and between product systems shall be addressed ac-cording to ISO 21930, Sections 7.2.4, 7.2.5, and 7.2.6 and EN15804, Sections 6.4.3.1 and 6.4.3.2. Generally speaking, allocation shall be avoided by dividing unit processes into sub-processes that can be allocated to co-products and by then collecting the input and output data related to these sub-processes.* ☐ *Unless specified otherwise in a sub-category Part B PCR, allocation shall be based on physical properties (e.g. mass, volume) when the difference in revenue from the co-products is low;* ☐ *In all other cases, allocation shall be based on economic values;* ☐ *Material flows carrying specific inherent properties, e.g. energy content, elementary composition (e.g. biogenic carbon content), shall always be allocated reflecting the physical flows, irrespective of the allocation chosen for the processes.* ☐ *Impacts from allocated co-products shall not be included in module D.* ☐ *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.* *NOTE 1: Contributions to the overall revenue of the order of 1% or less is regarded as very low. A difference in revenue of more than 25% is regarded as high.* *NOTE 2: A common position on the definition of the most appropriate allocation rule needs to be de-fined together with other relevant sectors.* *NOTE 3: Products and functions are the outputs and/or services provided by the process, having a positive economic value.* *NOTE 4: In industrial processes, there may be a wide variety of different types of materials produced in conjunction with the intended product. In business*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			vocabulary, these may be identified as by-products, co-products, intermediate products, non-core products or sub-products. In this Part A PCR these terms are treated as being equivalent. However, for the allocation of environmental aspects and impacts a distinction between co-products and products is made in this Part A PCR."		
TE76			**PCR Specific Part A (§3.3.1):** *Life Cycle Inventory Analysis – Allocation Procedures – Reuse, Recycling and Recovery* *[ISO 21930 Section 7.2.6] "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."* *It is important to note that "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."* *[EN15804 Section 6.4.3.3]: "The end-of-life system boundary of the construction product system is set where outputs of the system under study, e.g. materials, products or construction elements, have reached the end-of-waste state. Therefore, waste processing of the material flows (e.g. undergoing recovery or recycling processes) during any module of the product system (e.g. during the production stage, use stage or end-of-life stage) are included up to the system boundary of the respective module as defined above.* *Where relevant […], informative Module D declares potential benefits or avoided loads of secondary material, secondary fuel or recovered energy leaving the product system. Module D recognizes the "design for reuse, recycling and recovery" concept for construction works by indicating the potential benefits of avoided future use of primary materials and fuels while taking into account the loads associated with the recycling and recovery processes beyond the system boundary."* *NOTE 1: Module D also contains benefits from recovered energy exported from waste disposal processes declared in Module C4 and A5. .* *Where a secondary material or fuel crosses the system boundary and if it substitutes another material or fuel in the following product system, the potential benefits or avoided loads can be calculated based on a specified*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			scenario which is consistent with any other scenario for waste processing and is based on current average technology or practice. *If today's average is not available for the quantification of potential benefits or avoided loads, a conservative approach shall be used that substitutes primary material based on the current technology mix for the material.* *In Module D, the impacts of net output flows are calculated as follows:* *By adding all output flows of a secondary material or fuel and subtracting all input flows of this secondary material or fuel from each sub-module first (e.g. B1-B5, C1-C4 etc.), then from the modules (e.g. B, C), and finally from the total product system thus arriving at net output flows of secondary material or fuel from the product system;* *By adding the impacts connected to the recycling or recovery processes from be-yond the system boundary up to the point of functional equivalence where the secondary material or fuel substitutes primary production and subtracting the impacts resulting from the substituted production of the product or substituted generation of energy from primary sources;* *By applying a justified value-correction factor to reflect the difference in functional equivalence where the output flow does not reach the functional equivalence of the substitution process.* *In Module D substitution effects are only calculated for the resulting net output flow.* *The amount of secondary material output, which is for all practical purposes able to replace one to one the input of secondary material as a closed loop is allocated to the product system under study and not to Module D.* *NOTE 2: Avoided impacts from allocated co-products are not part of Module D information […].”* *When selecting the substituted processes, the following shall apply for packaging energy utilization (Also see Section 2.8.4.2):* *For production locations in the US, regionally specific inventory data on electricity based on the current version of EPA's eGRID database shall be used. Preference should be given to subnational consumption mixes that account for power trade be-tween these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used. Substituted thermal energy shall be accounted for as thermal energy from natural gas, indicating the year of reference.*		

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			* In the case of production facilities in Germany, the current average “Strom Deutsch-land” index shall be used for power and the “Thermal energy from natural gas” index for heat, indicating the year of reference.* *In the case of production facilities in Brazil, China, India, Japan, Korea, or Southeast Asia, refer to Section 2.8.8 for electricity requirements. Substituted thermal energy shall be accounted for as global average thermal energy from natural gas, indicating the year of reference.* *For production locations outside of the countries and region listed above, the respective location where energy is provided must be taken into consideration.* . *When selecting the substituted processes, the following end-of-life scenario shall apply for energetic utilization of the product:* *In the case of a primary market in the US, regionally specific inventory data on electricity based on the current version of EPA’s eGRID database shall be used. Preference should be given to subnational consumption mixes that account for power trade between these regions. Alternatively, US production mixes of the three continental interconnections (East, West, Texas) as well as those of Hawaii and Alaska may be used. Substituted thermal energy shall be accounted for as thermal energy from natural gas, indicating the year of reference.* *In the case of a primary market in Germany, the current average “Strom Deutsch-land” index shall be used for power and the “Thermal energy from natural gas” index for heat, indicating the year of reference.* *In the case of a primary market Brazil, China, India, Japan, Korea, or Southeast Asia, refer to Section 2.8.8 for electricity requirements. Substituted thermal energy shall be accounted for as global average thermal energy from natural gas, indicating the year of reference.* *For production locations outside of the countries and region listed above, the respective location where energy is provided must be taken into consideration.*		
TE77			**PCR Specific Part A (§3.3.2):** *Life Cycle Inventory Analysis – Allocation Procedures – Processes in the Project Report* *Allocations performed must be described in the project report, at least (if relevant):* *Allocations when using secondary materials as raw materials* *Allocations in the plant (differentiation from other products manufactured in the plant)* *Allocation of multi-input processes if performed during modelling*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Allocations of reuse, recycling and energy recovery *The allocation processes selected must be justified and the allocation factors used must be confirmed by independent sources.* *Uniform application of the allocation rules must be documented.*		
TE78			**PCR Specific Part B (§3.3.):** *System Boundary – Allocation* *Part A, Section 3.3 shall be used as the basis for allocation decisions, and mass should be used as the primary basis for co-product allocation in this Part B. Allocation methods deemed more appropriate than on the basis of mass (e.g. economic allocation) may be used but only when justified. The allocations of relevance for calculation (appropriation of impacts across various products) shall be indicated, at least:* *• Allocation in the use of recycled and/or secondary raw materials* *• Allocation of energy, ancillary and operating materials used for individual products in a factory whereby reference shall be made to the modules in which the allocations are performed.*	Requirement met.	
TE79			**PCR Specific Part A (§3.4):** *Life Cycle Inventory Analysis – Description of the Unit Processes in the Project Report.* *The project report must transparently document the unit process modelling in the LCA. With regards to data confidentiality, relevant confidential information shall be shared for verification purposes and kept confidential by the Program Operator. The report may not include confidential information for communication with third-parties.* *Documentation may be done in a tabular form or as flow charts (e.g. screenshots from LCA software), whereby the following must be clarified:* *Attribution of company data to LCI background data sets* *Allocation of process data to the life cycle modules in the LCA* *If several products are declared in a single EPD or if a product is manufactured at several locations, modelling must be described for each product and/or location and the weighing of data sets documented.*	Requirement met.	
TE80			**PCR Specific Part A (§4.0): Life Cycle Inventory Analysis and estimated impacts** *The results of the Life Cycle Assessment must be described in the project report in tabular form for all Modules A1 to D. The Life Cycle Inventory Analysis indicators to be declared and the estimated impacts shall also be indicated.*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			If individual modules or entire life cycle stages are not declared, the corresponding fields in the table must be marked as "MND" (module not declared).		
TE81			**PCR Specific Part A (§4.1): Life Cycle Inventory Analysis as per ISO 21930 and EN 15804** *[ISO 21930 Section 7.2.10]: "Parameters to describe the use of resources: The following environmental parameters use data from the inventory analysis. They describe the use of renewable and non-renewable material resources, renewable and non-renewable primary energy and water. The parameters are required and shall be specified in the EPD according to Table 6, adapted from ISO 21930, Section 7.2.10.* *Refer to the ACLCA ISO 21930 Guidance document for further calculation instructions.*	Requirement met.	

RPR_E: Renewable primary energy used as energy carrier (fuel)	(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	[MJ, LHV]
RPR_M: Renewable primary re- sources with energy content used as material	(First use) biobased materials used as materials (e.g. wood, hemp, etc.).	[MJ, LHV]
$NRPR_E$: Non-renewable primary resources used as an energy carrier (fuel)	(First use) materials such as peat, oil, gas, coal, uranium used as an energy source.	[MJ, LHV]
$NRPR_M$: Non-renewable primary resources with energy content used as material	(First use) primary resources such as oil, gas and coal, used for products (e.g. plastic-based products).	[MJ, LHV]

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**

SM: Secondary materials	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	[kg]	
RSF: Renewable secondary fuels	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. biomass residue pellets, chipped waste wood).	[MJ, LHV]	
NRSF: Non-renewable secondary fuels	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).	[MJ, LHV]	
RE: Recovered energy	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.	[MJ, LHV]	
FW: Use of net fresh water re-sources	See section 4.1.1 below	[m³]	

NOTE 1: In order to identify the input part of renewable/non-renewable primary energy used as an energy carrier and not as a raw materials, the parameter "use of renewable/non-renewable primary energy excluding the renewable/non-renewable primary energy resources used as raw materials"

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			parameter is considered and can be calculated as the difference between the total input of energy resources and the input of primary energy resources used as a raw materials. *The use of the primary energy, which is used as raw material, is calculated as the energy content from the mass of the components (content composition) multiplied with the respective lower calorific value (LHV) of the components.* *EN 15804 Section 7.2.4 requires the additional reporting of parameters RPRT (Total use of renewable primary resources with energy content) and NRPRT (Total non-renewable primary resources with energy content). RPRT = RPRE + RPRM, and NRPRT = NRPRE + NRPRM. For conformance with ISO 21930:2017, these parameters shall not be reported and are not included in Table 6.*		
TE82			**PCR Specific Part A (§4.1.1) Freshwater Consumption** *Net freshwater consumption shall be reported as an LCI indicator and calculated according to ISO 14046. Net freshwater is equal to consumptive freshwater use (freshwater consumption) and should not consider water which is not consumed.* *The parameter contains: evaporation (e.g. cooling towers), evapotranspiration (evaporation of irrigated water), embedded freshwater (e.g. concrete), drainage of freshwater into the ocean.* *Further guidance is provided in ISO 21930, Section 7.2.13, and additional calculation guidance may be provided in a sub-category Part B PCR.*	Requirement met.	
TE83			**PCR Specific Part A (§4.1.2)** *The indicators describing waste categories and other material flows are output flows derived from LCI and shall be reported according to ISO 21930 Section 7.2.14 and EN15804 Section 7.2.5. They shall be included in the EPD as follows:* ***Table 7. Life Cycle Inventory Results: Output Flows and Waste Categories*** **Parameter** | **Parameter Name** | HWD | Hazardous waste disposed | [kg] NHWD | Non-hazardous waste disposed | [kg]	Requirement met.	

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**

HLRW	High-level radioactive waste, conditioned, to final repository	[kg] or [m^3]
ILLRW	Intermediate- and low-level radioactive waste, conditioned, to final repository	[kg] or [m^3]
CRU	Components for re-use	[kg]
MR	Materials for recycling	[kg]
MER	Materials for energy recovery	[kg]
EE	Exported energy	MJ, heating value ([Hi] lower heating value) per energy carrier

"Hazardous waste disposed" is the amount of hazardous waste that is disposed according to the section 2.8.4.5, Table 4. Radioactive waste is not included.
"Non-hazardous waste disposed" is the amount of non-hazardous waste that is disposed.

"Radioactive waste disposed" is the amount of radioactive waste that is disposed. High-level radioactive waste, e.g., when generated by electricity production, consists mostly of spent fuel from reactors. Low- and intermediate-level radioactive wastes, e.g., when generated by electricity production, arise mainly from routine facility maintenance and operations.
See ISO 21930, section 7.2.14, Table 4 for how to assign output flows to information modules
C1-C4.

The output material flows are declared in the module from which they cross the system boundary, as a rule when they reach the end of waste status.

NOTE: For the calculation and communication of indicators on environmental aspects:
As long as the LCA software used does not allow distinguishing the ***primary energy used as raw material or as energy carrier,*** *it is permissible to*

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			calculate the primary energy as a fuel source across modules A1-A3 as the difference between primary energy and primary energy used as a raw material, where primary energy used as a raw material is calculated based on the product material composition and corresponding LHVs. When communicating the values in the EPD, this shall be indicated by the design of the frame in the table. *As long as the used LCA software does not allow calculating the* ***use of secondary materials or secondary fuels*** *directly, it is permissible to declare these indicators based on available information from the main system (i.e. manufacturer´s data) as a minimum value.* *The indicators may be declared for the production stage across the modules A1-A3. When communicating the values in the EPD, this is to be indicated by the design of the frame in the table.*		
TE84			**PCR Specific Part A (§4.2): Accounting for Biogenic Carbon Uptake and Emissions** *See ISO 21930, section 7.2.7, for requirements on accounting for the biogenic carbon removal(s) and emissions of the product system in the form of mass flows to and from nature. The amount of biogenic carbon contained within the packaging material shall be included in the scenario information for module A5. The amount of biogenic carbon removed via the declared unit of product shall be documented in the scenario information at end-of-life. In both instances, biogenic carbon shall be expressed as kg CO2.*	N/A. A5 is not reported.	
TE85			**PCR Specific Part A (§4.3): Accounting for Calcination and Carbonation** *According to ISO 21930 Section 7.2.8, "Carbonation is the reaction of atmospheric carbon dioxide with calcium oxide or calcium hydroxide containing products to form calcium carbonate.[…] Environmental impacts considered during the production, use and end-of-life stages shall include carbonation as detailed in ISO 21930, Section 7.2.8. More detailed guidance and requirements may be provided in a sub-category Part B PCR.*	N/A	
TE86			**PCR Specific Part A (§4.4): Accounting for Delayed Emissions** *Per ISO 21930 Section 7.2.9, there is no consensus of approaches to address delayed emissions in the calculation of 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 ISO 21930, Section 9.6) and the underlying methodology shall be referenced." More detailed guidance and requirements may be provided in a sub-category Part B PCR.*	N/A – delayed emissions not reported.	
TE87			**PCR Specific Part A (§4.5): Greenhouse Gas Emissions from Land-Use Change**	N/A	

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Page No.</th><th>(3)
Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th></tr>
<tr><td></td><td></td><td></td><td>Per ISO 21930 Section 7.2.11, “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.”
Refer to ISO 21930, Section 7.2.11, for further considerations.

More detailed guidance and requirements may be provided in a sub-category Part B PCR.</td><td></td><td></td></tr>
<tr><td>TE88</td><td></td><td></td><td>PCR Specific Part A (§4.6): Carbon Emissions and Uptake

[ISO 21930, section 7.2.12]: “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:

Table 8 shall be included in an EPD if included in the GWP calculation.

Table 8. Carbon Emissions and Removals
<table>
<tr><th>Parameter</th><th>Parameter</th><th>Unit</th></tr>
<tr><td>BCRP</td><td>Biogenic Carbon Removal from Product</td><td>[kg CO_2]</td></tr>
<tr><td>BCEP</td><td>Biogenic Carbon Emission from Product</td><td>[kg CO_2]</td></tr>
<tr><td>BCRK</td><td>Biogenic Carbon Removal from Packaging</td><td>[kg CO_2]</td></tr>
<tr><td>BCEK</td><td>Biogenic Carbon Emission from Packaging</td><td>[kg CO_2]</td></tr>
<tr><td>BCEW</td><td>Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes</td><td>[kg CO_2]</td></tr>
<tr><td>CCE</td><td>Calcination Carbon Emissions</td><td>[kg CO_2]</td></tr>
<tr><td>CCR</td><td>Carbonation Carbon Removals</td><td>[kg CO_2]</td></tr>
</table></td><td>Requirement met.</td><td></td></tr>
</table>

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<tr><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th><th>(5)</th><th>(6)</th></tr>
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<tr><td></td><td></td><td></td><td><table><tr><td><i>CWNR</i></td><td><i>Carbon Emissions from Combustion of Waste from Non- Renewable Sources used in Production Processes</i></td><td><i>[kg CO_2]</i></td></tr></table></td><td></td><td></td></tr>
<tr><td>TE89</td><td></td><td></td><td>PCR Specific Part B (§4): Scenarios and additional technical information
<i>The following information shall be reported for declared modules. Irrelevant or non-applicable modules and tables may be excluded in the EPD; additional information may also be listed if necessary.</i>
<i>The following technical information is a basis for the declared modules or may be used for developing specific scenarios in the context of a building assessment if modules are not declared (MND).</i></td><td>N/A</td><td></td></tr>
<tr><td>TE90</td><td></td><td></td><td>PCR Specific Part B (§4.1): Manufacturing
<i>The manufacturing process and locations shall be described and illustrated using a simple flow-chart. If the EPD applies to several locations producing the same product or a series of vertically integrated processes, the production processes for all locations shall be described and reference to quality management systems may be included.</i></td><td>N/A</td><td></td></tr>
<tr><td>TE91</td><td></td><td></td><td>PCR Specific Part B (§4.2): Disposal
<i>The possible disposal channels shall be indicated in accordance with disposal routes and waste classification referenced in Part A, Section 2.8.5 and 2.8.6.</i></td><td>N/A</td><td></td></tr>
<tr><td>TE92</td><td></td><td></td><td>PCR Specific Part B (§4): (§4.2): Disposal
<i>The possible disposal channels shall be indicated in accordance with disposal routes and waste classification referenced in Part A, Section 2.8.5 and 2.8.6.</i>
<i>TABLE 1. END OF LIFE (C1-C4)</i>
<table>
<tr><th><i>Name</i></th><th></th><th><i>Value</i></th><th><i>Unit</i></th></tr>
<tr><td><i>Assumptions for scenario development (description of deconstruction, collection, recovery, disposal method and transportation)</i></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2"><i>Collection process (specified by type)</i></td><td><i>Collected separately</i></td><td></td><td><i>kg</i></td></tr>
<tr><td><i>Collected with mixed construction waste</i></td><td></td><td><i>kg</i></td></tr>
<tr><td rowspan="4"><i>Recovery (specified by type)</i></td><td><i>Reuse</i></td><td></td><td><i>kg</i></td></tr>
<tr><td><i>Recycling</i></td><td></td><td><i>kg</i></td></tr>
<tr><td><i>Landfill</i></td><td></td><td><i>kg</i></td></tr>
<tr><td><i>Incineration</i></td><td></td><td><i>kg</i></td></tr>
</table></td><td>N/A</td><td></td></tr>
</table>

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<tr><th>(1)</th><th>(2)</th><th>(3)</th><th>(4)</th><th>(5)</th><th>(6)</th></tr>
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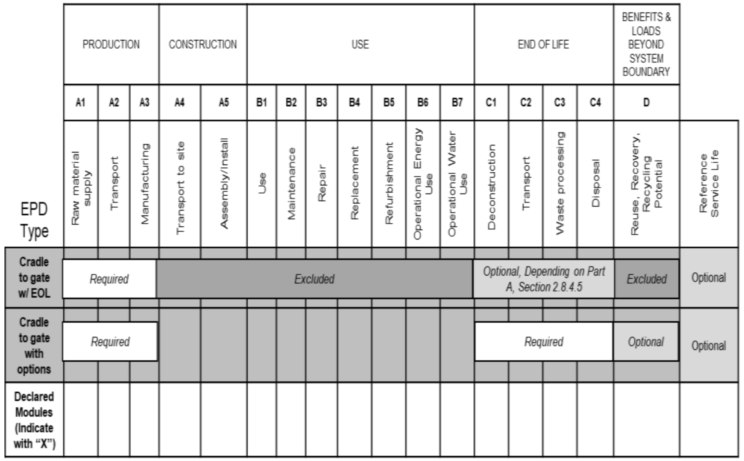
<tr><td></td><td></td><td></td><td>
<table>
<tr><td></td><td>Incineration with energy recovery</td><td></td><td>kg</td></tr>
<tr><td></td><td>Energy conversion efficiency rate</td><td></td><td></td></tr>
<tr><td>Disposal (specified by type)</td><td>Product or material for final deposition</td><td></td><td>kg</td></tr>
<tr><td colspan="2">Removals of biogenic carbon (excluding packaging)</td><td></td><td>kg CO2</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>TE93</td><td></td><td></td><td>PCR Specific Part B (§4.3): BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY (D)
Refer to Section 3.2.2 (of Part B) for discussion and describe methodology used to calculate Module D, if reported. Note that information modules C1 to C4 shall be declared when module D is declared.
TABLE 2. BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY (D), RELEVANT SCENARIO INFORMATION
<table>
<tr><th>Name</th><th>Value</th><th>Unit</th></tr>
<tr><td>Recycling rate of product %</td><td></td><td>%</td></tr>
<tr><td>Recycled content of product</td><td></td><td>%</td></tr>
</table>
</td><td>N/A.</td><td></td></tr>
<tr><td>TE94</td><td></td><td></td><td>PCR Specific Part B (§5): LCA Results
In Table 3, "Description of the system boundary," all declared modules shall be indicated with an "X”.
Modules A1, A2, and A3 shall be declared as separate modules.
Industry average EPDs shall report information on the statistical distribution of results for all TRACI indicators, including range, median and mean. Additional statistical information may also be reported.
Product specific EPDs which include averaging shall report the range of results for all TRACI indicators for products included in the average.
Per Part A, life cycle impact assessment (LCIA) results shall be declared using scientific notation with three significant digits (e.g. 1.23E-5 = 0.0000123) for each module. Uniform formatting shall be used for all indicator values.
● Required: North America (Part A, Section 4.7, Table 9, TRACI indicators with IPCC 2013 factors for GWP)
● Optional: EU (Part A, Section 4.8, Table 10, CML indicators)
● Optional: Rest of World (Part A, Section 4.9, Table 11, indicators as provided)

The following statements on comparability shall immediately follow the LCIA results table in an EPD:</td><td>Requirement met.</td><td></td></tr>
</table>

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Comparability: Comparisons cannot be made between product-specific or industry average EPDs at the design stage of a project, before a building has been specified. Comparisons may be made between product-specific or industry average EPDs at the time of product purchase when product performance and specifications have been established and serve as a functional unit for comparison. Environmental impact results shall be converted to a functional unit basis before any comparison is attempted. *Any comparison of EPDs shall be subject to the requirements of ISO 21930. EPDs are not comparative assertions and are either not comparable or have limited comparability when they have different system boundaries, are based on different product category rules or are missing relevant environmental impacts. Such comparison can be inaccurate, and could lead to erroneous selection of materials or products which are higher-impact, at least in some impact categories.* **TABLE 3. DESCRIPTION OF THE SYSTEM BOUNDARY MODULES** 		

	PRODUCTION			CONSTRUCTION		USE							END OF LIFE				BENEFITS & LOADS BEYOND SYSTEM BOUNDARY	
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	
EPD Type	Raw material supply	Transport	Manufacturing	Transport to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential	Reference Service Life
Cradle to gate w/ EOL	*Required*			*Excluded*									*Optional, Depending on Part A, Section 2.8.4.5*				*Excluded*	Optional
Cradle to gate with options	*Required*												*Required*				*Optional*	Optional
Declared Modules (Indicate with "X")																		

TE95			**PCR Specific Part B (§5.2): LCA Results from LCI** *Results derived from the product LCI shall be reported as follows:*	Requirement met.	

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			● *Resource use indicators (Part A, Section 4.1, Table 6)* ● *Output flows and waste category indicators (Part A, Section 4.1.2, Table 7)* ● *Carbon emissions and removals (Part A, Section 4.6, Table 8)*		
TE96			**ISO Requirement (§4.4.1):** *Life Cycle Impact Assessment – General* *The LCIA phase shall be carefully planned to achieve the goal and scope of an LCA study. The LCIA phase shall be coordinated with other phases of the LCA to take into account the following possible omissions and sources of uncertainty:* *a) whether the quality of the LCI data and results is sufficient to conduct the LCIA in accordance with the study goal and scope definition;* *b) 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;* *c) whether the environmental relevance of the LCIA results is decreased due to the LCI functional unit calculation, system wide averaging, aggregation and allocation.*	Requirement met.	
TE97			**ISO Requirement (§4.4.2.1):** *Life Cycle Impact Assessment – General* *The LCIA phase shall include the following mandatory elements:* *– selection of impact categories, category indicators and characterization models;* *– assignment of LCI results to the selected impact categories (classification);* *– calculation of category indicator results (characterization).*	Requirement met.	
TE98			**ISO Requirement (§4.4.2.2.1):** *Life Cycle Impact Assessment – Selection* *Whenever impact categories, category indicators and characterization models are selected in an LCA, the related information and sources shall be referenced. This also applies when new impact categories, category indicators or characterization models are defined.* *NOTE Examples of impact categories are described in ISO/TR 14047.* *Accurate and descriptive names shall be provided for the impact categories and category indicators.* *The selection of impact categories, category indicators and characterization models shall be both justified and consistent with the goal and scope of the LCA.* *The selection of impact categories shall reflect a comprehensive set of environmental issues related to the product system being studied, taking the goal and scope into consideration.*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
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			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. *The appropriateness of the characterization model used for deriving the category indicator in the context of the goal and scope of the study shall be described.* *LCI results other than mass and energy flow data included in an LCA (e.g. land use) shall be identified and their relationship to corresponding category indicators shall be determined.* *For most LCA studies, existing impact categories, category indicators or characterization models will be selected. However, in some cases existing impact categories, category indicators or characterization models are not sufficient to fulfil the defined goal and scope of the LCA, and new ones have to be defined. When new impact categories, category indicators or characterization models are defined, the recommendations in this sub-clause also apply.* *Figure 3 illustrates the concept of category indicators based on an environmental mechanism. The impact category "acidification" is used in Figure 3 as an example. Every impact category has its own environmental mechanism.* *Characterization models reflect the environmental mechanism by describing the relationship between the LCI results, category indicators and, in some cases, category endpoint(s). The characterization model is used to derive the characterization factors. The environmental mechanism is the total of environmental processes related to the characterization of the impacts.*		
TE99			**ISO Requirement (§4.4.2.2.2):** *Life Cycle Impact Assessment – Selection* *For each impact category, the necessary components of the LCIA include* *– identification of the category endpoint(s),* *– definition of the category indicator for given category endpoint(s),* *– identification of appropriate LCI results that can be assigned to the impact category, taking into account the chosen category indicator and identified category endpoint(s), and* *– identification of the characterization model and the characterization factors.* *This procedure facilitates the collection, assignment and characterization modelling of appropriate LCI results.*	Requirement met.	

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			This also helps to highlight the scientific and technical validity, assumptions, value-choices and degree of accuracy in the characterization model.		
TE100			**ISO Requirement (§4.4.2.2.2):** *Life Cycle Impact Assessment - The method of calculating indicator results shall be identified and documented, including the value-choices and assumptions used.*	Requirement met.	
TE101			**ISO Requirement (§4.4.3.1):** *Life Cycle Impact Assessment - The [optional] application and use of normalization, grouping and weighting methods shall be consistent with the goal and scope of the LCA and it shall be fully transparent. All methods and calculations used shall be documented to provide transparency.*	N/A	
TE102			**ISO Requirement (§4.4.5):** *Life Cycle Impact Assessment –* **LCIA intended to be used in comparative assertions intended to be disclosed to the public** An LCIA that is intended to be used in comparative assertions intended to be disclosed to the public shall employ a sufficiently comprehensive set of category indicators. The comparison shall be conducted category indicator by category indicator. An LCIA shall not provide the sole basis of comparative assertion intended to be disclosed to the public of overall environmental superiority or equivalence, as additional information will be necessary to overcome some of the inherent limitations in the LCIA. Value-choices, exclusion of spatial and temporal, threshold and dose-response information, relative approach, and the variation in precision among impact categories are examples of such limitations. LCIA results do not predict impacts on category endpoints, exceeding thresholds, safety margins or risks. Category indicators intended to be used in comparative assertions intended to be disclosed to the public shall, as a minimum, be – scientifically and technically valid, i.e. using a distinct identifiable environmental mechanism and/or reproducible empirical observation, and – environmentally relevant, i.e. have sufficiently clear links to the category endpoint(s) including, but not limited to, spatial and temporal characteristics. Category indicators intended to be used in comparative assertions intended to be disclosed to the public should be internationally accepted. Weighting, as described in 4.4.3.4, shall not be used in LCA studies intended to be used in comparative assertions intended to be disclosed to the public.	N/A	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			An analysis of results for sensitivity and uncertainty shall be conducted for studies intended to be used in comparative assertions intended to be disclosed to the public.		
TE103			**ISO Reporting Requirements (§5.2)** ***Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *e)* ***Life cycle impact assessment****, where applicable:* *1) the LCIA procedures, calculations and results of the study;* *2) limitations of the LCIA results relative to the defined goal and scope of the LCA;* *3) the relationship of LCIA results to the defined goal and scope, see 4.2;* *4) the relationship of the LCIA results to the LCI results, see 4.4;* *5) impact categories and category indicators considered, including a rationale for their selection and a reference to their source;* *6) descriptions of or reference to all characterization models, characterization factors and methods used, including all assumptions and limitations;* *7) descriptions of or reference to all value-choices used in relation to impact categories, characterization models, characterization factors, normalization, grouping, weighting and, elsewhere in the LCIA, a justification for their use and their influence on the results, conclusions and recommendations;* 8) a statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. and, when included as a part of the LCA, also i) a description and justification of the definition and description of any new impact categories, category indicators or characterization models used for the LCIA, ii) a statement and justification of any grouping of the impact categories, iii) any further procedures that transform the indicator results and a justification of the selected references, weighting factors, etc., iv) any analysis of the indicator results, for example sensitivity and uncertainty analysis or the use of environmental data, including any implication for the results, and v) data and indicator results reached prior to any normalization, grouping or weighting shall be made available together with the normalized, grouped or weighted results.	Requirement met.	
TE104			**PCR Specific Part A (§4.7): LCIA Indicators for North America** *The following information on environmental impacts is expressed by the impact category indicator results using characterization factors based on the*	Requirement met.	

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<tr><td></td><td></td><td></td><td>
current version of U.S. EPA’s Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) - http://www.epa.gov/nrmrl/std/traci/traci.html).
These predetermined parameters are required and shall be included in the EPD, at a minimum, as follows:
Table 9. NORTH AMERICAN LIFE CYCLE IMPACT ASSESSMENT RESULTS
<table>
<tr><th>Impact Category</th><th>Units</th></tr>
<tr><td>Global Warming Potential (GWP 100)</td><td>[kg CO2 eq]</td></tr>
<tr><td>Ozone Depletion Potential (ODP)</td><td>[kg CFC 11 eq]</td></tr>
<tr><td>Acidification Potential (AP)</td><td>[kg SO2 eq]</td></tr>
<tr><td>Eutrophication Potential (EP)</td><td>[kg N eq]</td></tr>
<tr><td>Smog Formation Potential (SFP)</td><td>[kg O_3 eq]</td></tr>
<tr><td>Abiotic Resource Depletion Potential of Non-renewable (fossil) energy resources (ADP_{fossil})</td><td>[MJ, LHV]</td></tr>
</table>
The table shall be preceded by a statement that “LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.”
It is further encouraged that additional impact measures be included in the product LCA in order to obtain a more complete understanding of environmental hot-spots for the industry being studied. Additional impact measures are encouraged to be reported with the below statement:
The EPD shall contain the following language, “These six impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.”
</td><td></td><td></td></tr>
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<tr><td></td><td></td><td></td><td><i>Toxicity impacts shall be reported under “Additional Environmental Information”. If toxicity is included, USEtox40 indicators shall be used and reported only as a percentage contribution analysis.</i>

<i>A sub-category Part B PCR may provide further requirements on the inclusion of other impact categories and methods to be included as additional environmental information.</i>

<i>Impact results may also be included for more than one characterization method as long as they are reported separately from the default TRACI values. .</i></td><td></td><td></td></tr>
<tr><td>TE105</td><td></td><td></td><td>PCR Specific Part A (§4.8): LCIA Indicators for Europe
<i>For conformance with EN 15804 in European markets, LCIA results shall be reported as follows using the characterization factors CML-IA version 4.2 from April 2013.</i>

<i>[EN15804, section 7.2.3]: “The following information on environmental impacts is expressed by the impact category parameters of LCIA using characterization factors. These predetermined parameters are required and shall be included in the EPD as follows:</i>

<i>Table 10. EU LIFE CYCLE IMPACT ASSESSMENT RESULTS</i>
<table>
<tr><th>Impact Category</th><th>Units</th></tr>
<tr><td>Global Warming Potential (GWP 100)</td><td>[kg CO$_2$ eq]</td></tr>
<tr><td>Depletion potential of the stratospheric ozone layer (ODP)</td><td>[kg CFC-11 eq]</td></tr>
<tr><td>Acidification Potential of soil and water (AP)</td><td>[kg SO$_2$ eq]</td></tr>
<tr><td>Eutrophication Potential (EP)</td><td>[kg (PO4)3- eq]</td></tr>
<tr><td>Photochemical Oxidant Creation Potential (POCP)</td><td>[kg ethane eq]</td></tr>
<tr><td>Abiotic depletion potential (ADP-elements) for non-fossil resources*</td><td>[kg Sb eq]</td></tr>
<tr><td>Abiotic depletion potential (ADP-fossil fuels) for fossil resources</td><td>[MJ, calorific value ([Hi] lower calorific value)]</td></tr>
</table></td><td>Requirement met.</td><td></td></tr>
</table>

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			NOTE 1: The indicator describing the depletion of elemental abiotic resources is subject to further scientific development. The use of this indicator is intended to be reviewed during the revision of this standard. The reporting of this category in ISO 21930 is options per section 7.3. *[EN15804, Section 6.5]: "The characterisation factors of the European Reference Life Cycle Data Base42 (ELCD) are used taking consideration of the respective ELCD updates.* *The characterization factors for the use of abiotic resources must be taken from the CML. The characterization factor for the use of abiotic resources (fossil substances) is the respective calorific value ([Hi] lower calorific value) at the fossil fuel extraction point."* *The characterization factors CML-IA version 4.2 from April 2013 apply (Institute of Environ-mental Sciences, Faculty of Science University of Leiden, Netherlands), which are identified as "base-line". The respective indication of the used characterization factors shall be given in the project report and in the EPD.* *Long-term emissions (>100 years) are not taken into consideration in the impact estimate.* *Apart from the results of the impact estimate, the following must also be indicated in the project report:* *Reference to all characterization models, characterization factors and methods used, as defined in this document* *A statement that the impact estimate results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks* *A sub-category Part B PCR may provide further requirements on the inclusion of other impact categories and methods to be included as additional environmental information.*		

<table>
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Para/ Fig/ Tbl/ Note</th><th>(4)
ISO/PCR Requirement</th><th>(5)
Comment (justification for change)/Proposed change</th><th>(6)
Decisions on each comment submitted</th></tr>
<tr><td></td><td></td><td></td><td><i>Impact results may also be included for more than one characterization method as long as they are reported separately from the default CML values.</i></td><td></td><td></td></tr>
<tr><td>TE106</td><td></td><td></td><td>PCR Specific Part A (§4.9): International LCIA Indicators
<i>The following default international characterization methods shall be included for EPDs intended primarily for markets outside of North America and Europe, and may be optionally included for all other EPDs:</i>

<i>Table 9. REST OF WORLD LIFE CYCLE IMPACT ASSESSMENT RESULTS</i>
<table>
<tr><th><i>Impact category and abbreviation</i></th><th><i>Method</i></th></tr>
<tr><td><i>Global warming potential (GWP 100)</i></td><td><i>IPCC</i></td></tr>
<tr><td><i>Ozone depletion potential (ODP)</i></td><td><i>WMO</i></td></tr>
<tr><td><i>Eutrophication potential (EP)</i></td><td><i>Heijungs et al.</i></td></tr>
<tr><td><i>Acidification potential (AP)</i></td><td><i>Hauschild and Wenzel</i></td></tr>
<tr><td><i>Photochemical oxidant creation potential (POCP)</i></td><td><i>Jenkin and Hayman</i></td></tr>
</table>
<i>Characterization factors of the Default International Characterization Method are publicly available on http://cml.leiden.edu/software/data-cmlia.htm.</i>

<i>The table shall be preceded by a statement that “LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks.”</i>

<i>A sub-category Part B PCR may provide further requirements on the inclusion of other impact categories and methods to be included as additional environmental information. Impact results may also be included for more than one characterization method as long as they are reported separately from the default method.</i></td><td>N/A</td><td></td></tr>
<tr><td>TE107</td><td></td><td></td><td>PCR Specific Part A (§4.10): OPTIONAL LCIA INDICATORS AND OTHER ADDITIONAL ENVIRONMENTAL INFORMATION
<i>Unless otherwise defined explicitly in the sub-category Part B PCR, an EPD may also include impact categories as defined in ISO 21930 Section 8.2 as “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: “[…]</i></td><td>Requirement met.</td><td></td></tr>
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(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			☐ *Abiotic depletion potential for non-fossil mineral resources (ADPelements)* ☐ *Land-use-related impacts, for example on biodiversity and/or soil fertility* ☐ *Toxicological aspects.* *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 Part B PCR."* *Additional environmental information may also be included of a qualitative nature, such as those in ISO 21930 Section 8.3:* ☐ *"Geographical aspects relating to the declared environmental aspects 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."*		
TE108			**PCR Specific Part A (§4.11.1): Mandatory Environmental Information** *EPDs shall list, at a minimum, all substances contained in the construction product that are identified as hazardous according to standards or regulations of the applicable market(s) in Section 2.8.4.5, Table 4. For products where no such substances are present, the EPD shall include the statement "no substances required to be reported as hazardous are associated with the production of this product."*	Requirement met.	
TE109			**PCR Specific Part A (§4.11.2): Dangerous Substances** *EPDs shall contain mandatory information about the release of dangerous, regulated sub-stances that affect health and environment according to the relevant market of applicability. A sub-category Part B PCR shall provide further requirements on testing and reporting the releases of dangerous substances to be included in this Section. According to ISO 21930 Section 8.4.2, this includes but is not limited to:* ☐ *Indoor air emissions* ☐ *Gamma or ionizing radiation emissions* ☐ *Chemicals released to air or leached to water and soil*	N/A	
TE110			**ISO Requirement (§4.5.1.1): *Life Cycle Interpretation*** *– General* *The life cycle interpretation phase of an LCA or an LCI study comprises several elements as depicted in Figure 4, as follows:* *– identification of the significant issues based on the results of the LCI and LCIA phases of LCA;*	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			– an evaluation that considers completeness, sensitivity and consistency checks; *– conclusions, limitations, and recommendations.* *The relationship of the interpretation phase to other phases of LCA is shown in Figure 4.* *The goal and scope definition and interpretation phases of life cycle assessment frame the study, whereas the other phases of LCA (LCI and LCIA) produce information on the product system.* *The results of the LCI or LCIA phases shall be interpreted according to the goal and scope of the study, and the interpretation shall include an assessment and a sensitivity check of the significant inputs, outputs and methodological choices in order to understand the uncertainty of the results.*		
TE111			**ISO Requirement (§4.5.1.2):** ***Life Cycle Interpretation*** *– General* *The interpretation shall also consider the following in relation to the goal of the study:* *– the appropriateness of the definitions of the system functions, the functional unit and system boundary;* *– limitations identified by the data quality assessment and the sensitivity analysis.* *The documentation of the data quality assessment, sensitivity analyses, conclusions and any recommendations from the LCI and LCIA results shall be checked.* *The LCI results should be interpreted with caution because they refer to input and output data and not to environmental impacts. In addition, uncertainty is introduced into the results of an LCI due to the compounded effects of input uncertainties and data variability. One approach is to characterize uncertainty in results by ranges and/or probability distributions. Whenever feasible, such analysis should be performed to better explain and support the LCI conclusions.*	Requirement met.	
TE112			**ISO Requirement (§4.5.2.3):** ***Life Cycle Interpretation*** *– Identification of Significant Issues.* *There are four types of information required from the preceding phases of the LCA:* *a) the findings from the preceding phases (LCI, LCIA) that shall be assembled and structured together with information on data quality;* *b) methodological choices, such as allocation rules and system boundary from the LCI and category indicators and models used in LCIA;* *c) the value-choices used in the study as found in the goal and scope definition;*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			d) the role and responsibilities of the different interested parties as found in the goal and scope definition in relation to the application, and also the results from a concurrent critical review process, if conducted. *When the results from the preceding phases (LCI, LCIA) have been found to meet the demands of the goal and scope of the study, the significance of these results shall then be determined. All relevant results available at the time shall be gathered and consolidated for further analysis, including information on data quality.*		
TE113			**ISO Requirement (§4.5.3.1):** ***Life Cycle Interpretation*** – *Evaluation - General* *The objectives of the evaluation element are to establish and enhance confidence in, and the reliability of, the results of the LCA or the LCI study, including the significant issues identified in the first element of the interpretation. 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.* *The evaluation shall be undertaken in accordance with the goal and scope of the study.* *During the evaluation, the use of the following three techniques shall be considered:* *– completeness check (see 4.5.3.2);* *– sensitivity check (see 4.5.3.3);* *– consistency check (see 4.5.3.4).* *The results of uncertainty analysis and data quality analysis should supplement these checks.*	Requirement met.	
TE114			**ISO Requirement (§4.5.3.2):** ***Life Cycle Interpretation*** – *Evaluation - Completeness* *The objective of the completeness check is to ensure that all relevant information and data needed for the interpretation are available and complete.* *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.* *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*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			adjusted. If the missing information is considered unnecessary, the reason for this should be recorded.		
TE115			**ISO Requirement (§4.5.3.3): *Life Cycle Interpretation*** – *Evaluation - Sensitivity* *The objective of the sensitivity check is to assess the reliability of the final results and conclusions by determining how they are affected by uncertainties in the data, allocation methods or calculation of category indicator results, etc.* *The sensitivity check shall include the results of the sensitivity analysis and uncertainty analysis, if performed in the preceding phases (LCI, LCIA).* *In a sensitivity check, consideration shall be given to* *– the issues predetermined by the goal and scope of the study,* *– the results from all other phases of the study, and* *– expert judgements and previous experiences.* *When an LCA is intended to be used in comparative assertions intended to be disclosed to the public, the evaluation element shall include interpretative statements based on detailed sensitivity analyses.* *The level of detail required in the sensitivity check depends mainly upon the findings of the inventory analysis and, if conducted, the impact assessment.* *The output of the sensitivity check determines the need for more extensive and/or precise sensitivity analysis as well as shows apparent effects on the study results.* *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.*	Requirement met.	
TE116			**ISO Requirement (§4.5.3.3): *Life Cycle Interpretation*** – *Evaluation - Consistency* *The objective of the consistency check is to determine whether the assumptions, methods and data are consistent with the goal and scope.* *If relevant to the LCA or LCI 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?* *b) Have regional and/or temporal differences, if any, been consistently applied?* *c) Have allocation rules and the system boundary been consistently applied to all product systems?* *d) Have the elements of impact assessment been consistently applied?*	Requirement met.	
TE117			**ISO Requirement (§4.5.4): *Life Cycle Interpretation – Conclusions, limitations and recommendations***	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			The objective of this part of the life cycle interpretation is to draw conclusions, identify limitations and make recommendations for the intended audience of the LCA. *Conclusions shall be drawn from the study. This should be done iteratively with the other elements in the life cycle interpretation phase. A logical sequence for the process is as follows:* *a) identify the significant issues;* *b) evaluate the methodology and results for completeness, sensitivity and consistency;* *c) draw preliminary conclusions and check that these are consistent with the requirements of the goal and scope of the study, including, in particular, data quality requirements, predefined assumptions and values, methodological and study limitations, and application-oriented requirements;* *d) if the conclusions are consistent, report them as full conclusions; otherwise return to previous steps a), b) or c) as appropriate.* *Recommendations shall be based on the final conclusions of the study and shall reflect a logical and reasonable consequence of the conclusions. Whenever appropriate to the goal and scope of the study, specific recommendations to decision-makers should be explained.* *Recommendations should relate to the intended application.*		
TE118			**ISO Reporting Requirements (§5.2)** ***Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *f)* ***Life cycle interpretation****:* *1) the results;* *2) assumptions and limitations associated with the interpretation of results, both methodology and data related;* *3) data quality assessment;* *4) full transparency in terms of value-choices, rationales and expert judgements.*	Requirement met.	
TE119			**PCR Specific Part A (§5):** *Life Cycle Interpretation* *The aggregation factors of the Life Cycle Inventory Analysis and the estimated impact indicators shall be interpreted in the project report with reference to the declared or functional unit and specifications essentially influencing the result, i.e. at least:* *[ISO 21930 Section 10.2 f and EN15804 Section 8.2]: […]* *"[Interpretation of] the results [based on a dominance analysis of selected indicators (for the relevant modules)];* *[The relationship between the Life Cycle Inventory Analysis results and the results of the impact estimate];*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			☐ *Assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related;* ☐ *The variance from the means of LCIA results should be described, if generic data are declared from several sources or for a range of similar products;* ☐ *Data quality assessment;* ☐ *Full transparency in terms of value-choices, rationales and expert judgements.”*		
TE120			**PCR Specific Part B (§6):** *Interpretation* *Interpretation requirements for the Project Report are provided in Part A, Section 5.* *An interpretation shall be provided in the EPD which discusses the assumptions and limitations associated with the interpretation of results as declared in the EPD, both methodology and data related.* *This interpretation shall also include a description of the time frame and/or variance of the LCIA results if the EPD is valid for several products. An illustration of the results with figures is recommended in the EPD, e.g. for the dominance analysis, the distribution of impacts across the modules, the CO2-balance, etc. as appropriate for a reader's understanding of the environmental profile of the declared product.*	Requirement met.	
TE121			**PCR Specific Part A (§6.1):** *Documentation of additional information: Laboratory Results and Scenario-Related Information* *[ISO 21930 Section 10.4 and EN15804 Section 8.3]: “The project report shall include any documentation on additional environmental information declared in the EPD as required in this standard. Such documentation on additional environmental information may include, e.g. as copies or references:* ☐ *Laboratory results/measurements for the content declaration;* ☐ *Laboratory results/measurements of functional/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, energy consumption during use, cleaning cycles etc.)* ☐ *Laboratory results/measurements for the declaration of emissions to indoor air, soil and water during the product’s use stage.”*	N/A	
TE122			**PCR Specific Part A (§6.2):** *Documentation for Calculating the Reference Service Life (RSL)*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			If the use stage is declared (Modules B1 to B7), a reference service life (RSL) must be indicated. In all other cases, indication of a RSL is optional. *[ISO 21930, Section 7.1.4]: "The RSL information to be declared in an EPD covering the use stage shall be provided by the manufacturer. The RSL shall refer to the declared technical and functional performance of the product within a construction works. It shall be established in accordance with any specific rules given in product standards and shall take into account ISO 15686-1, ISO 15686−2, ISO 15686−7 and ISO 15686−8. Where product standards pro-vide guidance on deriving the RSL, such guidance shall have priority.* *The RSL is dependent on the properties of the product and reference in-use conditions. In-formation on the product's RSL, therefore, requires specification of compatible scenarios for the production stage, construction stage and use stage. These conditions shall be declared together with the RSL and it shall be stated that the RSL applies for the reference in-use conditions only.* *Default values shall be provided and be based on published references. If longer RSLs are used, they shall be guaranteed by the signature of the most senior officer of the product manufacturer.* *NOTE Default values can be provided in a sub-category Part B PCR.* *Requirements and guidance on both the RSL and ESL for the estimation of service life are given in normative ISO 21930, Annex A. A sub-category Part B PCR should specify requirements to define the RSL for the given product group, where relevant.*		
TE123			**ISO Requirement (§6.1):** *Critical Review - General* *The scope and type of critical review desired shall be defined in the scope phase of an LCA, and the decision on the type of critical review shall be recorded.* *In order to decrease the likelihood of misunderstandings or negative effects on external interested parties, a panel of interested parties shall conduct critical reviews on LCA studies where the results are intended to be used to support a comparative assertion intended to be disclosed to the public.*	Requirement met.	
TE124			**ISO Requirement (§6.2):** *Critical Review - **Critical review by internal or external expert***	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			A critical review may be carried out by an internal or external expert. In such a case, an expert independent of the LCA shall perform the review. The review statement, comments of the practitioner and any response to recommendations made by the reviewer shall be included in the LCA report.		
TE125			**ISO Requirement (§6.1):** *Critical Review -* ***Critical review by panel of interested parties*** *A critical review may be carried out as a review by interested parties. In such a case, an external independent expert should be selected by the original study commissioner to act as chairperson of a review panel of at least three members. Based on the goal and scope of the study, the chairperson should select other independent qualified reviewers. This panel may include other interested parties affected by the conclusions drawn from the LCA, such as government agencies, non-governmental groups, competitors and affected industries.* *For LCIA, the expertise of reviewers in the scientific disciplines relevant to the important impact categories of the study, in addition to other expertise and interest, shall be considered.* *The review statement and review panel report, as well as comments of the expert and any responses to recommendations made by the reviewer or by the panel, shall be included in the LCA report*	N/A	
TE126			**ISO Reporting Requirements (§5.2)** ***Additional Requirements and Guidance -*** *The third-party report shall cover the following aspects:* *g) Critical review, where applicable:* *1) name and affiliation of reviewers;* *2) critical review reports;* *3) responses to recommendations.*	Requirement met.	
TE127			**PCR Specific Part A (§6.3):** *Data Available for Verification* *The information listed in ISO 21930 Section 10.5 shall be made available to the verifier, taking into account data confidentiality specified in ISO 21930 Section 10.3..*	Requirement met.	
TE128			**PCR Specific Part B (§7.1):** *Additional Environmental Information Results for Unfinished Steel* *In addition to reporting results for Modules A1, A2, and A3 for fabricated products within the scope of this PCR (see Scope section), disaggregated results for Module A1 may additionally be reported for the production of mill product.* *These results shall be reported on the basis of one (1) metric ton and optionally one (1) short ton may additionally be reported.*	N/A	
TE129			**PCR Specific Part B (§7.2):** *Additional Environmental Information Environment and Health During Manufacturing*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Measures relating to environmental and health protection during the manufacturing process extending beyond national guidelines (of the production country) should be described, e.g. reference to a product safety data sheet (SDS), description of Environmental Management Systems or similar, programs addressing air emissions, waste water, noise, etc.		
TE130			**PCR Specific Part B (§7.3):** *Additional Environmental Information* *Environment and Health During Installation* *Information should be provided in this section on the relationship between the product, the environment and health, including any possible harmful substances or emissions e.g. reference to a product safety data sheet (SDS). Any recommendations concerning cleaning, maintenance, etc. of the declared product should be listed in Section 4 “Technical information on scenarios”. In establishing safe thresholds of exposure for humans, measures such as Reference Concentrations (RfC) or Reference Dose (RfD) can be used, which are established by US EPA and available in the Integrated Risk Information System database. In establishing safe thresholds of exposure for flora/fauna, measures such as Criteria Maximum Concentration (CMC) or Criterion Continuous Concentration (CCC) can be used, also established by US EPA and available as part of the National Recommended Water Quality Criteria. Other data sources can be used to establish safe thresholds of exposure for humans and flora/fauna, with justification.*	N/A	
TE131			**PCR Specific Part B (§7.4):** *Additional Environmental Information* *Environmental Activities and Certifications* *Other environmental activities, such as participation in recycling or recovery programs along with the details of these programs and contact information, shall be provided.* *For certifications applied to the product and listed in the EPD, a statement shall be included on where an interested party can find details of the certification program.*	N/A	
TE132			**PCR Specific Part B (§7.5):** *Additional Environmental Information* *Further Information* *A reference source for additional information may be provided here, e.g. homepage, reference source for safety data sheet.*	N/A	
TE133			**PCR Specific Part A (§9.2) Industry-Average Benchmarking** *When a manufacturer-specific EPD is benchmarked against an industry-average EPD, the following requirements shall be met, in addition to the comparability requirements listed in ISO 21930 Section 5.5.* *If the industry association has a developed dedicated LCA and EPD generator tool, this tool shall be used for all EPD comparisons.*	N/A	

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			A manufacturer shall have participated, either originally or retroactively, in the industry-average EPD per the requirements outlined in this Part A PCR and potential additional requirements provided in a sub-category Part B PCR. *LCI data sources shall be consistent between the manufacturer-specific EPD and the industry-average benchmark EPD as it pertains to:* *o Background life cycle inventory data sets and reference year:* *• If a manufacturer-specific EPD is developed using the same LCI dataset(s) and version as the industry-average, then no recalculation is re-quired and comparison may proceed.* *• If the LCI dataset(s) used in the industry-average and manufacturer-specific EPDs are different, the industry average EPD results shall be re-calculated using the LCI dataset(s) used for manufacturer-specific EPD.* *o Priority of primary and secondary data sources.* *o Specific primary, non-life cycle inventory data (e.g. transportation distances and modes)* *A data quality check should be based on a plausibility check.* *LCA modelling software and version shall be consistent: o If a manufacturer-specific EPD is developed using the same LCA software plat-form and version as the industry-average, then no recalculation is required and comparison may proceed.* *o If the LCA software platforms used in the industry-average and manufacturer-specific EPDs are different, the industry average EPD results shall be recalculated using the software platform and version used for manufacturer-specific EPD.* *Life Cycle Impact Assessment method and version shall be consistent between the manufacturer-specific EPD and the industry-average benchmark EPD.* *The life cycle stages considered shall be consistent between the manufacturer-specific EPD and the industry-average benchmark EPD. If the scope of the PCR allows for optional reporting of modules not included in the industry-average EPD, they may not be included for benchmarking purposes.* *Manufacturer-specific use phase calculations in the Project Report shall be consistently applied between the manufacturer-specific EPD and the industry-average benchmark EPD as outlined in the sub-category Part B PCR.* *End of life assumptions in module C shall be consistently applied as specified in the core and sub-category Part B PCR between the manufacturer-specific EPD and the industry-average benchmark EPD.* *Cut-off criteria for inclusion of mass and energy flows shall be consistently applied as specified in this Part A PCR between the manufacturer-specific EPD and the industry-average benchmark EPD.*		

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Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			A comparison with the values reported in the Best Available Technology (BAT) document (gate-to-gate) and other available data sources (cradle-to-gate data from commercial databases and confidential sources) should be done as well as plausibility checks. *NOTE: Industry associations may want to provide a pathway for manufacturers to claim representation under a previously published industry average EPD, or claim “retroactive participation”, regard-less of why the manufacturer did not/was not able to originally participate. As such, sub-category Part B PCRs may specify any quantitative LCI/process data and qualitative data that must be submitted for a manufacturer to claim representation. These criteria may differ de-pending on the industry and their level of comfort. These submitted data are then reviewed by the Program Operator, which then confers with the industry association to reach consensus as to whether the manufacturer can be added. That said, the LCA report submitted to the Program Operator by the LCA practitioner must contain the uncertainty ranges for key LCI manufacturing and product data in order to make this determination.*		
TE134			**PCR Specific Part A (§9.3) Part B (§3.8) Manufacturer-Specific Benchmarking and Comparability** *When a manufacturer-specific EPD is benchmarked against an existing manufacturer-specific EPD from the same manufacturer, the following requirements shall be met in addition to the comparability requirements listed in ISO 21930, Section 5.5.:* *The life cycle stages considered for benchmarking in each EPD shall be consistent.* *Data sources shall be consistent as it pertains to:* *o Priority of primary and secondary data sources* *o Application of background LCI data sets and version. If LCI dataset method up-dates occur between the publication of the benchmark EPD and updated EPD, the benchmark EPD results shall be recalculated using the most recent LCI datasets and used for benchmarking with the updated EPD.* *o Application of specific secondary, non-LCI data.* *LCA modelling software and version used shall be consistent. If LCA software updates occur between the publication of the benchmark EPD and updated EPD, the benchmark EPD results shall be recalculated using the most recent software version and used for benchmarking with the updated EPD.*	N/A	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			* Cut-off criteria for inclusion of mass and energy flows shall be consistently applied.* * Product specific use phase calculations in the Project Report shall be consistently ap-plied as outlined in this Part A PCR or the sub-category Part B PCR* * End of life assumptions in Module C shall be consistently applied as specified in this Part A PCR or sub-category Part B PCR* * Providing they do not conflict with existing confidentiality agreements, sources of deviation from the benchmark EPD shall be documented and quantified, including but not limited to:* *o Number of manufacturing locations considered* *o Sourcing changes* *o Product design changes implemented* *o Process changes implemented* *o Processing waste treatment changes* *o End of life pathway changes* * When claiming impact reductions for green building schemes, results are significant as defined by at least a 5% or greater reduction in any given impact category with the exception of Ozone Depletion Potential (ODP). In the case of ODP, a 10% or greater reduction in impact qualifies as significant.* ***Part B 3.8 Comparability and Benchmarking*** *Comparison of EPD results between non-competitive products may be conducted per the requirements in Part A, Section 9.* *Comparisons cannot be made between product-specific or industry average EPDs at the design stage of a project, before a building has been specified. When comparing EPDs that include Module D, the calculation method(s) used to determine impacts and benefits must be identical.* *Comparisons may be made between product-specific or industry average EPDs at the time of product purchase when product performance and specifications have been established and serve as a functional unit for comparison.* *Environmental impact results based on a declared unit of a steel product do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without knowledge of how the physical properties of the steel product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted.*		
TE135			**PCR Specific Part B (§8) Supporting Documentation**	Requirement met.	

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			The Project Report Content, Structure, and Accessibility requirements to support an EPD created using this document are provided in Part A: Section 2. Project Report elements include general information (Part A: Section 2.1), study goal (Part A: Section 2.2), study scope (Part A: Section 2.8), and the life cycle inventory analysis, impact assessment, and interpretation (Part A: Section 3, 4, and 5). Additionally, the Project Report shall include additional required supporting documentation specified in this sub-category Part B and according to Part A: Section 6. *If relevant to the scope of the declared product, or due to the product material composition, it is recommended to provide sufficient supporting documentation in the EPD and Project Report. When providing documentation, testing protocols and other relevant information shall be indicated. If supporting documentation is not provided, the reasons shall be indicated in the EPD and Project Report.* *As a general rule, all statements shall be documented with measured data (presented by the corresponding test certificates). In the case of non-verifiable substances, the limit of detection shall be included in the declaration. Interpreting statements such as "… free of …" or "… are entirely harmless …" are not permissible.*		
TE136			**PCR Specific Part B (§9) References** *The literature referred to in the Environmental Product Declaration shall be cited. Standards and standards relating to evidence and/or technical features already cited in the EPD do not need to be listed here. This Part B PCR document shall be referenced.*	Requirement met.	
			ISO 14044:Amd 1:2017 Annex C - Footprints		
TE137			**ISO 14044:Amd 1:2017 Annex C - C.2 Reporting** *Further to the requirements specified in Clause 5 on the reporting of LCA, this annex provides clarification about the interface between footprint quantification and communication. Footprint reports should include a statement indicating, for example, that the analysis is limited and does not address other impacts, which can be as important. If any footprint information is not communicated to third parties, the reporting requirements of 5.1.1 shall apply. If any footprint information is intended to be communicated to third parties, a third-party report in accordance with 5.1.2 and 5.2 c) shall be prepared and shall become the footprint study report, regardless of the chosen footprint communication. This*	**N/A**	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			third-party report shall serve as an input for the development of any footprint communication formats that might have to fulfil additional requirements in accordance with the relevant International Standards on environmental labels and declarations developed by ISO/TC 207/SC 3. *Footprints are limited to only one environmental aspect or a limited set of impact category indicators. Footprints shall be named in a way that accurately reflects the area of concern or reflects the potential environmental impacts assessed. Where an area of concern has only been partially assessed, an alternative name descriptive of the narrower scope shall be applied.* *A footprint addresses one area of concern. This can conflict with the comprehensiveness principle of LCA. Therefore, the report of the footprint quantification shall document the limitations with regard to selected environmental impact categories in a transparent manner. While the selected footprint study can quantify an important environmental aspect or a potential environmental impact of a product or an organization, the LCIA profile, as specified in 4.4.1, includes results for a broader set of other impact category indicators. An objective of LCA is to allow an informed decision regarding a comprehensive set of potential environmental impacts. As a result, footprints shall not be used in comparative assertions intended to be disclosed to the public. A comprehensive evaluation of environmental performance of a product or an organization cannot be achieved through an analysis that considers only a single area of concern or a non-comprehensive set of potential environmental impacts or aspects. Decisions about product or organizational impacts that are only based on a single or few environmental issue(s) can conflict with goals and objectives related to other environmental issues.*		
TE138			**ISO 14044:Amd 1:2017 Annex C - C.3 Critical Review** *Further to the requirements specified in Clause 6 on the critical review of LCA, this annex provides clarification about the interface between footprint quantification and communication.* *When an organization decides to use a footprint study report as a basis of a footprint communication, this footprint study report shall be publicly available in accordance with 5.2.* *When a critical review is performed, it shall be in accordance with Clause 6 or ISO/TS 14071.*	N/A	
			ISO 14044:Amd 2:2020 Annex D – Allocation Procedures		
TE139			**ISO 14044:Amd 1:2017 Annex D – D.2 Expanding the product system** *Expanding the product system to include additional functions related to the co-products (see 4.3.4.2, step 1, option 2) can be a means of avoiding allocation.*	N/A – system expansion allocation method is not allowed. See comment TE26	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			NOTE 1 The concept of expanding the product system to include additional functions related to the co-products can also be referred to as system expansion or expanding the system boundary. *Therefore, the product system that is substituted by the co-product is integrated in the product system under study. In practice, the co-products are compared to other substitutable products, and the environmental burdens associated with the substituted product(s) are subtracted from the product system under study (see Figure 1). The identification of this substituted system is done in the same way as the identification of the upstream system for intermediate product inputs. See also ISO/TR 14049:2012, 6.4.* *The application of system expansion involves an understanding of the market for the co-products. Decisions about system expansion can be improved through understanding the way co-products compete with other products, as well as the effects of any product substitution upon production practices in the industries impacted by the co-products.* *Important considerations relating to the identification of product systems substituted by co-products include whether:* *— specific markets and technologies are affected;* *— the production volume of the studied product systems fluctuates in time;* *— a specific unit process is affected directly.* *If applicable, when the inputs are delivered through a market, it is also important to know:* *— whether any of the processes or technologies supplying the market are constrained, in which case their output does not change in spite of changes in demand;* *— which of the unconstrained suppliers/technologies has the highest or lowest production costs and, therefore, is the supplier/technology affected when the demand for the supplementary product is generally decreasing or increasing, respectively.* *EXAMPLE A fuel combustion process produces co-products of heat that is used for district heating as well as electricity. The inventory i.e. inputs and outputs, of the avoided electricity can be subtracted from the inventory of the fuel combustion process to determine the inventory of the heat.* *System expansion avoids allocation by integrating a functionally equivalent product system, that is assumed to be substituted by the co-product (product B), within the system boundary. The inputs and outputs associated with the*		

(1) **Com-ment Type & No.**	(2) **Page No.**	(3) **Para/ Fig/ Tbl/ Note**	(4) **ISO/PCR Requirement**	(5) **Comment (justification for change)/Proposed change**	(6) **Decisions on each comment submitted**
			substituted product system are assumed to be avoided by the production of the co-product (product B), as illustrated by the example in Figure D.1. *Since the substituted system has a negative sign, the addition of this system is mathematically the same as a subtraction. There is an additional example of this in ISO/TR 14049:2012, Figures 15 and 16.* *NOTE 2 Figure D.1 shows how to avoid allocation when the investigated product system has two products: product A (the product system under study) and product B (here, an energy product).* *In the case of recycling, one way to avoid allocation can be by calculating a recycling credit based on the technical substitutability of the secondary material(s), i.e., taking into account any changes to the inherent properties and quality of the secondary material versus the substituted primary material. If the secondary material X from the product system under study substitutes a primary material Y, then the recycling credit corresponds to subtracting the inventory associated with the acquisition of the primary material Y from the inventory calculated for the product system under study. If an input to a product system is a recycled material that has previously implied a credit to the product system that the recycled material comes from, such recycled material carries the credit as a potential environmental impact to the product system that it enters.*		
TE140			**ISO 14044:Amd 1:2017 Annex D – D.3 Allocation that reflects the underlying physical relationships** **D.3.1 General** *Physical allocation can be applied when a physical, i.e. causal, relationship can be identified between the inputs, outputs and co-products of the multifunctional process. Such a relationship exists when the amounts of the co-products can be independently varied. How the amounts of inputs and outputs (emissions and waste) change following such a variation can be used to allocate the inputs and outputs to the varied co-product.* *This allocation procedure (step 2, 4.3.4.2) is applicable when: a) the relative production of co-products can be independently varied through process management, and b) this has causal implications for the inputs required, emissions released, or waste produced.* *EXAMPLE 1 When aqueous ammonia (NH3) reacts with ethylene oxide (C2H4O), three co-products are produced: monoethanolamine (H2NCH2CH2OH), diethanolamine (HN(CH2CH2OH)2) and triethanolamine (N(CH2CH2OH)3). The relative production volume of the three co-products can be controlled by changing the proportion of the reactants in the solution,*	Requirement met.	

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			which means the amounts of the co-products can be varied independently, and all products are therefore determining products, independently of each other. Therefore, this combined production can be described for each product separately based on the stoichiometric requirements of each product, with the limiting group being hydroxyl (OH). To make 1 kg monoethanolamine, 0,279 kg ammonia and 0,721 kg ethylene oxide are needed. To identify these masses, the following formula is used: $m = n \times M$ *where* m mass (in kg); n amount of substance (in mol); M molar mass (in kg/mol). *EXAMPLE 2 ISO/TR 14049:2012, 7.3.1, provides another example where transportation fuel consumption is allocated between a packaging material and a commodity based on the proportion of payload used.*		
TE141			**ISO 14044:Amd 1:2017 Annex D – D.4 Allocation methods reflecting other relationships** **D.4.1 General** *According to 4.3.4.2, step 3, inputs and outputs can also be allocated between co-products reflecting other relationships between them, e.g. in proportion to the economic value of co-products (economic allocation).* *The most common form of economic allocation is based on the revenue obtained from the co-products.* *EXAMPLE 1 A dairy cow produces 70 % of its revenue through milk and 30 % through animals sold (calves and dairy cow at the end of life). This ratio can be used to allocate all inputs and outputs that can neither be directly attributed to the milk nor to the animals sold.* *EXAMPLE 2 Another example is given in ISO/TR 14049:2012, 7.3.2.*	Requirement met.	
			Are the methods used to carry out the study scientifically and technically valid?		
GE 1			The methods used to carry out the study are scientifically and technically valid.		
			Are the data used appropriate and reasonable in relation of the goal of the study?		
GE 2			Yes, the data used are appropriate and reasonable.		

Type of comment: **GE** = general **TE** = technical **ED** = editorial

(1)	(2)	(3)	(4)	(5)	(6)
Com-ment Type & No.	**Page No.**	**Para/ Fig/ Tbl/ Note**	**ISO/PCR Requirement**	**Comment (justification for change)/Proposed change**	**Decisions on each comment submitted**
			Do the interpretations reflect the limitations identified and the goal of the study		
GE 3			The study in general reflects the limitations identified.		
			Is the report transparent and consistent?		
GE 4			Minor findings based on this review need to be addressed. **All issues have been addressed.** The report is transparent and consistent.		
			Verification of the data per ISO 14025 §8.1.3		
GE5			a) conformance with the PCR;	There are items that need to be addressed. **All issues have been addressed.** The LCA project report conforms to the PCR.	
GE6			b) conformance with the ISO 14040 series of standards;	The study conforms to the ISO 14040 series of standards.	
GE7			c) conformance with general programme instructions for the Type III environmental declaration;	The study conforms to the general program instructions for SCS Global.	
GE8			d) that data evaluation includes coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;	The data evaluation is complete.	
GE9			e) the plausibility, quality and accuracy of the LCA-based data;	The LCA-based data are of acceptable plausibility, quality and accuracy.	
GE10			f) the quality and accuracy of additional environmental information;	The additional environmental information is of acceptable quality and accuracy.	
GE11			g) the quality and accuracy of the supporting information.	The supporting information is of acceptable quality and accuracy.	
			Editorial Comments		
ED1	p. 2	Footnote	In text the footnote standards for ISO 14040 and 14044 are AMD 1 and AMD 2 with respective dates of the year 2020 for both.		Footnotes have been updated **Acknowledged.**

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ED2	p. 7	Footnote	In text the footnote is number “9”, not “7”.		Footnote has been updated. **Acknowledged.**
ED3	p. 8	Footnote	The version of ecoinvent is listed as v3.7.1 on page 18.		Footnote updated **Acknowledged.**