Sustainable Minds®

SM Transparency Report™ / EPD Framework

Part A

LCA calculation rules and report requirements

Version 2016 | March 2016

Program Operator Consortium
programoperators.org

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Design greener products right, from the start

Version 2016 | March, 2016

Sustainable Minds Transparency Report™ / EPD Framework

Part A: LCA calculation rules and report requirements

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1. Introduction

This document was created by Joep Meijer, Naji Kasem and Kim Lewis, maintained by the SM Technical Advisory Board (TAB) and owned by Sustainable Minds as the Program Operator as outlined in ISO 14025:2006.

This document is part of a series of documents compromising the Sustainable Minds (SM) Transparency Report™ (TR) / EPD Framework:
- Governance document
- Part A. LCA calculation rules and background report requirements (*this document*)
- Part B. Product group definition
- SM Transparency Report / EPD content collection forms

The most recent version of these documents as well as all explanatory materials can be found at www.sustainableminds.com ensuring the transparency and accessibility of the program as outlined in ISO 14025:2006 Clause 5.9, Clause 6.8.1 and Clause 9.2.3. The 2016 versions of Part A, Part B, and the governance document have been updated to ensure compliance with the Guidance for Product Category Rule Development version 1.0.

1.1 General

This document is based on several public standards and life cycle assessment (LCA) good practice. It complies with the ISO 14040:2006, 14044:2006 and ISO 14025:2006 as well as ISO 14020:2000 and it builds on a vast experience and expertise in Life Cycle Assessment (LCA) and Environmental Product Declaration (EPD) programs around the world particularly EN 15804:2012+A1:2013. This is a living document with the intention of continuous improvement. The main driver for this process is the growth in products that have Sustainable Minds Transparency Reports / EPDs.

The intended application of this document is to provide a common structural set of general rules, requirements and guidelines applicable to any product in order to ensure that all Type III environmental declarations based on SM TR/EPD Framework are derived, verified and presented in a harmonized and consistent manner. An SM Transparency Report / EPD presents the summary of the LCA background report which includes quantified environmental information on the life cycle of a product in information modules. Modularity allows for an easy organization and expression of data packages throughout the life cycle of the product using consistent, reproducible and comparable underlying data (in compliance with ISO 14025:2006 Clause 5.3). The aim is to enhance and better allow comparisons between products of the same product group (see Section 5.2 herein). A product group consists of products that compete for/deliver the same function or purpose (see Part B. Product Group Definition). An SM Transparency Report / EPD of a product is created by applying the general rules of this document together with the specific rules of a Part B. A verified SM Transparency Report / EPD is an ISO 14025:2006 conformant Type III environmental declaration which communicates verifiable, accurate and non-misleading environmental information for products and their applications. The creation, development and use of SM Transparency Reports / EPDs are voluntary (in compliance with ISO 14025:2006 Clause 5.2).

1.2 Scope

This document provides the general rules that apply to any product and used in the development of an SM Transparency Report / EPD in conjunction with Part B. It specifies the standards of LCA calculation rules as a prerequisite of Sustainable Minds Transparency Reports / EPDs as well as the requirements of the LCA background report. It sets the parameters of the latest TRACI and/or CML impact assessment methods as the predetermined tool to report LCA data (inventory data categories and impact category

indicators) for all SM Transparency Reports / EPDs. The assessment of social and economic performances at product level is not covered in the SM TR/EPD Framework. Parts A and B establish the principles and specify the procedures for developing an SM TR/EPD. It further establishes the use of the ISO 14040:2006 and ISO 14044:2006 standards as well as EN 15804:2012+A1:2013 in the development of SM TRs/EPDs.

1.3 Objectives

Consistent with ISO 14025:2006 Clause 4, the overall goal of the framework is to encourage the demand for, and supply of, those products that cause less stress on the environment, through communication of verifiable and accurate information that is not misleading using a consistent, efficient, harmonized, and user-friendly framework. The goal is stimulating the potential for market-driven continuous environmental improvement using scientifically based fair choices. The objectives of SM TRs/EPDs are to:

a) Provide LCA-based information and additional information on the environmental aspects of products
b) Provide information for assessing the environmental impacts of products over their life cycle
c) Allow manufacturers to tell their side of the story on their efforts to decrease the stresses on the environment caused by their products
d) Assist purchasers and users to make informed comparisons between products of the same group
e) Encourage improvement of environmental performance
f) Facilitate manufacturer's transition and progress towards transparency and sustainability

1.4 Principles

The SM Transparency Report / EPD Framework is administered by the Technical Advisory Board (TAB) (see Governance Document) which oversees the compliance of the framework with the principles outlined in ISO 14025:2006 Clause 5. The members of TAB represent different types of organizations (industry, government, university, NGO, LCA experts or national trade organization). The board has as a minimum two LCA experts, one manufacturing industry representative and one representative from a verifying body. The TAB committee acts as an independent third party to organizations and manufacturers and checks the proposed rulings of the product group definitions (Part Bs) and the framework and makes changes. As a neutral body, it intervenes when issues of conflicts of interests arise. An overview of changes to this document is available as Appendix B to this document. The development and use of SM TRs/EPDs is voluntary. The SM TR/EPD Framework provides requirements for an organization choosing to develop and use an SM TR/EPD.

2. References

The SM TR/EPD Framework follows the ISO 14025:2006 and ISO 14040-44:2006 and is therefore in compliance with these standards. Furthermore, the Sustainable Minds and the TAB continually accept proposed reviews to the framework in order to comply with relevant normative standards and achieve the goals of environmental declarations.

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

Bare, J., Gloria, T. and Norris, G. 2006. Development of the Method and U.S. Normalization Database for Life Cycle Impact Assessment and Sustainability Metrics, Environmental Science and Technology, / VOL. 40, NO. 16, 2006

Bare, J. 2014. Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) TRACI version 2.1 User's Guide. US EPA Office of Research and Development, Washington, DC, EPA/600/R-12/554, http://nepis.epa.gov/Adobe/PDF/P100HN53.pdf

CEN/TC 175 FprEN 16485:2013, Round and sawn timber — Environmental Product Declarations — Product category rules for wood and wood-based products for use in construction

CEN/TR 15941 CEN/TR 15941:2010-03: Sustainability of construction works — Environmental Product Declarations — Methodology for selection and use of generic data

EN 15804:2012+A1:2013, Sustainability of construction works — Environmental Product Declarations — Core rules for the construction products, October 2013

IBU 2013. Product Category Rules for Building-Related Products and Services From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU) - Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Background Report. Version 1.2

ISO 14020:2000, Environmental labels and declarations- General Principles

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

ISO 14044:2006, Environmental Management — Life Cycle Assessment — Requirements and Instructions (ISO 14044:2006)

ISO 14025:2006, Environmental labels and declarations- Type III environmental declarations - Principles and procedures

Lautier, et al. (2010). Development of normalization factors for Canada and the United States and comparison with European factors. Science of the Total Environment. 409: 33-42

3. Terms, definitions and abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

NOTE: Terms are not defined where they retain their normal dictionary definition.

- ***Additional technical information*** – information that forms part of the SM Transparency Report / EPD by providing a basis for the development of scenarios [Adjusted from EN 15804:2012+A1:2013]
- ***Ancillary input*** - input material or product that's used by a unit process during the life cycle of the product, but which does not constitute part of the product [adjusted from ISO 14040:2006 and EN 15804:2012+A1:2013]
- ***Average data*** - data representative of a product, product group or construction service, provided by more than one supplier [EN 15804:2012+A1:2013]
- ***Comparative assertion*** - environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function [ISO 14044:2006]
- ***Competence*** - demonstrated personal attributes and demonstrated ability to apply knowledge and skills [ISO 14025:2006]
- ***Consumer*** - individual member of the general public purchasing or using goods, property or services for private purposes [ISO 14025:2006]
- ***Co-product*** - any of two or more marketable materials, products or fuels coming from the same unit process or product system, but which is not the object of the assessment [adapted from EN 15804:2012+A1:2013]
    - Note: Co-product, by-product and product have the same status and are used for identification of several distinguished flows of products from the same unit process. From co-product, by-product and product, waste is the only output to be distinguished as a non-product.
- ***Declared unit*** - quantity of a product for use as a reference unit in a Type III environmental declaration based on one or more information modules [adapted from EN 15804:2012+A1:2013]; [Examples - Mass (kg), volume (m^3)]
- ***Dummy*** - term used by US LCI database that refers to "empty" LCI data sets (technosphere processes).
- ***Environmental aspect*** - element of an organization's activities, products or services that can interact with the environment [ISO 14040:2006]
- ***Environmental impact*** - any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects [ISO 14001:2004]
- ***Environmental label / environmental declaration*** - claim which indicates the environmental aspects of a product or service [ISO 14025:2006]
    - Note: An environmental label or declaration may take the form of a statement, symbol or graphic on a product or package label, in product literature, in technical bulletins, in advertising or in publicity, amongst other things. [ISO 14020:2000]

- ***Environmental performance*** - performance related to environmental impacts and environmental aspects [EN 15804:2012+A1:2013]
- ***Fresh water-*** water having a low concentration of dissolved solids [ISO/DIS 14046].
    - Note 1: Fresh water typically contains less than 1000 milligrams per litre of dissolved solids and is generally accepted as suitable for withdrawal and treatment to produce potable water.
    - Note 2: The concentration of total dissolved solids can vary considerably over space and/or time.
- ***Functional equivalent*** - quantified functional requirements and/or technical requirements for a product or a product system for use as a basis for comparison [Adapted from EN 15804:2012+A1:2013]
- ***Functional unit*** - quantified performance of a product system for use as a reference unit [ISO 14040:2006]
- ***Information module*** - compilation of data to be used as a basis for an SM Transparency Report / EPD (i.e. Type Ill environmental declaration) covering a unit process or a combination of unit processes that are part of the life cycle of a product [Adapted from ISO 14025:2006]
- ***Integrated building technical system -*** are installed technical equipment supporting operation of a building. This includes technical building system for HVAC, lighting, domestic hot water and other system for sanitation, security, fire safety, internal transport and building automation and control and IT communication [Adapted from EN 15804:2012+A1:2013].
- ***Interested party*** – person or body interested in or affected by the development and use of an SM Transparency Report / EPD (i.e. Type III environmental declaration) [Adapted from ISO 14025:2006]
- ***Life cycle -*** consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal [ISO 14040:2006]
- ***Life cycle assessment (LCA)*** - compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle [ISO 14044:2006]
- ***Life cycle inventory analysis -*** phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle [ISO 14040:2006]
- ***Life cycle impact assessment*** - phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product [ISO 14040:2006]
- ***Non-renewable energy*** - energy from sources which are not defined as renewable energy sources [EN 15804:2012+A1:2013]
- ***Non-renewable resource*** - resource that exists in a finite amount that cannot be replenished on a human time scale [EN 15804:2012+A1:2013]
- ***Performance*** - expression relating to the magnitude of a particular aspect of the object of consideration relative to specified requirements, objectives or targets [EN 15804:2012+A1:2013]
- ***Post-consumer recycled content*** - Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material form distribution chains [ISO 14021]
- ***Pre-consumer recycled content*** - material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it [ISO 14021]

- ***Product*** - any goods or items (manufactured or processed) or any services or activities that support processes [adapted from EN 15804:2012+A1:2013]
- ***Product category*** - group of products that can fulfill equivalent functions [ISO 14025:2006]
- ***Product category rules (PCR)*** - set of specific rules, requirements and guidelines for developing Type Ill environmental declarations for one or more product categories [ISO 14025:2006]
- ***Product system*** - collection of unit processes with elementary and product flows, performing one or more defined functions, and which models the life cycle of product [ISO 14040:2006]
- ***Program operator*** - body or bodies that conduct/operate a Type Ill environmental declaration program [Adapted from ISO 14025:2006]
    - Note: A program operator can be a company or a group of companies, industrial sector or trade association, public authorities or agencies, or an independent scientific body or other organization.
- ***Reference service life (RSL)*** - service life of a product which is known to be expected under a particular set, i.e., a reference set, of in-use conditions and which may form the basis of estimating the service life under other in-use conditions [ISO 21930]
- ***Reference service life data (RSL data)*** - Information that includes the reference service life (RSL) and any qualitative or quantitative data describing the validity of the reference service life (RSL).
    - Example: typical data describing the validity of the RSL include the description of the component for which it applies, the reference in-use conditions under which it applies, and its quality [ISO 15686-8].
- ***Renewable energy*** - energy from renewable non-fossil sources [EN 15804:2012+A1:2013]
    - Examples: wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.
- ***Renewable resource*** - resource that is grown, naturally replenished or naturally cleansed, on a human time scale [EN 15804:2012+A1:2013]
    - Note: A renewable resource is capable of being exhausted, but may last indefinitely with proper stewardship. Examples include: trees in forests, grasses in grassland, fertile soil [ISO 21930:2007]
- ***Secondary fuel*** - fuel recovered from previous use or from waste, which substitutes primary fuels [EN 15804:2012+A1:2013]
    - Note 1: Processes providing a secondary fuel are considered from the point where the secondary fuel enters the system from the previous system.
    - Note 2: Any combustible material recovered from previous use or from waste from the previous product system and used as fuel in a following system is a secondary fuel.
    - Note 3: Examples for primary fuels are: coal, natural gas, biomass, etc.
    - Note 4: Examples for secondary fuels recovered from previous use or as waste are: solvents, wood, tires, oil, and animal fats.
- ***Secondary material*** - material recovered from previous use or from waste, which substitutes primary materials [EN 15804:2012+A1:2013]

  - Note 1: Secondary material is measured at the point where the secondary material enters the system from another system.
  - Note 2: Materials recovered from previous use or from waste from one product system and used as an input in another product system are secondary materials.
  - Note 3: Examples for secondary materials (to be measured at the system boundary) are recycled scrap metal, crushed concrete, glass cullet, recycled wood chips and recycled plastic.
- ***Scenario*** - collection of assumptions and information concerning an expected sequence of possible future events [EN 15804:2012+A1:2013]
- ***Specific data*** - data representative of a product, product group or service, provided by one supplier [Adapted from EN 15804:2012+A1:2013]
- ***Third party*** - person or body that is recognized as being independent of the parties involved, as concerns the issues in question [ISO 14025:2006]
  - Note: "Parties involved" are usually supplier ("first party") and purchaser ("second party") interests [ISO 14024:1999]
- ***Type III environmental declaration***- environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information [EN 15804:2012+A1:2013: adapted from ISO 14025:2006].
  - Note 1: Predetermined parameters are based on the ISO 14040 series of standards, which are comprised of ISO 14040:2006 and ISO 14044:2006.
  - Note 2: The additional environmental information may be quantitative or qualitative.
- ***Type III environmental declaration program*** - voluntary program for the development and use of Type III environmental declarations, based on a set of operating rules [ISO 14025:2006]
- ***Unit process*** - the smallest element considered in the life cycle inventory analysis for which input and output data are quantified [ISO 14040:2006]
- ***Upstream, downstream process*** - process(s) that either precedes (upstream) or follows (downstream) a given life cycle stage [EN 15804:2012+A1:2013]
- ***Verification*** - confirmation, through the provision of objective evidence, that specified requirements have been fulfilled [ISO 14025:2006 adapted from ISO 9000:2005]
- ***Verifier*** - person or body that carries out verification [ISO 14025:2006]
- ***Water consumption*** - water removed from but not returned to the same drainage basin
  - Note - Water consumption can be because of evaporation, transpiration, product integration or discharge into a different drainage basin or the sea. Evaporation from reservoirs can be included in water consumption [ISO/DIS 14046].
- ***Waste*** - substances or objects which the holder intends or is required to dispose of [ISO 14040:2006]

3.2 Abbreviations

ADP	Abiotic depletion potential
AP	Acidification potential
BACS	Building Automation and Control Systems
BEES	Building for Environment and Economic Sustainability
B to B	Business-to-business
B to C	Business-to-consumer
BTU	British Thermal Unit
CCTV	Closed-circuit Television
CFC	Chlorofluorocarbon
CO_2	Carbon dioxide
CRU	Components for re-use
CSI	Construction Specifications Institute
CTU	Comparative Toxicity Unit
DOE	Department of Energy
DU	Declared unit
EKAT	Environmental Knowledge and Assessment Tool
EN	European standard maintained by CEN (European Committee for Standardization),
EOL	End of life (also End-of-life)
EP	Eutrophication potential
EPA	Environmental Protection Agency
EPD	Environmental product declaration
ESL	Estimated service life
ft^2	Square foot (also square feet)
FU	Functional unit
GREET	The Greenhouse Gases, Regulated Emission, and Energy use in Transportation model
GWP	Global Warming Potential
IBU	German Institute for Construction and Environment
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
J	Joule
kg	kilogram
km	kilometer
kWh	kilowatt-hour
lb	pound
LCA	Life Cycle Assessment
LCI	Life cycle inventory
LCIA	Life Cycle Impact Assessment
LEED	Leadership in Energy and Environmental Design
m^2	square meter
m^3	cubic meter
mm	millimeter
mi	miles
MDL	Material for disposal to landfill
MER	Materials for energy recovery
MJ	Mega Joule
MND	Modules not declared
MR	Materials recycling
MSDS	Material Safety Data Sheet
N	Nitrogen

NA	North America (also North American)
NEI	National Emissions Inventory
NHWD	Non Hazardous Waste Disposed
NIST	National Institute of Standards and Technology
NOx	Nitrogen Oxide
NRMRL	National Risk Management Research Laboratory
NRMS	Non-Renewable Material Resources
NRPE	Non-Renewable Primary Energy resources
NRPE-F	Non-Renewable Primary Energy resources, fossil
NRPE-M	Non-Renewable Primary Energy resources, used as raw materials
NRPE-N	Non-Renewable Primary Energy resources, nuclear
NRSF	Non-Renewable Secondary Fuels
NUFW	Net Use of Fresh Water
O_3	Ozone
ODP	Ozone Depletion Potential
ORD	Office of Research and Development
PCR	Product category rule (also Product category rules)
PM	Particulate Matter
POCP	Photochemical ozone creation potential
R	Thermal resistance
RCRA	U.S. Resources Conservation and Recovery Act
RMS	Renewable Material Resources
RPE	Renewable Primary Energy resources
RPE-M	Renewable Primary Energy resource, used as raw materials
RSF	Renewable Secondary Fuels
RSL	Reference service life
RWD	Radioactive Waste Disposed
SETAC	Society of Environmental Toxicology and Chemistry
sq ft or sf	Square foot (also square feet)
SI Units	International System of Units
SM	Sustainable Minds
SO_2	Sulfur dioxide
STD	Sustainable Technology Division
TR	Transparency Report
TRACI	Tool for the Reduction and Assessment of Chemical and other environmental Impacts
TRI	Toxics Release Inventory
UNEP	United Nations Environment Programme
UNCPC	United Nations Central Product Code
US	United States
USETOX	model developed under UNEP-SETAC Life Cycle Initiative
VOC	Volatile Organic Compound
WMO	World Meteorological Organization

Modules are identified by terms as follows:

A1 to A3	Product stage modules
A4 to A5	Construction stage modules
B1 to B7	Use stage modules
C1 to C4	End of life stage modules
D	Benefits and loads beyond the system boundary

4. LCA background reports & SM Transparency Reports / EPDs

When creating an SM Transparency Report / EPD, an LCA background report must be submitted. This document specifies the standards of LCA calculation rules as a prerequisite of Sustainable Minds Transparency Reports / EPDs as well as the requirements of the LCA background report (in compliance with ISO 14025:2006 Clause 6.7.1).

4.1 Content, structure and accessibility of the background report

The background report:

- Represents the systematic and comprehensive summary of project documentation with the objective of supporting the examination of an SM Transparency Report / EPD. The background report must document that the information on which the LCA is based as well as the additional information contained in an SM Transparency Report / EPD complies with the requirements of this document.
- Must contain all of the data and information of importance for the details published in the SM Transparency Report / EPD and required in this set of rules. Particular care must be given to comprehensible explanations as to how the data and information declared in the SM Transparency Report / EPD arises from the LCA and how – if declared – the reference service life (RSL) was established.
- Is aligned towards the structure of this document.
- Must be accessible by the verifier under the conditions of confidentiality (see ISO 14025:2006 Clause 8.3).

The background report is not a component of public communication, yet a redacted version (see Section 4.3 herein) will be published on the Sustainable Minds' website in the references' section of the SM Transparency Report / EPD.

4.2 General information

The background report must contain the following general information:

- The client commissioning the LCA, the name(s) and affiliation(s) of the life cycle assessment practitioner(s), company contact;
- The report date; and
- A statement that the LCA was performed in agreement with the requirements of this document.

4.3 Publication

T**h**e full background report needs to be made available to Sustainable Minds, the reviewer and the verifying party. Furthermore, a redacted background report stripped of all confidential information needs to be provided to Sustainable Minds. The redacted background report will be made available by Sustainable Minds upon request.

4.4 Goal of the LCA study

The goal of the LCA study must be outlined in the background report and include:

- Reasons for performing the study;

- Intended use
- Target group, i.e. whether the information and data is intended for business-to-business and/or business-to-consumer communication.

4.5 Scope of the study

The scope of the study shall be detailed in the background report.

4.5.1 Declared/functional unit

The LCA must be calculated for a declared/functional unit of the product as outlined in Section 7.1 'Declared/functional unit' herein.

4.6 Declaration of product groups

The following nomenclature applies in SM Transparency Reports / EPDs, manufacturer declaration and manufacturers' group declaration:

4.6.1 Manufacturer declaration can be either a declaration of:

a) A specific product from a manufacturer's plant;
b) A specific product as an average from several of the manufacturer's plants;
c) An average product from a manufacturer's plant; or
d) An average product as an average from several of the manufacturer's plants

The represented site(s)/plant(s) shall be documented in the background report as well the SM Transparency Report / EPD.

4.6.2 Manufacturers' group declaration can be either a declaration of:

a) A specific product as an average from several manufacturers' plants; or
b) An average product as an average from several manufacturers' plants

Examples of manufacturers groups' are industry groups, industry group representatives or manufacturing collectives.

A reference product that describes a specific (usually typical or standard) product can also be declared.

Unless otherwise specified in Part B, classification and consequently the declared unit of one or several products can take either of the following forms:

- The values of the LCA can be derived from the declared product for any product in a range via rules to be documented, e.g. for comparable products of varying density;
- An "average" or "representative" product is declared; or
- The product with the most environmental impact is declared as representative for a range.

Calculation rules for averaging data

The calculation rules for forming averages in the declaration based on averaged data, (e.g. when a declared/functional unit has been defined for) shall be documented in the background report using one of the following:

- A group of similar products from various manufacturers
- The same product from various production locations
- A representative average of the product or a group of comparable products

The names of the represented manufacturers shall be listed in the SM Transparency Report / EPD.

4.7 Product definition

The product to be assessed must be described in terms of its technical and functional specifications, which include:

- Product identification (company logo and product logo and photo(s);
- Product name ID as it is known in the market;
- CSI (Construction Specifications Institute) master format classification; and
- The appropriate product specification from ASTM, ANSI or other relevant organization, including pertinent physical properties and technical information or any other market identification.

Additional attributes can be included as long as they uniquely identify either the product or its environmental performance.

EXAMPLE: Product certifications such as Greenguard

The product shall be defined by including the following:

- A list of products and other materials that fall within the defined scope of the SM Transparency Report / EPD (in compliance with ISO 14025:2006 Clause 6.7.1);
- Material content: a list of contents at 1% or greater by weight (i.e. most dominant), while describing the remainder in aggregate

NOTE: Material content aims at material characterization on the level of material types, such concrete, ABS and brass, but not on the level of chemical content.

- The following list of specifications per material of the (averaged or most dominant) contents:
    - Origin (extraction location, if known, or at least supplier's location);
    - Supply distance (distance to extraction location in addition to distance to supplier's location, or at least distance to supplier's location);
    - The percentage of recycled content – post-industrial;
    - The percentage of recycled content – post consumer; and
    - The percentage of renewable resource

NOTE: Confidential information does not need to be disclosed on the SM Transparency Report / EPD; in such cases, a notation that the information is confidential will be made along with a description of the function of the compound

Table 1. Example material definition template

Component	Material	Mass %	Availability				Origin of raw materials	Supply distance (km or miles)
			Renewable	Non-renewable	Recycled post-industrial	Recycled post-consumer		
Component 1	Material 1	X%	yes/no	yes/no	%	%	USA	a
	Material 2	Y%	yes/no	yes/no	%	%	Russia	b

Component 2	Material 3	Z%	yes/no	yes/no	%	%	Global	c

NOTE: Post-industrial recycled content is defined as the content derived from the same or other industrial processes
NOTE: Post-consumer recycled content is defined as the recycled content that does not fall under the definition of post-industrial recycled content (see ISO 14021)
NOTE: Renewable resource is defined as a resource renewable within a 100-year time frame

4.8 Use and/or area of application of the product

- The Part B of the declared product includes nationally accepted standards describing functional performance and can be used to describe the use and/or area of application of the product.
- The use and/or area of application of the declared product must be described in a cradle-to-gate SM Transparency Report / EPD, including functional parameters that are measureable and codified or specified in a commonly accepted national standard.

4.9 Depicting the allocation processes in the background report

Uniform application of the allocation rules must be documented in the background report. Allocations performed must be described in the background report, the following must at least be described (if relevant):
- Allocations in the use of secondary materials as raw materials;
- Allocations in the plant (delineation from other products manufactured in the plant);
- Allocation of multi-input processes (if performed during modeling); and
- Allocations of reuse, recycling and energy recovery.

The allocation processes selected must be justified and the allocation factors must be plausible and follows best practices of LCA.

4.10 Depicting the unit processes in the background report

The background report must document modeling of the unit processes in a transparent manner taking into consideration the ISO 14025:2006 data confidentiality provisions. This can be in tabular or as flow charts forms (e.g. screenshots from LCA software), whereby the following must be obvious:
- Attribution of company data to data sets from LCA software
- Allocation of processes data to the stages of the product's life cycle in the LCA

If several products are declared in a single SM Transparency Report / EPD or if a product is manufactured at several locations, modeling must be depicted for each product and/or location and the significance of data records shall documented.

If only a part of the results is presented, the following overviews need to be presented:
- List of all the used unit processes with names and quantities of the LCA functional unit or the declared unit of the SM Transparency Report / EPD.

4.11 SM Transparency Reports™ / EPDs

SM Transparency Reports / EPDs are intended to facilitate comparison of the environmental attributes of products that meet equivalent functional requirements. Quantitative data is reported in appropriate and consistent units of measurement as prescribed by the Part B and Part A of the Framework. Qualitative data, where provided, shall be comparable. The same methods or systems should be used to produce the qualitative information, and these methods and systems shall be identified. Details of the Part B and the overall SM TR/EPD Framework are publicly available on the Sustainable Minds website and can be forwarded to the purchaser or user of the product upon request (see ISO 14025:2006 Clause 7.1).

The SM Transparency Reports / EPDs content collection form can be found in Appendix C of this document (in compliance with ISO 14025:2006 Clause 7.2).

5. General aspects

5.1 System boundaries

The system boundaries follow a modular structure (in line with EN 15804:2012+A1:2013 and in compliance with ISO 14025:2006 Clause 5.4 and Clause 7.2.5). The environmental information of an SM Transparency Report / EPD covering all life cycle stages ("cradle to grave") shall be subdivided into the information module groups defined as A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and optionally D (Table 2). Information modules include impacts and aspects related to losses in the module in which the losses occur (i.e. production, transport and waste processing and disposal of the lost waste products and materials).

When a specific individual module (e.g. B2) and/or a specific group module (e.g. B6-B7) are decided not to be declared, their corresponding fields in the table (Table 2) must be marked as 'MND' which stands for Module Not Declared.

A graphical depiction of a flow diagram illustrating main production processes pursuant to the defined scope of the product declaration is considered to be a part of the background report, which is not accessible to public.

There are three options for the SM Transparency Report / EPD as illustrated in Table 3 (in compliance with ISO 14025:2006 Clause 5.8):

- Cradle-to-gate: only includes the A1-A3 module;
- Cradle-to-grave: includes all of the product stage modules, A1 through C4, where module D may be included; or
- Cradle-to-gate with Options: includes the A1-A3 and C1-C4 modules in addition to any of the remaining product stage modules.

5.2 Comparability

SM Transparency Reports / EPDs are not comparative assertions; that is, no claim of environmental superiority can be inferred or implied. SM Transparency Reports / EPDs enable purchasers and users to compare the environmental performance of products on a life cycle basis. They are designed to present information transparently to make the limitations of comparability more understandable. SM Transparency Reports / EPDs of products that comply with the same product group definition (Part B) and include the same life cycle stages, but are made by different manufacturers, may not sufficiently align to support direct comparisons. They therefore, cannot be used as comparative assertions unless the conditions defined in ISO 14025:2006 Clause 6.7.2. 'Requirements for comparability' are satisfied.

Table 2. System boundary options (only one row to be filled: X = a declared module; MND = module not declared)

	Product assessment information															
	Product life cycle information															Supplementary information (benefits and loads) beyond the product life cycle
SM Transparency Report / EPD aggregated modules	**Production**			**Construction/ Installation**		**Use**							**End of life**				**Recovery**
	A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
SM Transparency Reports / EPDs system boundary	Raw Materials	Transport	Manufacturing	Transport	Construction / installation stage	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Cradle-to-gate Declared unit	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND
Cradle-to-gate with options Declared / functional unit	X	X	X	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	X	X	X	X	Optional
Cradle-to-grave Functional unit	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Optional

5.3. Updating the SM Transparency Report / EPD

The SM TR/EPD verification is valid for five years, or as specified by the PCR. An organization may need to correct or amend information included in SM TRs/EPDs. SM TRs/EPDs shall be reassessed and updated as necessary to reflect changes in technology or other circumstances that could alter the content and accuracy of the declaration. When updating an SM TR/EPD, the same reviewers should do re-verification. The organization making the SM TR/EPD is responsible for notifying Sustainable Minds of the requested changes in the SM TR/EPD and supplying Sustainable Minds with a document from the verifier confirming conformance with relevant requirements. Sustainable Minds shall publish the updated declaration.

6. Life cycle stages

6.1 A1-A3: Product stage

The product stage is an information module that is always included in the SM Transparency Report / EPD. The system boundary shall include all processes that provide material and energy inputs into the system and the following manufacturing and transport processes of products up to the factory gate as well as the processing of any waste arising from those processes up to the end-of-waste state (before waste processing of any secondary materials and fuels) (EN 15804:2012+A1:2013 Clause 6.3.4.5 and Annex B) or disposal of final residues during the product stage.

The product stage includes the following information modules:
- A1: Raw material extraction and processing, processing of secondary material input (e.g. recycling processes)
- A2: Transport to the manufacturer
- A3: Manufacturing

Modules A1, A2 and A3 may be declared as an aggregated Module A1-A3.

The product stage includes, where relevant, information modules for:
- A1: Extraction and processing of raw materials (e.g. mining processes) and biomass production and processing (e.g. agricultural or forestry operations)
- A1: Reuse of products or materials from a previous product system
- A1: Processing of secondary materials used as input for manufacturing the product, but not including those processes that are part of the waste processing in the previous product system
- A1: Generation of electricity, steam and heat from primary energy resources, including extraction, refining and transport thereof
- A1: Energy recovery and other recovery processes from secondary fuels, but not including those processes that are part of waste processing in the previous product system
- A2: Transportation up to the factory gate in addition to internal transport
- A3: Production of ancillary materials or pre-products
- A3: Manufacturing of packaging
- A1-A3: Processing up to the end-of-waste state or disposal of final residues including any packaging not leaving the factory gate with the product.

The flows reaching the system at the A1-A3 boundary are determined as follows:
- Production waste whose materials are *internally recycled* can be considered as recycled within Modules A1-A3 to the maximum volume used in production. A co-product allocation is necessary for production waste exceeding the volumes (of on-site closed-loop recycling) used in Modules A1-A3.
- Co-product allocation is necessary for production waste whose materials are *reused* (i.e. open-loop recycling).

- 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 within 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). A co-product allocation is necessary for energy surpluses exceeding the volumes considered closed-loop.

The following allocation rules shall apply:

1- Regardless of the geographical coverage of a product system, the rules for defining the end-of-waste state of this document shall apply.

2- The output of waste during the A1-A3 life cycle stage may reach the end-of-waste state (the state after waste processing of any primary materials and fuels, and before waste processing of any secondary materials and fuels) (EN 15804:2012+A1:2013, Section 6.3.4.5). Said waste flows shall be allocated as co-products as described in Section 8.3.

3- In the case of input of secondary materials or energy recovered from secondary fuels, the system boundary between the system under study and the previous system (providing the secondary materials) is set where outputs of the previous system, e.g. materials, products or energy or building elements, reach the end-of-waste state (the state after waste processing of any primary materials and fuels, and before waste processing of any secondary materials and fuels) (Section 6.3.4.5 and Annex B of EN 15804:2012+A1:2013).

4- The use of energy carriers such as electricity, combustibles or fuels should be balanced within the module in which the energy carrier is used.

5- 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 and documented. Datasets with clear allocation procedures are preferred to be the first choice. The resulting material and energy flows and their amounts/volumes within Module A1-A3 are to be described transparently in the background report.

6- Loads and benefits from allocated co-products shall not be declared in the optional Module D (EN 15804:2012+A1:2013 Section 6.3.4.6). If such a co-product allocation is not possible, other methods may be chosen and shall be justified and documented. Therefore, as a general rule, potential loads or benefits from A1-A3 will not appear in Module D.

6.2 A4-A5: Construction/Installation stage

The construction and/or installation stage information module shall include all processes that provide materials, products and energy, as well as waste processing up to the end-of-waste state or disposal of final residues during this stage. These information modules also include all impacts and aspects related to any losses during this construction and/or installation process stage (i.e. production, transport, waste processing and disposal of the waste-losses of products and materials).

The construction and/or installation process stage includes the following information modules:
- A4: Transport/Delivery to the site where the product is installed, used and/or constructed
- A5: Construction/Installation

The construction and/or installation stage shall include, where relevant information modules for:
- A4-A5: Storage of products, including the provision of heating, cooling, humidity control etc.
- A4-A5: Waste of products (additional production processes required to compensate for the loss of waste of products)
- A4-A5: Waste processing of the waste from product packaging and product waste during the construction and/or installation process up to the end-of-waste state or disposal of final residues

In the case of a product sold as a system, then:
1- The production all materials and components needed in A5 are to be declared in A1-A3 (e.g. packaging).
2- The transport of the system to the construction/installation site is to be declared in A4. The installation, waste treatment inclusive, shall be declared in A5.

The following applies to information module A5:
1- In case energy recovery is chosen as a part of a scenario:
    - If no specific information for the recovery efficiency of the incineration plant is available, it shall be assumed for North American standards (with proper documentation and justification), that packaging material (and eventual product waste from the installation process) is treated thermally in a plant with less than 60% recovery (EN 15804:2012+A1:2013). Thus, the combustion process (loads) for the packaging is to be declared in module A5, while the resulting benefits are to be optionally declared in module D.
2- The information module A5 shall include manufacturing and transportation of ancillary materials in addition to any energy or water required for either the product installation (including any on-site operations to the product) or operation of the construction/installation site or both.

6.3 B1-B5: Use stage information modules

The use stage information modules include all processes and transportation of all materials, products and related energy or water use, as well as waste processing up to the end-of waste state or disposal of final residues during the use stage. These information modules also include all impacts and aspects related to the losses during the use stage (i.e. production, transport, waste processing and disposal of the lost products and materials).

The use stage information modules include the information modules covering the period from the sale / procurement or handover of the product, building or construction and/or installation work until it is uninstalled, dismantled, deconstructed or demolished (see EXAMPLE below). The use stage information modules also include the use of products, equipment and services in their proper function in addition to their use (see EXAMPLE below). Moreover, the use stage information modules include individual modules that cover maintenance (including cleaning), repair, replacement and refurbishment.

NOTE: The duration of the use stage of construction products may not be the same as the reference service life of a building.

EXAMPLE : For a building this would include protecting, conserving, moderating or controlling a building (e.g. modules describing the building operation through services such as heating, cooling, lighting, water supply and internal transport such as lifts and escalators).

While it is recognized that it may be difficult to separate all use stage processes and the associated aspects and impacts into these individual modules, any deviation from the categorization of aspects and impacts into Modules B1-B5 and B6-B7 shall be transparently reported and justified.

The use stage includes the following information modules:
- B1: Normal (i.e. anticipated) use the product
- B2: Maintenance
- B3: Repair
- B4: Replacement
- B5: Refurbishment

6.3.1 B1: Normal (i.e. anticipated) use of the product

Module B1 ‘Normal (i.e. anticipated) use the product’ covers environmental aspects and impacts arising from activities throughout the normal anticipated use of the product.

Information Module B1 covers any emissions to the environment that are not covered by B6 & B7 information modules (e.g. release of substances from the façade, roof, floor covering and other interior or exterior surfaces to indoor air, soil or water).

NOTE: The LCA background report and consequently the SM TR/EPD does not need to include this information (i.e. emissions to indoor air, soil and water during the use stage) if standards on measurement of release of regulated dangerous substances from products using harmonized test methods according to North American or European product standards are not available.

6.3.2 B2: Maintenance

Module B2 ‘Maintenance’ covers all planned technical services (e.g. work done on the product to replace worn, damaged or degraded parts) and associated administrative operations during the reference service life to maintain the product installed in a state in which it can perform its required functional and technical performance, as well as preserve its aesthetic qualities. This includes any and all preventative and regular maintenance activities such as cleaning and the planned technical service, replacement of worn, damaged or degraded parts. Water and energy usage required for cleaning shall be included in this module.

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

The boundary of Module B2 shall also include the following:
- The production and transportation of any component and ancillary products used for maintenance, including cleaning;
- Transport of any waste from maintenance processes or from maintenance-related processes; and
- The end-of-life processes of any waste from transportation and the maintenance processes, including the removal of any part of the component and ancillary materials.

NOTE: Module B2 would not cover maintenance, repair and/or replacement of a whole section of the building where the product is installed if these activities are part of a complete measure of the building. The same would be considered refurbishment and shall be included in Module B5.

6.3.3 B3: Repair

Module B3 ‘Repair’ covers all technical services (e.g. construction and/or installation work) and associated administrative operations during the reference service life in the form of corrective, responsive or reactive actions of a product or its parts installed in order to return it to an acceptable condition in which it can perform its required functional and technical performance as well as preserve its aesthetical qualities.

Replacement of a broken component or a part due to damage should be assigned to ‘repair’, whereas replacement of a whole product due to damage should be assigned to Module B4.

The boundary of Module B3 shall also include the following:
- Repair processes including:
    - the production of the repaired part of a component and of related used ancillary materials; and
    - energy and water usage during the repair process; and
    - the production and transport aspects and impacts of any materials’ waste during the repair processes;
- The transportation of the repaired components and of used ancillary materials, including production aspects and impacts of any damaged materials during transportation;

- The end of life processes of any losses suffered during transportation and the repair process, including the removal of the repaired parts of the component as well as ancillary materials.

EXAMPLE: For a window with damaged rubbers, this includes the production and transportation of new rubber as well as packaging, in addition to all impacts due to the repair process and the end-of-life stage of the rubber waste and packaging.

6.3.4 B4: Replacement

Module B4 'Replacement' covers all technical services and associated administrative operations during the reference service life associated with replacing a whole product in order to return product to a condition in which it can perform its required functional or technical performance.

The replacement of a broken component or part due to damage is considered repair and should be included in individual module B3, as fully discussed above. However, the replacement of a whole product due to damage should be considered replacement and should be included in individual module B4. On the other side, the replacement of a whole element as part of a concerted replacement program in the building is considered refurbishment and should be included in individual module B5.

The boundary of Module B4 shall also include the following:

- Replacement processes including:
  - the production of the replaced components and of related used ancillary materials; and
  - energy and water usage during the replacement process; and
  - the production and transport aspects and impacts of any materials' waste during the replacement processes;
- The transportation of the replaced components and of used ancillary materials, including production aspects and impacts of any damaged materials during transportation;
- The end-of-life processes of any losses suffered during transportation and the replacement process, including the removal of replaced components as well as ancillary materials.

EXAMPLE: A module B4 of a carpet being replaced at the end of its service life would include:

1- The production and transportation of the new carpet as well as packaging;
2- All impacts due to the installation process (adhesive, vacuum cleaning etc.);
3- Any waste from the installation of the replacement carpet, packaging waste and adhesive; and
4- The end of life stage of the original carpet.

6.3.5 B5: Refurbishment

Module B5 'Refurbishment' covers all technical services and associated administrative operations during the service life of a product associated with the return of the products or its parts to a condition in which the products can perform its required functions. These activities cover a concerted program of maintenance, repair and/or replacement activity, across a significant part or a whole section of the building where the product is installed. All similar restoration activities should be included within module B5.

The boundary of Module B5 shall also include the following:
- Refurbishment processes including:
    - The production of the components and of related used ancillary materials;
    - Energy and water usage during the refurbishment process; and
    - The production and transport aspects and impacts of any materials' waste during the refurbishment processes;
- The transportation of the refurbished components and of used ancillary materials, including production aspects and impacts of any damaged materials during transportation; and
- The end of life processes of any losses suffered during transportation and the refurbishment process, including the removal of components as well as ancillary materials.

6.4 B6-B7: Operational energy and water use

The use stage related to the operation of the product includes:
- B6: Operational energy use
- B7: Operational water use

These information modules include provision and transport of all materials, products, as well as energy and water provisions, waste processing up to the end-of-waste state or disposal of final residues during this part of the use stage which enable the accounted operational energy and water use.

EXAMPLE: Aspects related to the production, transportation and installation of technical equipment (such as Building Automation and Control Systems) required for supply energy and water to the building shall be assigned to Modules A1-A5. Energy and water use during maintenance, repair and replacement or refurbishment activities shall be assigned to Modules B2-B5. Aspects related to the waste processing and final disposal of materials shall be assigned to Modules C1-C4.

NOTE: Building Automation and Control Systems (BACS) are centralized, interlinked, networks of hardware and software which manage various building systems while ensuring optimal operational performance of mechanical, electrical and plumbing systems such as HVAC systems, power monitoring, plumbing and water monitoring, security, CCTV, fire alarm system, elevators and escalators, etc.

6.4.1 B6: Operational energy use

The boundary of module B6 'Operational energy use' includes energy use during the operation of the product, together with its associated environmental aspects and impacts including processing and transportation of any waste generated on site due to the use of energy. The foregoing can be measured using BACs.

NOTE: Manufacturers of BACs systems are significant resources to calculating the operational energy and water use automated and controlled through their systems.

NOTE: For SM TRs/EPDs aimed to North American market: guidance on the selection of standards for calculating operational energy use of technical building systems can be

obtained from ASHRAE Level I – III Procedures for Commercial Building Energy Audits (PCBEA), Second Edition.

NOTE: For SM TRs/EPDs aimed to European market: guidance on the selection of standards for calculating operational energy use of technical building systems can be obtained from CEN/TR 15615, Explanation of the general relationship between various European standards and the Energy Performance of Buildings Directive (EPBD) – Umbrella Document.

6.4.2 B7: Operational water use

Module B7 ‘Operational water use’ includes water use during the operation of the product, together with its associated environmental aspects and impacts considering the life cycle of water which includes production, transportation and wastewater treatment. The foregoing can be measured using BACs.

6.5 C1-C4: End-of-life stage information modules

The end-of-life stage of the product starts when it is replaced (see B4), dismantled or deconstructed from the building or construction and/or installation works and does not provide its initial functionality including provision and transport of all materials and associated energy and water use. However, the boundary of Modules C1-C4 to Module D is set where outputs (i.e. secondary materials or fuels) have reached the end-of-waste state (the state after waste processing of any primary materials and fuels, and before waste processing of any secondary materials and fuels) (EN 15804:2012+A1:2013, section 6.4.3).

Loads (e.g. emissions) from waste disposal in Module C4 are considered part of the product system under study, according to the “polluter pays principle.” If, however, this process generates energy such as heat and power from waste incineration or landfill, the potential benefits from utilization of such energy in the next product system may optionally be included and assigned to Module D and are calculated using current average substitution processes.

The end-of-life stage includes:
- C1: Un-installation, deconstruction and demolition
- C2: Transport to waste processing
- C3: Waste processing for reuse, recovery and/or recycling
- C4: Disposal

The end-of-life stage may also include optional information modules, where applicable, for:
- C1: Deconstruction which includes the dismantling or the demolition of the product from the building as well as the initial on-site sorting of the materials if applicable
- C2: Transportation of the discarded product to waste processing either to a recycling site or to final disposal
- C3: Waste processing of material flows intended for reuse, recycling and/or energy recovery (e.g. collection of waste fractions from deconstruction and their processing). Waste processing shall be modeled and the elementary flows shall be included in the inventory. In the case of energy recovery option only for materials that have reached the end-of-waste state, energy recovery materials considered are only those with energy recovery efficiency rate higher than 60% (without prejudice to existing legislations).
- C4: Waste disposal which includes physical pre-treatment and management of the disposal site

During the end-of-life stage of the product and its application (or the building), all output from the following are, at first, considered as waste:
- uninstallation, dismantling, deconstruction or demolition of the product (and/or building);
- maintenance (see B2), repair (see B3), replacement (see B4) or refurbishing (see B5) processes;
- products, debris, materials or elements etc.

This output however reaches the end-of-waste state only when it complies with all of the following criteria:
1. the recovered material, product or construction element is commonly used for specific purposes such as the function of a certain product as well as the assignment of a material as an input to the production process of another product or energy generation process;
2. a market or demand, identified by a positive economic value, exists for such a recovered material, product or construction element;

3. the recovered material, product or construction element fulfils the technical requirements for the specific purposes and meets the existing legislations and standards applicable to products; and
4. the use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

The criterion for "*overall adverse environmental or human health impacts*" shall refer to the limit values for pollutants set by regulations in place at the time of assessment and where necessary shall take into account adverse environmental effects. The presence of any hazardous substances exceeding these limits in the waste or showing one or more properties as listed in existing applicable legislation (e.g. the United States Resource Conservation and Recovery Act (RCRA)) prevents the waste from reaching the end-of-waste state (see ISO 14025:2006 Clause 6.7.1).

In principle, waste processing is part of the product system under study. In the case of materials leaving the system as secondary materials or fuels, processes such as collection and transport before the end-of-waste state are, as a rule, part of the waste processing of the product system under study (see C3). However, after having reached the end-of-waste state, further processing may also be necessary in order to replace primary materials or fuel input in another product system. Such processes are considered to be beyond the system boundaries and may be assigned to the optional module D. Secondary materials having left the system may be optionally declared as substituting primary production in module D, only if they have reached the functional equivalence of the substituted primary materials.

6.6 D: Benefits and loads beyond the system boundary information module

Reporting module D is optional. Module D aims at transparently reporting and declaring the environmental benefits or loads resulting from net flows of reusable products, recyclable materials and/or useful energy carriers leaving a product system (e.g. as secondary materials or fuels) only if they have not been allocated as co-products and have also passed the end-of-waste state. Avoided impacts from allocated co-products shall not be included in module D.

The net impacts are calculated as follows (Section 6.4.3.3 of EN 15804:2012+A1:2013):

- 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 beyond the system boundary (after the end-of-waste state) up to the point of functional equivalence where the secondary material or energy 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 substituting process.

Module D includes reuse, recovery and/or recycling potentials of products and materials expressed as net impacts and benefits. The information in Module D may also contain technical information, parameters describing environmental impact and resource use, and other environmental information describing different waste categories and output flows (Section 7 of EN 15804:2012+A1:2013).

In summary, three different cases can be distinguished, such as modeling the energetic use of waste-specific and declared:

- *Thermal treatment of waste* happens when the waste flow has not reached the end-of-waste status before the combustion and the incineration plant has an efficiency < 0.6.The environmental loads arising from both waste processing and incineration processes are declared as a disposal process in C4. The net produced energy due to waste treatment is declared as exported energy in C4 however, the benefits of that energy are declared in D.
- *Energy Recovery* happens when the waste flow does not reach the end-of-waste status before the combustion and the incineration plant has an efficiency > 0.6. The environmental impact of both waste processing and incineration processes are declared as an energy recovery process in C3. The net produced energy is declared as exported energy in C3, however, the associated benefits of that energy is declared in D.
- *Energetic use of a secondary fuel* happens when the waste flow reaches the-end-of-waste status *prior* to the combustion or thermal energy recovery process. This qualifies the material flow as a secondary fuel at the system boundary and the criteria of the efficiency is not applicable. The environmental impacts of waste treatment of the secondary fuel are accounted for in C3 and the material flow is declared as a material for an energy recovery process in C3. However, the benefits associated with the net generated energy are declared in D.

A summary is presented in Table 3.

Table 3. Energy recovery guidelines summary

	Landfill	Thermal treatment of waste	Energy recovery	Energetic use of secondary fuel	Recycling
Criterion 1	**Flow does not reach end-of-waste state**		**Flow reaches end-of-waste state**		
Criterion 2	**N/A**	**Combustion plant < 0.6**	**Combustion plant < 0.6**	**N/A**	**N/A**
Results of energetic use of waste on related modules					
C3			- Environmental impacts of energy recovery - produced net energy declared as exported energy	- Environmental impacts of waste treatment and processing - material flow declared as material for energy recovery	
C4		- Environmental impacts of disposal process - produced net energy due to treatment is declared as exported energy			
D		- Benefits of generated net energy (avoided impacts)	- Benefits of generated net energy (avoided impacts)	- Benefits of generated net energy (avoided impacts)	

7. Calculation rules for the LCA

7.1 Declared/functional unit

The LCA must be calculated for a declared/functional unit of the product as specified in Part B of relevance for the product to be declared depending on the system boundary.

If the entire life cycle of the product is to be declared, a functional unit shall be used. If the entire life cycle is declared, it is imperative that a reference service life (RSL) is indicated (see Section 7.2 “Documentation for calculating the Reference Service Life (RSL)” herein).

Usually, the declared unit refers to the product "from factory to gate". If a system sold by a manufacturer is declared, the declared unit may also refer to the product "as installed" (also see Section 6.2 “A4-A5: Construction/Installation Stage” herein).

The declared/functional unit shall be reported in its entirety (i.e. no percentages are allowed). Standard units can be declared (e.g. 1 m^2 of a defined thickness and density), whereby conversion into the declared/functional unit as specified in Part B is clear. In this case, a statement must be included in the LCA background report detailing the conversion.

The mass of the declared unit is to be indicated.

A declared unit is the quantity of a product that is covered in the SM Transparency Report / EPD. The declared unit, together with the selection of the included life cycle stages defines what parts of the functional unit and the full life cycle are covered in the SM Transparency Report / EPD.

7.2 Documentation for calculating the Reference Service Life (RSL)

Unless the entire life cycle of the product is declared (i.e. all modules except Module D), declaring a reference service life (RSL) is optional. Information on the product’s RSL requires specification of compatible scenarios for the product stage, construction and/or installation process stage and use stage. RSL is dependent on the properties of the product and the reference in-use conditions. These conditions shall be declared together with a RSL and it shall be stated that the RSL applies for the referenced in-use conditions only.

RSL information declared in an SM Transparency Report / 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. It shall be established in accordance with any specific rules given in the specific regional product standards and shall take into account the guidelines of ISO 15686-1, -2, -7 and -8.

7.3 Description of the system boundary in the background report

The description of the system boundary in the background report includes the following elements:

1. Description of an analysis period for each of the modules considered in the LCA, presenting the same using a flow chart is preferred
2. List of omissions of life cycle phases, processes or data needs

3. Assumptions in regards to power generation, including reference to studied year or period
4. Assumptions in regards to other relevant background data (see also section 7.5 “Selecting data / background data” below) impacting the description of the system boundary.

7.4 Criteria for the exclusion of inputs and outputs (cut-off rules)

Criteria for the exclusion of inputs and outputs (i.e. cut-off rules) in the LCA and information modules, as well as the exclusion of any additional information are intended to support an efficient calculation procedure and are in no way, shape or form intended to hide data. Therefore, any such exclusion shall be transparently documented in the background report including a description of the assumptions and application of the cut-off criteria as well as a list of processes not taken into consideration (in compliance with ISO 14025:2006 Clause 9.2.1). A statement on any omissions shall be included in the background report.

The following procedure shall be followed for the exclusion of inputs and outputs:

- All inputs and outputs to a unit process whose data is available shall be included in the calculations. Data gaps may be filled by conservative assumptions using either average or generic data. Any assumptions justifying either choice shall be documented;
- In the case of a unit process with insufficient input data or data gaps, the cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass of that unit process. The total neglected input flows per module group, (i.e. A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and D) shall be a maximum of 5% of the total mass and energy usage. Conservative assumptions combined with plausibility considerations and expert judgment can be used to demonstrate compliance with these criteria and the same shall be documented;
- Particular care should be given to including material and energy flows known to have the potential to cause significant impacts to the environmental indicators of this document (see Table 5 below). Conservative assumptions combined with plausibility considerations and expert judgment can be used to demonstrate compliance with these criteria and shall be documented.

7.5 Selecting data / background data

The following rules shall apply for data selection:

1- As a general rule, either specific data or average data derived from specific production processes shall be the first choice of data used in the calculations of an SM Transparency Report / EPD.

2- An SM Transparency Report / EPD describing an average product shall be calculated using representative average data of the products declared;

3- An SM Transparency Report / EPD describing a specific product shall be calculated using specific data of at least the processes on which the producer of the product has control over. Generic data may be used for the processes which the producer does not control, often referred to as upstream data (e.g. processes dealing with the production of input commodities such as raw material extraction or electricity generation).

4- A specific SM Transparency Report / EPD covering all life cycle stages (i.e. cradle to grave) may be calculated using generic data for some downstream processes (e.g. waste incineration). For the sake of comparability, the calculation of the use stage shall be based on the same additional technical information as required in this document.

5- The additional technical information for the development of scenarios shall be specific or average (when an average product is declared);

6- Documentation of technological, geographical and time related representativeness for generic data shall be provided in the background report.

NOTE: Publically available, generic data which may be average or specific, describe “upstream” and “downstream” processes.

7.6 Data / Background data quality requirements

In compliance with ISO 14025:2006 Clause 6.7.1, this document contains the list of the requirements of data/background data quality which includes coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty. The quality of the data used to calculate an SM Transparency Report / EPD shall be addressed in the background report (see ISO 14044:2006, 4.2.3.6). In addition, the following specific requirements shall apply for products (EN 15804:2012+A1:2013 section 6.3.7):

- Data sets used for calculations shall have been updated within the last 10 years for generic data and within the last 5 years for producer-specific data. Deviations shall be justified.
- Data sets shall be based on 1 year of averaged data; deviations shall be justified. The base year needs to be reported in both the background report and the SM Transparency Report / EPD. If future production conditions are to be incorporated at the time of generating the SM Transparency Report / EPD, the following shall apply:
    - Processes which do not have an influence on the manufacturing process (e.g. procurement of green electricity) can be integrated in the results. For green electricity, this means that the Declaration may not be issued until such a time as procurement takes place and is verified by the presence of a contract.
    - For processes which have an influence on the manufacturing process (e.g. new furnace), data must be available over a certain period of time which provides a representative set of data for the new process (a period of 3-4 months often suffice in such cases).
- 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 as indicated in a Part B.
- The technological coverage shall reflect the physical reality of the declared product or product group;
- 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 as outlined in this document.

Until pre-verified generic data sets are available nationally or internationally and referenced to in the background report, the following rules shall apply for selecting the background database:

- As a general rule, consistent background data must be used in order to ensure comparability of results.
- The choices need to be plausible.

EXAMPLE: GaBi databases as well as US-ecoinvent and the USLCI databases are example of generally accepted databases in the North American market.

NOTE: Further guidance on data selection may follow in future versions of this document.

The background report must:

- Indicate the data sets used in addition to their sources (e.g. name of data base, literary source), including the year for which the data set is representative of, as well as the percent contribution from each data set
- Indicate percent primary data vs percent secondary data (e.g. 100% primary data was used for gate to gate manufacturing, and 100% secondary data was used elsewhere)
- Document the representativeness of data sets used
- Document the treatment of missing data (as outlined in this document)
- Evaluate the data quality (in general or using a pedigree matrix or similar)

7.7 Power mix

The following applies in regards to selecting the power mix:

- At production facilities in the United States, regionally specific grid mix data from EPA's eGrid shall be used for electricity. 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. National averages are allowed for group averages or associations; however, the sensitivity of the results shall be checked using combined weights by production volumes.
- At production facilities outside the United States, applicable country-specific power mixes shall be assessed, otherwise, comparable country-specific processes shall be used provided they comply with the current state-of-the-art.
- At production facilities in several countries, applicable country-specific power mixes shall be assessed, otherwise, combined weighted by production volumes in the respective countries shall be used.
- If a contract is signed for a specific power mix, a contract must be available for at least three years including the year of the LCI that is declared and the two preceding or following years. The incorporation into the LCA calculations shall be documented on the SM TR/EPD.

7.8 Developing product level scenarios

With the exception of the required Modules A1 to A3 which describe the manufacturing stage of a product and are therefore already known, specific primary data for modules B and C are not commonly available. Where specific or average data is not available to use in modules B and C, scenarios shall support the calculations of information modules covering processes related to the environmental assessment of the remaining life cycle stage(s) of the product and shall support the environmental performance assessment of a building in its life cycle stages (construction and/or installation, use stage and end life). Where

reasonable scenarios for the specific stages can be modeled, those stages shall not be excluded. Assumptions made to create the scenarios are documented in Part B (see ISO 14025:2006 Clause 9.2.1).

Scenarios assist in the derivation of predetermined parameters of the SM Transparency Report / EPD following the calculation rules outlined in this document. Consequently, a scenario shall be realistic, shall be based on the relevant technical information defined in this document (see Section 7.5 “Selecting data / background data section” above) and shall be chosen to be the most probable representative of alternatives which shall be declared. Processes and procedures that are not in current use or have not been demonstrated to be practical shall not be included in a scenario.

Declared optional modules shall be calculated for specified scenarios and the relevant technical information (e.g. derived parameters) shall be documented in the background report together with the literary source (e.g. recycling rates).

EXAMPLE: A recycling system is not practical if it includes a reference to a return system for which the logistics have not been established.

EXAMPLE: Energy recovery not based on existing technology and current practice is not plausible.

8. Life cycle inventory analysis

8.1 Collecting data and calculation procedures

Data collection and corresponding calculation procedures shall consistently follow the ISO 14044:2006 throughout the study and they shall be documented in the background report. When transforming the inputs and outputs of combustible material into inputs and outputs of energy, the lower caloric value specific to the material shall be applied based on scientifically accepted values.

8.2 Allocations

Most industrial processes produce more than the intended product[1]. Normally more than one input flow is needed to produce one product and sometimes products are co-produced with other products. As a rule, the material flows between them are not distributed in a simple way. Intermediate and discarded products can be recycled to become inputs for other processes. When dealing with systems involving multiple products and recycling processes, allocation should be avoided as far as possible. Where unavoidable, allocation should be considered carefully and should be justified.

The use of upstream data, which do not respect the allocation principles described in this document and in line with ISO 14044:2006 allocation rules), shall be clearly stated and their usage shall be justified in the background report for the lack of alternative.

The principle of modularity shall be maintained (as described in ISO 14025:2006 Clause 5.4). Where processes influence the product's environmental performance during its life cycle, they shall be assigned to the module in the life cycle where they occur. In other words, all environmental aspects and impacts are declared in the life cycle stage where they appear.

The sum of the allocated inputs and outputs of a unit process shall be equal to the inputs and outputs of the unit process before allocation. This means that no double counting or omissions of inputs or outputs through allocation are permitted or justified.

8.3 Co-product allocation

Allocation shall be avoided as far as possible by dividing the unit processes to be allocated into different sub-processes that can be allocated to the co-products and by collecting the input and output data related to these sub-processes. If a process can be sub-divided but the respective data is not available, the inputs and outputs of the system under study should be partitioned between its different products or functions in a way which reflects the underlying physical relationships between them. In other words, the physical relationships shall reflect the way in which the inputs and outputs are influenced by the quantitative changes of the products or functions (i.e. the outputs and/or services provided by the process, having a positive economic value) delivered by the system.

[1] In industrial processes, there may be a wide variety of different types of materials produced in conjunction with the intended product. In business vocabulary, these may be identified as by-products, co-products, intermediate products, non-core products or sub-products. In this document, 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 document.

Plant data (such as energy carriers or ancillary materials and consumables) which cannot be allocated to a specific product on the basis of the processes or via a recipe, allocation by mass shall be followed.
In the case of joint co-production where the processes cannot be sub-divided, allocation shall respect the main purpose of the processes studied while allocating all relevant products and functions appropriately. The purpose of a plant and therefore of the related processes is generally declared in its permit and should be taken into account. Processes generating a very low contribution to the overall revenue may be neglected. Contributions to the overall revenue of the order of 1% or less are regarded as very low. A difference in revenue of more than 20% is regarded as high. Joint co-product allocation shall be allocated as follows:

- 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 in a way reflecting the physical flows, irrespective of the chosen allocation for the processes.

NOTE: A common position on the definition of the most appropriate allocation rule needs to be defined together with other relevant sectors as allocations rules are inherently sector specific.

NOTE: Allocation of plant data affecting the declared products must be documented. See section 7.4: Criteria for the exclusion of inputs and outputs (cut-off rules).

8.4 Allocation of multi-input processes

Multi-input processes refer to situations where various products are processed together within an individual process (e.g. a waste incineration plant, a bio-power station or a landfill site). In such case, allocation is performed on the basis of physical classification of the material flows. If necessary, the environmental impacts linked with the inputs are distributed depending on how they influence the subsequent production processes.

8.5 Allocation procedure for reuse, recycling and recovery

The end-of-life system boundary of the 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) within any module of the product system (e.g. during the production stage, use stage or end-of-life stage) are included in the system boundary of the respective module as defined in this document.

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. Where relevant, the optional Module D declares potential loads and benefits of secondary materials, secondary fuel or recovered energy leaving the product system. Module D recognizes the “design for reuse, recycling and recovery” concept for buildings 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.

Where a secondary material or fuel crosses the system boundary (e.g. at the end-of-waste state) 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 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.

In the optional Module D, the impacts of net 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 beyond the system boundary (i.e. after the end-of-waste state) 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 from the resulting net output flow).

When selecting the substituted processes for energetic utilization of the product, the appropriate national or regional processes should be selected where significant market shares are held.

9 Life cycle inventory analysis and estimated impacts

The framework follows the Option A methodology in the development of SM Transparency Reports / EPDs as outlined in ISO 14025:2006 Clause 6.8.2. The results of the LCA must be depicted in the background report in tabular form for all included modules similar to that of Table 2.

9.1 Life cycle impact assessment (LCIA)

The Life Cycle Impact Assessment (LCIA) results must be calculated using the latest TRACI impact assessment methodology. The impact indicators are derived by using the 100 year time horizon[2] factors, where relevant, as defined by TRACI 2.1 and/or CML classification and characterization[3].

NOTE: Adding a statement that LCIA results are relative and do not necessarily predict impacts on each respective category's end points, thresholds' exceedance, safety and health risks is mandatory.

An SM TR/EPD includes the ten impact categories shown in Table 4, five of which are mandatory for Program Operator Consortium-issued EPDs: ozone depletion, smog, acidification, eutrophication and global warming.

Table 4. Selected impact categories and units

Impact category	Unit
Acidification	kg SO_2 eq
Ecotoxicity	CTUe
Eutrophication	kg N eq
Global warming	kg CO_2 eq
Ozone depletion	kg CFC-11 eq
Carcinogenics	CTUh
Non-carcinogenics	CTUh
Respiratory effects	kg PM2.5 eq
Smog	kg O_3 eq
Fossil fuel depletion	MJ surplus

As part of the results, the following overviews must be presented:

- A list of substances in the LCI not recognized by impact assessment method and thus do not contribute to the impact categories (e.g. substances are flows provided by the manufacturer from the foreground system which are not characterized by any of the chosen LCIA methods in this Framework).

[2] The 100 year period relates to the period in which the environmental impacts are modeled. This is different from the time period of the functional unit. The two periods are related as follows: all environmental impacts that are created in the period of the functional unit, are modeled through life cycle impact assessment using a 100 year time horizon to understand the impacts that take place.
[3] J. Bare (2014). Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) TRACI version 2.1 User's Guide. US EPA Office of Research and Development, Washington, DC, EPA/600/R-12/554.

- A comprehensive list of the substances in the LCI with names and quantities exported from the model in the LCA program without any cut-off[4].

The LCIA indicators must be declared and the estimated impacts must also be reported.

Case of average products:
A deviation greater than 10% is considered significant. The background report and the SM Transparency Report / EPD shall, if applicable, include:

- A statement declaring whether variations of 10% or higher in any of the LCIA results exist.

EXAMPLE: "Deviations of 10% or higher in the LCIA results exist. They are caused by ____, ____ and ____."

- A statement specifying the LCIA results that make deviations higher than 20% need to be included.

EXAMPLE: "Deviations of 20% or higher in the LCIA results exist. They are caused by ____, ____ and ____."

Reporting of the EN 15804:2012+A1:2013 LCIA environmental parameters is optional (Table 5).

Table 5. Parameters from EN 15804:2012+A1:2013 describing the environmental impacts

Parameter	Description	Unit
GWP	Global warming potential	kg CO_2-eqv.
ODP	Depletion potential of the stratospheric ozone layer	kg CFC11-eqv.
AP	Acidification potential of land and water	kg SO_2-eqv.
EP	Eutrophication potential	kg PO_4^{3-}-eqv.
POCP	Formation potential of tropospheric photochemical oxidants	kg C_2H_4-eqv.
ABDM	Abiotic depletion potential for non-fossil resources	kg Sb -eqv.
ABDE	Abiotic depletion potential for fossil resources	MJ

NOTE: A check needs to be performed on the contribution of feedstock energy to the overall use of depletion of fossil energy resources. If the contribution is higher than 20% to the Fossil Fuel depletion or ABDE parameter described above a statement to that affect, including the percentage needs to be part of the background report and the SM Transparency Report / EPD.

EXAMPLE: "The contribution of feedstock energy to fossil fuel depletion and ABDE including feedstock energy is higher than 20%."

Reporting of the water footprint and carbon footprint is optional.
Water may be reported by following either EN 15804 or the GHG Protocol. The carbon footprint may be reported using the GHG Protocol. The methodology name and version number should be presented on the SM Transparency Report / EPD together with the results, either as a reference or in the name of the impact category.

[4] The reason no cut-off is allowed is because this is a calculated table and does not contain the original manufacturer's data.

9.2 Normalization and weighting

The SM millipoints as well as the normalized LCA results prior to weighting may be reported. For this purpose normalization[5] and weighting[6] is applied using the following table:

Table 6. SM normalization and weighting factors

Impact category	Normalization	Unit	Weighting (%)
Acidification	90.9	kg SO_2 eq /year /capita	3.6
Ecotoxicity	11000	CTUe /year /capita	8.4
Eutrophication	21.6	kg N eq /year /capita	7.2
Global warming	24200	kg CO_2 eq /year /capita	34.9
Ozone depletion	0.161	kg CFC-11 eq /year /capita	2.4
Carcinogenics	5.07E-05	CTUh /year /capita	9.6
Non-carcinogenics	1.05E-03	CTUh /year /capita	6.0
Respiratory effects	24.3	kg PM2.5 eq /year /capita	10.8
Smog	1390	kg O_3 eq /year /capita	4.8
Fossil fuel depletion	17300	MJ surplus /year /capita	12.1

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 background 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

9.3 Life cycle interpretation

Interpretation of the LCA results in the background report should at least discuss the parameters describing the environmental impact with reference to the declared unit and major specifications influencing the results. Interpretation shall also include the following:

1. Interpretation of the results based on a dominance analysis of selected indicators for the relevant modules. All processes or materials that have a contribution of 20% or more in any of the LCA results (= relevant impacts) need to be identified (overall and in each life cycle stage);
2. The relationship between the Life Cycle Inventory Analysis results and the results of the environmental impacts;

[5] Ryberg, Morten, et al (2013). 'Updated US and Canadian normalization factors for TRACI 2.1.' Clean Technologies and Environmental Policy.

[6] Gloria, T. P., B. C. Lippiatt & J. Cooper (2007). 'Life cycle impact assessment weights to support environmentally preferable purchasing in the United States.' Environmental Science & Technology, 41(21), 7551-7557.

3. A sensitivity analysis using the highest and lowest values for the most important choices and assumptions must be performed to check the robustness of the results of the LCA (disregarding outliers is appropriate). Identifying which choices or assumption influence the results in any environmental parameter by more than 20% shall be reported. Additionally, the chosen approach for the following parameters must also be reported:
    - The impact of the geographical and technological variation on various production locations;
    - The variation due to using average composition;
    - The variation due to using a group-average;
    - Allocation of recycling processes; and
    - Allocation of multi-input and multi-output processes.
4. Data quality assessment;
5. Full transparency in terms of values-choices, rationales and expert judgments

10 Documentation of additional information

Any additional information shall be documented in the background report including the following:

- Factual statements supported by appropriate internal and verified external documentation that relevant programs and plans to improve the environmental performance of the product are implemented or being implemented. The essence is providing a description about what the company is doing about the relevant impacts and efforts made to minimize them.
- Self-declared content about programs, strategies and successes, as long as they are relevant to the environmental performance of the product

Additional environmental information (whether LCA-based or not) related to the products overall environmental performance (such as relevant environmental aspects related to sustainable development) presented in the form of results from other environmental analysis tools is used where relevant (Part A) with the intention to ensure that all relevant environmental aspects of the product are covered in the SM Transparency Reports / EPDs (in compliance with ISO 14025:2006 Clause 6.8.2).

10.1 Relevant additional data/certifications related to environmental performance

All declared data and or certifications require reference and must comply with the applicable standards for the region that is declared in the functional unit.

This must include:

- Statements that relate to the scope of the Transparency Report
- Additional environmental statements which are mandatory through legislation, even for excluded stages (i.e. outside the scope)

This can include:

- Certificate's logo, certificate numbers and/or other relevant references
- Statements about environmental performance
- For European market SM TRs/EPDs: Substances that are regulated, for example under the European REACH program in case the product is available on the European market. Declare the following: 'the product contains no substances from the REACH Candidate list' or 'the product contains substances that are less than 0.1% by weight on the REACH Candidate list' or 'the product contains substances from the REACH Candidate list'. When the last category is relevant, list the substances.

10.2 Laboratory results and scenario-related information

The background report shall include any documentation on additional environmental information declared in the SM Transparency Report / EPD as required in this document. Such documentation (e.g. copies or references) on additional environmental information may include:

- laboratory results/measurements related to the content's declaration;
- laboratory results/measurements related to the functional/technical performance;

- documentation on declared technical information on life cycle stages that have not been considered in the LCA of the product but will be used for the assessment of buildings (e.g. transport distances, energy consumption during use, cleaning cycles etc.)
- laboratory results/measurements related to declarations of emissions to indoor air, soil and water during the product's use stage.

10.3 CO_2 certificates

CO_2 certificates such as Carbon Offsets cannot be utilized in the LCA study in that they cannot be used to reduce the total quantity of carbon dioxide equivalents reported in the study. They, however, can be included / specified in the SM Transparency Report / EPD as outlined in Appendix C section 6. The manufacturer must provide documentation showing ownership of the environmental benefit of such certificates for the entire duration of the validity of the SM Transparency Report / EPD.

Appendix A: Impact assessment methodology

The impact assessment is based on the TRACI methodology and is documented in (Bare, 2014). The contents of the documentation are presented in this appendix.

TRACI 2.1 (the Tool for the Reduction and Assessment of Chemical and other environmental Impacts) has been developed for sustainability metrics, life cycle impact assessment, industrial ecology, and process design impact assessment for developing increasingly sustainable products, processes, facilities, companies, and communities.

TRACI 2.1 allows an expanded quantification of stressors that have potential effects, including ozone depletion, global warming, acidification, eutrophication, photochemical smog formation, human health particulate effects, human health cancer, human health noncancer, ecotoxicity, and fossil fuel depletion effects. Research is ongoing to quantify the use of land and water in a future version of TRACI. The original version of TRACI was released in August 2002 (Bare et al. 2003) followed by a release of TRACI 2.0 in 2011 (Bare 2011).

Introduction

Impact assessment for environmental decision making in areas such as sustainability metrics, life cycle assessment (LCA), and industrial ecology involve the quantification of a large number of potential impacts. Unfortunately, completing comprehensive assessments for all potential effects at a high level of simulation, sophistication and disaggregation require excessively large amounts of time, data, knowledge, and resources. It therefore follows that every study must be limited in some aspects of sophistication and/or comprehensiveness.

While conducting several LCA case studies, the U.S. Environmental Protection Agency's (US EPA's) National Risk Management Research Laboratory conducted a literature survey of existing methodologies (Heijungs *et al.* 1992a, Heijungs *et al.* 1992b, Guinée *et al.* 2002, Goedkoop *et al.* 2009, Goedkoop & Spriensma 1999, Goedkoop *et al.* 1996, Hauschild & Wenzel 1998a, Hauschild & Wenzel 1998b, Wenzel *et al.* 1997, Wenzel & Hauschild 1997, Jolliet *et al.* 2003). As it was apparent that no tool existed that would allow a level of sophistication, comprehensiveness, and applicability to the United States, the US EPA decided to begin development of a software tool to conduct impact assessment with the best applicable methodologies within each category. This research effort was called TRACI – the Tool for the Reduction and Assessment of Chemical and other environmental Impacts (Bare *et al.* 2003).

As dictated within the ISO 14042 guidance in this area, an LCA has several steps, some of which may be iterative: inventory, impact assessment, normalization (optional), and either valuation, grouping, or weighting (optional) (International Standards Organization 2000). It is critical to consider the importance of each of these stages (e.g., without a strong inventory possessing high data quality, the results of the impact assessment will be less valuable). In addition, while it is important to show as much comprehensiveness as possible within each study, as was recently demonstrated at an US valuation exercise conducted at NIST, some impact category results may receive much more attention (Gloria *et al.* 2007).

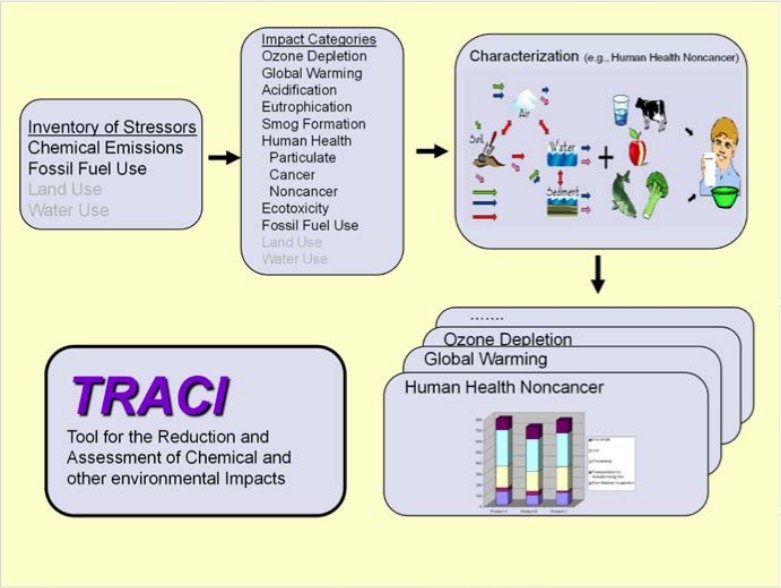
The first step in developing this tool was to select the impact categories for analysis and methodology development. It was soon recognized that the selection of these impact categories is a normative decision depending on what is valued to the individual user. In an attempt to be fully comprehensive in the original selection of impact categories, EPA initiated a taxonomy study of possible impacts (and impact categories) which could be included (Bare & Gloria 2008). From this greater list of impact categories, a smaller more manageable list of impact categories was selected for inclusion into TRACI and

subsequently, TRACI 2.1. This “manageable” list was selected for a variety of reasons, including consistency with existing regulations and policies, perceived importance, and ease of modeling.

The traditional pollution categories of ozone depletion, global warming, human health criteria, smog formation, acidification, and eutrophication were included within TRACI due to various programs and regulations within EPA and recognizing the value of minimizing effects from these categories. The category of human health was further subdivided into cancer, noncancer, and criteria pollutants (with an initial focus on particulates) to better reflect the focus of EPA regulations and to allow methodology development consistent with the U.S. regulations, handbooks, and guidelines. Smog formation is recognized as a significant environmental issue within the US and has separate regulations, which address its prevention. Smog formation effects were kept independent and not further aggregated with other human health impacts because environmental effects related to smog formation would have become lost in the process of aggregation. Particulate pollutants within TRACI are various sizes and forms of particulate matter (e.g., PM 2.5 and PM10) and pollutants which lead to respiratory impacts related to particulates (e.g., sulfur oxides and nitrogen oxides). They were maintained as a separate human health impact category allowing a modeling approach that can take advantage of the extensive epidemiological data associated with these well-studied impacts. The resource depletion categories are recognized as significant in the US, especially for fossil fuel use, land use, and water use. Although not included in TRACI 2.1, research is underway to include land use and water use impacts.

The categories within TRACI 2.1 are shown in Figure 1, with land use and water use being listed for future inclusion. It should be noted, however, that this list of impact categories is considered a minimal set that may be expanded in future versions. Further discussion about the history and development of TRACI, including the minimization of assumptions and value choices by the use of midpoint indicators, and a comparison to other methodologies may be found in supplemental documentation (Bare *et al.* 1999, Bare *et al.* 2000, Bare *et al.* 2003, Bare 2006, Bare & Gloria 2008, Bare & Gloria 2006, Hofstetter *et al.* 2002, Pennington & Bare 2001, Pennington *et al.* 2000).

Figure 1. TRACI 2.1 framework



Inventory

The TRACI framework begins with a user provided inventory of stressors. Within a gate-to-gate analysis, inventory data are often available from the facility or facilities. Within an LCA this may be supplemented by inventory data from suppliers, and/or publicly available databases such as those listed below: the 2006 US EPA's Greenhouse Gas Emissions (US Environmental Protection Agency 2008h, US Environmental Protection Agency 2008g, US Environmental Protection Agency 2008f), the 2006 US EPA's National Emissions Inventory (NEI) for Criteria Pollutants (US Environmental Protection Agency 2007b), the 2002 Hazardous Air Pollutants (US Environmental Protection Agency 2002), the 2006 US Department of Agriculture's (USDA's) Simulation of Nutrient Losses (US Department of Agriculture - Natural Resources Conservation Service 2006), the 2005 US Department of Energy's (US DOE's) Energy Consumption Estimates for fossil fuel depletion (US Department of Energy - Energy Information Administration 2008), the 2005 US EPA's Toxics Release Inventory (TRI) (US Environmental Protection Agency 2005a), and the NREL LCI database (US Department of Energy - National Renewable Energy Laboratory 2008). Data quality and applicability should be considered when including data sources.

Supporting data, such as the TRI database, which were not originally collected or developed for this intention may have some shortcomings. 1) Only exceedance of minimal reporting requirements may be included. 2) Groups of substances may be lumped together (e.g., mercury, mercury compounds, copper, copper compounds, chromium, chromium compounds, lead, and lead compounds). 3) The quality of the data may be uncertain and in many cases hard to predict. TRACI users are encouraged to use the highest quality data whenever possible for minimal data and modeling uncertainty.

Because TRACI is an impact assessment tool, the selection of inventory data source will not be further discussed here. The heart of the TRACI framework is the characterization of each of the impact categories.

Impact assessment methodologies

Whether the analysis is being conducted within an LCA, process design, or a sustainability metrics basis, in all impact categories, the underlying methodologies within TRACI utilize the amount of the chemical emission or resource used and the estimated potency of the stressor.

The estimated potency is based on the best available models and data for each impact category. For some impact categories (e.g., ozone depletion potentials, global warming potentials), there is international consensus on the relative potency of the chemicals listed. For other impact categories, the relative potency may be dependent on models related to chemical and physical principles and/or experimental data. Descriptions on individual impact categories are provided below and give greater detail about the modeling underlying each category.

In some impact categories, the location of the emission or resource used is of importance to the potency of the stressor, and the practitioner is encouraged to maintain the location with each stressor. In these cases, the individual stressors do not simply have one potency factor, but a potency factor at each of the locations. The calculations should then be conducted at each location and then summed up to see the total impact for the study overall. As an example, if an impact category (i) has a fate factor (F), and potency factor (P), then the site-specific analysis may be calculated as follows:

$$I^i = \sum_s \sum_x \sum_m F^i_{xms} P^i_{xms} M_{xms} \qquad (1)$$

Where:
I^i = the potential impact of all chemicals (x) for a specific impact category of concern (i)
F^i_{xms} =the fate of chemical (x) emitted to media (m) at site (s) for impact category (i)
P^i = the potency of chemical (x) emitted to media (m) at site (s) for impact category (i)
M_{xms} = the mass of chemical (x) emitted to media (m) at site (s)

There are many times when the site-specific location is not utilized. For example, for some individual impact categories, location does not influence the fate, transport, and potency to any great extent, and thus only one characterization factor is presented for global use (e.g., global climate change, stratospheric ozone depletion). At other times, the individual locations of the emissions are not known for a specific study and since all impact categories allow non site-specific characterization, the more site-generic characterization factors may be used. In these situations, the generalized equation without respect to location would be:

$$I^i - \sum_{xm} CF^i_{xm} * M_{xm} \qquad (2)$$

Where:
I^i = the potential impact of all chemicals (x) for a specific impact category of concern (i)
CF^i_{xm} = the characterization factor of chemical (x) emitted to media (m) for impact category (i)
M_{xm} =mass of chemical (x) emitted to media (m)

Although the original version of TRACI was released with site-specificity available for many of the impact categories, the vast majority of TRACI users have not been utilizing the site-specific features. This release of TRACI 2.1, as described below will focus on the US average characterization.

For emission related categories, characterization factors are available for the media listed in Table 7.

Table 7. Characterization factors are available for the media listed for each impact category

Impact category	Media
Ozone depletion	Air
Global climate	Air
Acidification	Air, water
Eutrophication	Air, water
Smog formation	Air
Human health particulate	Air
Human health cancer	Urban air, nonurban air, freshwater, seawater, natural soil, agricultural soil
Human health noncancer	Urban air, nonurban air, freshwater, seawater, natural soil, agricultural soil

Ecotoxicity	Urban air, nonurban air, freshwater, seawater, natural soil, agricultural soil

Acidification

Acidification is the increasing concentration of hydrogen ion (H+) within a local environment. This can be the result of the addition of acids (e.g., nitric acid and sulfuric acid) into the environment, or by the addition of other substances (e.g., ammonia) which increase the acidity of the environment due to various chemical reactions and/or biological activity, or by natural circumstances such as the change in soil concentrations because of the growth of local plant species.

Acidifying substances are often air emissions, which may travel for hundreds of miles prior to wet deposition as acid rain, fog, or snow or dry deposition as dust or smoke particulate matter on the soil or water. Sulfur dioxide and nitrogen oxides from fossil fuel combustion have been the largest contributors to acid rain (US Environmental Protection Agency 2008q).

Substances, which cause acidification, can cause damage to building materials, paints, and other human-built structures, lakes, streams, rivers, and various plants and animals. The sensitivity of various environments can depend on a number of factors including: the local buffering capacity, the local plant and animal species, and the existing acidity within the environment (US Environmental Protection Agency 2008c).

Consistent with the focus on providing midpoint assessments, TRACI 2.1 uses an acidification model which incorporates the increasing hydrogen ion potential within the environment without incorporation of site-specific characteristics such as the ability for certain environments to provide buffering capability (Wenzel *et al.* 1997, Wenzel & Hauschild 1997).

Eutrophication

Eutrophication is the “enrichment of an aquatic ecosystem with nutrients (nitrates, phosphates) that accelerate biological productivity (growth of algae and weeds) and an undesirable accumulation of algal biomass” (US Environmental Protection Agency 2008d). Although nitrogen and phosphorus play an important role in the fertilization of agricultural lands and other vegetation, excessive releases of either of these substances may provide undesired effects on the waterways in which they travel and their ultimate destination. While phosphorus usually has a more negative impact on freshwater lakes and streams (U.S. Environmental Protection Agency 2008), nitrogen is often more detrimental to coastal environments (Ecological Society of America 2000).

Some of the major substances which have a role in this impact category are difficult to characterize including emissions from: wastewater treatment plants, decaying plant life pulp and paper mills, food processing plants, and fertilizers used in agricultural, commercial, and individual household locations (US Environmental Protection Agency 1997). For example, the majority of fertilizer (when utilized correctly) provides the benefits for which it was purchased. However, depending on the slope of the fields, the precipitation, and volatilization of the fertilizer, some of this product may go beyond the original intended boundaries and cause unintended consequences downstream. It is these unintended consequences that are considered to be the emission in this case; whereas, the portion of the application that achieved its

goal of fertilizing fields was considered to be useful product (US Department of Energy - National Renewable Energy Laboratory 2008).

The original methodology utilized in TRACI allowed site-specific characterization, which is not supported, in the current version. Additional substances, which have the potential to cause eutrophication, have been added to TRACI 2.1.

Global climate change

“Global warming is an average increase in the temperature of the atmosphere near the Earth’s surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, “global warming” often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities” (US Environmental Protection Agency 2008b). The current trend is to use the phrase ‘climate change’ instead of global warming to denote the other changes which may occur in addition to temperature change (US Environmental Protection Agency 2008p).

During the last 200 years, the sources of greenhouse gases have increased (mostly caused from the increased combustion of fossil fuels (US Environmental Protection Agency 2008a)), while the sinks have decreased (e.g., deforestation and land use changes). The U.S. is keeping track of the greenhouse gas emissions (US Environmental Protection Agency 2008h, US Environmental Protection Agency 2008g) and has a policy in place for greenhouse gas reductions (US Environmental Protection Agency 2008p).

TRACI 2.1 utilizes global warming potentials (GWPs) for the calculation of the potency of greenhouse gases relative to CO2 (IPCC (Intergovernmental Panel on Climate Change) 2001). Consistent with the guidance of the United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC -The United Nations Framework Convention on Climate Change 2003), the US EPA uses GWPs with 100-year time horizons. TRACI 2.1 expands the list of substances found within the original version of TRACI and utilizes a hierarchy of data sources consistent international acceptance. This hierarchy of sources includes the most current GWPs published by the IPCC (Solomon 2011, Solomon *et al.* 2007, IPCC (Intergovernmental Panel on Climate Change) 2001, IPCC (Intergovernmental Panel on Climate Change) 1996).

Ozone depletion

Ozone within the stratosphere provides protection from radiation, which can lead to increased frequency of skin cancers and cataracts in the human populations. Additionally, ozone has been documented to have effects on crops, other plants, marine life, and human-built materials. Substances which have been reported and linked to decreasing the stratospheric ozone level are chlorofluorocarbons (CFCs) which are used as refrigerants, foam blowing agents, solvents, and halons which are used as fire extinguishing agents (US Environmental Protection Agency 2008j). Over 20 years ago, the United States signed the Montreal Protocol to reduce CFC production, and later implemented even more stringent reductions, which have led to a complete end of production of CFCs (by 1996) and halons (by 1994). Levels of total inorganic chlorine have been declining since 1998, and recovery of the ozone layer is expected in about 50 years (US Environmental Protection Agency 2008m).

There is international consensus on the use of ozone depletion potentials (ODPs), a metric proposed by the World Meteorological Organization (WMO) (Solomon & Albritton 1992, WMO (World Meteorological Organization) 1999), for calculating the relative importance of substances expected to contribute significantly to the breakdown of the ozone layer. The US EPA maintains websites listing various options for ODPs (US Environmental Protection Agency 2008k, US Environmental Protection Agency 2008l). These options are consistent with the US and WMO documents used internationally (WMO (World Meteorological Organization) 2003, US Environmental Protection Agency 1992, US Environmental Protection Agency 2003, WMO (World Meteorological Organization) 1999, US Environmental Protection Agency 2008l, US Environmental Protection Agency 2008j, US Environmental Protection Agency 2008k). Within TRACI 2.1, the most recent sources of ODPs were used for each substance.

Human health particulate

Although this category may be called the human health criteria pollutants category, it deals with a subset of the criteria pollutants, i.e., particulate matter and precursors to particulates. Particulate matter is a collection of small particles in ambient air which have the ability to cause negative human health effects including respiratory illness and death (US Environmental Protection Agency 2008n). Numerous epidemiology studies show an increased mortality rate with elevated levels of ambient particulate matter (US Environmental Protection Agency 2008n). Particulate matter may be emitted as particulates, or may be the product of chemical reactions in the air (secondary particulates). The most common precursors to secondary particulates are sulfur dioxide (SO2) and nitrogen oxides (NOx). Common sources of primary and secondary particulates are fossil fuel combustion, wood combustion, and dust particles from roads and fields (US Environmental Protection Agency 2008n). Particulate matter is divided into two major groups of concern: “inhalable coarse particles” which are between 2.5 micrometers and 10 micrometers in diameter, like dust from roadways, and “fine particles” which are smaller than or equal to 2.5 micrometers in diameter, and are often the products of combustion (US Environmental Protection Agency 2008o). Sensitive populations such as children, the elderly, and people with asthma are more susceptible to experiencing higher consequences (US Environmental Protection Agency 2008i). Although national US standards have existed since 1971, even more stringent standards were placed in 2006 (US Environmental Protection Agency 2006).

The method for calculation of human health impacts includes the modeling of the fate and exposure into intake fractions (i.e., that portion of the emitted substance, which is expected to be inhaled by a human being). These intake fractions are calculated as a function of the amount of substance emitted into the environment, the resulting increase in air concentration, and the breathing rate of the exposed population. The increasing air concentrations are a function of the location of the release and the accompanying meteorology and the background concentrations of substances, which may influence secondary particle formation. Substances were characterized using PM2.5 as the reference substance (Humbert 2009).

Human health cancer, noncancer and ecotoxicity

During the development of the original TRACI, human health was represented by three impact categories based on the current structure of the EPA regulations and the chemical and physical behaviors of the pollutants of concern. CalTOX was determined to be the best model for human health cancer and noncancer (McKone 1993), and the input parameters were selected to be consistent with the EPA Risk Assessment Guidelines and the Exposure Factors Handbook (U.S. Environmental Protection Agency 1997, US Environmental Protection Agency 1989a, US Environmental Protection Agency 1989b).

Research was conducted to determine the source of the major uncertainties and influence of site-specific parameters on the human toxicity potentials (Hertwich *et al.* 1999). The probabilistic research showed that for the majority of the TRI substances, chemical data (e.g., toxicity and half-life) had the most significant impact on data variability/uncertainty and that site-specific parameters had little effect on the relative human toxicity potentials (Hertwich *et al.* 1999). This research supported later development of global toxicity potentials for human health cancer and noncancer.

Under the Life Cycle Initiative of the United Nations Environment Program (UNEP) / Society of Environmental Toxicology and Chemistry (SETAC) various international multimedia model developers of CalTOX, IMPACT 2002, USES-LCA, BETR, EDIP, WATSON, and EcoSense created a global consensus model known as USEtox (Hauschild *et al.* 2008, Rosenbaum *et al.* 2008, USEtox Team 2010). Over the course of a series of workshops and numerous communications, model results from the original models were compared to determine the most influential parameters and largest sources of differences between the models using 45 organic substances, which were selected for their diversity in environmental partitioning, exposure pathway, persistence, and air transport. The USEtox model adopted many of the best features of the above-named models and was used to develop human health cancer and noncancer toxicity potentials and freshwater ecotoxicity potentials for over 3000 substances including organic and inorganic substances.

This list of 3000 substances goes beyond the list included within the original TRACI, because initially TRACI was focused on covering those chemicals of concern within the US (e.g., TRI chemicals). It has since been recognized that today's global economy often requires the inclusion of suppliers who are outside of the US within countries who may have their own lists of reportable chemicals. The USEtox expanded set allows this expansion into chemicals of concern globally.

USEtox is developed with two spatial scales: continental and global. The environmental compartments within the continental scale includes: urban air, rural air, agricultural soil, industrial soil, freshwater, and coastal marine water. USEtox includes most of the pathways found in the original EPA Risk Assessment Guidelines, including inhalation, ingestion of drinking water, produce, meat, milk, and freshwater and marine fish.

The USEtox model has been selected to replace the CalTOX model as the basis for the TRACI impact categories of human health cancer, noncancer, and ecotoxicity. It should be noted that some of the characterization factors included within the USEtox model are recommended while others are simply interim and should be used with caution (Rosenbaum *et al.* 2008, Hauschild *et al.* 2008).

The recommended units for the USEtox human health cancer, noncancer, and ecotoxicity are: CTUcancer, CTUnoncancer, and CTUeco, respectively. Although USEtox guidance allows for the combination of cancerous and noncancerous impacts, users of TRACI are encouraged to maintain these categories independently. Individual emissions to media may be combined to consolidate emissions to these three categories.

Photochemical smog formation

Ground level ozone is created by various chemical reactions, which occur between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in sunlight. Human health effects can result in a variety of respiratory issues including increasing symptoms of bronchitis, asthma, and emphysema. Permanent lung

damage may result from prolonged exposure to ozone. Ecological impacts include damage to various ecosystems and crop damage. The primary sources of ozone precursors are motor vehicles, electric power utilities and industrial facilities (US Environmental Protection Agency 2008e).

Within the Leiden University's CML 2002 Handbook (Guinée *et al.* 2002) are listed various options for "summer smog" modeling including: 1) Photochemical Ozone Creation Potentials (POCPs) (Derwent *et al.* 1996, Derwent *et al.* 1998, Jenkin & Hayman 1999, Andersson-Skold *et al.* 1992, Derwent 1991), and 2) Maximum Incremental Reactivity (MIR) (Carter 1994, Carter 1997, Carter 2000). More recent work is now available from Carter for MIR values. Some of this work was conducted specifically for TRACI (Carter 2007, Carter 2008).

Carter's MIRs have been selected for use within TRACI 2.1 for the following reasons. 1) It was developed specifically for the US. 2) It is comprehensive in impacts, covering human and environmental effects. 3) It has the most comprehensive substance coverage allowing greater differentiation of effects when available. The full set of POCPs recently available only cover 128 substances and the TRACI 2.1 MIRs cover nearly 1200 substances (Carter 2007, Carter 2008, Carter 2010b, Carter 2012). 4) It is the method that is used and recommended by the US EPA and individual states within the United States for other environmental programs, including cap and trade programs (US Environmental Protection Agency 2007a, US Environmental Protection Agency 2005b, US Environmental Protection Agency).

Many of the methods, including MIRs prior to the TRACI research, did not have a NOx value on the same scale as the VOCs. This was true for MIRs since the MIR reflects the degree of reactivity with NOx, a concept that is not reflective of NOx reactivity with NOx. At the request of this author, Carter was asked to develop and document a proxy NOx value on the same scale as the MIR (Carter 2008, Carter 2010a).

Modifications were made in the development of TRACI 2.1 when compared to the original version of TRACI. First, the MIRs were updated to include the latest work of Carter (Carter 2010b). More chemicals were added and the total number of pollutants now quantified in this category is nearly 1200 substances. Second, to be consistent with the presentation and units of other impact categories a reference substance was adopted. Thirdly, those twelve substances, which have a negative MIR, were set to zero. While it may be true there is a slightly beneficial effect to the reduction of ozone concentrations upon increased concentration of these pollutants, it was decided that providing "credit" for the additional release of pollutants was not generally a good practice. This is consistent with other recommendations in which negative MIRs were not given credits (Carter 2003).

Resource depletion

Resource depletion is an extremely important issue for the use and development of sustainability metrics and LCA methodologies. Unfortunately, it is one of the most difficult issues to quantify while minimizing value choices and assumptions. Because all of the previously described categories had legislation or international agreements related to their control, it was relatively easy to utilize the models, which were in existence for fate, transport, and potency for each impact category. A parallel track does not exist for these resource depletion categories. Therefore, it is recognized up front the quantification of these impact categories will be the most controversial.

Based on a review performed by the author, a determination was made that the initial resource depletion categories which would be addressed within TRACI would be fossil fuel use, land use, and water use. A

non-site-specific recommendation for fossil fuel use characterization was included within the original version of TRACI (Bare *et al.* 2003, Goedkoop & Spriensma 1999) and this reference methodology is maintained within this release of TRACI 2.1. Over the next few years, the author will be concentrating research efforts in land and water use and should have additional recommendations. In both cases, land and water use recommendations are expected to be site specific, because of the unique properties of location, meteorology, and existing ecosystems.

Interpretation

Notice that no conclusions can be drawn about the relative importance of the scores when compared across impact categories. Since each impact category has different units it is not appropriate to simply look at the values of each impact category and determine from this point which impact category is of most concern. To look at relative importance would involve normalization and weighting. None of the above impact categories have been aggregated using normalization or weighting. Even the human health impact categories have been maintained independently in these examples.

Whether using TRACI within previously developed software, or using it within an EXCEL spreadsheet, one of the most important phases is a proper interpretation of results. One important component of interpretation is an understanding of the uncertainty involved with various results. Uncertainty in the calculated results can be highly variable depending on the impact category and its underlying methodology. Within the USEtox Manual, for example, they mention that characterization factors associated with USEtox may span three orders of magnitude on the individual factors. Other impact categories such as ozone depletion may be based on chemical data and models with less associated uncertainty for individual substances. These uncertainties can best be understood by consulting the original sources of characterization factors.

Summary

TRACI 2.1 is now available for use in sustainability, life cycle impact assessment, process design, or pollution prevention. All of these applications require quantitative data to guide decision making which impacts the current and future generations. TRACI 2.1 has been updated to include additional substances and updated methodologies. Over the next few years, the US EPA will be continuing to expand research into the areas of land use and water use.

Disclaimer

Use of TRACI, including but not limited to the impact assessment modeling, does not create regulatory or scientific approval by the US EPA on any issues to which it is applied, nor does it release any users from any potential liability, either administratively or judicially, for any damage to human health or the environment. The US EPA does not make any warranty concerning the correctness of the database, any actions taken by third parties as a result of using the model, or the merchantability or fitness for a particular purpose of the model. The EPA does not endorse any products or services.

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Appendix B: Overview of changes to this document

Date:	Project: **SM Transparency Report / EPD**
SM Transparency Report / EPD Framework	Version:

#	**Clause No./ Subclause No./ Annex** (e.g. 3.1)	**Paragraph/ figure/table/note** (e.g. Table 1)	**Comment** Justification for change/ question	**Proposed change**	**Decisions** on each comment submitted	**Decision date**
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Appendix C: SM Transparency Report™ / EPD content requirements

Content list	What must communicated to be useful & be an ISO 14025 Type III environmental declaration
1. Company & product Identification	
Brand identification – company logo, product logo	
Company contact info	Name, corporate address, URL
Product photo(s)	As it looks when delivered
Product name(s)/ID(s)	That the market recognizes
Product(s) description	Description of what it does for the end-user, standards followed (e.g. EN 13310:2003, Kitchen sinks – Functional requirements and test methods), dimensions of the product(s), the use and/or area of application, material type, sub-category, and other pertinent physical properties and technical information
Product identification (e.g. model number)	
Part B / PCR identification	Reference the Part B / PCR used to create the SM TR/EPD. Include who the Part B / PCR review was conducted by. (e.g. Part B review conducted by the SM TAB, tab@sustainableminds.com)
Performance Dashboard	**Functional performance**
	User inserts product category-specific attribute list with scores. Required to be on the market or industry-accepted attributes.
	Environmental performance
	· Declared product unit
	· Single figure scores by SM impact scores and life cycle stage
Attributes	**Functional performance**
	Additional attributes that describe product performance, but not required to satisfy a minimum legal standard.
	Environmental performance
	Attributes that are relevant to the LCA results and have shown to reduce the footprint by more than 10% in any environmental parameter.
Certifications	**Functional performance**
	Mandatory and optional
	Environmental performance
	Mandatory and optional
2. Issuing party and verification information	
Issuing party information	Name, program name, address, logo, website
Third-party verifier information (when relevant)	Name, postal address, phone number, website, email address
Release date, valid until (5 years after release date, or as specified by the PCR)	
Reference to full LCA report	Include title, release date and software type and version used
Non-comparability statement	Include the following statement: "**SM Transparency Reports / EPDs enable purchasers and users to compare the environmental performance of products on a life cycle basis.** They are designed to present information transparently to make the limitations of comparability more understandable. SM Transparency Reports / EPDs of products that comply with the same PCR and include the same life cycle stages, but are made by different manufacturers, may not sufficiently align to support direct comparisons. They therefore, cannot be used as comparative assertions unless the conditions defined in ISO 14025 Section 6.7.2. 'Requirements for Comparability' are satisfied."
Verification level	Choose one of the following:

	□ Verified report and LCA results
	□ Self-declared report with ISO 14044 3rd party reviewed LCA results
	□ Self-declared report with self-declared LCA results
Verification statement	Include statement of verification (e.g. The LCA and Report are independently verified to the SM Transparency Report Framework and ISO 14025.)
Scope	Choose one of the following
	□ Cradle-to-grave (max)
	□ Cradle-to-gate with options
	□ Cradle-to-gate (min)
Time coverage	Indicate the year for which primary data have been collected.

3. LCA results

Functional unit quantified performance of a product system for use as a reference unit (for cradle-to-grave)	In the functional unit description, include: Quantity, performance, application, reference service life (RSL)
Declared unit (for cradle-gate or cradle-to-gate with options)	In the declared unit description, include: Quantity, performance, application
Material composition	What's in the product – list contents larger than 1% by weight, describe remainder in aggregate. Include the product and other materials that are within the scope of this report. Create a table declaring the product composition information. Materials that exist in the product that are considered proprietary by the manufacturer may be described with a generic descriptor which includes role and/or function. Additionally, where necessary, materials may be reported with a corresponding reasonable range of mass percentages for which they exist in the product or product range. Table headers: Component | Material | % by weight Additionally, specify materials and substances that can adversely affect human health and/or the environment, in all stages of the life cycle.
Numeric LCA results (defined by TRACI, needed for LEED, SM points), broken down in cradle-to-gate, use phase and end-of-life; info-graphics	Inclusion of [A1], [A2], [A3] are a mandatory minimum and for 'cradle-to-gate'. 'Cradle-to-grave' studies need to include all life cycle stages. All other studies are referred to as 'cradle-to-gate with options'. List the inclusions & exclusions for the following and add explicit details about exclusions. Indicate the impact assessment version used.

Lifecycle stages	**Production**	**Construction/ Installation**	**Use**	**End of life**	**Recovery**
Bold the information levels modules included: **Include photos to illustrate life stages. Actual manufacturer's photos preferred vs, stock**					
Information modules	A1 Supply chain	A4 Delivery	B1 Use	C1 Demolition	D Reuse, recovery and/or recycling
Included/Excluded	A2 Transportation	A5 Installation	B2 Maintenance	C2 Transportation	
	A3 Manufacturing		B3 Repair	C3 Waste processing	
			B4 Replacements	C4 Disposal	
			B5 Refurbishments		
			B6 Energy		
			B7 Water		

SM 2013 mPts (optional)	**Production**	**Construction**	**Use**	**End of life**	**Recovery**
Indicate total impacts by life cycle stages [mPts/functional unit] **Caption explaining materials or processes contributing >20% to total impacts in each lifecycle stage**					

Impact category	Unit	Production	Construction	Use	End of life	Recovery
Ecological indicators						
Acidification	kg SO2 eq					
Ecotoxicity	CTUe					
Eutrophication	kg N eq (nitrogen)					
Global warming	kg CO_2 eq (carbon dioxide)					
Ozone depletion	kg CFC-11 eq					
Human health indicators						
Carcinogenics	CTUh					
Non-carcinogenics	CTUh					
Respiratory effects	kg PM2.5 eq					
Smog	kg O_3 eq (ozone)					
Resource depletion						
Fossil fuel depletion	MJ surplus					

4. Variations that drive performance

Important parameters within the LCA, what are the major contributions

What things have range or variations, and the relevance

Report:

- All processes or materials that have a contribution of 20% or more in any of the LCA results (= relevant impacts)
- A sensitivity analysis for the most important choices and assumptions must be performed to check the robustness of the results of the LCA. Indicate which influence the results in any environmental parameter by more than 20%. State the chosen approach for these parameters.

Topics include:

- The impact of the geographical & technological variation over the different production locations.
- The variation due to variation in the average composition.
- The variation due to averaging for drawing up a 'group-average'.
- For above, use the highest and lowest values in the sensitivity analysis. Outliers can be disregarded.
- Allocation of recycling processes
- Allocation of multi- input and multi-output processes

Results Interpretation

What's causing the greatest impacts, which life cycle stages; what is the company doing about them?

5. Relevant additional environmental data/certifications related to environmental performance

All declared data and or certifications require reference and must comply with the applicable standards for the region declared in the functional unit. This can include:

- Certificate logos, certificate numbers and/or other references. Use logos when possible, link to the organization's web site
- Statements that relate to the scope of the SM Transparency Report / EPD
- Additional environmental statements which are mandatory through legislation, even for stages of the life cycle that are not part of the scope

6. Relevant product manufacturing/strategy about environmental ambition/programs

	• Relevant to LCA results • Content about programs, strategies and successes relevant to the environmental performance of the product. Detailed stories and images about environmental performance improvement methods and techniques such as: closed-loop recycling, up-cycling, renewable energy, sustainable supply chain efforts, etc.

See the document 'Part A: PCR compatibility appendices' for optional additional content requirements. These compatibility appendices give users the ability to create an SM Transparency Report / EPD compliant with PCRs created in other programs (not the SM TR/EPD Framework) by adding a Page 4 which clearly presents the additional content required by those PCRs.