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METHODOLOGICAL AND TECHNICAL GUIDELINES FOR THE DEVELOPMENT OF GENERIC LCA DATASETS FOR CONSTRUCTION MATERIALS

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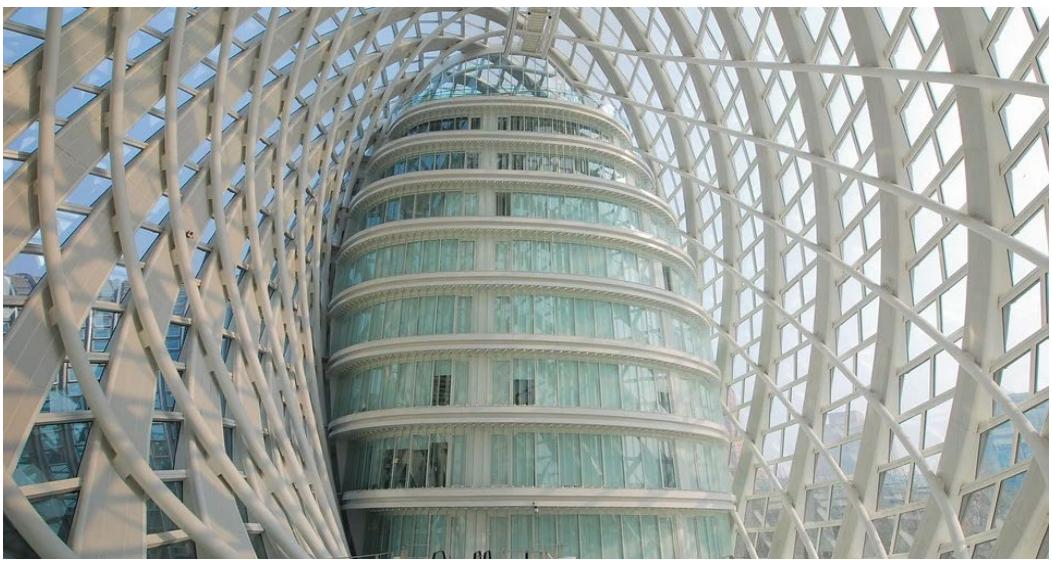

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Description	This document outlines the normative, methodical and technical aspects to be considered for the development of generic LCA datasets for construction materials within the scope of work of the Open Data for Climate initiative (ODCi).
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CHANGE LOG FOR THIS DOCUMENT

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3.0	April 24, 2024	Complete Revision of the Document
3.1	June 4, 2024	Added Section 2.14 with guidance for inventory indicators for A1-A3 datasets
3.2-3.4	Sept.-Dec. 2024	Intermediate internal versions, not shared
3.5	Oct. 2026	Clarification of some details, removed reference to a specific background database, added explanations for selection of background data
3.6	Oct. 2026	Revisions for Alignment with ODCi Product Brief

ABBREVIATIONS

BT	Building Transparency
AP	Acidification potential
BF	Blast Furnace
CEN	European Committee for Standardization
CPC	Central Product Classification
C-PCR	Complimentary Product Category Rules
CSI	Construction Specifications Institute
EAF	Electric Arc Furnace
EC3	Embodied Carbon in Construction Calculator
EF	Environmental Footprint
EoL	End-of-Life
EP	Eutrophication potential
EPD	Environmental product declaration
GWP	Global warming Potential
ILCD	The International Reference Life Cycle Data System
IPCC AR	Intergovernmental Panel on Climate Change Assessment Report
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
LC	Life Cycle
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
ODP	Ozone depletion potential
PCR	Product Category Rules
POCP	Photochemical Ozone Creation Potential
RSL	Reference Service Life
TRACI	Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts
UNDP	United Nations Development Programme
XML	extensible markup language

1. EXECUTIVE SUMMARY

The Open Data for Climate initiative (ODCi) develops generic Life Cycle Assessment (LCA) datasets for construction materials. Final, independently verified datasets and their documentation are intended to be openly available to the public. These datasets support embodied-carbon and building LCA assessments, fill regional data gaps, support baseline assessments, inform regulators, and promote life-cycle-based design decisions. Access to foreground models and other pre-release materials is governed separately by ODCi terms and conditions; open availability of final datasets does not imply unrestricted release of these materials.

The initial version of the database aims to provide a dataset package meeting the fundamental needs for building-level assessments, with data for building materials covering a broad range of technical and geographical scopes. The datasets will be provided in the OpenIMPACT and ILCD+EPD formats.

The actual database development has been preceded by a so-called preliminary study (Pre-Study) in which the methodological and technical approach for dataset development has been validated for feasibility and resource requirements. Furthermore, the preliminary study defined the provision of the LCA datasets in the OpenIMPACT and ILCD+EPD formats and specified the expandable scope of the database.

This document describes the methodological and technical approach in detail, including guidance on how to develop the data in accordance with the format requirements. The methodological principles and technical approach were developed by Ramboll and WAP Sustainability Consulting for Building Transparency from July 2022 to December 2022 and further developed during the project from 2023 to 2026. They include the following aspects:

1. Methodology specifications
2. Principles of data development
3. Technical modelling mechanisms for LCA data creation
4. 'SUPERFORMAT': A Mechanism to provide generic LCA data for construction materials in OpenImpact and ILCD+EPD data formats.

Furthermore, lessons learned regarding the overall work plan, technical approach, effort, and timeline have been incorporated to improve the timing and quality of the larger data project.

1. **Methodology specifications**
   A thorough methodological framework has been established, building on, and providing consistency with the standards ISO 21930 and EN 15804+A2. The document clearly delineates the system boundaries, declared units, representativeness, and other key methodological requirements imperative to the robustness and applicability of LCA datasets in construction. By laying down guidelines around factors such as geographical and technological representation, the data foundation laid in this chapter ensures that datasets are not only technically accurate but tailored to regional specifications.

2. **Principles of data development**
   Guidance has been established to help understand and streamline foreground and background data selection, underscoring the importance of a strategic approach to utilities, transportation, and data gaps. A set of stringent criteria for region definition has been outlined to guide the creation of geographically representative building material fact sheets. Together with a strong emphasis on data quality and the structured LCA quality assurance process, this chapter forms the cornerstone of the methodologies used to ensure the quality, consistency, and representativeness of the LCA data.

3. **Technical modelling mechanisms for LCA data creation**
   A detailed approach on the technical modeling mechanisms integral to the consistency and efficiency of LCA dataset creation has been established. The utilization of LCA software and databases, regionalized energy LCI models, and parameterized modelling templates are defined as tools for this process. The definition of these components for the process aims at providing a high degree of repeatability and accuracy in the data development process.

4. **'SUPERFORMAT': A common mechanism to provide generic LCA data for construction materials in OpenImpact and ILCD+EPD data formats.**
   The generic LCA data for construction materials will be provided to the public in OpenImpact and ILCD+EPD formats. Providing the LCA data in two formats will ensure applicability of the data both in the North American and in the European context. In the Pre-Study, the two data formats were reconciled and analyzed regarding applicability for generic datasets. The findings of the analysis have been translated into a so-called "Super" data format including instructions for developing the associated data documentation in both formats. The datasets developed will be documented in Excel-files, JSON format or similar mechanisms with the use of the "Super"-data format structure to allow these data to be processed into XML-files for the ILCD-EPD schema and into the JSON format for the OpenImpact format.

In summary, this document provides a comprehensive methodology which includes the development of a standard and reliable LCA data foundation for construction materials, applying a stringent quality assurance process across various stages of development. It emphasizes technological and geographic specificity in the datasets to ensure representative and applicable LCA outcomes aligned with international standards.

The ODCi Board is responsible for strategic governance, including approval of access, collaboration, publication and use of the data, including future hosting of data. The ODCi Steering Committee is responsible for technical execution and methodological implementation within that framework. To date, ODCi as an initiative is hosted and coordinated by Building Transparency on behalf of the partners of ODCi.

As of October 2026, foreground models and data research documentation are available for selected material groups, while no background database is connected to the foreground models, and no final datasets are created. Qualified LCA practitioners and data providers may connect a background LCI database that meets Section 3.2. Additional providers and extensions, including further regionalization, technology-specific variants and custom scenarios, may contribute to ODCi data only if they meet the same methodological, governance, independent-verification, publication and use requirements. Following verification, final datasets are intended to be published through the ECO Portal and EC3 alongside product-specific EPDs.

2. METHODOLOGY SPECIFICATIONS

This section details the recommended methodological framework for the development of LCA data for building materials. The aim is to secure the best possible consistency with available LCA data frameworks, particularly EN 15804+A2 and ISO 21930, as they form the basis for data for LCA studies on the level of buildings and construction works.

2.1 OVERVIEW: EN 15804+A2 AND ISO 21930

The framework for the development of generic LCA datasets for construction materials needs to be based on EN 15804+A2 and ISO 21930, the predominant standards for construction material EPDs (Environmental Product Declarations). Where the standards conflict with each other, the more conservative option should be selected (see Table 1 summarizing common and conflicting aspects). As both standards describe the process and provisions to develop product-specific data in an EPD format, these standards are applicable only with limitations for the development of generic datasets. This means that the proposed approach does not claim to be fully compliant with all provisions of the standards but to adopt calculation rules and to adapt rules that are specific to the development of manufacturer-specific data as appropriate.

Table 1: Comparative assessment of EN 15084+A2 and ISO 21930

Aspect	Findings of the comparison between EN 15084+A2 and ISO 21930
General Information	• Both standards require: • Description of product's use along with functional or declared unit. • Construction product identification by name (including product code) and a simple visual representation. • Inclusions and exclusions of the study to be stated. • Declaration of reference conditions for achieving the declared technical and functional performance. • Declaration of date of issue and period of validity which should be 5 years. • Description of additional materials Additionally, ISO 21930 requires description of the main product components or material, given in percentage. EN 15804+A2 also requires minimum substances contained in the product that are listed in the "Candidate List of Substances of Very High Concern for authorization" when their content exceeds the limits for registration with the European Chemicals Agency. It should be noted that these clauses are predominantly applicable for product specific EPDs while generic datasets may have a limitation to inform on such substances.
Reference Service Life	EN 15804+A2 requires the RSL to be described as part of the functional unit and considered in the calculation of replacements at both the construction product level and construction works level (B4) and refurbishment (B5). ISO 21930 also has same requirement with additional compliances to ISO 15686-1, ISO 15686-2, ISO 15686-7, and ISO 15686-8. The RSL description may be based on data collected as average data or at the beginning or end of the service life. The reference in-use achieving the following, where relevant: • declared product properties (at the shop gate) and those of any finishes, etc.; • appropriate requirements and application codes; • building orientation, shading, temperature
Selection of Data	Both standards require • Specific data (primary data) to be used for at least the main unit processes. • Generic and proxy data may be used for processes; including upstream and downstream processes. • Data sets used for calculations shall be valid for the current year and represent a reference year within 10 years for generic data and 5 years for producer specific data. Deviations shall be specified. • The technological and geographical coverage shall reflect the physical reality for the declared product or product group by as far as possible. EN 15804+A2 requires the documentation format and data sets for the LC inventory data used in the LCA modelling in alignment of current ILCD format and nomenclature. ISO 21930 additionally states: • Time period over which inputs to and outputs from the system shall be accounted for is 100 years from the year for which the data set is deemed representative; a longer time period shall be used if relevant and shall be justified.

Aspect	Findings of the comparison between EN 15084+A2 and ISO 21930
	• Emissions from a landfill should be accumulated over 100 years after the material was deposited on or in the landfill. With regards to the objective of developing generic data, the term 'primary data' will be interpreted as the acquisition of data specific to the production process(es) covered but obtained from industry-provided data sources (e.g., industry association reports or similar, preferred) or literature, not primary data from individual manufacturers.
Criteria for the exclusion of inputs and outputs	Both standards require: • All inputs and outputs shall be included, data gaps may be filled by conservation assumptions with average or generic data. • The cut off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process. • The total neglected input flows shall be maximum of 5% of energy use and mass ISO 21930 additionally allows for environmental impact to be used as a measurement unit for excluded flows. However, only energy use and mass are selected criteria for this methodology. Both standards state that particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this standard.
Scenarios	Both standards require the scenarios (e.g., for the use or end-of-life stage) to be realistic and be representative of one of the most likely alternatives. Also, more than one scenario can be assessed, and scenarios shall not include processes or procedures that are not in current use, or which have not been demonstrated to be practical.
General allocation	Both standards require: • The use of upstream data, which does not respect the allocation principles described in this standard shall be clearly stated and justified in the project report. These data shall be in line with ISO 14044 allocation rules. • Irrespective of the allocation approach chosen for a co-production process or for secondary flows crossing the system boundary between product systems, specific inherent properties of such co-products or flows, for example calorific content, composition (biogenic carbon content, $CaO/Ca(OH)_2$ content, etc.), shall not be allocated but always reflect the physical flows. • Avoided impacts from allocated co-products shall not be included in Module D. Further ISO 21930 requires that allocation to co-products shall respect the main purpose of the processes studied, allocating all relevant products and functions appropriately. The purpose of a plant and therefore of the related processes needs to be generally declared in its permit and shall be considered, to avoid disproportionate allocation of impacts to co-products. With regards to the objective of developing generic data, these provisions, specifically regarding the coverage of specific plants, representative descriptions of plants will be used, but single production facilities will not be referenced.
Co-Product Allocation	Co-Product Allocation refers to a joint co-production process, where the production of two products is inevitably linked and cannot be separated further. Both standards allow: • Allocation based on physical properties (e.g., mass, volume) when the difference in revenue from the co-products is low. • In all other cases, where no relevant underlying physical relationships can be identified, economic allocation should be used. EN 15804+A2 asks for economic allocation as the default approach. For consistency purposes, economic allocation is used in all default case, while exceptions may be defined explicitly. For co-products with high value such as steel and silicon, the impact allocation to low-value co-products used in cement and concrete may be omitted as a conservative choice, while economic allocation is required for the low-value product (as specified by ECO Platform Calculation Rules). This implies that methods like physical allocation or system expansion shall not be used for these low-value co-products. Example: Economic allocation should be used for co-products from processes like steel production, electricity generation, silicon metal and ferro-silicon alloys production, and aluminum-oxide-containing sources, regardless of the contribution of these co-products to the overall revenue (even if below 1%), while allocation may be omitted for the high-value co-product. Market prices, averaged over a specified period as per ISO 14044 Amd2:2020, shall be used for this purpose.
Allocation between product systems	EN 15804+A2 states that flows leaving the system at the end-of-waste boundary of the production state (A1-A3) shall be allocated as co-products. Loads and benefits from allocated co-products shall not be declared in Module D. The output of waste during this life cycle stage may reach the end-of-waste state when it complies with the conditions described in EN 15804 Section 6.3.5.5, end-of-life stage. Flows are then allocated as co-products as EN 15804 Section 6.4.3.2.

Aspect	Findings of the comparison between EN 15084+A2 and ISO 21930
(across the system boundary)	ISO 21930 states that no burdens are allocated across the system boundary with secondary material, secondary fuel, or recovered energy flows arising from waste. Recovery processes carry no allocated burdens and have no impact when they cross the system boundary between product systems and there is no allocation of impacts away from the studied product system to any wastes that are reused, recycled or recovered for use in subsequent product systems. As no allocation would be the conservative approach, ISO 21930 is followed in this case. This is also consistent with economic allocation with 0 price allocated to waste as a by-product.
Secondary material	Both standards require: • Secondary material to be measured at the point where the secondary material enters the system from another system. • Materials recovered from previous use or from waste from one product system and used as an input in the product system under assessment are secondary materials.
Secondary Fuel:	Both standards have same requirements with modelling of secondary fuel as follows: • Processes providing a secondary fuel are considered from the point where the secondary fuel enters the system from the previous system. • Any combustible material recovered from previous use or from waste from the previous product system and used as a fuel in the assessed system is a secondary fuel. • Waste from the product system that is going to combustion is not considered secondary fuel.
Biogenic Carbon	Both the standards state: • The biogenic carbon content shall be declared separately for the product and for any accompanying packaging. • Biogenic carbon contained in material leaving the product system shall be declared. • Quantity of removals of biogenic carbon within declared unit shall be documented at the EoL stage. • Additionally, ISO 21930 suggests for wood, biogenic carbon may be characterized with a -1 kg CO_2e/kg CO_2 biogenic carbon flow when entering the product system only when the wood originates from sustainably managed forests. With regards to the objective of developing generic data, assumptions on the use of wood from sustainably managed forests will be made per dataset. These assumptions will be made with regards to geography, share of wood from sustainably managed forests and other relevant parameters. The reference will be the assumption of sustainably managed forests with a rationale provided and any deviation from that will be maintained in a dedicated chapter of the final project report.
Carbonation	ISO 21930 suggests: • Environmental impacts considered during the production, use and end-of-life stages shall include carbonation. • Quantification of carbonation as part of the GWP shall be based on recognized methods for the calculation of carbonation and the underlying methodology shall be referenced in the project report and results interpreted with respect to uncertainty of calculations.
Accounting of delayed emissions	Both standards do not allow for the accounting of delayed emissions.
Greenhouse gas emissions from land-use change	ISO 21930 states that: • When significant, GHG emissions occurring as a result of land-use change shall be included in the quantification of the GWP. • This contribution to GWP shall be declared separately, including a short interpretation of the data. • Wood from sustainably managed forests may be accounted for as having zero emissions concerning land use change. EN 15804+A2 requires the declaration of GWP from land use and land use change (LULUC) as a sub-indicator of Global Warming Potential, contributing to GWP (total).
Carbon offsets	EN 15804+A2 exclusively states that carbon offsets shall not be included.

To ensure compliance of the LCA datasets with EN 15804+A2 and ISO 21930, the following rules have been defined:

2.2 SPECIAL CONSIDERATIONS WHEN APPLYING THE STANDARDS TO GENERIC DATA

Both ISO 21930 and EN 15804 target describing the development of data that is specific to dedicated products from dedicated manufacturers. As such, the application of these standards in the development of generic data requires additional considerations:

- *Non-inclusion of information that is available only in specific product cases*
  Some data that area required by the standards to be disclosed in EPD are applicable to specific product situations only. Such data will not be declared for generic data. Examples for these are the declaration of hazardous substances or Substances of Very High Concern (SVHC) that cannot be declared consistently on the level of generic data. Particularly, and declaration of such substances contained in products would presume the presence of these in all products of a category per-se. In addition, it might be misunderstood towards the secured absence of other hazardous substances in that product category.
- *Non-use of market-based approaches*
  Within the scope of both standards, and with the application being specified by ECO Platform, the use of market-based mechanisms to account for green energy supply is permitted for EPDs. Including such market-based mechanisms is based on the registration and cancelling of Guarantees of Origin (GO) in respective, regulated registries. As the application of green energy supply associated with the applicable GOs conflicts with the understanding of average or representative data for products on the market (GOs are deliberately a mechanism to separate a defined energy supply from the market average). As such, the use of market-based mechanisms is not available for generic data. Moreover, generic data is developed using the representative average energy supply, covering all products using the average grid mix, products using green energy and products using the residual (non-renewable) energy mix.
- *Non-use of Chain-of-Custody-based mechanisms*
  Any information or data requiring an established chain of custody for tracking, such as book-and-claim methods (as defined in ISO 22095), particularly Mass Balance Attribution, cannot be used in connection with generic data, as the application of the appropriate chain of custody mechanisms cannot be guaranteed. This does not apply to safeguarding mechanisms or responsibilities of manufacturers based on existing regulations in a certain region. In such cases and unless known to be unused or not applied in general, regulated obligations of manufacturers should be assumed to be in place. Examples might be the absence of restricted substances in products or the application of certain exhaust filtering mechanisms.

2.3 SYSTEM BOUNDARY

The scope of the database generally covers the entire life cycle of the products and building materials covered. This may be covered by either providing data for a certain material for all relevant life cycle stages or information modules, or by providing data for the manufacturing stage (modules A1-A3, 'cradle-to-gate') for a certain material only, with additional generic data to be provided to cover additional modules through the end-user of the database. The supply of data for the manufacturing stage and for other life cycle stages or information modules may be conducted in separate work items.

The comprehensive scope of the database requires thorough consideration as to how to ensure complete coverage. While it is evident that for any building material, the manufacturing stage ('cradle-to-gate', information modules A1-A3 as in EN 15804+A2/ISO 21930) needs to be covered, a broad range of use stage scenarios can be described only on the level of the construction works. For the End-of-Life (EoL) stage, including benefits and loads beyond the immediate system boundary (information modules C1-C4, D), the availability of dedicated datasets per building material is beneficial from the perspective of construction works-level LCA automation. However, the actual, i.e., the most plausible, EoL scenario for a given material, in a given geographical context is generally defined best in the context of the construction works and may deviate from any 'default-per-material' EoL scenario. As such, the definition of a set of default scenarios covering the most relevant EoL routes for the given range of building materials and differentiated by region is a valid initial approach to account for the EoL of building materials in the database.

As such, the primary system boundary for the generic LCA datasets is "cradle-to- gate". This means that all processes, material, and energy flows from raw material extraction (cradle) to the finished product at the manufacturing gate (in the case of regional production), respectively at a default 'delivery gate' in the case of imported materials are included. This includes packaging of the material at-gate.

Note: the manufacturing datasets are generally representative of the consumption in the respective region. For intra-regional production, this is accounted for as 'at-gate', while any imported materials account for the transport of the manufactured product from the manufacturing region to the consuming region, using default values as specified in APPENDIX D.

With the aim of supporting the appropriate utilization of EoL scenario datasets for any given material, specific parameters of relevance for selecting and/or adjusting the appropriate dataset for EoL will be provided with the manufacturing datasets, if appropriate. Such parameters will be defined in detail and include shares/quantities of secondary raw materials used in the product, and biogenic carbon content in the product. Generic datasets to cover EoL scenarios for the different material categories should cover, as a minimum, recycling routes, incineration with and/or without energy recovery, and landfilling. Additionally, generic datasets covering the deconstruction and disassembly processes in module C1 may be required. Such EoL datasets need to be sufficiently generic to allow the user of the data to describe a specific EoL for materials in the context of their actual use in the building or construction works.

In subsequent work, the scope of work for EoL scenario data may be extended to provide EoL datasets for all building materials covered in the database. Also, in further database development steps, it may be advisable to explore in greater detail the need and options to provide scenario datasets for the use stage as well.

2.4 DECLARED UNIT, REFERENCE FLOW AND DELIVERY GATE

The dataset covers the consumption mix in the reference regions. This causes the cradle-to-gate boundary of the datasets to become a "cradle-to-distribution-gate". Transport of products to the consumption market will hence be considered as part of the A3 module. This is consistent with the expectation that a typical user of the data will select the consumption market rather than the production region.

As the core manufacturing datasets cover the manufacturing up to the manufacturing gate, the concept of the declared unit is used to define reference flows. As commonly accepted for cradle-to-gate assessments (see "GHG Protocol Product Standard" (GHG Protocol, 2011) and others), the reference flow of *1 kg of the given product* is used. By default, and only with deviation in certain exceptions, *1 kg of packaged product* is the declared unit, where 1 kg is the net weight of the packaged product without packaging. Consequently, the packaging adds to the 1 kg net weight.

Note: in some cases, the declared unit of 1 kg packaged product represents the gross weight of product AND packaging. Users of the models are advised to validate the definition of the declared unit for each model individually.

Conversion factors are required to be supplied for products which are commonly declared on a piece, area, length, or volume basis. This includes the need for additional material information such as moisture content; for example, for timber, it will need to say 1 kg at 400 kg/m^3 and 12% moisture content. In cases where the declared unit is not mass, the conversion factor to 1 kg must be provided.

The reference flow is the amount of the building material on which the results are based. In this database, all results are by default valid for one kilogram of a product plus the associated product packaging, while exceptions may apply. Relevant material specifications and conversion factors that are needed to allow for scaling, such as density or thickness, are provided in the dataset documentation.

2.5 REPRESENTATIVENESS

The generic datasets are required to approximate market average consumption of any material that a dataset is developed for. It needs to be recognized that such data is imminently less accurate as

manufacturer-specific data provided in EPDs for instance, as it is required to cover average market situations and approximate shares of production technologies, transport distances, energy supply in production or imports into a region.

For generic data to be developed, the representativeness of the underlying literature data is evaluated during the process of data collection – see section 2.11 for the description of the scheme to assess data quality for information used in the LCA.

Relevant information regarding temporal, technological, and geographical coverage of the generic dataset is provided as part of the dataset documentation. These data allow users of the data to conduct the assessment of the representativeness of the generic data used in the context of the specific study.

It should be noted that on the level of a construction works assessment, the representativeness indicators need to be estimated for an active study using the generic data.

TEMPORAL

Foreground data are intended to represent the most recent calendar year. For developing generic datasets, the use of data from different years is deemed acceptable to some extent, as the represented average is expected to shift gradually only, which makes the use of data from multiple years acceptable. When using such data from different time spans, it needs to be secured that the data is still representative regarding e.g. technology shifts over time or shifting energy supply over time.

Background data should be as recent as possible, as defined by the data quality requirements in section 2.11.

GEOGRAPHICAL

Foreground data are intended to represent the production of the specified region and/or the production in these regions where major imports are coming from. Consumption mixes covering several regional productions, plus transport to the region of consumption are foreseen and expected to provide a sufficient level of geographical representativeness. For defining representative consumption mixes, a mix of up to three independent supply chains (differentiating either manufacturing technology and/or manufacturing regions) at maximum is deemed to be sufficient. The selection of supply chains should be based on each share of consumption. Less than three supply chains can be selected, if a total of approx. 80% of consumption are represented by less than three supply chains.

Background data are intended to represent the typical regions of sourcing, which may be domestic or international. A case-by-case assessment and decision is required for the selection of an existing background dataset or the adaptation of available data for improved accuracy. As the distinction between foreground and background data is less obvious in the case of developing generic data (manufacturers may follow different approaches to procuring or manufacturing precursors or components), reasonable judgements are required in the data development process.

TECHNOLOGICAL

Foreground data are intended to represent the technology mix as consumed within the specified region. Background data are intended to represent the technology mixes utilized within the sourcing regions. It should be noted that geographical and technological representativeness are in some cases inter-connected, e.g., when different manufacturing technologies are employed in the different regions.

2.6 ENVIRONMENTAL IMPACT INDICATORS

The environmental impacts selected align with ISO 21930 and EN 15804, requiring the use of the indicators defined in EN 15804 and TRACI 2.1 characterization methods for Europe and North America, respectively. Additional indicators for resource use, waste, output flows, and biogenic carbon content encompass both EN 15804+A2 and ISO 21930 requirements. Additionally, IPCC AR6

GWP100 results are reported to allow for comparisons internationally, as EN 15804 currently references EF 3.1[1] and TRACI references an earlier version of IPCC: AR4.

2.7 BIOGENIC CARBON

Within the EN 15804 impact assessment methodology, biogenic carbon is accounted for separately from fossil-based climate change. TRACI and IPCC AR6 GWP values are reported without any specification of biogenic carbon. Indicators on biogenic carbon uptakes and emissions are also reported, per ISO 21930 requirements. Finally, all biogenic carbon emissions from waste during manufacturing are assumed to be released, regardless of waste treatment method.

For any material, the dataset will report on the content of biogenic carbon in the product in [kg C and kg CO_2 / kg product] and packaging in [kg C and kg CO_2 / kg packaging] in two separate numbers. Since the default data covers cradle-to-gate, this is needed to properly handle carbon content further into the later life cycle stages.

In cases where economic allocation is applied to biogenic products, the values for the indicator $GWP_{biogenic}$ that report the uptake of biogenic carbon diverges from the biogenic carbon content in the allocated co-products. In these cases, a correction of the indicator $GWP_{biogenic}$ is required to ensure that the uptake of biogenic C corresponds to the biogenic carbon content in the product. Consistency in the biogenic carbon balance of a product is the paramount objective.

Note: for data covering the entire life cycle of a product, or dedicated end-of-life data for a certain product, combined with information on the biogenic carbon content of a product, the balance of elementary biogenic carbon (measured in [kg C]) must be closed, i.e. equals zero. For the indicator $GWP_{biogenic}$, however, this is not necessarily the case, as depending on the end-of-life route, some biogenic C may be converted into other C-containing emissions such as Methane (CH_4) which has a GWP characterization factor different from 1. Usually, the resulting values for $GWP_{biogenic}$ are >0 and are typically small, relative to the $GWP_{biogenic}$ in the A1-A3 data.

2.8 SECONDARY MATERIAL

Per EN 15804+A2 and ISO 21930, secondary material is measured at the point where the secondary material enters the system from another system and does not consider any upstream burdens. This is commonly referred to as the cut-off approach within LCA. By all means, the treatment of secondary material input to the production and the output of waste from the production stage needs to follow consistent calculation rules. The distinction of the processes associated with the previous product system and the product system under assessment should generally follow the concept of "End-of-Waste Status", as defined by the European Commission. While the precise definition of this End-of-Waste Status may be difficult to find, it generally follows the rule that if a waste is sold at a price, to be included in another product system, the End-of-Waste Status can be considered reached at the point of sale.

Note that the European Commission has defined and is in the process of defining specific criteria to identify the End-of-Waste Status for dedicated material categories. In case of doubt, such definition should be consulted, while its application is not mandatory in the scope of this methodology.

Additionally, no environmental credits are given for the recovery of materials or energy. Generic data can only consider a market average content of secondary material. Specific producer-related choices of buying material with higher secondary material content cannot be covered.

2.9 CUT-OFF RULES

In general, all inputs and outputs need to be included to ensure a complete assessment. As it is not possible to cover all materials, the following flows can be excluded ("cut-off") from the analysis, if no exact data can be found:

[1] Note: EN 15804+A2 contains a mechanism that permits the adoption of future revisions of the characterization model EF 3.1. As the characterization model may be updated in the future, special care in the maintenance and the continued development of the database is advised. It is recommended to review the impact of all updates and to decide about required updates and the process of existing datasets on a case-by-case basis.

- Renewable and non-renewable primary energy usage of up to 1% of total energy consumption
- Input flows of up to 1% of the total input mass[2]

In total, the sum of all excluded flows should stay below 5% of all energy use or input mass.

According to EN 15804+A2, "particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil". A similar statement is made in ISO 21930.

Note: If the unknown flow accumulates to more than 1%, the flow must be handled according to the procedures described in Section 3.6.

For the development of datasets, the following flows are cut-off from the system, due to their expected low relevance for the results:

- Infrastructure, such as factory construction, road wear, electricity grid usage, etc.
- Catalysts and enzymes used in the manufacturing steps, except when known to be complex and deemed significant for the environmental impact.
- Packaging material for the supply of raw materials, except where deemed significant for the environmental impact, based on LCA expert judgement. (Note: Packaging of the product is included in the calculation.)

Note: Background datasets may include infrastructure processes even where foreground infrastructure is excluded. The inclusion status and quantitative relevance of infrastructure in each selected background dataset shall be checked and documented. Where infrastructure cannot be separated without compromising dataset integrity, the deviation from the foreground cut-off rule shall be disclosed and assessed for consistency and materiality.

2.10 ALLOCATION

Co-product allocation follows the requirements of EN 15804+A2 and ISO 21930, with consideration of specific industry practices. In general, these standards state that co-product allocation, if unavoidable, should be based on physical properties. However, if the difference in revenue of the co-products is significant, economic allocation should be used.

Both standards permit economic allocation as the basis of partitioning the system to accommodate product-specific data and impact assessment. However, when compared (see 'allocation' in section 2.1) there are differences in defining by-products and consideration of waste flows in the system.

Thus, to streamline the approach, economic allocation will be predominantly applied, as the importance of by-products must be acknowledged irrespective of their economic value relative to the main product.

Waste flows leaving the manufacturing stage will be treated either as waste flow leaving the product system at the end-of-waste-state, or as a co-product with economic allocation with an allocated zero price value, which will be consistent with the ISO 21930 requirements as well.

Specifically, regarding co-products with high value such as electricity, steel and silicon, the impact allocation to low-value co-products used in cement and concrete may be omitted as a conservative choice, while economic allocation is always required for the low-value product (as specified by ECO Platform Calculation Rules, avoiding that the application of a cut-off rule might result in an emission deficit through inconsistent allocation). This rule is paramount to potentially conflicting rules in any PCR. If, for certain product categories, allocation schemes have been agreed and defined in respective c-PCR documents that are published as EN standards (particularly if such a c-PCR is part of a European harmonized Technical Specification under the EU Construction Products Regulation, CPR), the adoption of such allocation rules should be the first choice and will be evaluated and, in case of doubt or conflicting provisions, agreed with the ODCi Steering Committee. Doing so may be

[2] This is expanded to a general 1% cut-off rule. In EN 15804 this 1% cut-off only relates to insufficient data or data gaps.

of particular relevance, as certain allocation schemes may be subject to agreement (e.g., between involved industries) rather than being justified from a scientific perspective.

2.11 DATA QUALITY ASSESSMENT

Data quality criteria are defined by the UN Environment Global Guidance on LCA database development an in EN 15941, referring to EN 15804. These standards provide guidance on addressing data quality for EPDs which are product specific. These data quality assessments are available for assessing the quality of data in the context of a specific LCA calculation situation, respectively to assess the quality of data used for the calculation of a specific EPD. For generic datasets, in contrast, the assessment of the data quality is not possible to this extent, as no reference can be made to a specific situation to be approximated. Consequently, the dataset documentation will be required to provide the information required to assess the quality (and applicability) of the data in a specific modelling situation.

Additionally, and targeting the estimation of the quality of the generic datasets as such, focus lies on the estimation of the quality of the information used to develop the generic datasets. The data and information used for modelling the generic data is assessed on the scale of very poor to very good in terms of 3 scopes: technical, geographical, and temporal scope represented by each individual dataset. The aim for all data is to meet the level of "very good."

Table 2: Data Quality Assessment Guidance

Quality level	Source type	Description	Technical scope	Geographical scope	Time scope
Very good	Statistics	Periodically updated, transparent methodology, region specific	Data from processes and products under study.	Average for whole region	< 3 years
Good	EPDs and Datasets, Audited information (e.g. company reports)	Transparent, verified, product specific, LCA specific	Data from processes and products under study (with similar technology)	one datapoint from the region	< 6 years
Fair	Peer reviewed studies, technical sheets	Reviewed, could be too specific	Data from processes and products under study but from different technology	Proxy region	< 10 years
Poor	Grey literature	Mostly not externally reviewed	Data on related processes or products	Global datapoint	< 15 years
Very poor	Other	Sources like homepages etc.	Data on related processes but with a different scale or from different technology	Data from unknown or distinctly different area	> 15 years or unknown

Table 2 will be used as guidance for understanding, analyzing and reporting the data quality of the data inventory developed for each dataset.

2.12 UNCERTAINTY

Uncertainty is not assessed by means of a quantitative measure. The evaluation and understanding of uncertainty is supported by the modelling and disclosure of scenarios for each dataset that indicate the range of impact assessment results for a certain material in a given region. These scenarios are detailed in section 2.13 below.

2.13 SCENARIOS

Aiming to inform the user about the potential range of impact indicator results for a particular material in a given region, and to provide an indication of potential uncertainty, each dataset is represented through three scenarios.

The core dataset result is the "*typical*" scenario, representing the manufacturing situation that can be considered representative of the technologies and supply chains mostly used. This is intentionally not denoted as "average" as the quantitative evidence of a mean value cannot be secured with reasonable effort (or not at all due to lack of data) for generic LCA datasets.

The additional two scenarios that are calculated, analyzed and reported are:

1. The "*low*" scenario representing a parameter setting that is expected to result in low environmental impacts (i.e. good environmental performance), and
2. The "*high*" scenario representing a parameter setting that is expected to result in high environmental impacts (i.e. poor environmental performance) relative to the typical scenario.

The selection and ranges of parameters are derived from identifying the main parameters that drive the environmental impact of that material. While research focus should lie on the three most relevant parameters driving environmental impact, for certain materials the data research may lead to conclusions to select more or less driving parameters. For these parameters, the maximum and minimum numbers within the range of typically on the market available products are used to derive the *high* and the *low* scenarios. Emphasis should lie on identifying 'realistic min-/max-values' that reflect products actually available on the market as a mass product, not in selecting theoretical extremes without relevance on the market of this product.

In the definition of the values for the *high* and *low* scenarios, main attention should be given to the resulting impact in Global Warming Potential. It should be noted however that a high value for GWP does not necessarily correspond to the highest value in another impact category in the same scenario. The selection of parameters or the approach to conclude on the range of values per parameter are intentionally not defined in more detail or based on statistical distributions, as this is highly dependent on the type of material, region and manufacturing characteristics. The rationale of defining these scenarios needs to be subject to the data development's quality assurance and third-party verification mechanisms.

In the following, the logic of the scenario setup using the example of cement is depicted:

As main drivers of environmental performance the energy demand of clinker production, mainly impacted by the production technology (wet/dry) was identified, also the fuel mix for heat production in clinker production, including definition of non-primary fuel as waste or secondary fuel. Finally, the cement to clinker ratio was found to be relevant.

For the *high* scenario of clinker production, a high energy demand and carbon-heavy energy supply was assumed. For the clinker production's *low* scenario, a low energy demand and a less carbon-intensive energy supply was assumed. The clinker datasets of high impact were used for the cement data-scenarios with high clinker content (*high* scenarios for cement) and vice versa for *low* and *typical* dataset scenarios.

The following shares were chosen for the clinker production scenarios:

(see also section 3.3 with regards to the rationale behind these numbers)

2.14 USE OF SPECIFIC PRODUCT CATEGORY RULES

As numerous Product Category Rules (PCR) have been developed over the last years by different organizations and stakeholders, specific rules for the calculation of LCAs may be available for use. Specifically, complementary PCRs (c-PCR) have been developed by EPD Program Operators both, in North America and Europe. In addition, c-PCRs are under development by Technical Committees of the European standardization body CEN as part of the revision of European harmonized Technical Specifications (hEN). Any such PCRs may serve as reference while developing LCA data for the respective building materials. Available PCRs will have to be reviewed as the initial step of developing data for a product category. Review criteria are:

- Consistency of provisions in the PCR with the rules provided herein;
- Compliance with the underlying standards;
- Applicability of the provisions in the PCR for the specific building material or group thereof in view.

If such PCRs provide additional specifications or more detailed provisions, these will be applied in the best possible way and deviations and inconsistencies will be outlined in the project report, detailing the foundation for modelling work of the respective product category. Particular care will be given to aspects that are or may be subject to debate, securing consistency with the provisions specified in this document.

2.15 SPECIFIC GUIDANCE FOR INVENTORY INDICATORS

Implementation of inventory indicators is done in a way to ensure that calculation of resource use, waste, output flows, and carbon emissions and removals indicators conforms with EN 15804 and ISO 21930 requirements. For alignment with ISO 21930 requirements, the ACLCA Guidance is used as a reference.[3]

The table below details the indicators reported and what the scope of indicator coverage is in the case of cradle-to-gate datasets, covering information modules A1-A3.

Reporting of carbon emissions and removals is simplified to align with both EN 15804 and ISO 21930 requirements. Biogenic carbon in product and packaging are reported separately, as are emissions of carbon dioxide from combustion of renewable and non-renewable waste. Carbon emissions from calcination are also reported. ISO 21930 requires reporting of carbonation carbon removals if included in the GWP, however carbonation activities occur outside of A1-A3 and therefore carbonation carbon removals are not relevant for the cradle-to-gate datasets.

Note: for data covering other modules beyond A1-A3, such as use stage or end-of-life stages, the implementation may differ from what is described in this section. Example: for products reaching the end-of-life stage and intended to go to incineration, the energy content of the product would be reported as "Use of (non-/) renewable primary energy as energy carrier" in data reflecting the end-of-life stage.

Table 3: EN 15084 and ISO 21930 Inventory Metrics Included in Cradle-to-Gate Datasets

Indicator	Implementation*
Use of renewable primary energy as energy carrier (PERE)	Background data
Use of renewable primary energy resources used as raw materials (PERM)	Foreground data – calculated based on energy content of raw materials + packaging
Total use of renewable primary energy (PERT)	Foreground + background data PERE + PERM
Use of non renewable primary energy as energy carrier (PENRE)	Background data

[3] ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017, May 2019, https://aclca.org/wp-content/uploads/ISO-21930-Final.pdf

Indicator	Implementation*
Use of non renewable primary energy resources used as raw materials (PENRM)	Foreground data – calculated based on energy content of raw materials + packaging
Total use of non renewable primary energy resource (PENRT)	Foreground + background data – PENRE + PENRM
Use of secondary material (SM)	Foreground data – calculated based on secondary content of raw materials + packaging
Use of renewable secondary fuels (RSF)	Foreground data – calculated based on energy content of secondary fuels used in manufacturing
Use of non renewable secondary fuels (NRSF)	Foreground data – calculated based on energy content of secondary fuels used in manufacturing
Recovered Energy (RE)	Foreground data – calculated based on energy quantity imported to the product system for manufacturing
Net use of fresh water (FW)	Background data
Hazardous waste disposed (HWD)	Background data
Non hazardous waste disposed (NHWD)	Background data
Radioactive waste disposed (RWD)	Background data
High-level radioactive waste, conditioned, to final repository (HLRW) [kg]	Background data
Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW) [kg]	Background data
Components for re-use (CRU)	Foreground data – calculated based on quantity of components from manufacturing collected for reuse
Materials for recycling (MFR)	Foreground data – calculated based on quantity of material from manufacturing sent to recycling
Materials for energy recovery (MER)	Foreground data – calculated based on quantity of material from manufacturing sent to energy recovery facility
Exported electrical energy (EEE)	Foreground data – calculated based on energy quantity exported from manufacturing to outside the product system
Exported thermal energy (EET)	Foreground data – calculated based on energy quantity exported from manufacturing to outside the product system
Biogenic carbon in product	Foreground data – calculated based on biogenic carbon content in raw materials
Biogenic carbon in packaging	Foreground data – calculated based on biogenic carbon content in packaging materials
Biogenic carbon emission from renewable waste combustion	Foreground data – calculated from carbon dioxide emissions from waste combustion in manufacturing
Calcination carbon emissions	Foreground + background data – calculated from carbon dioxide emissions from calcination processes
Carbon emission from non-renewable waste combustion	Foreground data - calculated from carbon dioxide emissions from waste combustion in manufacturing

* Note: the actual implementation needs to be validated in view of the actual background database used. The implementation notice in this table is based on assumptions on how the indicators can be covered both in the foreground model and in background data.

Background data in this case means that the elementary flows required to calculate the indicator are contained in, or can be transparently derived from, the selected upstream datasets. Before use, completeness of the relevant flows, units, classifications and characterization mappings shall be verified; missing flows shall be added only from documented, methodologically compatible sources and shall be subject to QA.

The indicators

- Components for Re-Use (CRU),

- Materials For Recycling (MFR),
- Materials for Energy Recovery (MER),
- Exported Energy, Electric (EEE),
- Exported Energy, Thermal (EET)

are – for the purpose of providing generic datasets for modules A1-A3 – limited to results from the manufacturing stage in module A3. As such, by default for cradle-to-gate datasets, they will have a value of zero and will be reported with another number only if explicit information is available for calculation at the final material production stage or unit process data in A3. Note that this approach may be different from EPDs, where specific information on specific supply chains may be relevant. It should also be clear that these indicators are likely to have results associated with information modules of the End-of-Life Stage.

3. PRINCIPLES OF DATA DEVELOPMENT

This section documents the boundary conditions and key principles to be applied for setting up the LCI models of the building materials. The aim is to help data users to better understand the background and framework conditions to better use the datasets in building LCA models.

3.1 FOREGROUND DATA

Foreground data is defined as the specific or primary data that would typically be supplied by the manufacturer in an EPD, but in this case is obtained through existing literature review. It should represent the technology mix used in the specified region and be as recent as possible and be documented with the appropriate references. As part of the data collection process, a quality rating scheme for literature sources is used, helping to estimate the quality of the information used.

The datasets will represent consumption mixes for the respective regions, accounting for main imports as well as the major regional production. To support this, trade statistics are used.

1.1 SELECTION OF BACKGROUND DATA

Background data used for the development of generic datasets are required to support the development of data in line with the requirements specified in this document. In particular, this means that the methodological provisions of EN 15804+A2 and ISO 21930 need to be supported by the background database. Also, all environmental indicators specified in either of these two standards need to be supported by the database.

For any data development package, the background database shall be selected and documented before modelling starts. The selection shall be based on: methodological compatibility with EN 15804+A2 and ISO 21930; coverage of all required LCIA and inventory indicators; transparent system models, allocation rules and cut-off provisions; sufficient geographical, technological and temporal representativeness; availability of unit-process or sufficiently documented aggregated data; consistent elementary-flow mapping and units; documented data quality and uncertainty; reproducible versioning; interoperability with the selected modelling software and exchange formats; and license terms (either default terms or as a dedicated agreement) that permit the intended modelling, review, publication and long-term maintenance. If more than one database meets these criteria, the selection and reasons for preferring one source shall be recorded in the project documentation. If no data source meets all criteria comprehensively, deviations from these criteria shall be assessed, evaluated, and any decision documented. Note that the availability of license terms that permit the use of the data for the purpose of ODCi are non-negotiable and cannot be compromised. The modelling software and any supporting platform shall be documented separately and shall not determine the methodological requirements.

The selected background database shall be applied consistently across the data-development package. For every connected background dataset, system boundaries, reference product, declared unit, transport coverage and infrastructure inclusion must be reviewed. Transport (or other flows) already included in upstream datasets cannot be covered twice (in the background model and in the foreground modelling), while required flows shall not be omitted (not be left out both in the foreground model and in the background data). Both internal QA and the third-party verification shall use the documentation of the selected background database and consider the database-related aspects.

RAW MATERIALS

Upstream raw material production should represent the geographical scope from which the raw material is most commonly purchased. For the purpose of generic data development, however, main focus is laid on using available data from background database(s). It may or may not match the region of production for the finished product, and the individual decision on data should balance between availability of data, resulting data quality, potential adverse impact on the estimation accuracy of environmental impact, and effort required for the modelling. Datasets should represent

the technology predominantly used, or a mix of technologies where appropriate, and ideally be less than three years old, as compared to the reference year of the material entry.

Data availability by region and technology varies across background LCI databases. The following hierarchy should be followed when selecting upstream datasets.

1. The database's license requirements must provide the grounds for using the background data in the context of ODCi, the data and models being permitted to be disclosed to stakeholders, results be published, resulting data permitted to be used for various purposes incl. LCA of construction works.
2. If the required dataset is available for all or multiple countries within the region, then a weighted average will be used, based on
    a. production data, or
    b. population.
3. If the required dataset is available for only one country within a region, then that dataset will be selected.
4. If the required dataset is unavailable for any country within the region, the following options may be used, listed in order of preference:
    a. Comparable country/region dataset based on either,
        1) Technology,
        2) Electricity grid mix – if electricity intensive process, or
        3) Geography;
    b. Global average dataset;
    c. Dataset that reflects a conservative approximation.

Note that some materials may be better considered as global commodities, such as select metals, which may influence dataset selection.

INFORMATION ON TRADE BETWEEN REGIONS AS A DATA SOURCE

During the research for foreground data, statistics on trade quantities and production volumes related to the different regions are used. These data support the understanding of the origin(s) of the major quantities for the product in view. The modelling of the foreground data will then be made accordingly. For example, if the majority of a certain building material consumed in region A is produced in region B (e.g. production in Asia, consumption in South America), the production data and modelling needs to reflect this, including the transport required to deliver the required consumption mix for the building material. For generic data development, the UN Comtrade database[4] has been referenced, as it has a repository of official international trade statistics and relevant analytical tables, providing access to detailed global trade data.

3.2 UTILITIES

If no regional dataset for supply of electricity, thermal energy or water is available, a representative regional average will be created and used as the best estimate. See Section 3.7 for details on the regional definitions. The results of those datasets will be mixed based on their respective energy generation, material specific production mix, or population numbers, to estimate the missing regional dataset. By default, average location-based consumption mix data will be developed or used for utilities such as energy, including both the renewable energy consumption and the residual energy consumption will be used – consistently to the ECO Platform rule that if an EPD Program Operator decides not to allow accounting for green energy, all data are required to use location-based consumption mix data.

Note: Regional averages may be limited by the availability of country-specific datasets within that region, potentially resulting in the need for approximations with best-matching proxy data/datasets.

[4] Source: UN Comtrade Database: A global trade data platform https://comtradeplus.un.org/

Table 4: Dataset selection hierarchy

Utility	Dataset selection hierarchy
Electricity	Create regional average mix, based on the production mix of the building material in the region and available country-specific datasets. Create regional average mix, based on the available country-specific datasets and those countries' respective electricity production totals. Residual energy mix will not be used to avoid double counting and inconsistencies arising from the concurrent use of location-based and market-based methods.
Thermal energy	Mix is dependent on the region and technology used for each product. Where no data exists, use thermal energy mix for region. Average 'district or industrial' thermal energy mix for region is based on fuel type and production total for all countries within the region. This is limited by available country-specific datasets.
Water	Regionalized flows/exchanges to be used where available, ensuring water deprivation potential is correctly captured. Upstream energy for water treatment and pumping should be representative of the regional mix identified previously.

USE OF SECONDARY FUELS AS INPUT IN MANUFACTURING

If renewable secondary fuels are used in the manufacturing of the product, such as waste wood as fuel, the following rules apply (Note: these rules are already defined in this document and are consolidated for this specific case/in this specific section for clarification):

- The biogenic C balance must be closed for secondary renewable materials, used as fuel.
- Renewable secondary fuels must have the biogenic C-uptake as negative emission, and the emission is accounted for in the incineration of the fuel.

  Rationale for this: when renewable materials come from non-sustainable management regimes, the requirement to account for that in the C-balance (then it cannot be closed) is handled in the 'first' life cycle, but the material comes into our life cycle with sequestered biogenic carbon, requiring the biogenic C balance to be closed.

  Note: when referring to the 'biogenic C balance' this applies to the indicator $GWP_{biogenic}$ and potentially to associated GWP indicators.

Considerations regarding the system boundary of the modelled product system, related to the use of waste as a fuel vs. the use of secondary fuel, as input (for both, renewable and non-renewable materials):

- If waste is incinerated, the emissions are not included in the balance.
- If secondary fuels are incinerated, the emissions are accounted for as part of the impacts (information module A1).
- Decisive for the distinction whether an input is treated as waste or as secondary fuel is, if the end-of-waste status of this secondary material is reached before the incineration process: this is typically the case, e.g. if the product manufacturer paid a price for the fuel - then it is secondary fuel, if no price was paid, it is waste. Note: the end-of-waste status may also be defined by standards or regulations.
- The consequences from these options and from the fact that there may be tangible differences in that conclusion are reflected in the *low* / *typical* / *high* scenarios:
  - Default assumption, unless otherwise identified for a certain material category:
    - *low* scenario: 75% secondary input is waste, 25% is secondary fuel,
    - *typical* scenario: 25% secondary input is waste, 75% is secondary fuel,
    - *high* scenario: 100% secondary input is secondary fuel.

  Rationale: in EPDs, typically a 'gross' and a 'net' number are reported separately, gross accounting for the input as secondary fuel, net considering it to be waste entirely. The reflection of the bandwidth of decisions on that is covered by the scenarios.

Note: an example of a secondary fuel is old tires, an example of waste as fuel is animal by-products (fat, bones, meat).

3.3 TRANSPORTATION

As upstream transport of raw materials is often of little relevance in the LCA of building materials (exceptions exist and need to be accounted for) to the overall results of building materials. Instead of attempting to collect primary data for each product, regional average shares and distances for road, sea, and air transport will be used to estimate the impact of the actual transport. Exceptions are noted for products and regions with significant imports of major raw materials. In these cases, distribution from those regions will be captured.

Inbound distances for major raw materials and their mode of transport are assumed as follows across all material categories for consistency:

- Intra-country/region transport: 500 km by truck, or 50 km, if raw material supply is local, typically.
- Region-to-region distances are considered using default values in the distance matrix, given in APPENDIX D.
- Shipping is the preferred transport mode, air transport will be used only if reference is available.
- Waste transport default will be 100 km, unless reference is available for other data.
- Default datasets used for different modes of transport are as follows:
    - Road transport - Market dataset truck/lorry
    - Rail transport - Freight train dataset for Rail transport with 500 km wherever applicable
    - Sea transport - bulk carrier dataset

The methodology for calculating transport distances for road, sea and air transport within and between regions uses standardized assumptions and data from SeaRates.com. The share of Air transport is assumed to be zero in default scenarios for building products, and these values should be consistently applied throughout the project. Standardized assumptions are made for truck transport within each region. To estimate inter-regional transport, the main population clusters were researched, and the average sea distance between these clusters was calculated. The tables provided detail road, sea and air transport distances between all regions.

Additionally, for global datasets where specific sea transport data are unavailable, as a conservative approach a sea transport distance of 18,000 km will be considered.

3.4 PACKAGING

For packaging of the final product, only primary packaging should be considered (e.g., LDPE foil, corrugated board box). Secondary packaging should NOT be considered (e.g., EUR pallet, steel metal required to pack the primary packaging to be shipped).

By default, the declared unit is 1 kg of packaged product, where the reported reference flow of 1 kg refers to the net product weight without packaging. Packaging enters the product system in module A3 so that the total mass for the declared product at-gate is 1 kg, plus packaging.

Note that the declared unit may deviate from this rule for individual materials / models, and may declare 1 kg gross, i.e. 1 kg including the declared product AND the packaging. Users of the models are advised to verify this for each model individually.

If, for a material category, the declared unit is not expressed in weight (kg), packaging should be included by considering the appropriate declared unit indicated in the research documentation.

3.5 MISSING DATA

It lies within the goal of this project to create new knowledge and cover new regions or materials in a comparable way. As a result, there will be situations where no exact data can be found. In this case, the following order of priority should be applied to find acceptable estimates, based on:

1. Similar technologies or situations,
2. Expert information or estimations,
3. Conservative assumptions from general LCA practice.

3.6 REGIONALIZATION

One core objective of the ODCi database is the global applicability of the generic building material database.

In support of this objective, regionalization for the ODCi database has been derived in Step 1 of Phase 2 of ODCi, hence in previous work. As such, the rationale of regionalization is not mirrored here but assumed as an existing definition. It should be noted that the regionalization Approach is set up to permit adaptive regionalization, if required in later stages. This means that for dedicated purposes, a more granular breakdown of regions can be used to deliver regionalized datasets, with the datasets of the first data package to serve as a fallback layer. Note that the development of a global dataset only may be the approach of choice. While the decision for developing a global dataset only must be taken for any material individually, qualifying criteria for a global dataset only particularly include minor differences in regionalized production, main environmental impact drivers being region-independent, or lack of data that justifies dedicated regionalization.

For the first package of data delivered within ODCi, a default regionalization has been defined, differentiating on the highest aggregation level the regions

- Asia
- Africa
- Oceania
- Europe
- Central and South America
- North America
- Middle East

Appendix B details the breakdown of these regions to sub-regions and member-countries. Practical consequences of regionalization are particularly the setup of regionalized consumption mixes for electric energy and industrial heat, as well as the allocation of trade data for regional production, exports and imports of materials, as a basis for the supply chain modelling.

3.7 BUILDING MATERIAL DATASET DOCUMENTATION

For each building product, a Dataset Documentation Sheet records the core product description, system boundaries, declared unit, representativeness, assumptions and limitations, regional characteristics, and technical LCA information (see Table 5). Pre-release sheets are supplied without reference to a specific background database and are subject to ODCi access terms. Before final dataset release, the selected background database, version, system model, connected datasets and relevant limitations must be added. Final, verified datasets and their completed documentation are intended to be openly available to the public.[5]

Table 5: Dataset documentation: data fields covered

Material Name:	**This field provides a proper identification of the construction material which the dataset represents along with the CSI Master format code.**
Alternate names:	This field provides alternative names used in the industry.

[5] Note: in earlier versions of this document, and in earlier reports related to the development of the ODCi approach, these documents were referred to as "factsheets".

Material Name:	**This field provides a proper identification of the construction material which the dataset represents along with the CSI Master format code.**
Type of Dataset(s):	This field indicates whether a dataset is global or regionalized.
Region of Representation:	This field provides geographical scope of the dataset, i.e., the specific region if a regionalized dataset has been indicated.
Product Overview:	This field provides a product description overview.
Product Function:	This field provides the function of the product which supports the development of the declared unit and any necessary conversion factors.
Product image:	This field provides a visual representation of the product.
Production Overview:	This field provides a description of the technologies, and the method of manufacturing the product.
Region of representation production volumes (including major manufactures/countries within region):	This field provides an overview of production in the selected region or the global scenario of production of the construction material.
Import/Export details:	This field provides an overview of import/export volumes or shares of the selected region or the global scenario of consumption of the construction material.
Major production technologies:	This field provides an overview of major production technology of the selected construction material in the defined region.
Data period:	This field indicates the temporal representation of the data used for developing the dataset(s).
Main parameters that drive environmental impact:	This field provides the processes or parameters of the product system that are expected to be the main contributors to environmental impacts and thus need to be specifically considered when compiling the LCI (Life Cycle Inventory)
Declared Unit:	This field provides details of the declared unit of the dataset(s).
Reference Flow:	This field provides details of the reference flow used for the material category model development.
Unit process data:	This field provides details of the unit process developed for the material.
Assumptions and Limitations:	This field provides the relevant assumptions or limitations identified in the dataset development.
Model Schematic:	This field provides a schematic of the LCA model developed for the material category.

Material Name:	**This field provides a proper identification of the construction material which the dataset represents along with the CSI Master format code.**
References:	This field provides the literature references used in developing the dataset documentation.

3.8 LCA QUALITY ASSURANCE AND DATA VERIFICATION

To ensure a robust and reliable generic LCA data foundation, three quality check gates will be applied along the LCA dataset development and documentation. These quality gates identify data gaps, review the use of appropriate data sources, adequate application of modelling principles and methodology defined and streamlined approach of dataset development.

Every QA step, from initial data collection – QA Gate 1 – to model review – QA Gate 2 – and final dataset review – QA Gate 3 – is conducted using standardized QA checklists with dedicated QA-questions. The checklists are set up in a way to facilitate documentation of the data development team / QA manager communication, with the possibility to provide comments and ratings of the maturity of the reviewed result. The checklists will be maintained as documentation of the QA-process for each material category and the associated datasets.

Each QA Gate follows a dedicated objective:

- QA Gate 1: review data collected to enable the LCA modelling. Data must be reviewed for representativeness, completeness, scope coverage, as defined in this document, respectively.
- QA Gate 2: review of the LCA model for implementation of the calculation rules and methodology and appropriate implementation of the data researched.
- QA Gate 3: final review of the completed datasets, indicator results and documentation.

QA Gates 1 and 2 may be passed for stripped foreground models without connected background data; Gate 2 is subject to the limitation that modelling may require adjustment when background data are connected. All deferred background-data, boundary, mapping, indicator and result checks must be completed by Gate 3. These internal QA gates are not a substitute for independent third-party verification.

Complete and final independent third-party verification is required for any dataset intended to be released or recognized as ODCi data. ECO Platform[6] has developed a dedicated generic-data verification scheme covering verification requirements, actor roles and sampling procedures[7]. Verification may be staged: data collection and foreground-model verification may follow QA Gates 1 and 2, respectively. However, final verification must cover the foreground model, connected background data and resulting LCA indicators and can only be completed after dataset finalization. The existing ECO Platform Generic Data Verification Guidelines are expected to be adapted to the stripped-model approach and tested in a pilot before full verification activities are planned and scaled. Each verification stage follows the relevant QA gate; completion of an earlier stage does not establish final dataset verification.

Note: The foreground models described in the Product Brief (Oct. 2026) have passed Gate 1 (data collection) and Gate 2 (model review), with the Gate 2 limitation that adjustments may be needed once background data are connected. Gate 3 follows dataset finalization. This status does not imply completion of independent third-party verification. Regional energy models require their own QA and third-party verification before use in material models, as specified in Section 4.2.

[6] https://www.eco-platform.org/

[7] ECO Platform Generic Data Verification Guidelines: adaptation to the stripped-model approach and pilot testing remain pending before full verification activities are planned and scaled (status: October 2026).

4. TECHNICAL MODELLING MECHANISMS FOR LCA DATA CREATION

This chapter illustrates technical modelling mechanisms to ensure consistency, repeatability and efficient development of many LCA datasets. General note: the approach described in this section is specific to the actual work of the initial data development project. Deviating from this approach should be well-considered but may be considered compliant with the provisions defined in this document.

A key challenge in producing a large amount of LCA data sets is ensuring consistency in the setup of LCA models across a team of LCA practitioners involved in the project. Irrespective of the methodological specifications, the LCA practitioner has a certain degree of freedom regarding the level of detail and setup of the LCA model built. This includes decisions about secondary data, model completeness, allocation, end-of-life, and many other issues.

To minimize any consistency risks in the setup of the LCA models for the defined building products, several key-elements need to be considered:

- Use one common LCA background database that complies with the rules specified in this document, and in particular it should be compatible with EN 15804+A2 and ISO 21930 and deliver the indicators defined for impact reporting.
- Use a common LCA software approach as far as possible.
- Use a consistent set of templates for setup of the LCA models in the expert modelling environment, covering the cradle-to-gate stage of the product life cycle with a standardized structure and breakdown.
- Provide regionalized LCI models of energy supply, for calculating alternative, geography-specific LCA-models.

Approaching the development of LCA datasets via the use of template LCI models not only ensures modelling consistency but also helps to speed up the dataset development process.

4.1 USE OF LCA-SOFTWARE AND DATABASE

For the first tranche of datasets, the modelling software and background database actually used shall be defined and recorded in the tranche-specific project documentation, including software version, database version, system model, allocation model, LCIA methods, elementary-flow mapping and any modifications.

For future data development phases, any software and background database may be used if they meet the requirements in Section 3.2 and if the resulting models can be reproduced, reviewed and exported in the required formats. Energy and other utility models shall be constructed from documented country- or region-specific generation or supply shares and compatible unit-process datasets. Where a required supplier dataset is unavailable, an appropriate proxy shall be created from documented foreground parameters, elementary flows and upstream datasets; proxies, transformations and exclusions shall be recorded, tested for mass and energy balance, and reviewed for methodological consistency.

The Umberto software is used for developing all LCI models and subsequently the Product Sustainability (PS) platform is used for exchanging intermediate models between different material groups and also as a repository for model components. To support the modelling of building material data in Umberto, a dedicated tenant in Product Sustainability, used for ODCi's data development exclusively is intended to be set up and maintained by an organization designated under ODCi governance. This tenant is the central registry for remote models available as model components for all ODCi modelling. For example, energy models (electric energy from grid, regionalized, and industrial heat, regionalized) should be developed in Umberto software and made available as remote model components through the ODCi tenant in iPoint's Product Sustainability platform. These models are accessed through Umberto and used in multiple material models as consistent model components. It should be noted that such models require close interaction and integration with background data and can only be made available to the building material models to the extent that a background database has been defined for use.

4.2 REGIONALISED ENERGY LCI MODEL

Regionalised electricity and industrial-heat models, resp. datasets, are required as reusable utility models for all regions defined in the regionalisation scheme. The models shall represent average, location-based supply to the manufacturing regions. The same regional boundaries, reference period, system boundaries, modelling conventions and quality requirements shall be applied consistently across all utility models. As a general assumption, the build-up of such models directly relies on data provided through background data (e.g. national electricity grid mix datasets).

The applicable definition of regions, including the allocation of countries to regions and sub-regions, shall follow the regionalization framework established for the database. Where hierarchical regions are used, higher-level regions should be derived from documented lower-level regional compositions. The hierarchical definition of regions for ODCi is documented in Table 6.

Table 6: Regionalization for the scope definition of the dataset development

Regionalization level 1	Regionalization level 2	Regionalization level 3
Global		
Africa	North Africa	North Africa
	Sub-Sahara Africa	Equatorial Africa
		Southern Africa
Middle East	Middle East	UAE
		Other Middle East
North America	North America	US / Canada
Central & South America	Central America	Mexico
		Other Central America
	South America	Brazil
		Other South America
	The Caribbean	The Caribbean
Europe	European Union	EU-27 / Central Europe
		EU 27 / Mediterranean
	Other Europe	Western Non-EU
		Eastern Non-EU
Oceania	Oceania	Australia / NZ
		Other Oceania
Asia	Other Southeast Asia	Southeast Asia
		East Asia
	China	China
	India	India
	Other Asia	Eurasia/Central Asia
		Southern Asia

A common reference period should be defined based on the most representative and recent statistical information available. The selected period, geographical coverage, data sources, units and any transformations applied to the statistics shall be documented.

The regionalized energy models are developed in connection with the background database selected for the respective data development phase. Statistical data are used to define the geographical and technological composition of the mixes, whereas the associated life cycle inventories, upstream supply chains, conversion efficiencies, allocation procedures and elementary flows should be taken from the selected background database. The database version, system model and component datasets are therefore documented for each implementation.

Only datasets with compatible reference products, system boundaries and modelling conventions are combined. For electricity, consistency is required regarding voltage level, network losses, imports and exports, and the distinction between generation and consumption mixes. For industrial heat, the supplied heat service, fuel, technology, efficiency, temperature level and treatment of combined heat and power are considered.

Quality assurance and third-party verification are required to verify the completeness of regional coverage, consistency of model composition and reproducibility of the resulting utility datasets. These review steps should be taken ahead of any use of the energy models in the modelling of building material data and should provide the grounds to secure consistent modelling and representation of energy data.

Electricity data

For electricity, regional utility models should be established for all regions defined in the regionalization scheme. The regional composition is determined by using publicly available electricity generation or electricity supply statistics for the countries assigned to each region. Country contributions are expressed as relative shares of the regional total and serve as weighting factors for the construction of regional electricity-market models within the selected background database.

To ensure transparency and reproducibility, a regional electricity composition table should be maintained for all regions listed in Table 6. The table should identify the countries assigned to each region together with their corresponding contribution to the regional electricity mix. APPENDIX B documents the regions with countries and the composition of electricity mixes for the regions. Country shares are derived from the selected statistical reference period and normalized to 100% for each region. The resulting country-share matrix constitutes the geographical basis for the regional electricity models and shall be updated whenever regional boundaries or reference statistics are revised. The data documented in APPENDIX B are based on [Our World in Data, 2023]. Note that 2019 data are used and provided in APPENDIX B, as this was the most recent available annual data that was not biased by Covid-19.

Where country-specific electricity-market datasets are available in the selected background database, regional electricity models are created by combining the corresponding country datasets according to the calculated country shares. If no suitable country-specific dataset is available, a representative proxy may be selected based on geographical proximity, similarity of electricity generation structure, or the availability of a suitable higher-level regional dataset. Any such proxy assumptions need to be documented as part of the model development process.

The methodology is intended to represent average location-based electricity supply and therefore excludes market-based instruments, contractual electricity claims or residual-mix approaches. Any treatment of imports, exports, transmission losses or transformation losses shall follow the modelling conventions applied within the selected background database and shall be implemented consistently across all regional electricity models. As mentioned before, in support of consistent use of the energy models, these shall be made available to all material models as remote model components through Product Sustainability. Figure 1 displays an example of energy models made available as remote model components (not maintained on the PS Platform).

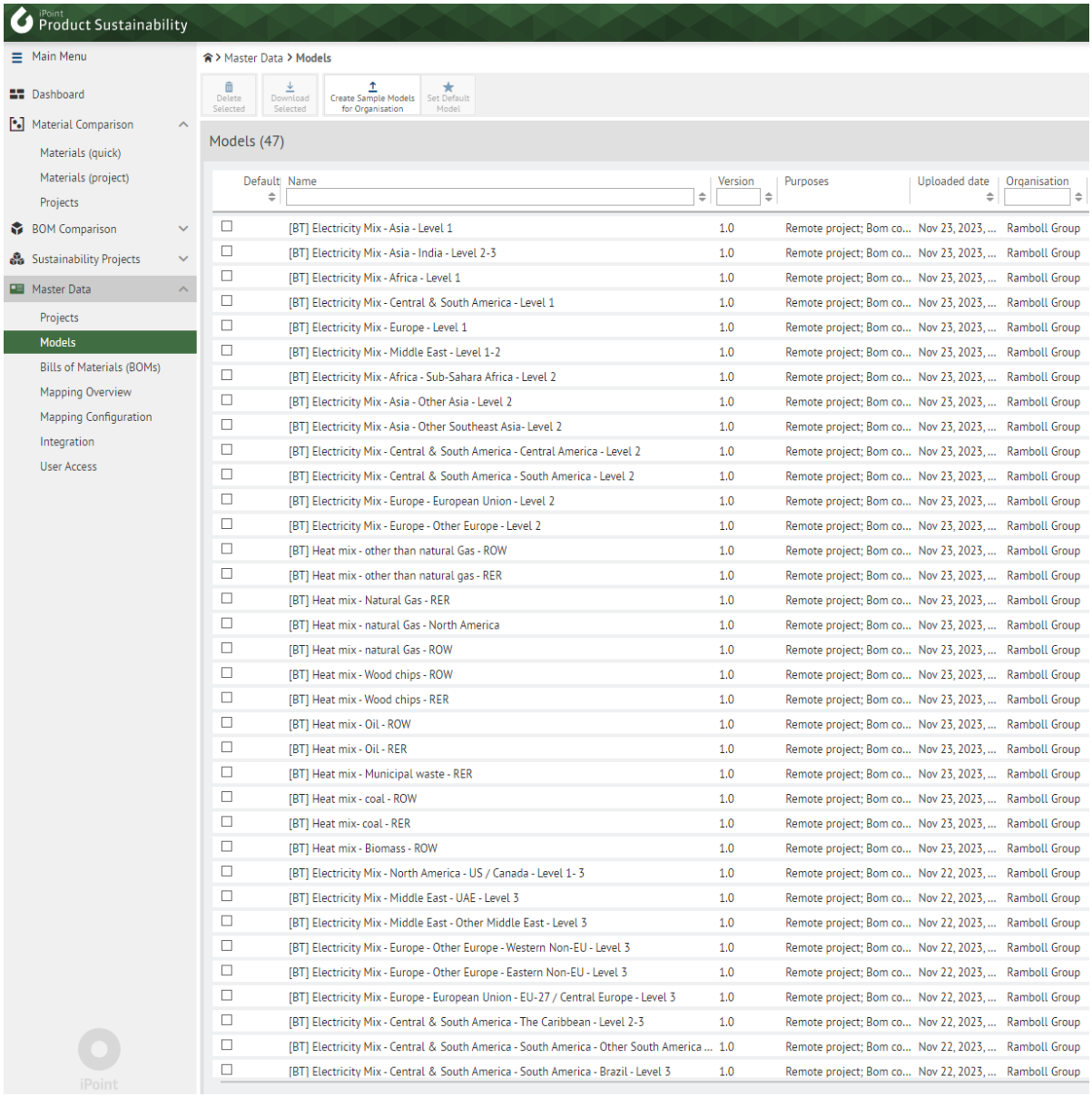

Figure 1: Example of uploaded energy models to iPoint's Product Sustainability Platform . Note: these energy data are not maintained and need to be created based on the background database used.

Thermal Energy / Industrial Heat

For industrial heat, no equivalent country-share matrix is established. Instead, regional process-heat models are developed using technology-specific and fuel-specific information that reflects the characteristics of the respective heat service. Depending on data availability, regional heat models may be based on regional fuel shares, technology distributions, useful heat statistics, or other representative information sources. The objective is to represent the most relevant industrial heat supply technologies for the respective region while maintaining consistency with the selected background database and the defined heat-service specification.

As these models are more closely related to information typically available in LCI-models in background databases, the specific setup of the datasets and their specific composition is more dependent on the actual background database selected.

In some cases, dependent on the background database, a feasible approach may be to identify individual heat generation datasets with a dedicated regionalization that may be different from the

analyzed region, but that may be applicable with regards to the technologies of heat supply represented. In such cases, the use of heat supply data with adjusted parameters such as supply chain of energy carriers, energy conversion parameters, and consumption mix of heat from different sources may be an approach that is sufficiently accurate in view of the significant averaging of data in the process of creating generic material manufacturing datasets. Part of these considerations must be to provide a consistent energy data framework, as inconsistencies may jeopardize the conclusions drawn from analyzing material manufacturing data that use the energy data.

4.3 PARAMETERIZED PRODUCT LCI TEMPLATE MODEL

In general, the use of standardized modelling templates in the LCA software used supports the development of data in a consistent way. For using the Umberto software, in connection with a background database meeting the requirements in Section 3.2, a parameterized product LCI template model (Figure 2) has been set up to streamline the modelling of different materials. The template model allows the modelling of multiple routes/technology of production to be combined in a single model. To support compliance with the requirements defined in this document, the modular structure of life cycle stages / information modules is implemented, providing for the modules A1-A3 as a default. Transport of raw materials in module A2 and transport of the final product in A3 up to the gate ("distribution gate") for consumption mix datasets is available in the template. The availability of parallel supply chain routes permits the modelling of consumption mixes for materials, allowing the coverage of either different manufacturing technologies, or different production regions, or both.

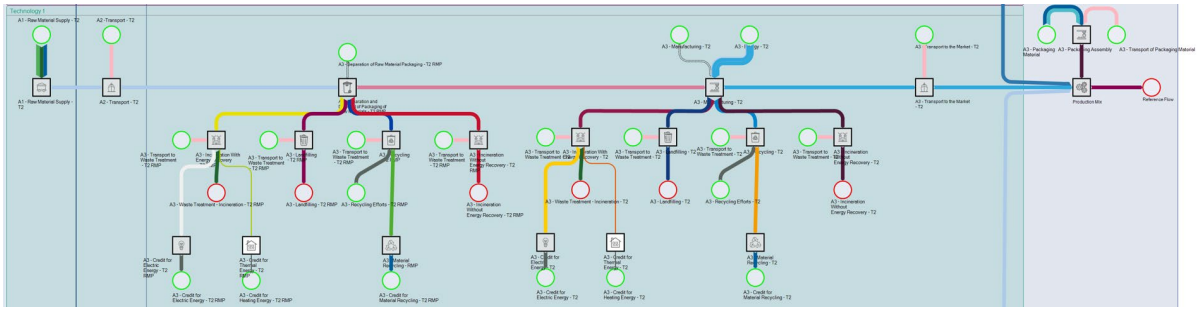

Figure 2: Parameterized Product LCI Template Model

The model templates are also used to provide scenarios to be implemented, delivering the results for the low-impact, high-impact and typical scenarios that are developed for each dataset (see Figure 3).

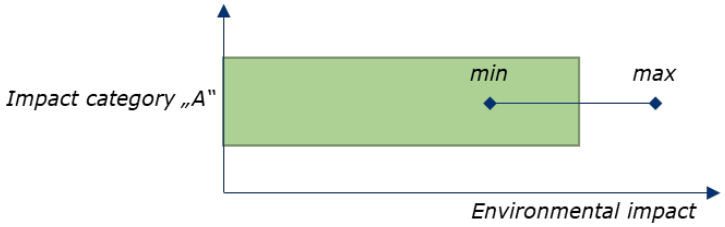

Figure 3: Representation of LICA results of a sample material

5. "SUPERFORMAT": DATA FOR OPENIMPACT & ILCD+EPD

This section defines how the generic LCA data for construction materials can be provided in the OpenIMPACT and ILCD+EPD data formats. The OpenIMPACT format is predominantly used in the North American market and the ILCD+EPD format is well established in Europe. With these, the aim is to provide the LCA data with a global coverage in a format that is internationally available, accepted and compatible with other data (e.g., EPDs).

The generic LCA data for construction materials will be provided in OpenImpact and ILCD+EPD formats. Providing the LCA data in two data formats will ensure applicability of the data both in the North American and in the European context. For the acceptance of the data as the main source for building LCA calculations in both markets, it is of great advantage if the data is available in a format that is compatible with other data in this market.

In this Pre-study, the two data formats were reconciled and analyzed regarding applicability for generic data sets. This data format reconciliation includes the identification of specific methodological constraints for either of the formats. The methodological definitions in this report are set up in a way to secure not only technical but also methodological consistency to other relevant data in the respective format.

The findings from the analysis have been translated into a so-called "Super" data format, or "SuperFormat", including instructions for developing the associated data documentation in both formats. The preliminary format definition is given below with example data added in APPENDIX C. The "Super" data format is a superset of the required data inputs for both OpenImpact and ILCD+EPD schemas. It can be used to create either a complete OpenImpact document or a complete ILCD+EPD document.

The "Super" data format was developed by identifying and including the required fields present in both schemas and the required fields present in only one schema or the other. Fields are considered identical in both schemas if their data types and semantics are compatible, e.g., when a given field is expected to contain a floating-point number in both systems, and that number encodes the same information about the product when either the OpenImpact or ILCD+EPD document is interpreted by an end user. Fields with similar names and data types in both schemas were either linked or disambiguated by referencing schema design documents. Naming conventions and field descriptions in the Super Format have been developed to provide maximum clarity of purpose for each field.

The SuperFormat in APPENDIX C contains the mandatory fields from either output format to define a minimum viable common structure. Additional optional fields may be proposed to meet documented user or publication-channel needs. The Steering Committee evaluates their technical implementation within the Board-approved governance framework, and in close cooperation with owners of publication channels.

It should be noted that any such dataset is also specific with regard to the information module of the life cycle stages covered. This means that manufacturing datasets (cradle-to-shop-gate) contain the information "A1-A3" in data field no. 58 "Module/Phase". If datasets with a different coverage are intended to be provided, the module needs to be provided accordingly (e.g., for EoL data sets with recycling and disposal, this might be "C3-C4").

Part of this reconciliation is also the collection of feedback towards the owners of these data formats. Items found that should be addressed in the openImpact and the ILCD+EPD formats are indicated in the comments' column in APPENDIX C. They include data fields missing in openImpact that may be beneficial in the future, new indicators from TRACI and the suggestion to add fields for additional classification schemes, particularly UN CPC and UN SPSC for increasing compatibility. In this context, the database development project should account for the option to update the underlying formats which may have an influence on the workflow of data documentation and format management.

The datasets are documented using the SuperFormat structure, with Excel and, where appropriate, JSON as intermediate formats. They are then processed into XML for ILCD+EPD and JSON for OpenImpact. Technical implementation is coordinated with the relevant publication channels and any host designated through ODCi governance. Final datasets require connected background data,

completed documentation, QA Gate 3 and independent third-party verification before release as ODCi data.

Table 7: Definitions for data fields for the super-data format, covering openImpact and ILCD+EPD

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
1	UUID		Auto Value	ilcd_uuid	UUID of data set		UUID		
2			Auto Value	id		open_xpd_uuid		Start with "EST"	10/10/2022 - Leave it blank and EC3 will generate and add to datasets
3	Dataset Name		Yes	name	Name	string	Text	string < 200 chars	
4	Dataset Classes		Yes	product_classes	Classification	/product_class	-	≤255 dict entries	Add UNCPC to openImpact (list is extensible) OR: to accommodate various classification schemes, these schemes should be added to both formats as separate fields: CSI MasterFormat, UN CPC, UN SPSC
18	Reference flow (in "kg" by default)		Yes	kg_per_declared_unit_range	Reference flow(s)	/range	Reference to flow	Unit is always "kg"	
19	Declared unit		Yes	declared_unit	Functional unit, production period, or other parameter	/amount	Text	See "Units"	
20	Reference year		Yes		Reference year		Integer		Model represents 2021
21	Data set valid until		Yes		Data set valid until		Integer		
23	Geography		Yes	geography	Location	list of string	Location code	2-letter country codes, M49 region codes or the alias "EU27" for the 27 members of the Euro bloc	
25	Description of manufacturing process		Yes	manufacturing_description	Technology description including background system	string (gfm)	Text	string < 2000 chars	openImpact: Optional

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
26	Product Function		Yes	product_usage_description	Technical purpose of product or process	string (gfm)	Text	string < 2000 chars	openImpact: Optional
29	Applicable Product category rules/ Standards		Yes	pcr	LCA methodology report	/pcr	Reference to source	{"id","pcrxpgq2","issuer":{"name":"UL","web_domain":"ul.com"},"name":"c-PCR-003 Concrete and concrete elements (EN 16757)","date_of_issue":"2019-02-11T00:00:00Z","version":"1.0.2"}	openImpact: Optional, ISO 21930, EN 15804+A2.
30	Subtype		Yes		Subtype		Enumerated list		
31	Data sources		Yes		Data sources used for this data set		Reference to source		
32	Use advice for data set		Yes		Use advice for data set		Text		
34	Type of review		Yes	review_type	Type of review		Enumerated list		*openImpact doesn't have a schema for this. openImpact to follow ILCD's list*
36	Reviewer name and institution		Yes	reviewer, reviewer_org	Reviewer name and institution	/user, /org	Reference to contact		EC3 to connect on their end. JSON field
39	Compliance system name		Yes		Compliance system name		Reference to source		
43	Time stamp		Yes		Time stamp (last saved)		Time stamp		This field is not mandatory for openImpact. Don't need this since any errors corrected would be a new dataset
44	Data set format(s)		Yes	doctype	Data set format(s)	string	Reference to source	From list in open-xpd-guid	

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
45	Data set modeller		Yes		Data set generator / modeller		Reference to contact		*new field - to be added to openImpact*
47	Version		Yes	version	Data set version	Number	Version number	Integer. Always increments. Always greater than previous value.	
48	Preceding dataset version		Yes	preceding_id	Preceding data set version	url	UUID and version number of last preceding data set, URL		openImpact: Leave blank for version 1. EC3 ids/ URL/ ILCD UUID for preceding dataset version. For now single reference - URL
49	Publisher of dataset		Yes	publisher	Publisher of the data set	/org	Reference to Contact		
51	Issuer of data set		Yes		Issuer of the data set		Reference to Contact		Not relevant for generic dataset
53	Owner of data set		Yes		Owner of data set		Reference to contact		Same as publisher
54	Copyright regulations		Yes		Copyright?		yes/no		
55	License terms		Yes	license_terms	License type	/license_terms	Enumerated list	License	ILCD+EPD: Free of charge for all users and uses Free of charge for some user types or use types Free of charge for members only License fee Other
56	Access and use restrictions		Yes	private	Access and use restrictions	boolean	Text	True or False	Access restrictions / use conditions for this data set as free text or referring to e.g. license conditions. In case of no restrictions "None" is entered. Private=="TRUE" means no one except

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
									owner has access. Else everyone has access
57	Indicator		Yes		Indicator		Reference to LCIA method		LCI indicators
58	Module		Yes		Module/Phase		Text		
60	Value		Yes		Value		Real		
61	Unit		Yes		Unit		Reference to unit group		Depends on indicator
62	Indicator		Yes		Indicator		Reference to LCIA method		
63	Module		Yes		Module/Phase		Text		
65	Value		Yes		Value		Real		
66	Unit		Yes		Unit		Reference to unit group		Depends on indicator
67	Material properties		Yes	specs	Material properties	list of /spec		≤255 entries in list	
68	Biogenic carbon content in product	kg C	Yes	kg_C_biogenic_per_declared_unit	Biogenic carbon content in product	/amount	kg C		
69	Biogenic carbon content in accompanying packaging	kg C	Yes		Biogenic carbon content in accompanying packaging		kg C		
70	EN 15804+A2 Indicator - Global Warming Potential - total (GWP-total)	kg CO2 eq.	Yes		Global Warming Potential - total (GWP-total)		kg CO2 eq.		EN 15804+A2 Indicator
71	EN 15804+A2 Indicator - Global Warming Potential - fossil fuels (GWP-fossil)	kg CO2 eq.	Yes		Global Warming Potential - fossil fuels (GWP-fossil)		kg CO2 eq.		EN 15804+A2 Indicator

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
72	EN 15804+A2 Indicator - Global Warming Potential - biogenic (GWP-biogenic)	kg CO2 eq.	Yes		Global Warming Potential - biogenic (GWP-biogenic)		kg CO2 eq.		EN 15804+A2 Indicator
73	EN 15804+A2 Indicator - Global Warming Potential - land use and land use change (GWP-luluc)	kg CO2 eq.	Yes		Global Warming Potential - land use and land use change (GWP-luluc)		kg CO2 eq.		EN 15804+A2 Indicator
74	EN 15804+A2 Indicator - Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.	Yes		Depletion potential of the stratospheric ozone layer (ODP)		kg CFC-11 eq.		EN 15804+A2 Indicator
75	EN 15804+A2 Indicator - Acidification potential, Accumulated Exceedance (AP)	mol H+ eq.	Yes		Acidification potential, Accumulated Exceedance (AP)		mol H+ eq.		EN 15804+A2 Indicator
76	EN 15804+A2 Indicator - Eutrophication potential - freshwater (EP-freshwater)	kg P eq.	Yes		Eutrophication potential - freshwater (EP-freshwater)		kg P eq.		EN 15804+A2 Indicator
77	EN 15804+A2 Indicator - Eutrophication potential - marine (EP-marine)	kg N eq.	Yes		Eutrophication potential - marine (EP-marine)		kg N eq.		EN 15804+A2 Indicator
78	EN 15804+A2 Indicator - Eutrophication potential - terrestrial (EP-terrestrial)	mol N eq.	Yes		Eutrophication potential - terrestrial (EP-terrestrial)		mol N eq.		EN 15804+A2 Indicator

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
79	EN 15804+A2 Indicator - Photochemical Ozone Creation Potential (POCP)	kg NMVOC eq.	Yes		Photochemical Ozone Creation Potential (POCP)		kg NMVOC eq.		EN 15804+A2 Indicator
80	EN 15804+A2 Indicator, Impact category not listed in openImpact - Abiotic depletion potential - non-fossil resources (ADPE)	kg Sb eq	Yes		Abiotic depletion potential - non-fossil resources (ADPE)		kg Sb eq		EN 15804+A2 Indicator, *Impact category not listed in openImpact*
81	EN 15804+A2 Indicator, Impact category not listed in openImpact - Abiotic depletion potential - fossil resources (ADPF)	MJ	Yes		Abiotic depletion potential - fossil resources (ADPF)		MJ		EN 15804+A2 Indicator, *Impact category not listed in openImpact*
82	EN 15804+A2 Indicator, Impact category not listed in openImpact - Water (user) deprivation potential (WDP)	m3 world eq. deprived	Yes		Water (user) deprivation potential (WDP)		m3 world eq. deprived		EN 15804+A2 Indicator, *Impact category not listed in openImpact*
89	TRACI 2.1, Global Warming Air- [kg CO2 eq.] -	kg CO2 eq.	Yes	gw		/impacts - kg CO2 eq.	kg CO2 eq.	[1, 255] entries in list. More impactsets allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact type except "gwp".	TRACI 2.1, Global Warming Air, considering biogenic carbon to be accounted for with uptake = -1 and emissions = +1 [kg CO2 eq.]
90	TRACI 2.1, Acidification [kg SO2 eq.] -	kg SO2 eq.	Yes	ap		/impacts - kg SO2 eq.	kg SO2 eq.	[1, 255] entries in list. More impactsets	TRACI 2.1, Acidification [kg SO2 eq.]

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
								allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact type except "gwp".	
91	TRACI 2.1, Eutrophication [kg N eq.] -	kg N eq.	Yes	ep		/impacts - kg N eq.	kg N eq.	[1, 255] entries in list. More impactsets allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact type except "gwp".	TRACI 2.1, Eutrophication [kg N eq.]
92	TRACI 2.1, Ozone Depletion Air [kg CFC 11 eq.] -	kg CFC11e	Yes	odp		/impacts - kg CFC11e	kg CFC11e	[1, 255] entries in list. More impactsets allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact type except "gwp".	TRACI 2.1, Ozone Depletion Air [kg CFC 11 eq.]
94	TRACI 2.1, Smog Air [kg O3 eq.] - new indicator - to be added to openImpact -	kg O3e	Yes	pocp		/impacts - kg O3e	kg O3e	[1, 255] entries in list. More impactsets allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact	TRACI 2.1, Smog Air [kg O3 eq.] - *new indicator - to be added to openImpact*

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
								type except "gwp".	
96	IPCC AR6 GWP 100- (version Aug. 2021) [kg CO2 eq.] - new indicator - to be added to openImpact -	kg CO2 eq.	Yes	ipcc_ar6_gwp		/impacts - kg CO2 eq.	kg CO2 eq.	[1, 255] entries in list. More impactsets allowed with different LCIA methods. Implementations of the spec are allowed to ignore any passed impact type except "gwp".	IPCC AR6 GWP 100 (version Aug. 2021), considering biogenic carbon to be accounted for with uptake = -1 and emissions = +1 [kg CO2 eq.] - *new indicator - to be added to openImpact*
98	Use of renewable primary energy as energy carrier (PERE)	MJ	Yes	RPRe	Use of renewable primary energy as energy carrier (PERE)	/resource_use_set	MJ	<255 entries in a dictionary	
99	Use of renewable primary energy resources used as raw materials (PERM)	MJ	Yes	RPRm	Use of renewable primary energy resources used as raw materials (PERM)	/resource_use_set	MJ	<255 entries in a dictionary	
100	Total use of renewable primary energy (PERT)	MJ	Yes	RPRt	Total use of renewable primary energy (PERT)		MJ		
101	Use of non renewable primary energy as energy carrier (PENRE)	MJ	Yes	NRPRe	Use of non renewable primary energy as energy carrier (PENRE)	/resource_use_set	MJ	<255 entries in a dictionary	
102	Use of non renewable primary energy resources used as raw materials (PENRM)	MJ	Yes	NRPRm	Use of non renewable primary energy resources used as raw materials (PENRM)	/resource_use_set	MJ	<255 entries in a dictionary	
103	Total use of non renewable primary energy resource (PENRT)	MJ	Yes	NRPRt	Total use of non renewable primary energy resource (PENRT)		MJ		

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
104	Use of secondary material (SM)	kg	Yes	sm	Use of secondary material (SM)	/resource_use_set	kg	<255 entries in a dictionary	
105	Use of renewable secondary fuels (RSF)	MJ	Yes	rsf	Use of renewable secondary fuels (RSF)	/resource_use_set	MJ	<255 entries in a dictionary	
106	Use of non renewable secondary fuels (NRSF)	MJ	Yes	nrsf	Use of non renewable secondary fuels (NRSF)	/resource_use_set	MJ	<255 entries in a dictionary	
107	Net use of fresh water (FW)	m3	Yes	fw	Net use of fresh water (FW)	/resource_use_set	m3	<255 entries in a dictionary	
108	Hazardous waste disposed (HWD)	kg	Yes	hwd	Hazardous waste disposed (HWD)	/output_flow_set	kg	<255 entries in a dictionary	
109	Non hazardous waste disposed (NHWD)	kg	Yes	nhwd	Non hazardous waste disposed (NHWD)	/output_flow_set	kg	<255 entries in a dictionary	
110	Radioactive waste disposed (RWD)	kg	Yes	hlrw+illrw	Radioactive waste disposed (RWD)	/output_flow_set	kg	<255 entries in a dictionary	
111	High-level radioactive waste, conditioned, to final repository (HLRW) [kg]	0	Yes	hlrw					High-level radioactive waste, conditioned, to final repository (HLRW) [kg]
112	Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW) [kg]	0	Yes	illrw					Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW) [kg]
113	Components for re-use (CRU)	kg	Yes	cru	Components for re-use (CRU)	/output_flow_set	kg	<255 entries in a dictionary	
114	Materials for recycling (MFR)	kg	Yes	mr	Materials for recycling (MFR)	/output_flow_set	kg	<255 entries in a dictionary	
115	Materials for energy recovery (MER)	kg	Yes	mer	Materials for energy recovery (MER)	/output_flow_set	kg	<255 entries in a dictionary	

Original Order	Super Format Name	Unit	Mandatory for Generic Dataset	openImpact Field	ILCD+EPD Field	openImpact Type	ILCD+EPD Type	openImpact Constraints	Comments
116	Exported electrical energy (EEE)	MJ	Yes	ee	Exported electrical energy (EEE)	/output_flow_set	MJ	<255 entries in a dictionary	
117	Exported thermal energy (EET)	MJ	Yes	eh	Exported thermal energy (EET)	/output_flow_set	MJ	<255 entries in a dictionary	

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APPENDIX A. DATABASE DEVELOPMENT PROCESS

To create a comprehensive and iterative process of data development and validation, aimed at creating reliable and transparent material datasets for the Open Data for Climate initiative (ODCi), Ramboll developed a structured process which has been described in the section below.

Operational Program Management:

- A structured approach has been established for the project to ensure consistent handling of each material category and associated dataset.
- Resources developed for consistency include material lists, LCA models, dataset templates, and procedure manuals.
- Operational management tools like Miro boards help in managing multi-location teams, tracking progress, and facilitating frequent check-in calls.

The approach can be summarized in a schematic given below in Figure 4.

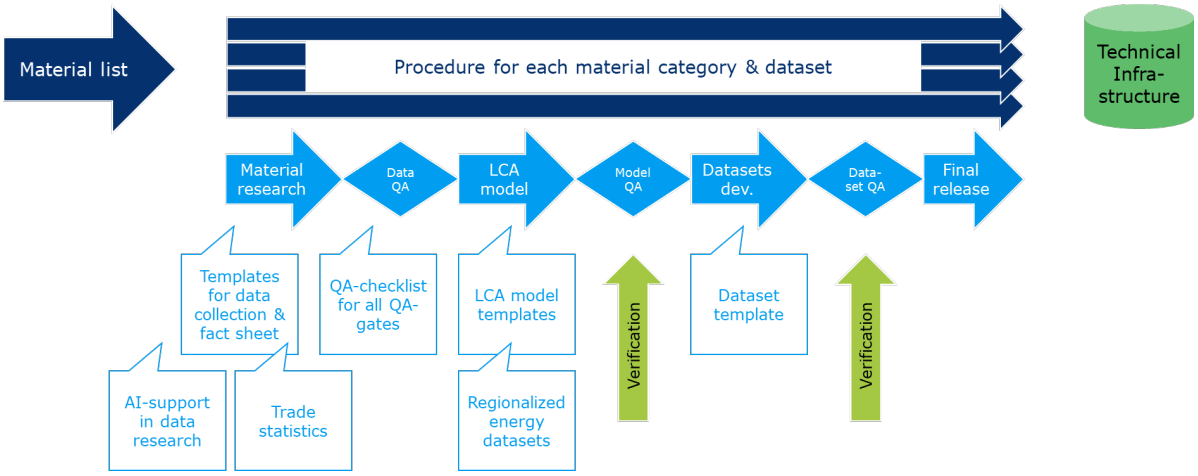

Figure 4: Schematic of dataset development process

Data Quality Assurance:

- The quality assurance of collected research data follows the Gate 1 checklist before use in foreground modelling. Gate 2 reviews the model and Gate 3 reviews completed datasets, including all checks deferred until background data are connected. Feedback loops to researchers and modelers are documented.
- Improvements to the QA process, such as more frequent check-ins and detailed data quality assessments, have been adopted based on key learnings from initial QA activities.
- The LCA calculation utilizes templates in the Umberto modeling environment to guarantee consistency.

Quality Assurance Gates:

- The process includes three dedicated QA gates managed by a designated QA team.
  QA steps encompass Data QA, Model QA, and Dataset QA at different stages of the project.
  The QA process is based on default QA checklists that are mandatory to use for all data development work. The checklists need to be set up in a way that any iterative exchange between the data modelling expert and the QA manager is documented completely. The items of the QA checklists are documented in APPENDIX E.

Technical Infrastructure:

- LCA model templates, regional energy datasets, and dataset templates are part of the development of the SuperFormat which will feed into the technical infrastructure, aimed at ensuring standardized processes.

Artificial Intelligence (AI) support plays an integral role in data research, making repetitive tasks more efficient. It should be noted that there has been strong emphasis of using source backed data to meet the requirements of standard frameworks. It must be noted that AI-based data and materials are human-reviewed and therefore not labelled as 'AI-created' or similar.

LCA Model Quality Assurance:

- General Checklist: Includes model file name verification, database usage, nomenclature, and comprehensive comments detailing dataset modeler, product, process description, and assumptions.
- Functionality Review: This ensures data compliance, including background dataset choices, proxy dataset use, assumptions, parameters, water, carbon, scrap, and energy balance reviews.
- Compliance and Analysis: Ensures correct implementation of indicators, cut-off criteria, system expansion, functional unit, and reference flow, as well as correct attribution to Information Modules (A1/A2/A3).
- Results Evaluation: Includes contribution analysis, sensitivity analysis, benchmarking against existing datasets, and plausibility checks.

The structured approach, aided by a robust QA process, sets a solid foundation for the verification scheme of the LCA project. This approach will likely improve the quality and efficiency of environmental assessments across the construction-material categories covered by ODCi.

APPENDIX B. REGIONS

Regions and their Representative Countries

The Table on the following pages detail the hierarchical regionalization, including allocation of countries to regions. Additionally, regional electricity grid mix data are provided. The regional electricity grid mixes are provided as mix of contributing countries, with the share of each contributing country to the respective regional grid mix, reflecting the "Regional Level 1". Note that these mix data are approximations, neglecting some countries' contribution to the regional mixes, and may have to be adjusted, depending on available national electricity datasets in the background data used for modelling.

Table 8: Regions and their Representative Countries (following pages)

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
Africa	North Africa	North Africa	Mauritania	MR	-
			Libya	LY	3,83%
			Tunisia	TN	2,49%
			Morocco	MA	4,86%
			Algeria	DZ	9,86%
			Egypt	EG	24,27%
	Sub-Sahara Africa	Equatorial Africa	Uganda	UG	-
			Mali	ML	-
			Burkina Faso	BF	-
			Guinea	GN	-
			Madagascar	MG	-
			Equatorial Guinea	GQ	-
			Rwanda	RW	-
			Benin	BJ	0,02%
			Niger	NE	0,07%
			Togo	TG	0,07%
			Gabon	GA	0,36%
			Seychelles	SC	-
			Cape Verde	CV	-
			Burundi	BI	-
			Somalia	SO	-
			Senegal	SN	0,63%
			Liberia	LR	-
			Chad	TD	-
			Gambia	GM	-
			Kenya	KE	1,3%
			Sierra Leone	SL	-
			Central African Republic	CF	-
			Congo, Democratic Republic of the	CD	1,11%
			Tanzania, United Republic Of	TZ	0,89%

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
			Comoros	KM	-
			Sao Tome and Principe	ST	-
			Guinea-Bissau	GW	-
			Djibouti	DJ	-
			Cameroon	CM	1,01%
			Eritrea	ER	0,05%
			Nigeria	NG	3,55%
			South Sudan	SS	0,07%
			Sudan	SD	1,73%
			Congo	CG	0,45%
			Ethiopia	ET	1,71%
			Cote d'Ivoire	CI	1,08%
			Ghana	GH	2,04%
		Southern Africa	Namibia	NA	0,12%
			Eswatini	SZ	-
			Malawi	MW	-
			Zimbabwe	ZW	1,37%
			Botswana	BW	0,37%
			Lesotho	LS	-
			Angola	AO	1,64%
			Mauritius	MU	0,37%
			Zambia	ZM	1,94%
			Mozambique	MZ	2,18%
			South Africa	ZA	30,56%
Asia	China	China	China	CN	54,73%
	India	India	India	IN	11,83%
	Other Asia	Eurasia/Central Asia	Kyrgyzstan	KG	0,11%
			Uzbekistan	UZ	0,46%
			Tajikistan	TJ	0,15%
			Kazakhstan	KZ	0,78%
			Turkmenistan	TM	0,19%
			Russia	RU	8,16%
		Southern Asia	Bhutan	BT	-

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
			Nepal	NP	0,03%
			Maldives	MV	-
			Sri Lanka	LK	0,12%
			Bangladesh	BD	0,65%
			Pakistan	PK	1,00%
	Other Southeast Asia	East Asia	Korea, Democratic People's Republic of	KP	0,12%
			Taiwan, Province of China	TW	2,00%
			Korea, Republic of	KR	4,28%
			Japan	JP	7,48%
		Southeast Asia	Thailand	TH	1,36%
			Lao People's Democratic Republic	LA	-
			Cambodia	KH	0,06%
			Brunei Darussalam	BN	0,03%
			Timor-Leste	TL	-
			Myanmar	MM	0,18%
			Singapore	SG	0,39%
			Philippines	PH	0,77%
			Malaysia	MY	1,30%
			Viet Nam	VN	1,66%
			Indonesia	ID	2,15%
Central and South America	Central America	Mexico	Mexico	MX	21,12%
		Other Central America	El Salvador	SV	0,36%
			Belize	BZ	-
			Nicaragua	NI	0,28%
			Honduras	HN	0,68%
			Costa Rica	CR	0,70%
			Panama	PA	0,76%
			Guatemala	GT	0,82%
	South America	Brazil	Brazil	BR	38,39%

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
			Venezuela	VE	4,91%
			Argentina	AR	8,55%
			Suriname	SR	-
			Guyana	GY	-
			Bolivia, Plurinational State of	BO	0,61%
		Other South America	Peru	PE	3,50%
			Ecuador	EC	2,01%
			Uruguay	UY	0,97%
			Chile	CL	5,13%
			Colombia	CO	4,95%
			Paraguay	PY	3,00%
			Bahamas	BS	-
			Barbados	BB	-
			Saint Lucia	LC	-
			Antigua and Barbuda	AG	-
			Saint Kitts and Nevis	KN	-
			Grenada	GD	-
	The Caribbean	The Caribbean	Saint Vincent and the Grenadines	VC	-
			Dominica	DM	-
			Cuba	CU	1,20%
			Dominican Republic	DO	1,16%
			Haiti	HT	0,06%
			Jamaica	JM	0,26%
			Trinidad and Tobago	TT	0,56%
			Italy	IT	7,83%
			Spain	ES	7,13%
Europe	European Union	EU 27 / Mediterranean	Greece	GR	1,30%
			Croatia	HR	0,34%
			Portugal	PT	1,42%

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
			Romania	RO	1,59%
			Malta	MT	0,06%
			Cyprus	CY	0,14%
			Bulgaria	BG	1,18%
			France	FR	15,00%
			Gibraltar	GI	-
		EU-27 / Central Europe	Finland	FI	1,85%
			Hungary	HU	0,91%
			Poland	PL	4,37%
			Lithuania	LT	0,11%
			Denmark	DK	0,79%
			Luxembourg	LU	0,05%
			Estonia	EE	0,20%
			Slovakia	SK	0,76%
			Latvia	LV	0,17%
			Ireland	IE	0,83%
			Netherlands	NL	3,23%
			Austria	AT	1,98%
			Slovenia	SI	0,43%
			Belgium	BE	2,50%
			Czechia	CZ	2,32%
			Sweden	SE	4,49%
			Germany	DE	16,18%
	Other Europe	Eastern Non-EU	Moldova, Republic of	MD	0,02%
			Albania	AL	0,14%
			North Macedonia	MK	0,16%
			Georgia	GE	0,32%
			Montenegro	ME	0,09%
			Serbia	RS	0,98%
			Azerbaijan	AZ	0,69%
			Bosnia and Herzegovina	BA	0,46%
			Belarus	BY	1,08%

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
			Ukraine	UA	4,11%
			Kosovo	XK	0,17%
		Western Non-EU	United Kingdom	GB	8,63%
			Iceland	IS	0,52%
			Andorra	AD	-
			Liechtenstein	LI	-
			Monaco	MC	-
			San Marino	SM	-
			Holy See (Vatican City State)	VA	-
			Norway	NO	3,59%
			Switzerland	CH	1,92%
Middle East	Middle East	Other Middle East	Saudi Arabia	SA	21,82%
			Palestinian Territory, Occupied	PS	-
			Afghanistan	AF	-
			Lebanon	LB	1,30%
			Bahrain	BH	2,04%
			Jordan	JO	1,27%
			Yemen	YE	0,22%
			Syrian Arab Republic	SY	1,11%
			Armenia	AM	0,47%
			Iraq	IQ	6,89%
			Turkey	TR	19,76%
			Oman	OM	2,53%
			Qatar	QA	3,24%
			Kuwait	KW	4,89%
			Iran (Islamic Republic of)	IR	20,74%
			Israel	IL	4,71%
		UAE	United Arab Emirates	AE	9,00%
North America	North America	US / Canada	Canada	CA	12,86%
			United States	US	87,14%

Regional Level 1	Sub- Region Level 2	Sub- Region Level 3	Country Level 4	Country code	% share per regional electricity mix (regional level 1)
Oceania	Oceania	Australia / NZ	New Zealand	NZ	14,51%
			Australia	AU	85,49%
		Other Oceania	Papua New Guinea	PG	-
			Fiji	FJ	-
			Samoa	WS	-
			Solomon Islands	SB	-
			Vanuatu	VU	-
			Tonga	TO	-
			Kiribati	KI	-
			Nauru	NR	-
			Marshall Islands	MH	-
			Micronesia	UN-MICRONESIA	-
			Palau	PW	-
		Other Oceania	Tuvalu	TV	-

APPENDIX C. SUPERFORMAT STRUCTURE

No.	Super Format Name	Description	Unit	Indicator Results 'Low' Case	Indicator Results Typical	Indicator Results 'High' Case
1	UUID					
2	Dataset Name					
3	Dataset Classes					
4	Reference flow (in "kg" by default)					
5	Declared unit					
6	Reference year					
7	Data set valid until					
8	Geography					
9	Description of manufacturing process					
10	Product Function					
11	Applicable Product category rules/ Standards					
12	Subtype					
13	Data sources					
14	Use advice for data set					
15	Type of review					
16	Reviewer name and institution					
17	Compliance system name					
18	Time stamp					
19	Data set format(s)					
20	Data set modeller					

21	Version					
22	Preceding dataset version					
23	Publisher of dataset					
24	Issuer of data set					
25	Owner of data set					
26	Copyright regulations					
27	License terms					
28	Access and use restrictions					
29	Indicator					
30	Module					
31	Value					
32	Unit					
33	Material properties					
34	Biogenic carbon content in product		kg C			
35	Biogenic carbon content in accompanying packaging		kg C			
36	EN 15804+A2 Indicator - Global Warming Potential - total (GWP-total)		kg CO_2 eq.			
37	EN 15804+A2 Indicator - Global Warming Potential - fossil fuels (GWP-fossil)		kg CO_2 eq.			
38	EN 15804+A2 Indicator - Global Warming Potential - biogenic (GWP-biogenic)		kg CO_2 eq.			
39	EN 15804+A2 Indicator - Global Warming Potential - land use and land use change (GWP-luluc)		kg CO_2 eq.			

40	EN 15804+A2 Indicator - Depletion potential of the stratospheric ozone layer (ODP)		kg CFC-11 eq.			
41	EN 15804+A2 Indicator - Acidification potential, Accumulated Exceedance (AP)		mol H+ eq.			
42	EN 15804+A2 Indicator - Eutrophication potential - freshwater (EP- freshwater)		kg P eq.			
43	EN 15804+A2 Indicator - Eutrophication potential - marine (EP- marine)		kg N eq.			
44	EN 15804+A2 Indicator - Eutrophication potential - terrestrial (EP- terrestrial)		mol N eq.			
45	EN 15804+A2 Indicator - Photochemical Ozone Creation Potential (POCP)		kg NMVOC eq.			
46	EN 15804+A2 Indicator, Impact category not listed in openImpact - Abiotic depletion potential - non-fossil resources (ADPE)		kg Sb eq			
47	EN 15804+A2 Indicator, Impact category not listed in openImpact - Abiotic depletion potential - fossil resources (ADPF)		MJ			
48	EN 15804+A2 Indicator, Impact category not listed in openImpact - Water (user) deprivation potential (WDP)		m3 world eq. deprived			
49	TRACI 2.1, Global Warming Air ~~incl. biogenic carbon~~ [kg CO2 eq.] -		kg CO2 eq.			

50	TRACI 2.1, Acidification [kg SO2 eq.] -		kg SO2 eq.			
51	TRACI 2.1, Eutrophication [kg N eq.] -		kg N eq.			
52	TRACI 2.1, Ozone Depletion Air [kg CFC 11 eq.] -		kg CFC11e			
53	TRACI 2.1, Smog Air [kg O3 eq.] - new indicator - to be added to openImpact -		kg O3e			
54	IPCC AR6 GWP 100 (version Aug. 2021) [kg CO2 eq.] - new indicator - to be added to openImpact -		kg CO2 eq.			
55	Use of renewable primary energy as energy carrier (PERE)		MJ			
56	Use of renewable primary energy resources used as raw materials (PERM)		MJ			
57	Total use of renewable primary energy (PERT)		MJ			
58	Use of non renewable primary energy as energy carrier (PENRE)		MJ			
59	Use of non renewable primary energy resources used as raw materials (PENRM)		MJ			
60	Total use of non renewable primary energy resource (PENRT)		MJ			
61	Use of secondary material (SM)		kg			
62	Use of renewable secondary fuels (RSF)		MJ			
63	Use of non renewable secondary fuels (NRSF)		MJ			

64	Net use of fresh water (FW)		m3			
65	Hazardous waste disposed (HWD)		kg			
66	Non hazardous waste disposed (NHWD)		kg			
67	Radioactive waste disposed (RWD)		kg			
68	High-level radioactive waste, conditioned, to final repository (HLRW) [kg]		kg			
69	Intermediate- and low-level radioactive waste, conditioned, to final repository (ILLRW) [kg]		kg			
70	Components for re-use (CRU)		kg			
71	Materials for recycling (MFR)		kg			
72	Materials for energy recovery (MER)		kg			
73	Exported electrical energy (EEE)		MJ			
74	Exported thermal energy (EET)		MJ			
75	Recovered Energy (RE)		MJ			
76	Biogenic carbon emission from renewable waste combustion (BCEW)		kg CO2			
77	Calcination carbon emissions (CCE)		kg CO2			
78	Carbon emission from non-renewable waste combustion (CWNR)		kg CO2			

APPENDIX D. TRANSPORT DISTANCE TABLES

The default distances to be used in the data development between the regions are presented in the following tables. The distances cover road, sea and air transport. Air transport is assumed to be 0 tkm in the default scenarios for building products, and only to be used where reference information is available.

Average road distances							
all values in km	Africa	Middle East	Asia	South and central America	North America	Europe	Oceania
Africa	50	1000	1000	1000	1000	1000	1000
Middle East	1000	50	1000	1000	1000	1000	1000
Asia	1000	1000	50	1000	1000	1000	1000
South and central America	1000	1000	1000	50	1000	1000	1000
North America	1000	1000	1000	1000	50	1000	1000
Europe	1000	1000	1000	1000	1000	50	1000
Oceania	1000	1000	1000	1000	1000	1000	50

Average sea distances							
all values in km	Africa	Middle East	Asia	South and central America	North America	Europe	Oceania
Africa	0	17200	12500	11300	14600	9100	13800
Middle East	17200	0	10000	15600	10800	9200	14900
Asia	12500	10000	0	18400	18600	14200	11400
South and central America	11300	15600	18400	0	10300	10600	17400
North America	14600	10800	18600	10300	0	9900	17500

Europe	9100	9200	14200	10600	9900	0	19800
Oceania	13800	14900	11400	17400	17500	19800	0

Average air distances							
all values in km	Africa	Middle East	Asia	South and central America	North America	Europe	Oceania
Africa	0	3600	8800	9300	13400	6400	12200
Middle East	3600	0	6000	12300	12500	4900	12100
Asia	8800	6000	0	18100	13200	9200	7400
South and central America	9300	12300	18100	0	8000	9900	13400
North America	13400	12500	13200	8000	0	7700	14500
Europe	6400	4900	9200	9900	7700	0	16500
Oceania	12200	12100	7400	13400	14500	16500	0

APPENDIX E. QA CHECKLISTS

All QA checklists are provided with a multi-column setup to permit the documentation of the iterative exchange between the data research specialists and the QA manager.

Figure 5: columns used in all QA checklists

Note that the checklist questions for each QA gate as provided below depict the most recent version of the QA checklists used in the data development process. Earlier versions of the checklists have been used for some material categories and may use a different list of QA-questions. Mostly, wording has been adjusted, and additional clarity has been provided (e.g. the "Typical" scenario is referred to as "Average" in earlier versions of the QA checklists).

QA Gate 1: Data Research

The first QA gate reviews the information collected, which is then meant to inform the modelling of the building material, specific datasets to cover, regionalization, technologies, etc. Successfully passing this QA Gate should minimize the risk of lack of data in the actual modelling process.

Table 9: Qualifying questions in the Quality Assurance Gate 1: Data Research.

Technical Data	Product description (including technical specifications)
Technical Data	Major technologies identified (incl. reference to regions, if applicable)
Economic Data	Production and consumption data
Economic Data	Major manufacturing regions/countries
Economic Data	For consumption datasets for regions: contributions (%) for regional production and import from other regions correctly derived
Data Quality Documentation	Data quality estimation provided
General Model / Scenarios / Overview Parameters	Main parameters that likely drive environmental impacts identified
General Model	All relevant processes are included
General Model / Scenarios	Identification of missing data, methods for filling those gaps, and any assumptions
General Model	Model Schematic
General Model / Scenarios	Mass balance (per unit process): inputs, outputs, scraps, water, etc.
General Model / Scenarios	Cut-off criteria (1%-weight)
General Model / Scenarios	C balance (fossil, biogenic) and LULUC (if relevant)
General Model / Scenarios	Is energy consumption correctly assumed

General Model / Scenarios	Do we have the data for transport? (i.e., distances, means of transport)
General Model / Scenarios	Is waste treatment process in A1-A3 assumed
General Model / Scenarios	Do we have data for packaging of the product at gate?
General Model / Scenarios	Do we have data for packaging of inputs / raw materials?
General Model / Scenarios	Direct emissions included (i.e., combustion) and balance of elements (e.g., N, P, K in agriculture)
Scenarios / Overview Parameters	Summary of parameters reported for each scenario (region)
General Model / Scenarios	Documentation of References
General Model / Scenarios / Overview Parameters	For high & low scenarios: Driving parameters, relevant values

QA Gate 2: LCA Modelling

The second QA Gate reviews the modelling, including the implementation of the data that has been acquired previously, compliance with methodological specifications, and the technical implementation of the model. While it may be beneficial to conduct part of the QA-analyses with regards to calculated LCIA results, this is an optional item that can be pursued, if background data is available, but can be omitted (and left for QA Gate 3), if background data has not been added to the model yet.

Table 10: Qualifying questions in the Quality Assurance Gate 2: LCA Model

Model file name, nomenclature, template
Selected background database, version and system model (if applicable) recorded in the comment cell; for a stripped foreground model, record that background data connection is pending and defer the associated checks to Gate 3.
Comment with details of dataset modeler, product, process description, assumptions in the model, last edited
Consistent use of template in Umberto (e.g., datasets modelled in scenarios)
Elementary flows: Is Water emission to air correctly included as elementary flow?
Elementary flows: Direct emissions from combustion of (fossil, biogenic) fuels included and fugitive emissions from processes (e.g., clinker)
Elementary flow: Is biogenic uptake (carbon dioxide in air) included (e.g., forestry operations)?
Elementary flow: Is land use occupation and transformation included if not already included in aggregated datasets?
Choice of datasets from the selected background database: check mappings (from Umberto export), reference products, system boundaries and transport coverage; document deferred checks for stripped foreground models and complete them by Gate 3.
Correct implementation of Indicators (incl. LCI indicators) for EN 15804+A2 and ISO 21930, and for SuperFormat requirements (e.g., PERM, PERNT, secondary resources)
Is transport correctly modelled?

Are secondary resources modelled correctly?
Is allocation correctly implemented?
Is the declared unit and reference flow correctly implemented, including explicit net-product or gross product-plus-packaging mass and any conversion factors?
Parameters (in Umberto correctly set?)
Energy balance correctly implemented (e.g., check unit (MJ or GJ or kWh), check mapping for energy)
Process waste treatment correctly implemented in A1-A3
Packaging correctly implemented: raw material packaging, recycling of raw material packaging, product packaging
Documentation: very relevant (!) notes on plans, comments in the description field in the documentation tab
Check of example LCIA results of dataset or reference scenario (including benchmarking against existing datasets and contribution analysis and plausibility check)
Are high & low scenarios (driving parameters, relevant values) correctly implemented
Data quality check (data quality assessment as defined in section 2.11 of the methodology) - calculation in Excel?
Compliance with modelling principles - topics not mentioned above

QA Gate 3: Datasets

The third QA Gate finally reviews the resulting datasets and their LCIA / indicator results. This should include benchmarking with other data that is publicly available. If the qualitative review of the resulting indicator values has been integrated with QA Gate 2 – which may be an efficient option – then QA Gate 3 is limited to reviewing the correct transfer of data and results from model and documentation data into result datasets.

Table 11: Qualifying questions for QA Gate 3: Datasets.

Dataset Name & Dataset Classes
Reference Flow & Declared Unit
Reference year
Geography
Technical product (manufacturing process) description & Product Function
Data Sources
Biogenic carbon content in product
Biogenic carbon content in accompanying packaging

LCIA Indicators EN 15804 ‘Typical’ - values in dataset correct (transfer from model ok)
LCIA Indicators EN 15804 'Low' Scenario - values in dataset correct (transfer from model ok)
LCIA Indicators EN 15804 'High' Scenario - values in dataset correct (transfer from model ok)
LCIA Indicators TRACI ‘Typical’ - values in dataset correct (transfer from model ok)
LCIA Indicators TRACI 'Low' Scenario - values in dataset correct (transfer from model ok)
LCIA Indicators TRACI 'High' Scenario - values in dataset correct (transfer from model ok)
Resource & Energy Indicators EN 15804 ‘Typical’ - values in dataset correct (transfer from model ok)
Resource & Energy Indicators EN 15804 'Low' Scenario - values in dataset correct (transfer from model ok)
Resource & Energy Indicators EN 15804 'High' Scenario - values in dataset correct (transfer from model ok)
Plausibility check 1: LCIA Indicators: EN 15804 & TRACI indicators - similar patterns
Plausibility check 2: GWP EN 15804 ‘Typical’: reference to existing similar data - results plausible?
Plausibility check 2: GWP EN 15804 'Low': reference to existing best-in-class data - results plausible?
Plausibility check 2: GWP EN 15804 'High': reference to existing similar (worst case) data - results plausible?
Plausibility check 3: GWP EN 15804 ‘Typical’, 'Low' and 'High': Values for different regions plausible? (Compare with existing other data, if possible)