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BRE Global Product Category Rules (PCR) For Type III EPD of Construction Products to EN 15804+A1

PN 514 Rev 2.0

Contents

Revision of the BRE Global Product Category Rules

The BRE Global Product Category Rules (PCR) for Type III environmental product declaration of construction products to EN 15804 will be revised by issue of revised editions or amendments. Details will be posted on the BRE Green Book Live website at www.greenbooklive.com.

Technical or other changes which affect the requirements for the issue of an environmental product declaration will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, update to normative reference details, the addition of notes for clarification, etc.) may be made as amendments.

The revision (issue) number will be given in decimal format with the integer part giving the issue and the fractional part giving the number of amendments (e.g. Rev 2.3 indicates that the document is at issue 2 and this is the 3rd amendment to issue 2).

Users of this BRE Global PCR should ensure that they possess the latest issue and amendment.

Changes/amendments issued since last publication

This Rev 2.0 supersedes Rev 1.0 which was published in April 2017.

Date	Type	Text/Clause affected
11 Jan 2018	Amendment	Text in clause 6.4.2
		Text in Appendix C3.1
		Table C.1 of Appendix C6
		Table C.2 of Appendix C6
28 April 2017	Amendment	Update to references within PCR (EN 15804:2012+A1:2017 shortened to EN 15804+A1)
		Inclusion of one new normative reference (PD CEN/TR 16970:2016)
		Text in clause 3.14
		Text in clause 3.18
		Text in clause 5.4
		Text in clause 5.6
		Text in clause 6.2
		Text, Figure 6.1, Tables and illustrative examples in clause 6.3.4

Date	Type	Text/Clause affected
		Text in clause 6.3.5
		Text in clause 6.3.11
		Text in clause 6.4.1
		Text in clause 7.1
		Text and Table 7.2 in clause 7.2.1
		Text in clause 7.6
		Text in clause 8.2
		Text in Appendix A
		Text in Appendix B

Introduction

Manufacturers of construction products, designers, users and owners of buildings and others active in the building and construction sector are demanding information that will enable them to make decisions which address environmental impacts of buildings and other construction works. An increasingly common solution is to create *environmental product declarations* (EPD). These are ISO Type III environmental declarations providing quantified environmental data for predetermined indicators using independently verified life cycle assessment (LCA).

EPD are similar to the nutritional information found on the back of food packets. EPD present quantified environmental information on the life cycle of a product, i.e. the impacts caused throughout its life. In Europe, EPD for construction products are derived according to the requirements of EN 15804, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. Published in 2012 by the European Committee for Standardisation (CEN), EN 15804 is part of a suite of standards for the assessment of the sustainability of construction works at both product level and building level. This suite of standards includes:

- EN 15643-1, Sustainability of construction works – Sustainability assessment of buildings – Part 1: General framework
- EN 15643-2, Sustainability of construction works – Assessment of buildings – Part 2: Framework for the assessment of environmental performance
- EN 15978, Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method
- CEN/TR 15941, Sustainability of construction works – Environmental product declarations – Methodology for the selection and use of generic data
- EN 15942, Sustainability of construction works – Environmental product declarations – Communication formats: business to business

This document forms the product category rules (PCR) for BRE's Type III EPD programme. Due to the on-going nature of the work of the CEN Technical Committee (TC 350), and the continuing developments in LCA, it is anticipated that the information contained in this PCR will continue to evolve.

NOTE: Compliance with this PCR does not confer immunity from legal obligations. Users of this PCR should ensure that they possess the latest issue and all amendments.

NOTE: Throughout this PCR document, the abbreviation 'EPD' is both the singular and plural form for ISO Type III environmental product declarations.

1 Scope

This is a PCR document for the assessment of the environmental performance of construction products. It describes BRE's methodology for creating an EPD for any construction product or service.

The advantage of a single PCR covering all construction products is that it enables all sectors to readily see how all materials are assessed at the product level. As there is currently no such PCR existing, BRE has created a new PCR to fulfil this purpose.

This PCR document has been prepared to be in line with the requirements of EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products (EN 15804+A1).

The methodology underpinning the EPD has therefore also been prepared to be in conformity with the relevant ISO standards for Type III environmental declarations, ISO 14025:2010 and ISO 21930:2007, and the standards relating to environmental management using life cycle assessment, ISO 14040:2006 and 14044:2006.

NOTE: (Prior to the publication of the first issue of this PCR document) Permission to reproduce extracts from BS EN 15804:2012, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products is granted by BSI. British Standards can be obtained in PDF or hard copy formats from the BSI online shop: www.bsigroup.com/Shop or by contacting BSI Customer Services for hardcopies only: Tel: +44 (0)20 8996 9001, Email: cservices@bsigroup.com.

2 Normative references

The following referenced and unreferenced documents are indispensable for the application of this document.

- EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products
- EN 15643-1:2010, Sustainability of construction works – Sustainability assessment of buildings – Part 1: General framework
- EN 15643-2:2011, Sustainability of construction works – Assessment of buildings – Part 2: Framework for the assessment of environmental performance
- EN 15978:2011, Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method
- CEN/TR 15941:2010, Sustainability of construction works – Environmental product declarations – Methodology for selection and use of generic data
- EN 15942:2011, Sustainability of construction works – Environmental product declarations – Communication formats: business to business
- EN 16485:2014, Round and sawn timber – Environmental Product Declarations – Product category rules for wood and wood-based products for use in construction
- EN 16449:2014, Wood and wood-based products – Calculation of the biogenic carbon content of wood and conversion to carbon dioxide
- ISO 14025:2010, Environmental labels and declarations – Type III Environmental declarations – Principles and procedures (identical to ISO 14025:2006)
- ISO 21930:2007, Sustainability of construction works – Environmental declaration of building products (as referenced by EN 15804)
- ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework
- ISO 14044:2006, Environmental management – Life cycle assessment – Requirements and guidelines
- PD CEN/TR 16970:2016, Sustainability of construction works. Guidance for the implementation of EN 15804

NOTE: Throughout this PCR, all undated references to standards refer to the current published version of those standards (including any amendments). Clauses with dated references within the PCR refer only to the cited edition of the particular standard(s). All references to specific clauses and general texts in EN 15804+A1 refer to the cited normative edition, EN 15804:2012+A1:2013.

3 Terms and Definitions

The technical terms and concepts employed in life cycle assessment are defined in accordance with EN 15804+A1. Terms are not defined where they retain their normal dictionary definition. Where bold type is used within a definition, this indicates a cross reference to another term defined in this clause.

3.1 Ancillary product / Complementary product

Construction product that enables another construction product to fulfil its purpose in the intended application, for example, fasteners used to attach structural panels to framing members.

3.2 Average data

Data representative of a product, product group or construction service, provided by more than one supplier. A product group or construction service can contain similar products or construction services.

3.3 Building product / Construction product

Goods or services used during the life cycle of a building or other construction works.

In this PCR, the term ’product’ used alone relates not only to product systems but can also include service systems. In either case, the declaration is presented in a manner that clearly indicates whether the declaration applies to goods, or only to a part of the goods or packaging, or to an element of a service. See ISO 14025:2010, clause 7.2.2.

The manufacturing or processing of goods used as a building product may take place at the factory or on the construction site.

The use of services can occur at any stage of the life cycle of the building or other construction works.

Whereas ISO use ‘building product’, in this PCR the term ‘construction product’ is used. There is no difference in meaning intended between the two terms as defined above and the choice is based on the more common usage of ‘construction product’ in the UK and Europe.

3.4 Carbonation

The formation of calcium carbonate in products containing calcium oxide or calcium hydroxide (such as concrete) as a result of chemical reaction between carbon dioxide from the air with calcium hydroxide in the product.

3.5 Characterisation factor

Factor derived from a characterisation model which is applied to convert an assigned life cycle inventory (LCI) analysis result to the common unit of the category indicator.

3.6 Declared unit

Quantity of a **construction product** for use as a reference unit in an EPD, based on LCA, for the expression of environmental information needed in **information modules**, for example kg, m, m^2, m^3.

The declared unit shall only be used where the function and the reference scenario for the whole life cycle, at the building level, cannot be stated.

3.7 Functional equivalence

The comparability of one or more products or services using common functional performance criteria. It is considered in the context of a building or an assembly of **construction products**, and is the basis on which a **functional unit** can be defined.

3.8 Functional unit

Quantified performance of a product system for a **construction product** for use as a reference unit in an EPD based on LCA.

3.9 Gate

Point at which the **construction product** or material leaves the factory before it becomes an input into another manufacturing process or before it goes to the distributor, a factory or building site.

3.10 Generic data

Data that is publicly available, and may be **average data** or **specific data**

3.11 Information module

Compilation of data to be used as a basis for a **Type III environmental declaration**, covering a unit process or a combination of unit processes that are part of the life cycle of a product.

3.12 Non-renewable energy

Energy from sources which cannot be replenished on a human time scale (fossil sources) for example coal, oil, natural gas and uranium.

3.13 Non-renewable resource

Resource that exists in a fixed amount that cannot be replenished on a human time scale. In the context of EN 15804+A1, this relates to a resource that could be used for energy but is used as a raw material, for example oil (petrochemicals) for polymer manufacture. Consequently, water is excluded from this indicator.

3.14 PCR review

Process whereby a third party panel carries out a formal critical assessment of the **product category rules**.

3.15 Product category

Group of products that can fulfil equivalent functions.

3.16 Product category rules (PCR)

Set of specific rules, requirements and guidelines for developing **Type III environmental declarations** for one or more product categories. This BRE PCR applies to the product category "**construction products**".

3.17 Programme operator

Body that conducts an ISO **Type III environmental product declaration** programme, such as BRE Global.

3.18 Radioactive waste

Waste containing radioactive material. Radioactive waste is categorised by the International Atomic Energy Agency (IAEA) as exempt waste (EW), low and intermediate-level waste (LILW), or high-level waste (HLW). LILW is further sub-divided according to the half-lives of the radionuclides it contains into “short lived” (less than 30 years) and long lived (more than 30 years). The IAEA classification of radioactive waste considers qualitative and quantitative factors including activity levels and heat content.

In this PCR the radioactive waste indicator described in EN 15804+A1 is taken to represent the total mass of LILW and HLW.

Beyond the requirements of the standard, BRE has defined an additional parameter for reporting HLW, and derived characterisation factors for this because: (i) The World Nuclear Association estimates that HLW accounts for over 95% of the radioactivity produced from electricity generation, (ii) HLW is the most problematic waste to deal with and presents the greatest risks to humans and ecosystems, and (iii) HLW is the only category of radioactive waste from electricity generation that must be declared under the fuel mix disclosure requirements of European Directive 2003/54/EC. HLW can therefore be reported as additional environmental information in EPD generated using this PCR.

3.19 Reference service life

Service life of a **construction product** that is known or to be expected under a reference set of in-use conditions and which may form the basis of estimating the service life under other in-use conditions.

The reference service life is applied to the **functional unit** or **declared unit**. See EN 15804+A1, Annex A.

3.20 Renewable energy

Energy from renewable sources (typically non-fossil sources) for example solar, wind, hydro (excluding pumped-through hydro) and biomass.

3.21 Renewable resource

Resource that is grown, naturally replenished or cleansed on a human time scale, for example, trees in forests, grasses in grasslands and fertile soil. A renewable resource is capable of being exhausted, but may last indefinitely with proper stewardship.

In this PCR water has been excluded from the definition of renewable resource, and is only reported in the ‘net fresh water’ indicator described in EN 15804+A1.

3.22 Secondary fuel

Fuel recovered from previous use or from **waste** which substitutes primary fuels. See EN 15804+A1, clause 3.28, Notes 1, 2, 3 and 4.

3.23 Secondary material

Material recovered from previous use or from **waste** which substitutes primary materials. See EN 15804+A1, clause 3.29, Notes 1, 2 and 3.

3.24 Sequestration (of carbon)

The removal and storage of carbon dioxide from the atmosphere in biomaterials such as timber and agricultural products.

3.25 Service life

The period of time from construction/installation during which a building or its components meets or exceeds its performance requirements.

3.26 Specific data

Data representative of a product, product group or construction service, provided by one supplier.

3.27 Study period

The period of time over which the environmental impacts of a building or its components shall be measured.

3.28 Third party

Person or body that is recognised as being independent of the parties involved, as concerns the issues in question.

3.29 Type III environmental declaration / environmental product declaration (EPD)

Environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information. The predetermined parameters are based on the ISO 14040 series of standards, which is made up of ISO 14040 and ISO 14044.

The additional environmental information may be quantitative or qualitative.

3.30 Waste

EN 15804+A1 defines waste as ‘substance or object which the holder discards or intends or is required to discard’.

4 Abbreviations

DU Declared Unit

EPD Environmental Product Declaration

FU Functional Unit

IAEA International Atomic Energy Agency

LCA Life Cycle Assessment

LCI Life Cycle Inventory

LCIA Life Cycle Impact Assessment

PCR Product Category Rules

RSL Reference Service Life

SP Study Period

SVHC Substances of Very High Concern (European Chemicals Agency)

5 General Programme Information

5.1 Objectives

For the PCR to be used to produce EPD for construction products and services that:

1. Provide a measurable and verifiable data source for the assessment of the environmental performance of buildings.
2. Enable interested parties to compare the environmental impacts of different construction products as they are used within a building, based on units of equivalent functionality. EN 15804+A1, clause 5.3, on comparability of EPD for construction products sets out the strict requirements for comparison.
3. Provide a means of collecting relevant data for the preparation of product level and building level tools for comparing the environmental impacts of construction products and compliant software tools.

5.2 Types of EPD with respect to life cycle stages covered

This PCR adopts the information module approach required by EN 15804+A1 (as illustrated in Figure 5.1). There are three types of EPD based on this PCR, as shown in Table 5.1.

Table 5.1: The three types of EPD

EPD Type	Life cycle stages included	Units	Use for comparison
Cradle-to-Gate	Covering product stage information A1 to A3 (raw material supply, transport, manufacturing of products, and all upstream processes from cradle-to-gate). This comprises the minimum of processes that shall be required in a declaration for compliance with EN 15804+A1	Declared unit	Shall not be used for comparison
Cradle-to-Gate with options	Covering product stage information as a minimum, plus any other information modules from both the use stage and the end-of-life stage (B1 through to C4). Benefits and loads beyond the system boundary (Module D) may be included	Declared unit or functional unit	Can be used for comparison, subject to conditions as stated in EN 15804+A1 clause 5.3
Cradle-to-Grave	Covering all of the life cycle stages as a minimum, including end-of-life at or beyond the study period. Benefits and loads beyond the system boundary (Module D) may be included	Functional unit	Can be used for comparison, subject to conditions as stated in EN 15804+A1 clause 5.3

	Life cycle stages	Product			Construction		Use stage							End-of-life				Benefits and loads beyond the system boundary
							Related to the building fabric					Related to the building operation						
	Modules	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
		Raw material supply	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Demolition	Transport	Waste processing	Disposal	Reuse / Recovery / Recycling potential
		Scenarios																
Type of EPD	Cradle to Gate[1]	M	M	M														
	Cradle to Gate with option(s)[2,4]	M	M	M	O	O	O	O	O	O	O	O	O	O	O	O	O	O
	Cradle to Grave[3,4]	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	O

Key M mandatory O optional

Notes
[1] for a declared unit
[2] for a declared unit or functional unit
[3] for a functional unit
[4] Reference Service Life to be included only if all scenarios are included

Figure 5.1: Illustration of mandatory and optional elements and information modules for construction products, adapted from EN 15804+A1

It is possible to have an EPD for a material (e.g. cement), for a product or component (e.g. brick or bricks and mortar), and for an assembly of products or components (a building element e.g. an external wall), which can then be used at both product level and building level assessments. Note that the EPD of an assembly of materials, products or components can incorporate the results of the EPD of all the constituent materials and construction products. This is described in clause 5.4 (Modularity) in ISO 14025:2010.

5.3 Comparability of EPD of construction products

In principle, comparison of the environmental performance of construction products using EPD information shall only be carried out at the building level using the same functional unit in a complete life cycle (cradle-to-grave EPD), as it should be based on their use in and impacts on the building.

Comparison at sub-building level can also be carried out subject to conditions, provided the technical and functional performances are identical. See EN 15804+A1 and ISO 14025 for further guidance. This PCR shall apply the same conditions as listed in EN 15804+A1, clause 5.3 and ISO 14025:2010, clause 6.7.2.

5.4 Additional Information

The following two categories of information which are not derived from LCA are addressed by this PCR:

Additional technical information, consisting of physical data characterising the product's functional performance during the life cycle beyond the product stage of the life cycle, i.e. in construction, use, and end-of-life stages, shall be provided by the manufacturer where

applicable. This information is used to support the consistent development of scenarios in respective modules for the evaluation of these life cycle stages at the building level.

Additional information on emissions to indoor air, soil and water during the use stage, describing release of dangerous substances to indoor air, soil and water which are not covered by impact assessment shall also be provided where applicable, subject to the availability of harmonised measurement methods as provided by Technical Committees of CEN, such as TC 351.

See section 7.3 and 7.4 in this PCR for further guidance on reporting of additional information.

5.5 Ownership, responsibility and liability for the EPD

The manufacturer (or group of manufacturers) is the sole owner, and has liability and responsibility for an EPD. See EN 15804+A1, clause 5.5.

5.6 Communication formats

EPD produced using this PCR can either be for business to consumer communication (formatted according to conditions listed in ISO 14025:2010) or for business to business communication (formatted in accordance with EN 15942:2011).

For BRE Global EN 15804 EPD, BRE has developed a template in line with the requirements of EN 15942:2011, available to programme members from the BRE Programme Operator.

6 Product Category Rules for LCA

6.1 Product Category

This PCR document sets out the product category rules for all construction products. Where specific rules apply for particular groups, these shall be clearly stated.

6.2 Life Cycle Stages and their information modules to be included

As specified in Figure 5.1, the environmental information in a BRE EPD covering all life cycle stages (cradle-to-grave) shall be subdivided into the following information module groups:

- Product stage comprising:
  - A1 – raw material supply, including processing of secondary material input
  - A2 – transport of raw material and secondary material to the manufacturer
  - A3 – manufacture of the construction products, and all upstream processes from cradle to gate
- Construction process stage comprising:
  - A4 – transport of construction products to the building site
  - A5 – the building installation/construction
- Use stage (related to building fabric):
  - B1 – use of the installed product, service or appliance
  - B2 – maintenance of the product
  - B3 – repair of the product
  - B4 – replacement of the product
  - B5 – refurbishment of the construction product
- Use stage (related to operation of building):
  - B6 – operational energy
  - B7 – operational water use
- End-of-life stage comprising:
  - C1 – demolition of the building/building product
  - C2 – transport of the demolition waste comprising the end-of-life construction product to waste processing facility or to final disposal
  - C3 – waste processing operations for reuse, recovery or recycling
  - C4 – final disposal of end-of-life construction product
- Benefits and loads beyond the system boundary:

- D – reuse/recovery/recycling potential evaluated as net impacts and benefits

The product stage modules A1 – A3 comprises the minimum processes that shall be included in an EPD (i.e. cradle-to-gate is the minimum). Further, modules A1, A2 and A3 may be declared as one aggregated module A1 – A3.

In order to evaluate the impacts of the product in the life cycle stages that depend on the building context, scenarios have to be defined to identify the specific conditions and assumptions of the evaluation. This is to ensure that the product data used in this product level assessment are applicable in a building level assessment. For example, the building type in which a carpet product is to be installed and the scope of the building assessment will determine the scenarios in the building life cycle, and these in turn determine the scenarios that shall be evaluated for the installation (A4 – A5), the use pattern (B1 – B7) and the end of life (C1 – C3) excluding final disposal (which will be product dependent). See EN 15978:2011 for more information on building life cycle stages scenario definition for building level assessment.

6.3 Calculation Rules for LCA – General aspects

6.3.1 Functional Unit

In conducting an LCA, a functional unit is a quantified performance of a product system under study, for use as a reference unit for the inputs and outputs of the system. This reference unit enables different product systems capable of performing the same function to be compared. To generate an LCA-based EPD for a construction product, the functional unit of a construction product is based on:

- The quantified, relevant functional use or performance characteristic of the construction product when integrated into a building, taking into account the functional equivalent of the building.
- The product's reference service life (see 6.3.3 of this PCR) or required service life of the building, as this relates functional performance of a construction product over a relevant time period (study period).

The EPD shall state the conversion factors required to calculate between the functional unit and the declared unit (for example densities, unit volumes).

6.3.2 Declared Unit

The declared unit shall be applied in place of a functional unit when an EPD is based on a cradle-to-gate LCA, and, also on a cradle-to-gate with options LCA where suitable. The declared unit in the EPD shall be one of the unit types listed below:

- Mass, e.g. 1 tonne of brick
- Area, e.g. 1 square metre of carpet
- Length, e.g. 1 metre of pipe
- Volume, e.g. 1 cubic metre of timber
- Item/piece, e.g. 1 radiator

6.3.3 Reference Service Life (RSL)

The reference service life of a product is considered within the context of its use in a building, and is relevant to the use stage assessment. In cradle-to-grave assessments some materials, components or building elements may be expected to need maintenance, refurbishment or replacement before the end of the study period. This is dealt with in the PCR by determining a reference service life for each material, component or building element, as informed by the manufacturer. The RSL depends on the functional performance of the product, the construction stage, and the reference conditions of the use stage. Therefore, the RSL can only be declared for a cradle-to-grave EPD or a cradle-to-gate EPD with options where all the scenarios for modules B1 – B5 have been provided. The RSL shall be verifiable.

Using information provided by the manufacturer, the number of maintenance, refurbishment or replacement operations is calculated by considering the likelihood that the component will be replaced within the study period. This shall be taken into account in the EPD. Note that the RSL is not the same as the study period (see Section 3.24 in this PCR). See EN 15804+A1, Annex A (normative) for requirements and guidance on determining RSL.

In the context of a building level assessment, if a component in an element is expected to be replaced within the study period and can be replaced without removing the rest of the building element, then only the materials associated with that particular component will be replaced. If other components of the building element, or the entire element, must be replaced because of the shorter lived components, then all the relevant components or element will be replaced within the assessment, even if the materials removed have a potentially longer lifetime.

6.3.4 System Boundaries

System boundaries have been established in accordance with the provisions of ISO 14044:2006, clause 4.3.3.4 and EN 15804+A1, clause 6.3.4. This BRE PCR covers three types of EPD: (i) Cradle-to-Gate, (ii) Cradle-to-gate with options, and (iii) Cradle-to-Grave.

The EPD shall present data covering the relevant life cycle stages as illustrated in Figure 5.1.

The environmental information of an EPD covering all life cycle stages (cradle-to-grave) shall be subdivided into the information modules groups within each life cycle stage, i.e. in addition to the product stage whose modules A1 – A3 may be aggregated, the remaining modules in the construction stage (A4 – A5), use stage – building fabric (B1 – B5), and –operation (B6 – B7), end of life stage (C1 – C4), and Module D if included, shall be presented separately.

Product stage, information modules A1 – A3

The product stage shall include the information modules as stated in EN 15804+A1, clause 6.3.4.2.

See Table 6.1. This stage includes the provision of all materials, products and energy, as well as waste processing up to the end-of-waste state (i.e. no longer considered a waste material, as defined in EN 15804+A1, clause 6.3.4.5) or disposal of final residues during the product stage. In addition to the outputs of the product stage, the system boundary also includes any other output leaving the system that has a value associated with it. Such outputs shall be identified as co-products of the system.

Table 6.1: Product stage

Module	Modelling requirements
A1	All raw material inputs required, virgin and secondary for the manufacture of the quantity of the declared unit or functional unit (DU/FU) of the study product
A2	Transport of the raw materials inputs and any other process inputs to the manufacturing plant
A3	The manufacturing process (energy, water), waste generated and disposed, other emissions, packaging and ancillary materials used and wasted, all other wastes from manufacturing plant allocated to the study product

Maintenance of equipment is not included in the LCA except for frequently consumed items which are included in the inventory if they meet the data 1% cut-off rule or cannot be excluded according to the rules in 6.3.5 below.

All energy used in factories and factory support offices is included. Head offices and sales offices etc. are excluded. For renewable energy schemes, see 6.3.11 below.

Construction process stage, information modules A4 – A5

The construction process stage shall include the information modules as stated in EN 15804+A1, clause 6.3.4.3.

Table 6.2: Construction stage

Module	Modelling requirements
A4	Transport of the amount of the DU/FU of the product from manufacturing plant (gate) to the construction/installation site
A5	Installation of DU/FU of the product (energy, water), ancillary installation materials (e.g. screws/nails/glue, etc.), plus disposal of any amount wasted (e.g. based on a representative installation wastage rate) plus A1 – A3 for the quantity of product wasted during installation (that needs to be remanufactured to fulfil the installation of the correct quantity of the DU/FU) plus the delivery (A4) of this replacement quantity to site. Also includes any storage requirements for the product on site before installation, where applicable

See Table 6.2. This stage also includes waste processing up to the end-of-waste state or disposal of final residues. In addition, the energy from storage of construction products, i.e. provision of heating, cooling, humidity control, etc. where applicable may be included where data is available. The transport and installation of the construction product are dependent on the context of the building where the construction product is used.

For the EPD data to adequately support a building level assessment, ancillary products and any energy or water required for installation as well as on-site operations for the construction product shall be included.

Use stage, information modules B1 – B7

The use stage relating to the building fabric and the operation of the building (Table 6.3) shall include the information modules as stated in EN 15804+A1, clauses 6.3.4.4.2 and 6.3.4.4.3.

NOTE: Depending on the LCA study, the study period (SP) may or may not be the same as the product's reference service life (RSL).

Table 6.3: Use stage (related to the building fabric and to the operation of the building

Module	Modelling requirements
B1	Any emissions to the environment during the use of the product over the study period
B2	Preventative and regular maintenance: ***planned*** cleaning, servicing, replacement or mending of worn, damaged or degraded ***parts of the product*** during the product's RSL. If the LCA SP is longer than the product's RSL, this should reflect the first service life and the additional service life required to fulfil the function in the total study period. Covers the maintenance required, e.g. cleaning chemicals and energy and any disposal of such process emissions like the waste cleaning chemicals, or (if replacement) the A1 – A3 and A4 for the replacement part of product, the disposal of the part of product being replaced, and the A5 for ancillary materials used (e.g. glue), energy, water, other wastes generated and disposed, any emissions
B3	Corrective, responsive or reactive repair of the product or part of the product during the product's RSL or the LCA SP. Includes an assumption of how many such repair situations will arise during the SP or RSL. Covers (if replacement of a part of the product) the A1 – A3 and A4 for the replacement part of product, the disposal of the part of product being replaced, and the A5 for ancillary materials used (e.g. glue), energy, water, other wastes generated and disposed, any emissions
B4	The replacement of the entire product due to damage during the SP. Covers the A1 – A3, A4 and A5 of the DU/FU of product, and the processes for deconstructing (removing) the entire damaged product, managing the waste and disposing of the waste (i.e. the entire end of life C1 – C4 for the DU/FU amount that is being replaced) B4 also covers the ***replacement of the entire product at the end of its RSL***
B5	The refurbishment of the entire product as part of a planned or scheduled programme of maintenance, repair and or replacement of a significant part of, or the entire building in which the product is installed. It is therefore actually either B2, B3 or B4 for the DU/FU, whichever is appropriate. In principle, the replacement of the entire construction product as part of a scheduled programme of refurbishment of the building is reported here as refurbishment of the product
B6 and B7	Energy and water use for the operation of the product in the building (applicable only to building integrated technical systems, e.g. for HVAC, lighting, cold and hot water and other sanitation systems, security, internal transport, etc.)

Notes:

1. It may be difficult to separate the use stage processes into the different modules B2 to B5, therefore the scenarios will always need to be clearly described in the EPD
2. replacement of the entire product due to damage shall be reported in B4, replacement
3. replacement of the entire product as part of a scheduled programme of refurbishment for the building shall be reported in B5, refurbishment
4. care should be taken to recognise that modules B1 to B5 will not be relevant for a lot of construction products, even in a Cradle-to-Grave EPD
5. further, apart from for building services products, B6 and B7 will also not be relevant for most construction products

Information module B1 refers to emissions to the environment, for example release of substances from painted surfaces and these shall be reported as additional information on release of dangerous substances to indoor air, soil and water once horizontal measurement standards have been published by CEN TC 351 (see NOTE 1 in EN 15804+A1, clause 6.3.4.4.2). Note that known emissions to the environment during the application of products such as painting will be reported as part of construction (installation) process stage, A5 above.

The impacts of maintenance (B2) are directly related to the context of the building, and shall be assessed with defined scenarios. This also applies to repair (B3), replacement (B4) and refurbishment (B5); and the assessment shall include production, transportation, use of energy and water, and any associated wastage and end-of-life processes. Here are three examples of use stage calculations for a window unit, a carpet product, and an insulation panel.

Number of replacements is derived as follows (rounded up to the nearest whole number):

$$\frac{SP}{product\ RSL} - 1$$

Example for a window					**comment**
product Reference Service Life (RSL), years	40				
LCA Study Period (SP), years	60				
no. of replacements in SP (round up to the next whole no.)	0.5	1			at year 40
scenario	**Information module**	**per year**	**per RSL**	**per SP**	**comment**
clean glass panes of glazing unit	maintenance - B2	12	480	720	
clean window frame	maintenance - B2	6	240	360	
grease window hardware (e.g. handles)	maintenance - B2	2	80	120	
repair or replace worn hardware at a planned point	maintenance - B2	1	40	60	
repair or replace glazing unit at a planned point	maintenance - B2	0.1	4	6	assuming a scchedule of once every 10 years
replace glazing unit due to broken glass pane	repair - B3	N/A	1	1	assuming one incidence during RSL or SP
replace damaged hardware	repair - B3	N/A	1	1	assuming one incidence during RSL or SP
replace the entire window due to damage	replacement - B4	N/A	1	1	assuming one incidence during RSL or SP
replace the entire window at end of its RSL	replacement - B4	N/A		1	
replace entire window when the building is refurbished	refurbishment - B5	N/A		1	assuming refurbishment of the building once in SP

Example for a carpet product					**comment**
product Reference Service Life (RSL), years	25				
LCA Study Period (SP), years	60				
no. of replacements in SP (round up to the next whole no.)	1.4	2			at year 25, and then at year 50
scenario	**Information module**	**per year**	**per RSL**	**per SP**	**comment**
clean carpet	maintenance - B2	12	300	720	
replace installation glue at a planned point	maintenance - B2	1	25	60	assuming a scchedule of once every year
replace carpet due to damage	replacement - B4	N/A	1	1	assuming one incidence during RSL or SP
replace the carpet at end of its RSL	replacement - B4	N/A		2	

Example for an insulation panel					**comment**
product Reference Service Life (RSL), years	40				
LCA Study Period (SP), years	50				
no. of replacements in SP (round up to the next whole no.)	0.25	1			at year 40
scenario	**Information module**	**per year**	**per RSL**	**per SP**	**comment**
clean the panel	maintenance - B2	1	40	50	
replace the panel due to damage	replacement - B4	N/A	1	1	assuming one incidence during RSL or SP
replace the panel at end of its RSL	replacement - B4	N/A		1	
replace panel when the building is refurbished	refurbishment - B5	N/A		1	assuming refurbishment of the building once in SP

The boundaries of operational energy use (B6) and operational water use (B7) shall include the energy and water use during the operation of the product, together with its associated environmental aspects and impacts including processing and transportation of any waste arising on site from the use of energy and or water. This covers integrated technical building systems for building services elements, e.g. for heating, ventilation and cooling, lighting, domestic water services, communication and IT, internal transport (e.g. lifts), fire and security.

Operational energy use can be obtained for example using Standard Assessment Procedure (SAP) for energy ratings for dwellings, and the impacts of the life cycle stages of the equipment required to supply energy to the building shall be assessed in the respective modules A1 – A5, B2 –B5, and C1 – C4.

Operational water use covers the study period for the assessment, beginning from handover of the building to the user.

End-of-life stage, information modules C1 – C4

As stated in EN 15804+A1, clause 6.3.4.5, the end-of-life stage of a construction product starts when it is replaced, dismantled or deconstructed from the building (or at the building's end-of-life) and does not provide any further functionality. Products which reach the end of life during the construction stage (A4 –A5) and the use stage (B1 – B7) have their end-of-life considered within the life cycle stage in which it arises. The treatment of end-of-life of products in any life cycle stage is assessed following the procedures set out in this section. See Table 6.4.

During the end-of-life stage, all outputs from the system (i.e. leaving the building) are considered to be waste until they reach the end-of-waste state. The end-of-waste state is reached when any such material or output complies with all the following criteria (see EN 15804+A1, clause 6.3.4.5):

- It is (commonly) used for specific purposes
- There is an existing market or demand for it
- Its use is legal
- Its use will not lead to overall adverse effects, such as SVHC[1] limits

The benefits and loads from the use of end-of-waste state materials in another product system (i.e. beyond the system boundary) are reported in Module D, see below. Note that materials for energy recovery are materials that have reached the end-of-waste state and are used in an energy recovery process with an energy efficiency rate (of the process) higher than 60%.

The potential benefits from utilising energy arising from a waste disposal process in information module C4, e.g. incineration of waste and landfill gas can also be presented in Module D, using current average substitution processes. See EN 15804+A1, clause 6.3.4.5.

Table 6.4: End-of-life stage

Module	Modelling requirements
C1	Deconstruction (dismantling/demolition) of the DU/FU of the product from a building
C2	Transporting the waste product to sorting/recycling or to end of life disposal site
C3	Sorting, collection, processing of waste product for the different routes (reuse, recycling, energy recovery, final disposal) at a waste processing facility
C4	Final disposal at disposal site, including any required pre-treatment and the management of the disposal facility

Benefits and loads beyond the product system boundary, information Module D

The stage shall include the information module as stated in EN 15804+A1, clause 6.3.4.6.

Module D covers the net benefits and loads arising from the reuse of products or the recycling or recovery of energy from end-of-waste state materials resulting from the construction stage (A4 – A5), the use stage (B1 – B7) and the end of life stage (C1 – C4). Typically, any outputs leaving the system from modules A1 – A3 are accounted for as a co-product if they have a value associated with them or as a waste if there is no value associated with them. Consequently it is expected that there will generally be no Module D declarations arising from Modules A1 – A3. Figure 6.1 below provides graphical guidance on the application of Module D.

[1] Candidate List of Substances of Very High Concern for Authorisation of the European Chemicals Agency

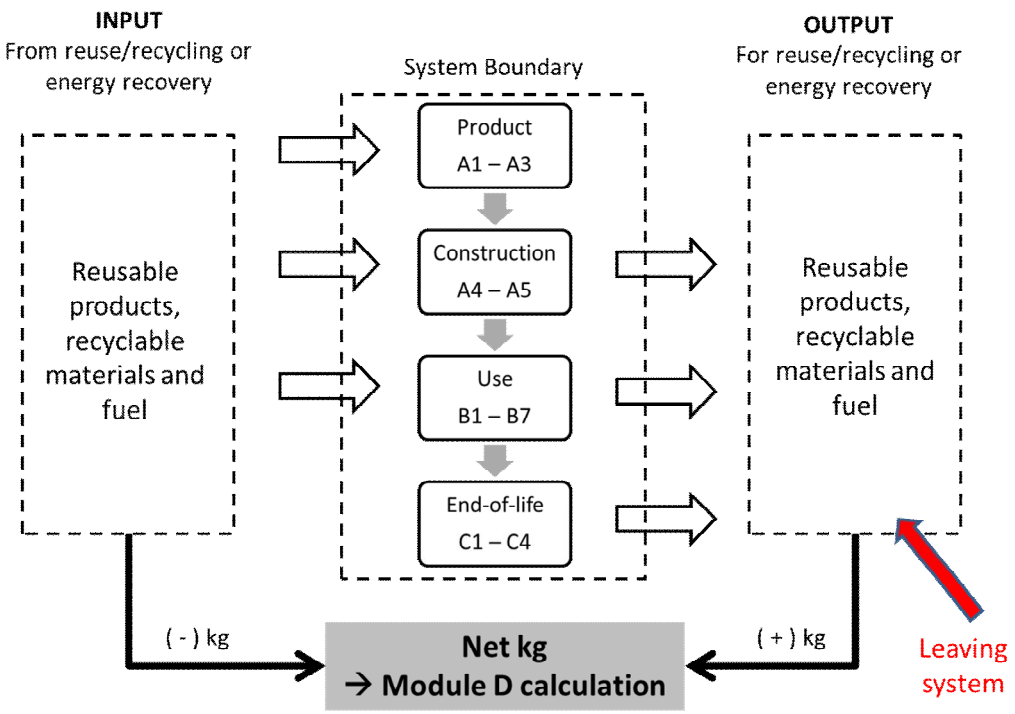

Figure 6.1: Module D Principles

Examples of secondary materials include recycled scrap metal, crushed concrete, glass cullet, recycled wood chips and recycled plastic, while energy carriers include any combustible material which is fed into an energy recovery process that has process efficiency greater than 60%.

Module D is applied only to products/materials which substitute other materials or fuels in another product system (e.g. as secondary materials and energy carriers) and have reached the end-of-waste state. Further, Module D can only be calculated based on a specified scenario which is consistent with any other scenario for waste processing and is based on current average technology or practice. See EN 15804+A1, clause 6.4.3.3. The reuse, recovery or recycling scenario must be clearly stated in the EPD.

Double counting must be avoided by excluding flows of co-products, and by calculating the net output flows of the secondary material or fuel from the product system. The following is an example of net output flow and module D calculation.

Example: The following scenarios are for an EPD being generated for a product A, with a declared unit of 10 kg. After deconstruction and transport to waste processing, the output at end of life is 8 kg available for recycling and 2 kg which is to be disposed of in a landfill:

- the 8 kg of scrap (waste) material has reached the end of waste state, and is therefore available for reuse in a future system
- the impacts of processing the waste to obtain the 8 kg are to be reported in information module C3

- the impacts of final disposal of the 2 kg are to be reported in module C4

Assuming the recovered material is capable of replacing a virgin material on a 1:1 basis in the production of another product B (i.e. a future use), then the net output flow and Module D calculations that can be reported for product A are as follows:

1. If the 8 kg of end of waste state material is available to replace 8 kg of virgin material, then the benefit of avoiding 8 kg of virgin material production are reported in Module D for product A
2. If the product A initially had a 50% recycled content (i.e. based on recycled input in the product stage A1-A3 of product A), then the net output flow is actually 8 kg – (10*50%) = 3 kg. Therefore 3 kg of end of waste material is available to replace 3 kg of virgin material in the future use, and the benefit of avoiding 3 kg of virgin material production are reported in Module D for product A
3. If the 3 kg of end of waste material available from 2 above required a further processing step to make it suitable for a 1:1 replacement of virgin material, resulting in a further loss of 0.5 kg, meaning only 2.5 kg from the end of waste material ends up in the future product, then the impacts of this additional processing, as well as the impacts from disposing of 0.5 kg, are subtracted from the avoided impacts of producing 2.5 kg of virgin material for product B. This is reported as the Module D for product A.
4. If the product A actually had 90% recycled content (and not 50% as in scenario 2 above), then the net output flow is in fact 8 kg – (10*90%) = -1 kg. This implies that product B will actually need an additional 1 kg of virgin material (instead of just 2 kg). This negative flow of scrap material is a load rather than a benefit, and it is therefore not anticipated that the EPD for product A will include a Module D section showing this burden

For further guidance in the calculation of the net output flows and benefits and loads in Module D, see EN 15804+A1, clause 6.4.3.3 and in this BRE PCR, clause 6.5.3. Module D does not affect the other modules as it is independent of other calculation rules.

6.3.5 Criteria for the exclusion of inputs and outputs

The criteria for the exclusion of inputs and outputs are to be applied as stated in clause 6.3.5 of EN 15804+A1.

The inventory process gathers all the inputs to the plant that are associated with a product, including product ingredients, packaging materials and consumable items. For many processes, a large number of substances and materials are used in very small quantities and it is unrealistic to gather data on all of these.

However, it is important that significant environmental effects are not omitted by ignoring low mass flows of substances. Analysis may later reveal that these substances do not significantly affect the overall result but it is important that data is provided to enable this conclusion to be drawn. To achieve this, the following conventions are applied:

In case of insufficient data or data gaps for a unit process, the cut-off criteria shall be 1% of the total mass input of that process. The total of neglected input flows per module shall be a

maximum of 5% of energy usage and mass. The exception is if they have any of the following in which case they have to be included:

- Significant effects of or energy use in their extraction, their use, or disposal
- Are classed as hazardous waste

Mass balance checks ensure the inputs stated are sufficient to produce all the outputs, including waste arising. Whereas EN 15804+A1 allows for a maximum of 5% deficit, this BRE PCR recommends that where there are insufficient inputs to account for all outputs, the input inventories should be adjusted proportionally to 100% to balance this deficit.

6.3.6 Selection of data

In general, a combination of generic and manufacturer-specific data shall be the preferred choice for use in calculating an EPD as follows:

- Specific or average data that has been derived from specific production processes shall be used in the production/manufacturing LCA. Specific data may also be used for upstream processes (raw material production) where available
- Generic data shall be used for all other upstream and downstream processes that are beyond the control of the manufacturer (i.e. raw material production, construction product installation, use and end-of-life respectively)

Where a cradle-to-grave EPD has been calculated using generic data for downstream processes, e.g. for the disposal scenario in the end-of-life stage, to ensure consistency and comparability, both the use stage and the end-of-life stages shall be based on the same additional technical information stated by the manufacturer for the development of the scenarios for the LCA. The technological, geographical and time period of the generic data used shall be documented in the project report (see CEN/TR 15941:2010 for guidance on selection and use of generic data).

6.3.7 Data quality requirements

In accordance with ISO 14044:2006, clause 4.2.3.6, the quality of the data used to calculate the EPD shall be addressed in the project report. In addition, the specific requirements listed in EN 15804+A1, clause 6.3.7 shall apply for construction products. The most current, available data shall be used to calculate an EPD. The manufacturer-specific data shall cover a production period of 1 year and this data period shall be documented, and deviations from this data range shall be justified. Generic or specific data used for the calculations shall have been updated within the last 5 years for manufacturer-specific data and within the last 10 years for generic data.

For guidance on how to deal with data gaps refer to CEN/TR 15941:2010.

6.3.8 Developing product level scenarios

Realistic and representative scenarios shall be based on relevant technical information and shall support the calculation of the information modules as shown in Figure 5.1 and the assessment of the environmental performance of a building (building level assessment) in construction, use and end-of-life stages. See EN 15804+A1, clause 6.3.8: a scenario shall be realistic and representative of one of the most probable alternatives. (If there are, e.g. three different applications, the most representative one, or all three scenarios shall be declared).

6.3.9 Units

SI units shall be used. Exceptions are:

- Resources used for energy input (kWh or MJ)
- Water use (cubic metres)
- Temperature (degrees Celsius)
- Time (minutes, hours, days, years)
- Transport (tonnes.kilometres)

6.3.10 Imports

The inputs and outputs attributed to imports of raw materials, finished materials and products are, wherever possible, based upon analyses appropriate to the country of origin and include the energy of transportation. Where data for the country of origin are not available, the input and output data are based upon the most comparable product (internationally or domestically produced) with an addition made for the transportation from the country of origin.

6.3.11 Treatment of renewable energy purchase schemes

Many energy suppliers offer “Green Supply” tariffs to their customers. The structure of these tariffs, their relationship with carbon markets, regional and national energy regulation, and their eventual effectiveness in providing additional low impact energy varies widely. The significant potential for double counting of benefits makes their inclusion in EPD problematic.

In order to maintain full transparency, evidence of renewable energy purchase should be externally validated, e.g. in the UK, whereas a previous Green Energy Supply Certification Scheme launched in 2010 was withdrawn in 2015, it is possible to obtain tariffs that comply with specific requirements of the European Ecolabel for Energy (EKOenergy)[2] for example.

When calculating impacts associated with standard energy supply national or regional average energy models shall be used. This requirement may be reassessed if evidence from a credible accreditation or validation system can be provided.

6.3.12 Treatment of onsite Low or Zero Carbon energy generation (LZC)

Benefits associated with onsite Low or Zero Carbon energy generation may be recognised in EPD produced according to this PCR subject to the following requirements:

- If the LZC installation is an “Accredited Renewable” then evidence that all certificates and tradable permits associated with the declared consumption have been accounted for must be provided. In the UK renewables installations are accredited by the energy regulator, Ofgem, via the Renewables and CHP Register. Relevant certificates and permits are Renewables Obligation Certificates (ROCs), Climate Change Levy Exemption Certificates (LECs) and Renewable Energy Guarantee of Origin (REGOs). Outside the UK equivalent evidence shall be provided.
- A written statement shall be provided to confirm that any benefits claimed have not been traded via UNFCCC mechanisms, emissions trading schemes (e.g. EU ETS) or

[2] http://www.ekoenergy.org/ecolabel/criteria/ accessed April 2017

voluntary carbon markets. If the installation received funds via market mechanisms then this must be declared and any associated benefits accounted for so as to avoid double counting.

- If the LZC installation is too small to qualify as an Accredited Renewable then evidence that the LZC product has been certificated by an accredited Certification Body shall be provided. In the UK such schemes include the Microgeneration Certification Scheme (MCS) and the CEN Solar Keymark scheme. UK Certification Bodies are accredited by United Kingdom Accreditation Services (UKAS). Outside the UK equivalent evidence shall be provided.
- Any benefits associated with net exports from onsite LZC generation (supply minus onsite demand) shall not be attributed to products covered by the EPD.

6.3.13 Treatment of Carbon Offset Schemes

Benefits associated with carbon offset schemes shall not be included in EPD conducted to this PCR.

6.4 Calculation Rules for LCA – Specific aspects

6.4.1 Carbon Storage (Sequestration)

Carbon sequestration refers to the removal and storage of carbon in biomaterials such as timber and agricultural products. In this PCR, carbon sequestration is evaluated in the product stage (A1 – A3) for biomaterial construction products. Both a mass balance and a carbon balance shall be carried out to ensure that the carbon dioxide equivalent emissions computed for the product system takes into account the actual carbon stored within the construction product.

Sequestered carbon is an inherent physical property, and the content leaving the system either in co-products, secondary materials, or materials for reuse, recycling, incineration or landfill disposal is considered when evaluating the carbon content of the construction product and the quantity of carbon dioxide needed to sequester that amount of carbon.

When conducting LCA for biomaterial based construction products, the amount of carbon sequestered in the raw material input may already be accounted for in the biomaterial dataset directly available in the database in use, e.g. ecoinvent v3. In other instances, the carbon sequestered will need to be derived using a standardised calculation method.

See Appendix B of this PCR for guidance on calculating the amount of carbon sequestered in biomaterial based construction products.

This PCR does not report carbon sequestered separately in the LCA results generated, but instead presents a total (net) carbon quantity in the respective information module within the respective parameter (kg CO_2 equivalent).

6.4.2 Carbonation (of concrete)

This PCR takes into account the carbonation of concrete, which is the uptake (absorption reaction) of carbon dioxide from the atmosphere by the calcium oxide (CaO) or calcium hydroxide ($Ca(OH)_2$) within the construction product. The reaction is only for surfaces exposed to air, and is dependent on the porosity and the strength of the product.

Calcium oxide, also referred to as lime or quicklime, results from the calcination (heat treatment) of calcium carbonates ($CaCO_3$), accompanied by the release of carbon dioxide to the atmosphere. Calcium hydroxide, also referred to as hydrated lime, is obtained from the mixture of quicklime with water.

For products containing pure lime, 100% of the calcium oxide is assumed to carbonate within a short time after construction/installation. Therefore, the carbonation of lime is considered in the construction stage (A5) for both quick lime and hydrated lime, and is equivalent to the carbon dioxide expelled from the calcium carbonate in making the lime.

For products containing cementitious material the amount of carbonation can be calculated for both low-strength and high strength concrete, mortars, and screeds, taking into account the effect of the strength of the concrete on the rate of carbonation. This is evaluated in the use stage (B1).

For finished precast concrete products stored at stockyards before being transported to the installation site, carbonation is considered in the manufacturing stage (A3) and may continue to the construction stage (A5) and the use stage (B1).

End-of-life concrete that has been disposed of in landfill (end-of-life stage, C4) continues to carbonate, as well as concrete that is crushed and exposed to air prior to landfilling. The amount of carbonation is based on the typical particle size, the existing level of carbonation, the likely depth of further carbonation, and, more importantly, the conditions in the landfill.

See Appendix C of this BRE PCR for further guidance on calculating the carbonation of concrete.

6.5 Inventory Analysis

6.5.1 Collecting data

Data collection shall follow the guidance provided in ISO 14044:2006, clause 4.3.2.

In addition to manufacturing process data (covering 1 year of production, deviations from this period shall be justified), manufacturers shall provide a process flow diagram, including any major transportation stages with a clearly marked system boundary to indicate included and excluded processes. The resulting inventory is checked for balance in mass and water (including taking into account the evaporation of water).

The total mass flowing into the system boundary must be accounted for with an equivalent mass flow out of the system boundary. The material input and output, the water use and the energy consumption data are checked for appropriateness compared to known systems.

6.5.2 Calculation procedures

The calculation procedures described in ISO 14044:2006 and EN 15804+A1 shall apply. The same calculation procedure shall be applied consistently throughout the study.

6.5.3 Allocation of input flows and output emissions

Allocation of material and energy flows

Allocation procedures shall be according to ISO 14044:2006, clause 4.3.4, and the rules stated in EN 15804+A1 are based on the ISO 14044 guidance. However, the basic

procedures and assumptions used in ISO 14044:2006 have been refined in order to reflect the goal and scope of EN 15804+A1 and EN 15643-2:2011. For multiple products (co-products), the materials, energy flows and associated emissions are allocated to the different products as shown in Figure 6.2 by process subdivision, appropriate physical property, or on the basis of revenue contribution. Revenue is defined as the total income generated from the sale of all the outputs (i.e. price per tonne multiplied by total tonnes sold). In the Figure, ΔR is the difference in revenue generated by the co-products and %R is percentage of revenue generated by individual co-products.

This allocation hierarchy also applies to process wastes from the product stage (A1 – A3), which are sold on for subsequent reuse or value recovery, as process wastes are considered as co-products if they have reached the end-of-waste state. Any waste processing that occurs in any module of the product system under study is included in the system boundary of the respective module, i.e. the impacts are allocated within the life cycle stage that generates them. Therefore, this allocation procedure is not applicable to wastes from the other stages (A4 – C4). The net impacts of which can be reported in Module D. See the text on allocation for future material and energy recovery below.

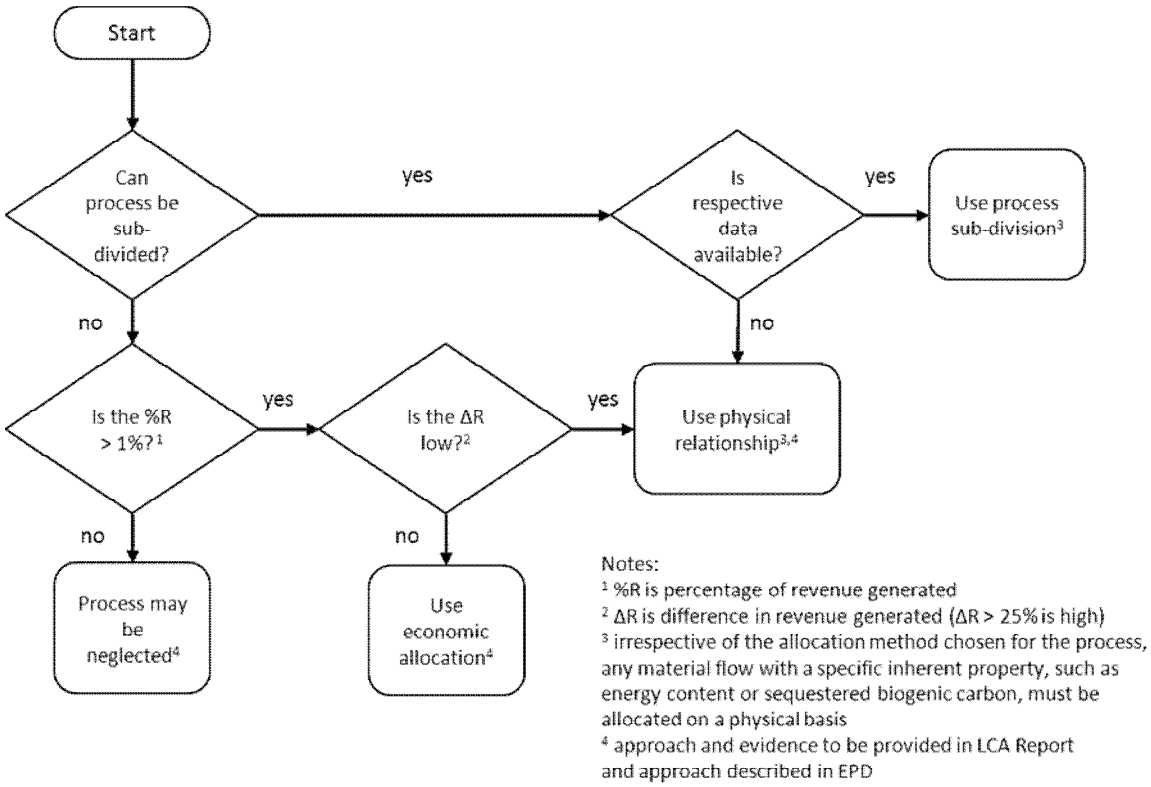

Figure 6.2: BRE allocation preference

Examples of physical property for allocation include mass, volume or surface area, etc. For economic allocation (allocation by value), a percentage revenue contribution of less than 1%

is considered as a 'very low contribution' and such a co-product may be neglected in the allocation i.e. no impacts from the process are allocated to the co-product.

Allocation procedure for future material and energy recovery

The end-of-life system boundary of the product system is set where the system outputs (e.g. materials, products or construction elements) have reached the end of waste state. When a material leaves the system boundary at the end-of-waste state in Modules A4 – C4, the potential loads and benefits of net flows (see section on Module D in 6.3.4 of this PCR, and EN 15804+A1, clause 6.4.3.3) of reusable products, recyclable materials and/or useful energy carriers leaving the product system can be declared in Module D based on a specified scenario (see EN 15804+A1, clause 6.4.3.3). This scenario shall be consistent with any other scenario for waste processing and be based on current average technology or practice.

The method for calculating the net impacts is detailed in clause 6.4.3.3 of EN 15804+A1.

6.6 Impact Assessment

As specified in EN 15804+A1 clause 6.5, the impact assessment shall be carried out for the following impact categories using baseline characterisation factors from CML – IA version listed in Annex C of EN 15804+A1:

- Global Warming
- Ozone Depletion
- Acidification of Soil and Water
- Eutrophication
- Photochemical Ozone Creation
- Depletion of Abiotic Resources (Elements)
- Depletion of Abiotic Resources (Fossil)

7 Content of the Environmental Product Declaration

7.1 Declaration of general information

EPD issued using this PCR shall fulfil the formatting requirements in clause 7.6 of this PCR, and shall include the parameters identified in EN 15804+A1, clause 7.1 on declaration of general information.

7.2 Declaration of parameters derived from LCA

To illustrate the product system studied, the EPD shall contain a simple flow diagram of the processes included in the LCA. They shall be sub-divided at least into the life cycle stages of the product: production, and if applicable construction, use and end-of-life (see Figure 5.1). See EN 15804+A1, clause 7.2.1. The environmental impacts shall be declared and reported using the parameters and units shown in Table 7.1 below.

Table 7.1: Parameters describing environmental impacts

Impact Category	Parameter	Unit
Global Warming	Global warming potential, GWP	kg CO_2 eq., 100 years
Ozone Depletion	Depletion potential of the stratospheric ozone layer, ODP	kg CFC 11 eq.
Acidification for Soil and Water	Acidification potential of soil and water, AP	kg SO_2 eq.
Eutrophication	Eutrophication potential, EP	kg $(PO_4)^{3-}$ eq.
Photochemical Ozone Creation	Formation potential of tropospheric ozone, POCP	kg C_2H_4 eq.
Depletion of Abiotic Resources – elements	Abiotic depletion potential for non-fossil resources, ADP-elements	kg Sb eq.
Depletion of Abiotic Resources – fossil fuels	Abiotic depletion potential for fossil resources, ADP-fossil fuels	MJ, net calorific value

7.2.1 Other parameters

The following environmental information, describing resource use, waste and other output flows, which is derived from LCI, but not assigned to the impact categories listed in Table 7.1, shall be included in the EPD as shown in Table 7.2 below.

Table 7.2: Other parameters (combined for ease of presentation)

	Parameter	Unit
Parameters describing resource use	Use of renewable primary energy excluding renewable primary energy resources used as raw materials, PERE	MJ, net calorific value
	Use of renewable primary energy resources used as raw materials, PERM	MJ, net calorific value
	Total use of renewable primary energy resources, PERT	MJ, net calorific value
	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials, PENRE	MJ, net calorific value
	Use of non-renewable primary energy resources used as raw materials, PENRM	MJ, net calorific value
	Total use of non-renewable primary energy resources, PENRT	MJ, net calorific value
	Use of secondary material, SM	kg
	Use of renewable secondary fuels, RSF	MJ, net calorific value
	Use of non-renewable secondary fuels, NRSF	MJ, net calorific value
	Net use of fresh water, FW	m^3
Parameters describing waste to disposal	Hazardous waste, HWD	kg
	Non-hazardous waste, NHWD	kg
	Radioactive waste disposed (total low, intermediate and high level waste), RWD	kg
Parameters describing other output flows	Components for reuse, CRU	kg
	Materials for recycling, MFR	kg
	Materials for energy recovery, MER	kg
	Export energy, EE	MJ per energy carrier

For additional guidance, see NOTES in clauses 7.2.3, 7.2.4 and 7.2.5 in EN 15804+A1.

The values presented in the results section of an EPD (covering both the environmental parameters in Table 7.1 and the other parameters in Table 7.2) generated using this PCR shall be to a maximum of 3 significant figures, and shall be consistent throughout the results section. These values shall be per declared or functional unit. In the absence of values, the following information shall be entered as appropriate:

- MND: 'Module not declared', for modules that have simply not been declared in the EPD
- MNR: 'Module not relevant', for modules that have not been declared because they are not relevant or not applicable to the construction product
- INA: 'Indicator not assessed', for an indicator (parameter) that is not assessed even though the module is declared
- AGG: 'Aggregated', refers to an aggregated value, applicable only to results for A1 to A3 (see clause 7.5 below).

Where a zero (0) value is entered this shall be for a parameter that has been assessed and evaluated to give a zero result.

7.3 Scenarios and additional technical information

The selection of scenarios in the life cycle stages that depend on the building context should reflect the specific conditions and assumptions that support the use of the product data in both the product level and in a building level assessment (see Figure 5.1 in this BRE PCR).

These scenarios are for optional life cycle stages in a cradle-to-gate with options EPD, and if these optional stages are declared then the scenarios shall be specified and included in the EPD. For a cradle-to-grave EPD, all modules shall be calculated for specified scenarios and declared in the EPD.

Additional technical information supporting scenario development that is declared shall comply with EN 15804+A1 clause 7.3, and shall be declared separately from the LCA derived parameters. See Tables 7 – 12 in EN 15804+A1 for examples of technical information for different modules in the life cycle stages, including parameters and units.

7.4 Additional information on emissions to indoor air, soil and water during the use stage

Additional information on emissions to indoor air, soil and water during the use stage for construction products exposed to interior spaces of the building shall be required when horizontal measurement standards are published by CEN TC 351, as stated in EN 15804+A1 clause 7.4.

7.5 Aggregation of information modules

The indicators declared in the individual information modules of a product life cycle A1 to A5, B1 to B7, C1 to C4 and Module D as described in Figure 5.1 shall not be added up to give sub-total results for the modules A, B, C or D respectively. As an exception, information modules A1, A2 and A3 may be aggregated to give results for the product stage – the underlying data for these modules are not based on scenarios.

7.6 Format of BRE EN 15804 EPD

The BRE EPD template is available from the Programme Operator (BRE Global) for members of the BRE Global EN 15804 EPD programme.

In addition to the requirements for general information to be declared in the EPD described in EN 15804+A1 clause 7.1, a BRE EPD shall include the Information Transfer Matrix (ITM) described in Annex A (normative) of EN 15942:2011, which is a standardised part of EPD communication. The requirements in EN 15942:2011 clause 6 on formatting apply to both electronic and paper versions of a BRE EPD, including the following:

- The information in the EPD shall not be misleading
- The EPD information shall be accurately placed in the unique position as identified in the ITM.

Users of this PCR not intending to generate a BRE EPD may present their EPD in line with the respective Programme Operator requirements, provided the minimum formatting requirements contained in both EN 15804+A1 and EN 15942:2011 are fulfilled.

8 Project Report

The project report summarises the project documentation in a systematic and comprehensive way in order to support effective verification of the EPD.

The project report supports the data published in the EPD and sets out how the EPD was prepared in accordance with this PCR, including a list of all assumptions made. The project report shall record that the LCA based information and the additional information as declared in the EPD meet the requirements of EN 15804+A1. It shall be made available to the verifier with the requirements on confidentiality stated in ISO 14025:2010. The project report is not part of the public communication.

The project report shall follow the instructions given in ISO 14044:2006, clause 5.2 and EN 15804+A1, clauses 8.2 and 8.3.

8.1 Data availability for verification

To facilitate verification it is considered good practice to make the following information available to the verifier, taking into account data confidentiality according to EN 15804+A1, clause 8.4:

a) Analysis of material and energy flows to justify their inclusion or exclusion, including mass and water balance

b) Quantitative description of unit processes that are defined to model processes and life cycle stages of the declared unit

c) Attribution of process and life cycle data to datasets of an LCA software (if used)

d) LCIA results per modules of unit processes, e.g. structured according to life cycle stages

e) LCIA results per production plant/product if generic data is declared from several plants or for a range of similar products

f) Documentation that substantiates the percentages and figures used for the calculations in the end-of-life scenario and the RSL values

g) Documentation that substantiates the percentages and figures (number of cycles, prices, etc.) used for the calculations in the allocation procedure, if it differs from the PCR.

8.2 Validity of EPD

EPD are valid for a maximum of 5 years from the date of issue, after which the EPD shall be reviewed and verified.

An EPD does not have to be recalculated after 5 years if the underlying data have not changed significantly (but should be re-issued for currency). A significant change is deemed to be a change in the product composition or production process which results in a change of greater than +/- 10% of any one of the declared parameters of the EPD.

Appendix A – BRE PCR Peer Review and Industry Consultation

This peer review and industry consultation was on the Issue 0.0 of this PCR published in July 2013.

Peer Review Statement

The following experts in LCA and buildings have undertaken a critical review of the final draft PCR and issued the following statement:

- Wayne Trusty, President, Wayne B Trusty & Associates Limited (Chair)
- Jane Anderson, Principal Consultant, PE INTERNATIONAL
- Sverre Fossdal, Verification Leader, The Norwegian EPD Foundation

"The review was performed according to Clause 8.1.2 of ISO 14025:2006(E), taking into consideration the EN 15804 standard. With the exception of the following points, the panel confirms that the PCR is in compliance with the referenced standards, and commends BRE for its work and its willingness to take account of and incorporate Panel comments throughout the process.

There are two areas where the panel could not confirm compliance. Because the PCR is still at a final draft stage and has not yet been released for stakeholder review or public comment, the panel cannot confirm consultation as required under ISO 14025:2010. Further, the BRE General programme of instructions have not yet been finalised and were not available to the review panel. As a result, the panel cannot confirm that the PCR meets the ISO 14025 requirement that it fulfil those instructions."

Public Consultation

Following the peer review, a public consultation was carried out in line with the requirements of ISO 14025:2010 clause 6.5.

The comments received have been compiled and responded to by BRE, and published on the BRE website, www.bre.co.uk.

Statement of review of General Programme Instruction and Public Comments

Following the industry consultation process, the Chairman of the Peer Review Panel, Wayne Trusty, has reviewed the public consultation comments, the final draft of the PCR, and the BRE General programme of instructions; and issued the following statement:

"BRE Global requested that I review the General Programme Instructions and additions made to the PCR following a public consultation. I have done so as past Chairman of the Peer Review Panel and am not currently representing the other panel members.

On the basis of my review, I am satisfied that the PCR meets the ISO 14025 requirement that it fulfill the General Programme Instructions. I can also confirm that BRE Global has undertaken a public consultation process and that resulting changes to the PCR are not substantive."

Appendix B – Carbon Sequestration

This section describes how the BRE EN 15804 PCR deals with carbon sequestration in construction products made from biomaterials, in particular where carbon sequestration is not automatically accounted for in the secondary dataset used for the biomaterials in the respective LCA study.

B1 Introduction

In this PCR, carbon sequestration refers to the long-term storage of carbon in biomaterial construction products (such as timber, wood-based panels, plant fibres e.g. hemp and flax, plant oils e.g. palm and linseed, sheep's wool etc.), and is considered in the product stage (information modules A1 – A3).

Sequestered carbon is an inherent physical property and, therefore, only physical allocation shall be used. Furthermore, sequestered carbon shall be calculated as only that present in the biomaterial in the finished construction product (declared or functional unit), and not that sequestered in the amount of biomaterial input required to make the product. The carbon balance of the producing system is currently excluded from the assessment, since there is not yet sufficiently robust information available to enable its contribution to be included.

The carbon content (C_f) used for the calculation of sequestered carbon in the product must be documented and justified.

Sequestered carbon will be assumed to remain in the product for the product's service life and no carbon storage benefit scenarios will be allowed[3]. Appropriate models will be applied for the disposal routes for the product arising during life cycle stages B and C; these models will account for the releases associated with the sequestered carbon, e.g. the landfill model will address emissions including CO_2 and methane with the emissions for landfill in the UK adapted according to GasSim[4].

Greenhouse gas emissions associated with land use change will be included according to the Intergovernmental Panel on Climate Change's (IPCC) Guidelines for National Greenhouse Gas Inventories. These impacts shall be allocated according to the hierarchy set out in Figure 6.2.

B2 Calculating CO_2 eq. emissions

Example for Solid Timber:

Each carbon atom within the timber construction product has been sequestered from a carbon dioxide molecule in the atmosphere. If the carbon content of the product is known, then the amount of carbon sequestered in the product can be calculated. The sequestering of carbon requires the absorption of CO_2; this implies that to sequester 1 atom of carbon needs the uptake of 1 molecule of CO_2.

An example of the calculation for the amount of CO_2 required to produce a given mass of timber is presented below:

[3] EN 16485:2014 includes a technical scenario for calculating a carbon storage benefit.
[4] www.gassim.co.uk

Mass of CO_2 sequestered $= m_{dry}(timber) \times C_f \times \frac{m.m_{CO_2}}{m.m_C}$ Eqn. 1

Where C_f = percentage of carbon in dry matter, for timber = 0.5 (50%)

$m.m_{CO_2}$ = molecular mass of CO_2 (44)

$m.m_C$ = atomic mass of carbon (12)

$m_{dry}(timber)$ = dry weight of the timber in the finished product. If the moisture content[5] (mc as a decimal) and the wet weight (m_{wet}) of the timber are known, $m_{dry} = m_{wet}/(mc+1)$

By substituting for the masses of carbon and CO_2, Eqn. 1 above becomes:

Mass of CO_2 sequestered $= m_{dry}(timber) \times 0.5 \times \frac{44}{12}$

$= m_{dry}(timber) \times 1.833$ Eqn. 2

For example, using Eqn. 2 above, the amount of CO_2 sequestered in 1 m^3 of timber with a density of 370 kg/m^3 at 12% moisture content (dry mass basis) is 605.6 kg. This amount of CO_2 in air shall be included as a negative emission of biogenic CO_2 to the total CO_2 equivalent emissions of the assessed timber construction product for the calculation of GWP. Further, the resulting EPD shall include the density of the product, the moisture content (dry mass basis) and the percentage carbon content assumed.

The method described above is in line with EN 16449:2014.

[5] The moisture content of timber and wood-based panels is typically calculated on a dry mass basis. Paper and some wood-based panels sometimes used a wet mass basis for moisture content (i.e. dry material + water = 100%). For a wet mass basisi, moisture content $m_{dry} = m_{wet}\ (1 - mc)$

Appendix C – Carbonation of products containing calcium oxide/calcium hydroxide

This section describes how the BRE EN 15804 PCR deals with the carbonation of calcium oxide or calcium hydroxide within construction products.

C1 Introduction

The BRE PCR takes into account the carbonation of calcium oxide (CaO) within products containing lime. The reaction is only for surfaces exposed to air, and is dependent on the porosity and the strength of the concrete product, and particle size (for crushed concrete products). Different assumptions have been made for different products. In general, the following factors affect carbonation of concrete products:

- Calcium oxide / hydroxide content
- Porosity / strength
- Atmospheric conditions; warmth and moisture
- Surface area / particle size
- Time and rate of reaction

C2 Products Containing Lime

For products containing pure lime, 100% of the CaO is assumed to carbonate within a short time after construction/installation in the building, depending on the prevailing environmental conditions. The porosity and permeability of the lime mortar due to the presence of free lime is the basis for the rate of the carbonation reaction. The carbonation of the lime over time is the effective hardening process of the lime mortar. Therefore, the carbonation of lime is considered in the construction stage (information module A5) for both quick lime and hydrated lime. The amount of carbonation is equivalent to the carbon dioxide (CO_2) expelled from the calcium carbonate in making the lime.

C3 Virgin Products Containing Cementitious Material

The amount of carbonation for cement based products has been calculated based on the approach provided in a Danish report "Guidelines- Uptake of carbon dioxide in the life cycle inventory of concrete"[6] , and from information supplied by the Concrete Centre in the UK. This document can be obtained from the Concrete Centre or BRE.

The approach covers two aspects: the depth of carbonation which can be expected in different elements and the amount of carbonation. For products containing cementitious material, the amount of carbonation can be calculated for both low-strength and high strength concrete, mortars, and screeds, taking into account the effect of the strength of the concrete on the rate of carbonation. This is evaluated in the use stage (information module B1).

[6] Kirsten Pommer & Claus Pade, 'Guidelines- Uptake of carbon dioxide in the life cycle inventory of concrete', Danish Technological Institute, October 2005, prepared as part of the Nordic Innovation Centre Project, 'CO_2 Uptake During the Concrete Life Cycle'

Based on results from the study, and discussions with the Concrete Centre, concrete products have been split into two groups. For either group, the assumptions about the rate of carbonation of different types of products are similar. For all concrete it is the area exposed rather than weight of the material that is the key factor in determining how much CO_2 will be absorbed.

C3.1 Group 1

This covers blocks, low strength concrete, mortar and screeds. The key assumption is that the total depth of the product will carbonate within the building lifetime. For example, using estimates provided within the Danish report, the depth of carbonation for 'sheltered' and indoors' locations occurring within 50 years is 88 mm. Since carbonation occurs from both sides of the block, the total theoretical depth of carbonation would be approximately 180 mm, which is greater than the depth of most blocks, low strength concrete and mortars. For screeds, most are less than 100 mm thick and will therefore carbonate even though only one face is exposed.

The amount of carbonation (kg) per volume (m^3) of concrete (i.e. amount of CO_2 reabsorbed through carbonation) is therefore based on the percentage of CaO which will carbonate and the amount of CaO within the product, see Eqn. 1 below. For these products, based on data provided by the Concrete Centre, the assumption is that 63% of the CaO will carbonate. The amount of CaO can be calculated from the amount of cement within the concrete product, the percentage of clinker within the cement and the percentage of CaO within the clinker, see Eqn. 2.

Carbonation (kg/m^3) $= 0.63 \times M_{CaO} \times \frac{m.m_{CO_2}}{m.m_{CaO}}$ Eqn. 1

Where 0.63 = amount of CaO that will carbonate

$m.m_{CO_2}$ = molecular mass of CO2 (44)

$m.m_{CaO}$ = molecular mass of CaO (56)

M_{CaO} = mass of CaO within the concrete product (kg/m^3), obtained as shown below:

Mass of CaO, $M_{CaO} = Q_{Cem} \times \%C_{Cem} \times \%CaO_C$ Eqn. 2

Where Q_{Cem} = amount of cement in the concrete (kg/m^3)

$\%C_{Cem}$ = percentage of clinker in cement (80% for ready mix, 90% for precast and 80% for paving)

$\%CaO_C$ = percentage of CaO within clinker (65%)

By substitution, Eqn. 1 above becomes

Carbonation (kg/m^3) $= 0.63 \times Q_{Cem} \times \%C_{Cem} \times 0.65 \times \frac{44}{56}$ Eqn. 3

If ($0.63 \times 0.65 \times \frac{44}{56}$) in Eqn. 3 above is replaced by 'z', then the equation can be re-written thus:

Carbonation (kg/m^3) = $z \times Q_{Cem} \times \%C_{Cem}$ Eqn. 4

This is to be reported in the use stage, information module B1.

Note: where Q_{cem} is given in kg/tonne of the product, the carbonation quantity obtained is therefore also in kg/tonne of the product.

C3.2 Group 2

The second group covers high strength ready mix and precast concrete and paving.

For these products, because the strength of the concrete is higher, the amount of carbonation is less during the building lifetime, and the Danish Guidelines provide an estimate of the depth of carbonation expected, and therefore factors which can be used to provide indicative carbonation and mass of carbon dioxide reabsorbed for various elements.

The mass of CO_2 absorbed (kg) for these high strength concrete layers, as a function of the area exposed, is therefore calculated as shown in Eqn. 5:

Carbonation = $\left(K \times S \times \sqrt{SP}\right) \times \left(z \times Q_{Cem} \times \%C_{Cem}\right)$ Eqn. 5

Where K = depth of carbonation (m)

S = surface area (m^2)

SP = study period (years)

This is to be reported in the use stage, information module B1.

Values for the depth of carbonation K have been derived including correction factors for surface conditions and for concretes using replacements (Tables 4.1 and 4.3 respectively of the Danish report). See summary Table C.2 below.

C4 Crushed concrete disposed in landfill

Additionally, where concrete is disposed (landfilled), further carbonation is assumed to take place as the concrete is broken up and buried. The carbonation is attributed to the original product and is presented in information module C4, end-of-life disposal.

The amount of carbonation within crushed landfilled concrete is based on the typical particle size, the existing level of carbonation and the likely depth of further carbonation – as concrete which has already carbonated cannot carbonate again. The volume of carbonation for concrete disposed in landfill (kg/m3) is obtained by adjusting Eqn. 3 as shown below:

Carbonation = $x \times y \times z \times Q_{Cem} \times \%C_{Cem}$ Eqn. 6

Where x = quantity of concrete product available to carbonate (%)

y = quantity of concrete product that can carbonate in the period (%)

Example: Assuming a carbonated volume of 5% at demolition, an average particle size of 150 mm diameter, and assuming the same conditions for landfill as with buried infrastructure, the depth of carbonation is $0.75mm \times \sqrt{year}$ (from the Danish report) which, over a period of 100 years, means that only approximately 25% of the concrete will be able to carbonate in the landfill. The quantity of concrete for carbonation is therefore reduced by 5% (i.e. x = 95%) to account for the concrete which has already carbonated, previously reported in an earlier life cycle stage, and by 75% (i.e. y = 25%) to account for the concrete within the 150 mm diameter particles which will not carbonate in the period. Therefore, in this example, the volume of carbonation for the concrete disposed in landfill (kg/m^3) is obtained as:

Carbonation = $95\% \times 25\% \times z \times Q_{Cem} \times \%C_{Cem}$ Eqn. 7

Note: for non-concrete hardcore there is no carbonation. For hardcore sourced from low strength concretes or blocks, there will also be no carbonation as the concretes will have fully carbonated already.

C5 Crushed Concrete for recycling

This section is only relevant for an EPD of recycled concrete.

Concrete which is recycled as either aggregate or hardcore has the potential to continue to carbonate depending on its previous life. Again, the amount of carbonation within recycled concrete is based on the typical particle size, the existing level of carbonation and the likely depth of further carbonation.

The calculation is to be carried out as for crushed concrete for landfilling, Eqn. 6.

Note: for non-concrete hardcore there is no carbonation. For hardcore sourced from low strength concretes or blocks, there will also be no carbonation as the concretes will have fully carbonated already.

C6 Additional information

The tables below (C.1 and C.2) provide additional information for calculating carbonation during life cycle stages and for correction factors respectively.

Table C.1: Carbonation during the life cycle stages

Life cycle stage	Low & mid strength, <35 MPa			High strength, >35 MPa	
	Mortars, screeds	Blocks, concrete	Ready mix	Precast	Paving
Construction stage	A5-	A5-	-	-	-
Use stage	-	-	B1	B1	B1
End-of-life stage	-	-	C4	C4	C4

Note: No carbonation can be declared in Module D

Table C.2: Correction factors (adapted from the Danish report)

Correction factors		Low strength		Mid strength	High strength	
		Mortars, screeds, <15 MPa	Blocks, concrete, <15 MPa	Ready mix, 23-35 MPa	Precast, >35 MPa	Paving, >35 MPa
Life cycle stage	A5	Exposed & indoors	Indoors	-	-	-
	B1	-	-	Exposed & buried	Exposed, sheltered & indoors	Exposed & buried
	C4	-	-	Buried	Buried	Buried
Surface conditions, $k1$, in mm * (year)$^{0.5}$	A5	10	15			
	B1	n/a	n/a	1.25	2.33	1
	C4	n/a	n/a	1	0.75	0.75
Surface treatment, $k2$		n/a	n/a	1	1	1
Depth of carbonation (m), during the use stage	$K = k1 \times k2$			**0.00125**	**0.00233**	**0.001**

Where the depth of carbonation in mm * (year)$^{0.5}$ = $K = k1 \times k2$

For concretes using cement replacements, it is necessary to include a correction factor. Table 4.3 of the Danish report provides correction factors, and by extrapolation from the table, the following factors are applied to high strength concretes using pulverised fuel ash (PFA) and ground granulated blast furnace slag (GGBS):

- 30% PFA 30: 10% higher (i.e. multiply by 1.10)
- 50% GGBS: 25% higher (i.e. multiply by 1.25)

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