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MILIEUDATABASE

THE FOUNDATION FOR SUSTAINABLE CONSTRUCTION

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# Environmental Performance Assessment Method for Construction Works

Calculation method to determine the environmental performance of construction works throughout their service life, based on EN 15804+A2.

STICHTING NATIONAL ENVIRONMENTAL DATABASE
www.milieudatabase.nl

# Contents

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# 1. Introduction

## 1.1. General

**The Environmental Performance Assessment Method for Construction Works (hereinafter referred to as Assessment Method) was developed for unambiguous and verifiable calculation of material-related environmental performance of construction works[1]. The Assessment Method forms a cohesive package with the National Environmental Database (NMD) and the calculation rules, all of which are administered by Stichting National Environmental Database (Stichting NMD).**

The European standard EN 15804:2012+A2:2019 (hereinafter referred to as EN 15804) forms the basis for this Assessment Method. EN 15804 was developed for Environmental Product Declarations (EPDs) at product level. In this version of the Assessment Method, EN 15804:2012+A1:2013 has also been considered exclusively for the purpose of determining characterised impact scores (See 2.6.5). Specific agreements for producing and using EPDs for material-related assessment at construction work level in the Dutch context are included in this Assessment Method.

The most important additions to / deviations from EN 15804 are:

1. In addition to EN 15804:2012+A1:2013, there are additional environmental impact indicators relating to human and ecotoxicity. Without these indicators, some desirable environmental improvements, such as the use of air scrubbers to assess air quality, would not be assessed positively.
2. Specific standard values are prescribed for several processes. This is necessary to avoid unjustified differences between construction products when calculating the environmental performance of construction works.
3. Reference is made to a process database for raw materials and basic processes.
4. Future scenarios are permitted in the product scenarios within certain conditions. This makes it possible to include product scenarios at the start of their life cycle.

NEN-EN 15978 (hereinafter referred to as EN 15978) was published to assess the environmental performance of buildings. EN 15804 is based on this standard and the construction work calculation is therefore also based on the EN 15978 system. A decision was made not to follow EN 15978 explicitly. EN 15978 only supplements EN 15804 for material-related environmental performance of buildings to a limited extent and also covers the use phase of the building itself (heating, cooling, etc.). EN 15978 also focuses exclusively on buildings, while the Assessment Method applies equally to civil engineering structures. As well as EN 15978, a specific EN standard will probably be formulated in CEN TC 350 for the environmental performance of civil engineering structures.

The Assessment Method comprises agreements that are generic for construction works in general (applying to both buildings and civil engineering structures) and agreements that are specific to buildings or civil engineering structures.

The specific Dutch implementation of EN 15804 in the Assessment Method and its use in building regulations and tender procedures for civil engineering structures requires that environmental performance calculations of buildings and construction works adhere strictly to this (Assessment Method) implementation of EN 15804.

[1] *In this version of the Assessment Method 'construction works' replaces 'buildings (in practice sometimes referred to as C&U) and civil engineering structures'. Construction works are also understood to mean buildings. Civil engineering involves rail projects, earthworks, roadworks and waterway construction. In this context, it refers more broadly to the entire infrastructure sector, including, for example, railway construction and energy infrastructure.*

This adherence safeguards the use of equivalent environmental data. Additional choices need to be made in calculating the environmental performance of construction works.

These are recorded explicitly below. This concerns:
- determining scenarios and standard values for the Dutch context, where possible and necessary;
- the use of generic data (non-proprietary data) if no producer or sector specific data are available.

**The Assessment Method cannot be read as a stand-alone document. Knowledge of the underlying standards, particularly EN 15804, EN 15978, ISO 14044 and ISO 14025, is needed to produce an EPD in accordance with the Assessment Method.**

## 1.2. National Environmental Database

The NMD, managed by Stichting NMD, was established to enable unambiguous calculation of environmental performance of construction works in the Dutch context. The NMD contains information about products formulated in accordance with the Assessment Method in the form of Environmental Product Declarations that refer to environmental profiles. These Environmental Product Declarations and environmental profiles are used in the validated calculation tools to calculate the environmental performance of construction works. In combination with the calculation rules described in the Assessment Method, this ensures verifiable, reproducible and unambiguous calculation results.

There are four product information categories in the NMD:
- Category 1: proprietary data, verified by an independent, qualified third party in accordance with the NMD Verification Protocol. For whom: manufacturers/producers, suppliers.
- Category 2: non-proprietary data, verified by an independent, qualified third party in accordance with the NMD Verification Protocol, including a statement of representativeness, for example, for the Dutch Market or a group of producers, and mentioning the participating companies. For whom: groups of manufacturers, suppliers, sectors, governments, etc.
- Category 3: non-proprietary data, owned and managed by Stichting NMD and not verified according to the NMD Verification Protocol. All procedures relating to category 3 product information can be found on the website of Stichting NMD: *www.milieudatabase.nl*. Public availability: underlying data (structure of Environmental Product Declarations and basic processes) are publicly available via the Stichting NMD website: *www.milieudatabase.nl*.
- Category 3a: External supply of energy (carriers). Non-proprietary data (unbranded) from externally supplied energy carriers, such as electricity, gas, heat and fuels, and from standard data, for the material related impact of the energy carriers. Data is owned and managed by Stichting NMD. A 30% surcharge factor does not apply. Data complies with the preconditions as described on the page about category 3 data on: *www.milieudatabase.nl*. Public availability: underlying data (structure of Environmental Product Declarations and basic processes) are publicly available via the Stichting NMD website: *www.milieudatabase.nl*.

Categories 1 and 2 data that are included in the NMD are supplied by construction product producers and sectors. They also remain owners of the environmental profiles. The Assessment Method serves as a product category rule (PCR) for the Life Cycle Assessment (LCA) that is carried out in order to be able to produce an Environmental Product Declaration (EPD). This makes the environmental information from the EPDs suitable for inclusion in the NMD as category 1 and category 2 product information. The Assessment Method therefore indicates how EPDs should be formulated as these supply information for the Environmental Product Declarations. EPDs are in line with EN 15804. The Assessment Method is a generic PCR for construction products. I n addition to the Assessment Method, sectors produce product-specific product category rules (PCRs).

Category 3 data are a catch-all solution to provide environmental profiles in the NMD in the absence of, and as a counterpart to, category 1 and category 2 data for a construction product. Stichting NMD is owner of these environmental profiles.

A surcharge factor is applied to category 3 environmental profiles, because experience has shown that unverified environmental profiles often indicate a too low environmental impact as the inventory data are less complete, and to stimulate the submission of category 1 and 2 data to the database. This surcharge factor is determined by Stichting NMD, which manages the NMD, and is implemented in the calculation tools via the calculation rules. An overview of the agreements and procedures for category 3 Environmental Product Declarations is included on *www.milieudatabase.nl*.

In addition to the Environmental Product Declarations in the NMD, Stichting NMD also manages the process database. The NMD process database contains category 1 & 2 processes and generic processes (category 3) based on Ecoinvent 'allocation, cut-off by classification' adapted for use in the context of the Assessment Method. The processes (e.g. sand, cement, steel and diesel) are used by LCA authors when drawing up LCAs for category 1 & 2 Environmental Product Declarations. The representativeness of the generic processes used should be considered in the LCA report on which the EPD is based. The generic basic processes (category 3) are also used as the basis for the category 3 Environmental Product Declarations in the NMD. These category 3 declarations are therefore updated when changes are made to Ecoinvent or the Assessment Method.

**Set A1 is supplied based on Ecoinvent version 3.6. Set A2 based on Ecoinvent version 3.9.1. Files containing A2 data based on Ecoinvent version 3.6 will still be accepted until 1-7-2025. It is mandatory to supply both sets.**

The Assessment Method, the calculation rules, the NMD and the process database are a cohesive package that enable an unambiguous calculation of the environmental performance of construction works. Figure 1 indicates that the Assessment Method serves as a product category rule (PCR) to produce EPDs as well as to determine the calculation rules for the core of the calculation tools.

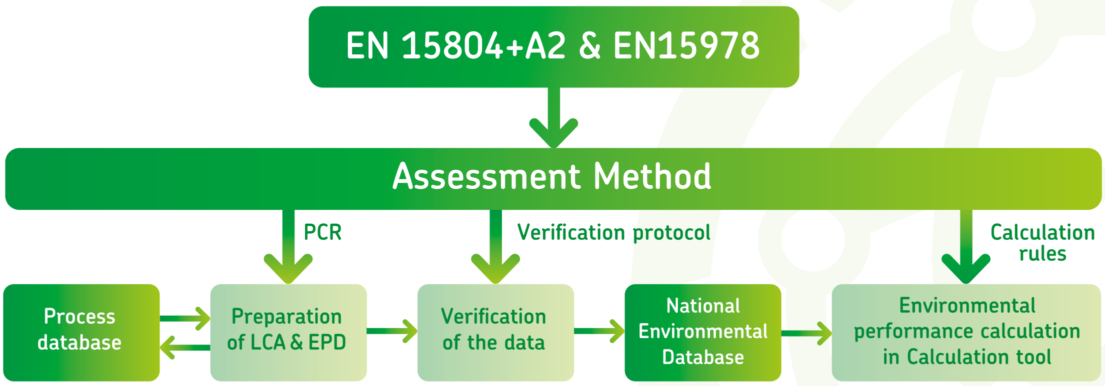



*Figure 1: Visualisation of the data flow between the two databases managed by Stichting NMD, the environmental performance and the elements for which the Assessment Method prescribes requirements.*

## 1.3 Verification of category 1 and 2 product information

Environmental data incorporated in the NMD in accordance with this Assessment Method are verified in compliance with the procedure and requirements of the latest NMD Verification Protocol version. Additional information can be found on *www.milieudatabase.nl* to assess whether supplied environmental data has been prepared in accordance with the Assessment Method. The MRPI®-EPD VERIFICATION on The PCR-NL, for instance, is a useful tool. However, this is a supplement and the most recent version of the Verification Protocol should always be followed for the final assessment. Both the EPD, including the entire underlying project documentation, as well as the entire input form part of the verification. The input is verified in the NMD input platform as made available to Stichting NMD's recognised LCA reviewers. The EPD compiler is responsible for checking the latest version of the NMD Verification Protocol.

To enable assessment according to the NMD Verification Protocol, the LCA practitioner should complete the Assessment Tables document stating in the comments' column where the requested information can be found in the project file and add this completed document to the project file. The document with the assessment tables is available as a Word file on the Stichting NMD website, *www.milieudatabase.nl*. The assessment tables form a basis for the verification. The LCA principles from the core standards (see normative references in section 2.2) are also checked during verification.

## 1.4 Reading guide

This version of the Assessment Method replaces the March 2022 version 1.0 with amendments 4 and 5. The methodical requirements for the LCA and the product information based on EN 15804 are presented in chapter 2. It offers directions for formulating Environmental Product Declarations (EPDs) in the Dutch context in such a way that the environmental information they contain is suitable for inclusion in the NMD. Chapter 2 virtually follows the EN 15804 section layout. Supplements to EN 15804 are indicated for each section, if applicable. As well as the additions to EN 15804, clarifying texts have been included that help produce unambiguous environmental information.

The guidelines for assessing the environmental performance at construction work level are presented in chapter 3. This sets out which features of the building are relevant. It also describes the calculation rules for the calculation at construction work level for each life cycle phase. Furthermore, it provides an explanation of the rules regarding unforeseen reuse, renovation and transformation. Chapter 4 provides the procedure to include building-related energy use in addition to the EPB calculation for C&U and the ECI calculation for civil engineering structures. This chapter is optional and its use is not mandatory.

Not all concepts are defined in the main text. Appendix I includes the terms, definitions & abbreviations used in this Assessment Method.

Appendix II contains an overview of the processes that fall within the system boundaries. A step-by-step plan for determining end-of-waste is provided in Appendix III. Appendix IV provides an informative indication of which structures and installations are taken into account in assessing the environmental performance of a building. It also provides an overview of the scope of a construction work calculation.

Finally, Appendix V (pertaining to section 2.6.4.3) describes how the net impact of module D must be calculated.

# 2. Methodical requirements (EN 15804+A2) to determine the environmental performance of construction and other products, installations and processes

**This chapter can only be fully understood in combination with EN 15804 and follows almost the same chapter structure. In each section title, the title used in EN 15804 is shown in brackets.**

## 2.1. Goal and scope (EN 15804 1 Scope)

The product information (Environmental Product Declarations) is used for the construction work calculations and must be suitable for use in the Dutch context and to achieve the intended uniformity. The rules in the Assessment Method are aligned to this goal.
In addition to EN 15804, the Assessment Method provides:

- requirements for determining standard scenarios for the Dutch context, where possible and necessary;
- requirements for determining standard values of background processes for the Dutch context, where possible and necessary;
- requirements for determining the reference service life;
- requirements for preparing the project file for the verification procedure.

The Assessment Method target group comprises:

- LCA practitioners for Environmental Product Declarations for inclusion in the National Environmental Database (NMD);
- compilers of basic processes for inclusion in the process database, for use as input for LCAs;
- instrument owners and managers of databases for producing uniform construction work calculations in the Netherlands;
- Calculation rules, applicable within this Assessment Method.

## 2.2 Normative references (EN 15804 2 Normative references)

The following documents are invaluable in using this document. For dated references, only the stated version applies. For undated references, the latest version of the document applies, including later addenda:

*NEN-EN 15804+A2:2019 Sustainability of construction works - Environmental Product Declarations – Core rules for the product category of construction products.*

In turn, EN 15804 is based on several international LCA standards. These therefore apply to the Assessment Method:

*ISO 14025:2010, Environmental labels and declarations – Type III environmental declarations – principles and procedures (ISO 14025:2006)*
*ISO 14044:2006 Environmental management – Life cycle assessment – requirements and guidelines (ISO 14044:2006)*
*EN 15978 - Sustainability of construction works – Assessment of the Environmental performance of buildings – Calculation method*

In addition, c-PCRs have been developed in CEN/product TCs that have the status of EN standards.

## 2.3 Terms and definitions (EN 15804 3 Terms and definitions)

The terms and definitions are included in Appendix I. For all terms from EN 15804, the section number is included in brackets.

## 2.4 Abbreviations (EN 15804 4 Abbreviations)

The abbreviations are included in Appendix I. EN 15804 applies.

## 2.5 General aspects (EN 15804 5 General aspects)

### 2.5.1 Goal
EN 15804 applies.

Complementary product category rules (c-PCRs) may also apply. The c-PCRs that meet the criteria must be adhered to when formulating category 1 and 2 data in line with the Assessment Method. For a current overview of mandatory c-PCRs, see the Stichting NMD website, *www.milieudatabase.nl*.

### 2.5.2 Types of EPD and associated life cycle phases
In deviation from EN 15804, the LCA-based information in an EPD includes the following life cycle phases (see Figure 2):

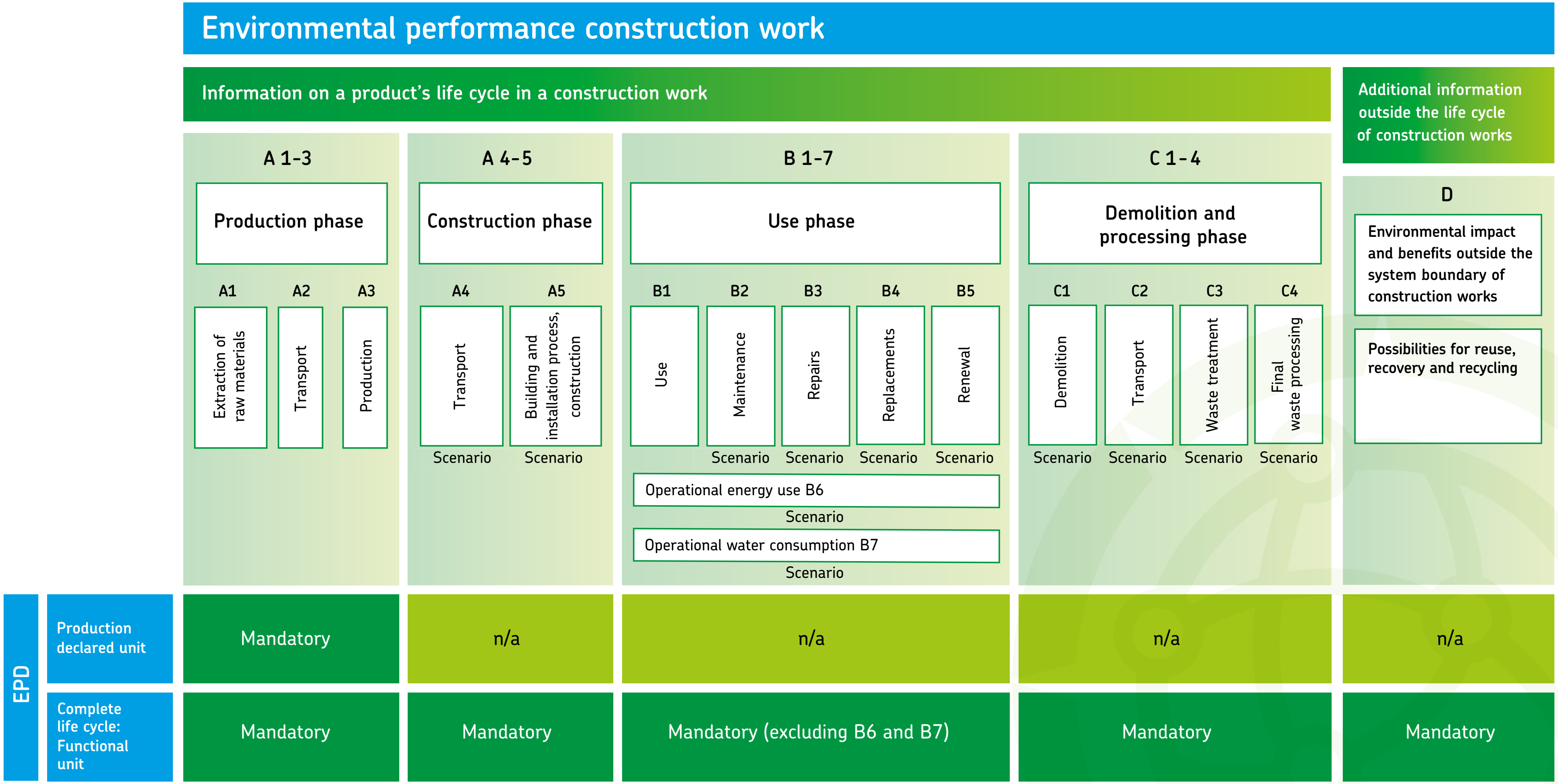
*either:*
Only the production phase (A1-A3) as basic processes. These processes are made available to LCA practitioners via the Stichting National Environmental Database (Stichting NMD) process database. These processes are not issued as Environmental Product Declarations for the calculation tools.

*or:*
The entire life cycle of a product in construction works, modules A to D (excluding B6 and B7). If no information is available from the LCA for the specific EPD, default values can be used for the use and maintenance phase of construction works.

The information per life cycle stage is arranged in a large number of information modules and in accordance with EN 15804: for example for phase A, the production phase, these are A1, A2, A3, A4 and A5. Modules A1-A3 are aggregated and included in the NMD.

For inclusion in the NMD as Environmental Product Declarations, data must be provided from the entire life cycle as described above. If desired, data of individual modules can also be included in the process database. For more information, see the protocol 'supply of processes for the NMD process database', which can be downloaded at *www.milieudatabase.nl*.

*Figure 2: Life cycle phases EPD*



**2.5.3 Comparability of construction product EPDs**
EN 15804 applies.

**2.5.4 Additional information**
EN 15804 applies.

The Assessment Method also provides guidance on the necessary information in Environmental Product Declarations on scaling. See paragraph 2.11.

**2.5.5 Ownership, responsibility and liability**
EN 15804 applies.

**2.5.6 Communication formats**
Specific formats for the basic processes (see *www.milieudatabase.nl*) and the Environmental Product Declarations are prescribed for inclusion of environmental data in the NMD (see the NMD input platform).

Additional information can be found on *www.milieudatabase.nl* to assess whether supplied environmental data has been prepared in accordance with the Assessment Method. The MRPI®-EPD VERIFICATION on The PCR-NL, for instance, is a useful tool. However, this is a supplement and the most recent version of the Verification Protocol should always be followed for the final assessment.

## 2.6 Product category rules for the LCA (EN 15804 6 PCR)

**2.6.1 Product category**
EN 15804 applies.

**2.6.2 Life cycle phases and the information modules to be included**
EN 15804 applies.

**2.6.3 Calculation rules for the LCA**
The reference unit of EPDs may refer to a declared unit or to a functional unit. An EPD must cover all relevant life cycle phases. If only basic processes are supplied, modules A1 – A3 will suffice.

*2.6.3.1 Functional unit or declared unit*
EN 15804 applies.

The product's functional unit for including environmental information from the EPD in the NMD should be selected in accordance with the NMD functional descriptions and ordering structure.

A product is something that is marketed by the supplier and purchased by the buyer for use during the life cycle of a construction work. A product can be a physical product (e.g. 1 m2 of window frame), but also an activity (e.g. 1 tkm of rail transport). The NMD distinguishes total products and partial products. The required performance is recorded in functional descriptions per element (C&U) or chapter (Civil Engineering Structures). The total products provide all the services required per element/chapter; the partial products provide only parts of these. Both total as well as partial products are saved in the NMD as individual products. In the NMD, information is saved per product.

The products in the NMD have been assigned a unit in line with how they are traded on the market. These are also logical units for the materialisation of construction works in the validated calculation tools. Examples are a frame in m2 and hinges and locks per item. It is not logical to include hinges and locks in $m^2$.

A disadvantage is that any deviating units make product comparisons complex. Insight into the products that score better, or more poorly, is handy when optimising the design. This is why it is now also possible to express the ECI of a product per 'reference unit' of the element (component). Presenting this in both the 'market unit' as well as in the 'reference unit' concerns an additional functionality, which can be offered by the validated calculation tools. This other method of presentation is therefore a side issue and has no influence on environmental performance at construction work level.

The conversion factor in the calculation tools converts 'market units' into 'reference units'. This factor is added to the product data in the NMD as an extra. As a result, the factor falls within the product data quality control system.

The total overview is included in the NMD input platform (enter NMD Environmental Product Declarations). An Excel version is also available on the Stichting NMD website *www.milieudatabase.nl*. This is a non-exhaustive list. If the proposed product does not occur within one or more desired functional descriptions, a request can be submitted to Stichting NMD to make adjustments or include a new functional description. **PLEASE NOTE: an Environmental Product Declaration that cannot be linked to the database cannot be included. The EPD compiler is responsible for identifying this in time and for submitting a request to Stichting NMD.**

Prior to including the environmental data from the EPD in the NMD, the available environmental data must be supplemented with data for all relevant life cycle phases. Information modules B6 and B7 (see Figure 2) are excluded from this.

The declared unit must be measurable and must contain:

- a description of the construction product or the building's or civil engineering structure's construction element;
- a specification of the construction product or building's or civil engineering structure's construction element;
- if applicable, the possible fields of application, expressed in categories or quality designations where necessary, together with the service life of the construction product or the building's or civil engineering structure's construction element where relevant for each field of application;
- the amount of the construction product expressed in an SI unit or a combination of SI units;
- the weight of the construction product;
- the materialisation of the construction product in material description and weight.

Descriptions in certificates or statements of the construction product or building's or civil engineering structure's construction element are guiding, as are descriptions in sector-wide accepted documents, guidelines, methods and systems.

*2.6.3.2 Functional unit*
EN 15804 applies.

*2.6.3.3 Declared unit*
EN 15804 applies.

*2.6.3.4 Reference service life*
EN 15804 applies.

The reference service life is declared by the producer with substantiation. If this is not available, the reference service life per type of construction product from the publication Service life of construction products [SBR, 2011 – Knowledge database ISSO] can be used.

There are products that experts indicate have an average service life in standard situations of certainly more than 100 years. One example is a concrete foundation pile. It is assumed that the service life expectancy of these products is the same as that of the construction work in which the product is used. These products are recognisable in the NMD by a product service life of 999 years. The calculation rules mean that for these products, the product service life used in the calculation is limited to the service life of the construction work.

*2.6.3.5 System boundaries*
EN 15804 applies.

A process tree is produced within the system boundary in which at least the information modules from Figure 2 are distinguished: Production phase (A1-A3), Construction phase (with transport A4 and building and installation process/construction A5 separate), Use and maintenance phase (B1-B5, in separate modules), Demolition and processing phase (C1-C4, in separate modules) and module D.

A non-exhaustive but purely informative overview of processes that should and should not be incorporated is included in Appendix II, System boundaries. This overview can be used as a checklist for both the compiler and verifier of an LCA for an EPD. The system boundaries must be reported in such a way that these are clearly verifiable for the verifier.

In accordance with EN 15804, waste processing is included in the life cycle phase in which it originates.

*Production phase (A1-3)*
EN 15804 applies.

Streams that lose their waste status and leave the production phase (A1-A3) must be allocated as by-products (see EN 15804 6.4.3.2). Environmental impact and avoided environmental impact of allocated by-products are not included in module D (see EN 15804 6.3.4.6). If such an allocation of by-products is not possible, other methods can be chosen, if substantiated.

**PLEASE NOTE: If the LCA practitioner considers that another method is needed, different conditions for the verification apply. The proposed solution will then be presented to the TIC and included for publication by Stichting NMD as approved exception. The LCA practitioner is responsible for taking into account the longer turnaround time for the verification.**

Environmental impacts for the processing of production waste are incorporated in the production phase. In deviation from EN 15804, benefits from avoided energy production by means of waste incineration of production waste are declared in module A1-A3. This is based on the same calculation as in module D 'D avoided energy production (AVI)'.

### Calculation rules A1-A3

The environmental impacts of the (NMD basic) processes used are multiplied by the specified quantity used per process.

$$MP_{A1-A3} = \sum_{p=1}^{n} AF * MP_p * Q$$

$MP_{A1-A3}$ = environmental profile in module A1-A3 of a product component;

AF = allocation factor;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used;

$n_p$ = the number of processes used in the product component within the relevant module;

With:

$$AF = \frac{A_{PR}}{(A_{PR}+A_{CPR})}$$

AF = allocation factor; (0≤ AF ≤1)

$A_{PR}$ = Allocation value of the product;

$A_{CPR}$ = Allocation value of the co-product.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*Transport phase (A4)*
EN 15804 applies.

The transport phase (A4) starts when the construction product or element is ready for transport from the producer to the buyer, and ends when it is delivered to the construction site adjacent to the means of transport.

*Note 1:* Routes through any intermediate organisations should also be included, for example, if there is a trader or processor between the producer and the construction site.

*Note 2:* Within the calculation of the number of units of the unit process used for transport, the load factor of the means of transport and the density of the product must be taken into account. With insulation materials, the limiting factor may, for example, be volume; therefore, mass transport processes in tonne-kilometres are not always representative.

**Calculation rules A4**

$$MP_{A4} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{A4}$ = environmental profile in module A4 of a product component;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used;

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*Building and installation process / construction (A5)*
EN 15804 applies.

These processes (A5) are included in the form of one or more scenarios.
Standard values for 'loss in the form of construction waste' are included in section 2.6.3.6.

**Calculation rules A5**

$$MP_{A5} = Vf * (MP_{A1A3} + MP_{A4} + MP_{C2} + MP_{C3} + MP_{C4}) + \sum_{p=1}^{n} MP_p * Q$$

$MP_{A5}$ = environmental profile in module A5 of a product component;

Vf = loss fraction in the construction and installation phase (in percentage Lf ≥ 0%);

$MP_{A1-A3}$ = environmental profile in module A1-A3;

$MP_{A4}$ = environmental profile in module A4;

$MP_{C2}$ = environmental profile transport of installation losses;

$MP_{C3}$ = environmental profile waste processing of installation losses;

$MP_{C4}$ = environmental profile final waste processing of installation losses;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used within the relevant module;

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*Use phase (B1-5)*

B1 – The use of the construction product (life cycle phase B1) concerns the application in the Netherlands.

B2 – The maintenance (life cycle phase B2) concerns only material-related maintenance and not construction workrelated or location-related maintenance. Cleaning maintenance is only included if functionally important.

B3 – Repair (life cycle phase B3) concerns the predictable repairs that can be calculated in the form of a scenario.

B4 – Replacement of the entire product is defined in the calculation rules at building level by multiplying the Environmental Product Declarations. Replacement of the entire product will therefore not be reported separately in the use phase. Replacement of components that cannot match the service life of the entire product are included here.

*Note 1:* EN 15804 does not distinguish between replacements of product components and total products. The breakdown at product level and construction work level is important within the application context of the Assessment Method.

*Note 2:* The production phase, installation, use and end-of-life of the replaced product component in B4 may be the same as the original product component, but they may also differ.

*Example 1: An air handling unit with a service life of 25 years needs a fan replacement after 15 years. The fan is included in the Environmental Product Declaration as a product component and has 0.67 replacements in module B4 (25/15-1). The replaced product component has the same environmental impact and installation/ waste processing scenario as the original product. The environmental impact in B4 is calculated as: 0.67* (Environmental impact of the product component from A1-A3, A4, A5, B1-B3, C1-C4). The replacement of the entire installation in relation to a reference service life of the construction work is calculated at construction work level within calculation tools. Full product replacements are not part of B4 of the Environmental Product Declaration. These are reflected in module B4 at construction work level.*

B5 – Renovation (life cycle phase B5) is not part of this Assessment Method.
For energy use during use (life cycle phase B6), see chapter 4.

### Calculation rules B1

$$MP_{B1} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{B1}$ = environmental profile in module B1 of a product component;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (Can have any value, including less than 0 in the case of negative emissions.);

$n_p$ = the number of processes used in the product component within the relevant module.

### Calculation rules B2

$$MP_{B2} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{B2}$ = environmental profile in module B2 of a product component;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (≥ 0);

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

### Calculation rules B3

$$MP_{B3} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{B3}$ = environmental profile in module B3 of a product component;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (≥ 0);

$n_p$ = the number of processes used in the product component within the relevant module.

### Calculation rules B4

The number of product component replacements is calculated as:

$$n_V = \frac{L_{pr}}{L_{on}} - 1$$

$n_V$ = number of replacements of product component used (≥ 0), rounded to 2 decimal places;

$L_{pr}$ = service life of the product;

$L_{on}$ = service life of the product component.

$$MP_{B4} = (MP_{A1A3} + MP_{A4} + MP_{A5} + MP_{B1} + MP_{B2} + MP_{B3} + MP_{C1} + MP_{C2} + MP_{C3} + MP_{C4}) * n_V$$

$MP_{B4}$ = environmental profile in module B4 of a product component;

$MP_{A1-A3}$ = environmental profile in module A1-A3 of a product component;

$MP_{A4}$ = environmental profile in module A4 of a product component;

$MP_{A5}$ = environmental profile in module A5 of a product component;

$MP_{B1}$ = environmental profile in module B1 of a product component;

$MP_{B2}$ = environmental profile in module B2 of a product component;

$MP_{B3}$ = environmental profile in module B3 of a product component;

$MP_{C1}$ = environmental profile in module C1 of a product component;

$MP_{C2}$ = environmental profile in module C2 of a product component;

$MP_{C3}$ = environmental profile in module C3 of a product component;

$MP_{C4}$ = environmental profile in module C4 of a product component;

$n_V$ = number of replacements of product component used (≥ 0), rounded to 2 decimal places.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*Demolition and processing phase (C1-4)*

C1 – The demolition phase, which starts when the construction work is no longer in use and ends when the construction work has been demolished or dismantled. This phase, therefore, comprises the activities at the demolition location.

*Note 1:* It is also possible that a construction work is reused or partly reused or that parts remain for use in a new application. Any dismantling activities are then modelled in the demolition phase. Any activities for reuse are modelled in the processing phase.

*Note 2:* If a material, product or element is left without fulfilling a further function ('left without function'), it is treated as waste.

**Calculation rules C1**

$$MP_{C1} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{C1}$ = environmental profile in module C1 of a product component;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (≥ 0);

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*Example 1: An example of partial reuse of a construction work is a sand bed from a road that is reused for the reconstruction of the road. In this example, no demolition works take place to the sand bed. Any recompaction of the sand bed falls under the processing phase and is modelled according to the allocation procedure in section 2.6.4.3 and corresponding Appendix V.*

For the end-of-waste phase, the system boundary is determined in accordance with Appendix III.

C2 - EN 15804 applies.
Standard values for the transport distances to the sorting locations, landfill locations and waste incineration plants (AVI's) are included in section 2.6.3.6.

**Calculation rules C2**

$$MP_{C2} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{C2}$ = environmental profile in module C2;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (≥ 0);

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

C3 - EN 15804 applies.

**Calculation rules C3**

$$MP_{C3} = \sum_{p=1}^{n} MP_p * Q$$

$MP_{C3}$ = environmental profile in module C3;

$MP_p$ = environmental profile of unit process or emission used;

Q = number of units of the unit process or emission used. (≥ 0);

$n_p$ = the number of processes used in the product component within the relevant module.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

C4 - EN 15804 applies.
For landfill processes, an end point of 100 years after landfill is assumed (see also 2.6.3.7 under generic data).

Module D - EN 15804 applies.
Section 2.6.4.3 and corresponding Appendix V describe how the net impact of module D must be calculated.

C3, C4 and module D – The environmental impact is calculated via the end-of-life processing scenarios as published on the National Environmental Database website. Further guidance on this is given in 2.6.4.3 and corresponding Appendix V. Module D includes the avoided energy as described in 'Incineration in a waste incineration plant' in 2.6.3.6.

In deviation from EN 15804, no benefits are attributed within the Assessment Method to avoided energy production from landfills.

### Calculation rules module D

Module D consists of three segments for benefits and costs relating to: substitution of primary materials through material conservation (recycling and reuse), substitution for energy generation through exported energy from AVI, and substitution for exported secondary fuels. There are benefits in module D when net secondary raw materials are transferred. If the net output of the secondary flows is negative, this will be set equal to 0 in module D. Module D also includes reprocessing processes to achieve the raw material equivalent for substitution from the moment the end-of-waste status is reached.

$$MP_D = MP_{Dm} + MP_{Davi} + MP_{Db}$$

$MP_D$ = environmental profile in module D of a product component;

$MP_{Dm}$ = environmental profile in module D based on material conservation of a product component;

$MP_{Davi}$ = environmental profile in module D based on exported energy by AVI of a product component;

$MP_{Db}$ = environmental profile in module D based on exported secondary fuels of a product component.

Module D benefits and costs of installation loss (A5) and replacements (B4) are declared in module D.

### D material conservation (recycling & reuse)

Module D benefits and costs from material conservation is based on the calculation of the net output flow of secondary material. For secondary materials, EN15804 6.4.3.3 does not distinguish between materials for/from recycling and materials for/from reuse. It does, however, add a quality factor to determine the raw material equivalent. If more secondary material goes into the product than comes out, there is a net loss of secondary material, and substitution costs apply.

If the net output of the secondary flows is negative, this will be set equal to 0 in module D.

$$MP_{Dm} = \sum_{s=1}^{n}(MP_s * \frac{K_{uit}}{K_{sub}} * \max(0, Q_{MR\,uit} - Q_{MS\,in})) + \sum_{p=1}^{n} MP_p * Q$$

$MP_{Dm}$ = environmental profile in module D based on material conservation of a product component;

$MP_s$ = environmental profile of unit process or substitution process used for primary materials saved/lost (through recycling or reuse);

NMD module D basic processes for substitution already include a quality correction factor; when using these processes, Kuit/Ksub = 1 applies.

$K_{uit}$ = quality of material or product transferred;

$K_{sub}$ = quality of the substitution process;

$Q_{MR\,uit}$ = number of units of material for material conservation (recycling and reuse) of the unit process used upon reaching end-of-waste status. Within the unit process, this is the sum of outgoing material for material conservation of modules A4-A5, B1-B5, or C1-C4. (≥ 0);

$Q_{MS\,in}$ = number of units of material with a secondary origin from the unit process used. Calculated as Secondary input may originate from modules A1-A3, A5, B1-B5 (≥ 0);

$MP_p$ = environmental profile of unit process or emission used. This includes any additional materials/processes (environmental costs) required to achieve the substitution equivalent from end-of-waste status. (These environmental costs are included as standard in NMD module D basic processes.);

Q = number of units of the unit process or emission used. (≥ 0);

n = the number of processes used in the product component within the relevant module. There are '$n_s$' substitution processes and '$n_p$' unit processes.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

## D avoided energy production (AVI)

For module D AVI with energy recovery, a distinction is made between avoided energy production from renewable raw materials and avoided energy production from fossil raw materials. For each process used, the LCA practitioner will classify the raw materials according to the definitions of renewable raw materials and non-renewable raw materials as set out in this Assessment Method.

$$MP_{Davi} = \sum_{aviher=1}^{n} (MP_{aviher} * (Q_{M\,her} * \%avi * LHV)) + \sum_{avifossiel=1}^{n} (MP_{avifossiel} * (Q_{M\,fossiel} * \%avi * LHV))$$

$MP_{Davi}$ = environmental profile in module D based on avoided energy production by AVI of a product component;

$MP_{aviher}$ = environmental profile of unit process or substitution process used for energy saved from renewable sources. The standard processes established by NMD are used for this purpose.

$Q_{M\,her}$ = number of units of renewable material. For the unit process, this is the sum of outgoing renewable material for modules A4-A5, B1-B5, or C1-C4. (≥ 0);

%avi = the AVI percentage in the waste processing scenario of the relevant material;

LHV = Lower heating value of the process used (≥ 0);

$MP_{avifossiel}$ = environmental profile of unit process or substitution process used for energy saved/lost from fossil sources. The standard processes established by NMD are used for this purpose.

$Q_{M\,fossiel}$ = number of units of fossil material. For the unit process, this is the sum of outgoing fossil material for modules A4-A5, B1-B5, or C1-C4. (≥ 0);

n = the number of processes used in the product component within the relevant module. There are '$n_{aviher}$' renewable processes, materials and '$n_{avifossiel}$' fossil processes, materials.

## D exported secondary fuels

$$MP_{Db} = \sum_{b=1}^{n} (MP_b * \max(0, Q_{SB\,uit} - Q_{SB\,in})) + \sum_{p=1}^{n} (MP_p * Q)$$

$MP_{Db}$ = environmental profile in module D based on exported secondary fuels of a product component;

$MP_b$ = environmental profile of unit process or substitution process used for fuels saved/lost;

$Q_{SB\,uit}$ = number of units of material for exported secondary fuels from the unit process used when reaching end-of-waste status. May originate from modules A4-A5, B1-B5, or C1-C4. (≥ 0);

$Q_{SB\,in}$ = number of units of secondary fuels used. Secondary fuels used may originate from modules A1-A3, A5, B1-B5 (≥ 0);

$MP_p$ = environmental profile of unit process or emission used. This includes any additional materials/processes required to achieve the substitution equivalent from end-of-waste status.

Q = number of units of the unit process or emission used. (≥ 0)

n = = the number of processes used in the product component within the relevant module. There are '$n_b$' processes for secondary fuels and '$n_p$' unit processes.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

### Raw material equivalent

The raw material equivalent(s) must be determined to calculate the correct benefits and costs in module D. The raw material equivalent indicates how much and which primary production process (in module A1-3 of another product system) can save a secondary material or secondary fuel because it is considered technically equivalent.

The raw material equivalent should be determined (within the defined product system) for each individual/ unique flow of:

- *Secondary materials as input flows in the product phase (Module A).*
- *Secondary fuel as input flow in the product phase (Module A).*
- *Products for reuse as output flows in the processing phase (Module C).*
- *Materials for recycling as output flows in the processing phase (Module C).*
- *Materials for energy recovery as output flows in the processing phase (Module C).*

Further guidance on this and examples are given in 2.6.4.3.

The raw material equivalent, as a representative substitution process for Module D, should be substantiated for these above flows with the standard data quality control and representativeness check.

For exported energy, no specific choice and justification of the raw material equivalent needs to be given. This output flow should be included according to the method described in 'Incineration in a waste incineration plant' in 2.6.3.7.

In the case of products for reuse as output flows in the processing phase, as mentioned above, the representative substitution at product level is expressed in a quality factor K. This quality factor is a measure of a product's remaining quality (not the material flows) compared to the initial product. The quality factor K is expressed in a % between 1 and 100 and can be determined by the producer through:

1. Substantiating technical quality following initial use; or
2. Anticipated residual service life of the 2nd use; or
3. Market value of the product for reuse in relation to the market value of the new product.

The above options are in order of preference for determining K.

The quality factor K becomes part of the end-of-life processing scenario of the relevant product and is expressed as follows:

$$\text{Milieu impact module D} = \text{vew}\ (\%) \times (\text{mbD} \times K) + \text{mlD}$$

vew (%) = percentage of reuse from end-of-life processing scenario
mbD = environmental benefits outside product system
mlD = environmental costs outside product system

The factor K only applies to the benefits (not the impact) outside the product system; after all, it concerns the representative substitution at product level. The necessary additions in process, material, etc. that are required must be declared as environmental costs in D, of course for the full 100%.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

Factor K is part of the end-of-life processing scenario for the reuse component; the other material flows are processed further in accordance with this Assessment Method's standard requirements.

Assumptions about future reuse must be based on substantiated data, as prescribed in the LCA standards included in section 2.2 of this Assessment Method, and not on intentions. Restraint should be exercised with regard to forms of reuse that cannot yet be demonstrated in practice. The reuse component or factor K is part of the verified file and must, of course, also comply with all generic requirements from the Assessment Method.

If desired, several product scenarios can be considered, as included in section 2.6.3.9. An Environmental Product Declaration can be produced for a reused product if desired.

*Example 1: 1 m$^2$ masonry dry stacked; the producer has demonstrably substantiated that the quality of individual bricks is comparable after initial use, but that 15% of the individual bricks are rejected during reuse due to damage, and the product is further modelled as waste or as recycling flow. The quality factor K for this product is 100% as the quality is, after all, the same. However, losses from rejection must be accounted for in module D. In this case (85% × K=) 85% net of product reuse can be calculated in the end-of-life processing scenario for this product.*

*Example 2: 1 aluminium exterior door frame; the supplier offers both new and used frames from a similar series with a market value difference of 40%. The quality factor K for this product is 60%. In the case of a reuse percentage* of 50%, the net reuse percentage becomes 50% × K = 30%.*

*Example 2a: If the producer has a refurbishment programme that reduces the market value difference to 5% through repair and/or other processes, the quality factor K is 95%. However, the additional materials and processes that are added to the product must be fully declared as impact in module D. The net reuse percentage can be calculated here as 50% (reuse percentage) x K = 47.5%*

** The remaining part will be modelled as waste or recycling flow.*

*Example 3: 1 m2 interior wall; a product-as-a-service programme for interior walls was established by the supplier. For the use of 1m2 interior wall, the producer used market figures to demonstrate that on average 40% of interior walls are reused in projects in this programme. As the interior walls can be reused up to three times with adaptations, the actual use is four times, including initial use. The quality therefore decreases by 25% per cycle (from 100 to 0). The reuse percentage is an average of the number of times the product is reused.*

Module A – 40% of production is reuse, of which only the additional transport is allocated to A1-A3.
Module D – quality factor K is ((1×75%) +(1×50%) +(1×25%))/4 = 37.5%
Module D – the adaptations required for reuse are included as environmental costs in Module D, weighted equally to quality factor K. The remaining part will be modelled as waste or recycling flow.

This was used to develop a scenario with which an Environmental Product Declaration will be drawn up for a wall as a service from this supplier. Of course, an explanation of the scope in service life of the concept is part of the Environmental Product Declaration; in this example this would be 4 times 25 years.

*Example 4: 1 steel doorway with a span of 15 metres can be reused after its end of life. The doorway then needs a new coating, and 11% new material is needed. The K factor amounts to 89% based on the new material that needs to be added for the new desired quality or functionality. Of the adaptations required for reuse, the application of the new coating must be included as environmental impact in module D. The foundation will not be reused in this example. No quality factor K then needs to be determined; after all, reuse is already 0% in the end-of-life processing scenario.*

*2.6.3.6 Criteria for omitting input and output*
EN 15804 applies.

Production, delivery, removal, maintenance and end-of-life processing of capital goods are included. Infrastructure and capital goods are included in Ecoinvent - allocation, cut-off by classification data - which is used as standard database. Ecoinvent data are also used including infrastructure and capital goods. If the contribution of capital goods to each individual environmental impact category of the production phase module (A1-A3) is less than 5%, provided this is substantiated, this may be disregarded.

In addition to EN 15804, an input that contributes less than 1% of the primary energy use and less than 1% of the total mass of the process in question, and for this reason could be omitted, should be included if it is expected to contribute more than an estimated 5% to one of the environmental impacts of the construction product per module, for example per module A1-A3, A4-A5, B1-B5, C3-C4 and D. As an additional requirement, the sum of environmental impact per module not taken into account in this way may not exceed 5% of the total per environmental impact category across the entire life cycle.

The evaluation of environmental impacts for omitting inputs and outputs should be based on the environmental impacts from set A2, and the environmental impacts from set A1. Within set A2, for the contribution of environmental impacts to Global Warming Potential, only the total result 'Global Warming Potential – total' is considered.

**Set A1 is supplied based on Ecoinvent version 3.6. Set A2 based on Ecoinvent version 3.9.1.**
**Files containing A2 data based on Ecoinvent version 3.6 will still be accepted until 1-7-2025.**
**It is mandatory to supply both sets.**

*2.6.3.7 Selection of data*
The following requirements apply in addition to EN 15804.

### Representativeness of the processes of the manufacturer

Individual production locations must derive their data from that location.
If in the case of horizontal aggregation in the product system all production locations supply data, the result is automatically representative of the relevant group. If not all production locations from the group provide data, a representative cross-section should be made from the group of production locations, as far as they produce for the Dutch market, with regard to geographical and technical differences that may lead to differences in environmental impact.

*Note 1:* Whether this is the case can be determined by identifying the data that most influence the environmental impact, and the geographical and technological aspects involved.

*Note 2:* Horizontal aggregation can take place both at one producer's different product locations and at groups of producers or sectors that produce an Environmental Product Declaration.

If the producer is unwilling or unable to use representative production locations, but relies on random locations, the data will no longer be valid for the producer, but for the producer's relevant production location(s).

To determine the percentage, the average composition is based on the entire production's annual or multi-annual figures, weighted, according to production quantities[2], where applicable. Instead of the average composition, a composition covering more than 80% of the production quantity in the year of study or a specific composition may also be chosen. Such a choice must be transparent.

*Example 1: A material that contains component Y is produced in 3 charges per year. Charge 1 delivers 10 kg of the material with 0.02 kg Y/kg; charge 2 delivers 15 kg with 0.1 kg Y/kg; charge 3 delivers 5 kg with 0.08 kg Y/kg. The ratio in production quantities of the charges is therefore: 10:15:5 = 2:3:1 or: 2 (33 %): 3 (50 %): 1 (17 %). The average percentage Y then amounts to: 0.33 × 0.02 + 0.5 × 0.1 + 0.17 × 0.08 = 0.07 kg Y/kg.*

### Representativeness of other data

The other processes in the product system must give a representative or typical picture of the current geographical and technological situation. The area of application to which this norm applies is the Netherlands. 'Representative' means that data accurately reflect the real population. 'Typical' means that the data describe a certain, common situation (also called modal).
*Note 3:* The requirements for representativeness apply to all economic flows, including the service life used to determine the number of replacements, the percentages of primary and secondary material used or the end-of-life processing scenario.

If an existing EPD is used to draw up an EPD for a raw material, the representativeness of that EPD for this specific raw material must be demonstrated. If the EPD has been produced according to the Assessment Method and has been assessed according to the NMD Verification Protocol, the underlying data, which is often not publicly accessible, does not need to be further analysed.

*2 Or production level if that is a common unit.*

## Generic data

In addition to EN 15804, for the production of raw materials it is preferable to use data from the producer's own supplier. If it can be demonstrated that the supplier has no data available or does not want to make these data available, generic data can be used.

For generic data, in principle, the process database based on the Ecoinvent 'allocation, cut-off by classification' database will be used. Long-term (>100 years) emissions, modelled separately within Ecoinvent, particularly for leaching, are not included. The cut-off after 100 years applies to all modules A-D and to all data, both generic and specific.

When using generic data for processes that process secondary raw materials or co-products, or when applying generic data from waste processing processes, it should be checked as part of the data quality control that the system boundaries and any allocation method of the processes used are in accordance with EN 15804 requirements.

## Standard values

The following standard values apply:

- transport distance single journey to the construction site if the construction product is produced in the Netherlands: for bulk material 50 km, for other materials, products and elements 150 km;
  for civil engineering structures the transport distance per structure is offset in the calculation tool;
- location to determine transport distance of materials from abroad to and from the construction site or buyer: Utrecht;

*Note 4:* If a material comes from abroad and the average distance to the Dutch market is not known, the distance between the production location and Utrecht is used.

- end-of-life processing scenario in accordance with the table on *www.milieudatabase.nl*;
- transport distance single journey from the demolition location to the sorting and/or crushing plant for recycling: 50 km;
- transport distance single journey from the demolition location to the sorting and/or storage location for reuse: 50 km;
- transport distance single journey for removal of soil: 50 km;
- transport distance single journey from the demolition location to the landfill location: 100 km;
- transport distance single journey of combustible material from the demolition location to the waste incineration plant (AVI): 150 km;
- Transport distance single for leaving in place: 0 km.

If specific data for transport distances are available, it is possible to deviate from the standard values.

The starting point for front-end transport processes in the case of LCAs for complete construction works is that one uniform choice should be made within the entire LCA. The choice should be generic (all distances for delivery and removal to the construction works are generic) or specific (all distances for delivery and removal to the construction works are specific); a mix is not permitted.

Return transport processes should be included in the calculation unless it can be demonstrated that this involves return loads. The inclusion of return loads is achieved by calculating the one-way trip and the average load factor as applied by Ecoinvent. This load factor is already incorporated in the Ecoinvent transport processes. The load factor is for large trucks (load capacity '>32t'), which account for approximately 60% of the process 'Transport, freight, truck, unspecified {GLO}| market group for transport, freight, truck, unspecified | Cut-off, U,' 50%; this corresponds effectively with outward journey full and return journey empty.

If it is demonstrated that the return journeys involve full loads, half the single journey distance can be used, but the result must be increased by 25% as a fully loaded truck consumes approximately 25% more fuel than a truck with an average load. This basically means that the distance used to calculate when the return loads are demonstrably full is 62.5% (0.5 x 1.25) of the one-way distance.

For the removal of demolition debris and for the removal of soil, the means of transport is: "Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U" (Ecoinvent 3.6 and 3.9.1).

Within the Assessment Method the following processes from the process database are used:

- Diesel, low-sulphur {RER}| market group for | Cut-off, U [Ecoinvent 3.6]
- Diesel, low-sulphur {RER}| market group for diesel, sulphur | Cut-off, U [Ecoinvent 3.9.1]

This process describes diesel production from raw materials, rather than its combustion.

- Natural gas, high pressure {NL}| market for | Cut-off, U [Ecoinvent 3.6]
- Natural gas, high pressure {NL}| market for natural gas, high pressure | Cut-off, U [Ecoinvent 3.9.1]

This process describes gas extraction and production, rather than its combustion.

- For energy from natural gas the following is used: 'Heat, district or industrial, natural gas {Europe without Switzerland} heat production, natural gas, at industrial furnace >100kW | Cut-off, U' (process in MJ) [Ecoinvent 3.6 and 3.9.1]. An energy value of 31.65 MJ/Nm3 is used.[3]
- Diesel, burned in building machine {GLO}| processing | Cut-off, U [Ecoinvent 3.6]
- Diesel, burned in building machine {GLO}| market for diesel, burned in building machine | Cut-off, U [Ecoinvent 3.9.1]

This process describes diesel consumption (production of diesel and combustion emissions).

- Electricity, low voltage {NL}| market for | Cut-off, U [Ecoinvent 3.6]
- Electricity, low voltage {NL}| market for electricity, low voltage | Cut-off, U [Ecoinvent 3.9.1]

This process describes electrical energy use (230-400 V), including production from raw materials and distribution (grid and transformer losses).

- Transport, freight, lorry, unspecified {GLO}| market group for transport, freight, lorry, unspecified | Cut-off, U [Ecoinvent 3.6 and 3.9.1]

This process describes transport of 1 tonne of freight per truck over 1 km (including return journey), including diesel production and consumption.

- Transport, freight, inland waterways, barge {GLO}| market group for transport, freight, inland waterways, barge | Cut-off, U [Ecoinvent 3.6 and 3.9.1]

[3] *A deliberate decision was made not to opt for a 'market' process as that database process involves a combination of industrial furnace and co-generation (combined heat and power), and in principle, co-generation does not play a role in industrial processes. The standard energy value is based on the 'Dutch list of energy carriers and standard $CO_2$ emission factors, January 2018 version' (Netherlands Enterprise Agency). This value may not be adjusted for the use of Dutch natural gas. In the case of foreign natural gas, an appropriate specific value should be sought from literature.*

This process describes transport of 1 tonne of freight per inland vessel over 1 km, including fuel production and consumption.

- Transport, freight, sea, bulk carrier for dry goods {GLO}| market for transport, freight, sea, bulk carrier for dry goods | Cut-off, U [Ecoinvent 3.6 and 3.9.1]

This process describes transport of 1 tonne of freight per bulk carrier over 1 km, including fuel production and consumption. If this process is chosen, proper justification is necessary. If in doubt, the process for a container ship should be used.

- Transport, freight, sea, container ship {GLO}| market for transport, freight, sea, container ship | Cut-off, U [Ecoinvent 3.6 and 3.9.1]

This process describes transport of 1 tonne of freight per container ship over 1 km, including fuel production and consumption.

- For other background processes not mentioned here, an LCA practitioner will make the most appropriate choice from or in line with Ecoinvent.

## Loss in the form of construction waste

Some of the materials will be lost in the supply, storage and construction process itself. This waste has a relevant impact on the material flows. The loss depends heavily on the application, the construction site and how carefully the materials are handled. The Assessment Method applies several standard calculation rules for the release of construction waste. If it is desirable to deviate from these standard values, this is possible provided the research results include numerical substantiation.

*Prefab products*
Prefab products are manufactured in series and under controlled conditions. Waste is often immediately re-entered into the process. It is assumed that 3% of the materials will be lost (at the construction site or during transport).

*In-situ products*
Products must be made to fit at the construction site (e.g. bricks). This generally creates more waste. Moreover, part of the materials is lost through damage or weather conditions. It is assumed that 5% of the materials will be lost.

*Auxiliary and finishing materials*
Auxiliary and finishing materials, such as sealants, adhesives and paints, often leave residues that become unusable after a while. A lot of material also often remains on the packaging or on the tools used to apply the materials. It is assumed that 15% of the materials will be lost.

### Incineration in a waste incineration plant (AVI)

In the case of incineration in a waste incineration plant (AVI) in module C, the avoided energy production can be offset in module D from the amount of net exported energy (MJ per energy carrier). This information is included in module D. Section 2.6.4.3 and corresponding Appendix V describe how the net impact of this avoided impact must be calculated in module D. In the case of incineration in module A1-A3, the avoided emission should not be declared in module D but in module A1-A3.

The following was taken as the average net efficiency of the Dutch waste incineration plants (AVI)[4]:
18% electrical and 31% thermal (Ecoinvent waste incineration processes do mention incineration values, but do not include avoided production; the efficiencies mentioned deviate from the Dutch ones). The waste-to-energy plant (AEC) must meet EU efficiency requirements for the avoided energy production to be calculated.

- When incinerating waste based on fossil raw materials:
  - For saved electricity: 'Electricity, high voltage {NL}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U'
  - For saved heat: 'Heat, district or industrial, natural gas {Europe without Switzerland}| heat production, natural gas, at industrial furnace >100kW | Cut-off, U'
- When incinerating waste based on renewable raw materials:
  - For saved electricity: 'Electricity, high voltage {NL}| heat and power co-generation, wood chips, 6667 kW, state-of-the-art 2014 | Cut-off, U'
  - For saved heat: 'Heat, district or industrial, other than natural gas {NL}| heat and power co-generation, wood chips, 6667 kW, state-of-the-art 2014 | Cut-off, U'
- Settlement takes place on the basis of the Lower Heating Values (LHV) provided by Ecoinvent in the process descriptions. Several LHVs are included below:

*Table 1: generic LHVs*

| | LHV (MJ/kg) |
|---|---|
| ***based on fossil raw materials*** | |
| PET | 22.95 |
| HDPE | 42.47 |
| LDPE | 42.47 |
| PP | 32.78 |
| EPS | 32.20 |
| ABS | 35.20 |
| PVC | 21.51 |
| ***based on renewable raw materials*** | |
| Carton | 15.92 |
| Wood | 13.99 |
| Cotton | 14.45 |
| Paper | 14.11 |

The LHVs included here are generic and conservative. If specific data from specific streams are available within the scope and context of the LCA study, these can be used.

[4] *Written announcement based on the annual verification of the R1 status for 2016 [RWS-WVL 2018]*

*2.6.3.8 Data quality*
EN 15804 applies.

The following passage (see EN 15804 6.3.8.2) comes into effect when that system is available: "the documentation format and data sets for the LC inventory data used in the LCA modelling shall use the current ILCD format and nomenclature as defined in the document, 'International Reference Life Cycle Data System (ILCD) Handbook - Nomenclature and other conventions'."

If the aforementioned ILCD format has not yet been followed, the following applies:
In addition to EN 15804, data quality must be assessed using a data quality system developed for three categories:

- unit processes (see NMD Verification Protocol August 2024, Appendix D)
- horizontal aggregated processes (see NMD Verification Protocol August 2024, Appendix D)
- vertical aggregated processes (see NMD Verification Protocol August 2024, Appendix D)

*2.6.3.9 Development of product scenarios*
EN 15804 applies.

As an exception to the timeliness rule, a future scenario may be assumed for the end-of-life processing scenario if the hardship clause that there will be a demonstrable working (return) system at the time of the end-of-life processing is complied with. The plausibility of this is an explicit part of the file verification.

'Working' means that:

- the collection structure has been provided for economically and logistically;
- the economic preconditions are stimulating;
- the efficiency of the system or return system serves as starting point;
- the technical infrastructure for the recycling process is available and it may be assumed that the required capacity will follow the market;
- the application in which the recycled material is included is known or it can be assumed that there is a sufficient market.

*Example 1: When using new hydraulic engineering blocks, it can be assumed that there is sufficient market for reuse, as product reuse is common in this application.*

*Example 2: A return system that has been declared generally binding can be used as a scenario.*

For waste, specific end-of-life processing scenarios have been developed per basic profile. If no specific value is available, standard values are given in the table on *www.milieudatabase.nl*.

If multiple installation options are available for a product (or functional unit) that have an impact on the end-of-life phase and/or the options for reuse, recovery or recycling, multiple environmental profiles (C1-C4, D) can be provided. The following preconditions apply here:

- the product delivered is in fact suitable for the application;
- additional resources and/or substances are declared in the relevant module D;
- specific design conditions for application are clearly described;
- end-of-life processing scenarios are up-to-date with the same exception applying as described previously.

*2.6.3.10 Units*
EN 15804 applies.

**2.6.4 Life Cycle Inventory Analysis**

*2.6.4.1 Data collection*
In addition to EN 15804, requirements have been set on data precision.
For the processes carried out at the construction product producer, the energy balance will have to be determined at company level and deviations will have to be corrected to an accuracy of ≥ 95%. For more details, see 2.6.3.5 for omitting data.

For the processes carried out at the construction product producer, the mass balance per process used will have to be determined (if different from the data at company level) and deviations will have to be corrected to an accuracy of ≥ 95%. The mass balance concerns the actual consumed amounts per process. The validity of the remaining processes needs to be checked by determining the mass balance per process and correcting deviations to an accuracy of ≥ 95%. For more details, see 2.6.3.5 for omitting data.

In addition to EN 15804, suppliers are first approached for their own (front-end) data before using generic data if necessary; specific data always take precedence over generic data.

In addition to EN 15804, for a large number of standard processes Ecoinvent is prescribed as a data source. This indicates which environmental interventions should at least be considered, how sum parameters should be handled and how biogenic carbon dioxide should be handled.

The preferred order for determining emissions is:
1. Methods designated in laws, decrees or ministerial regulations;
2. Methods from standard sheets;
3. Methods that are described in (possibly sector specific) private law agreements.

The following interventions must have a value:
emissions to air when using thermal energy of CO2, CO, NOx, SO2, CxHy and particulates (PM10: particulates < 10 µm);
- emissions to water of COD, BOD, P-total, N-total and solid matter (PM10: particulates < 10 µm); emission to the soil of PAHs and heavy metals;
- other emissions for which environmental regulations impose requirements on the producer of the construction material, product or element.

The name must be such that this creates the least possible likelihood of misunderstanding. The name must indicate what has actually been determined. If available, an index name from the CAS registration system should be used, unless this name does not match the name in the list of environmental interventions from the latest CML-NMD method, available from Stichting NMD.

## Data not from the producer

Those supplying to and purchasing from the relevant construction product's production locations must be asked to make data available about the production process in accordance with the requirements set by this standard.

*Note 1:* Data from producers (primary source) can be provided in the form of process data, in the form of a cradle-to-gate LCI or in the form of an environmental profile. The representativeness for use in the Netherlands must be established. This motivation is an explicit part of the file verification.

If a supplier or buyer provides no or insufficient data, public sources, industry figures and literature data will be used.

*Note 2:* Conversions or estimates may be necessary when using public sources and literature. This should preferably be done by an expert in the relevant field ('expert guess').

Common public sources and literature sources should be used, i.e. those most widely accepted by LCA practitioners.

If processes are available from different regions, the following order of priority will be used:

1) the relevant country;
2) a comparable neighbouring country;
3) the relevant region (for example Northwest Europe);
4) the relevant continent or sub-continent;
5) the world.

*Example 1: Suppose that the database contains standard values of three electricity processes: one based on the Dutch fuel mix, one based on the German mix and one as a European average. For a process that takes place in the Netherlands, the Dutch mix should be selected. For a process that takes place in Spain, the European mix should be selected.*

If there is any doubt about the representativeness of the data, the worst case data should be used. The plausibility of the used data is an explicit part of the file verification.

*Example 2: If a producer uses generic data from the NMD for a certain raw material and there are doubts about whether this raw material falls within the range of product data in the NMD and generic data are also available in Ecoinvent for the same raw material, which leads to a higher environmental impact, he may only use the NMD data if he demonstrates that it is more representative for his raw material.*

## Completeness of individual environmental interventions

All environmental interventions from the most recent CML-NMD method that are available via www.milieudatabase.nl for set A1 and those of the International Reference Life Cycle Data System (ILCD) Handbook ('identified by the name EN_15804'), must be considered. The interventions will then be awarded a value unless the value is unknown. This creates the following three parts:

a) a positive or negative value;
b) the value 0 (for all interventions of which the value is below the detection limit);
*Note 3:* Values may both be measured and rationalised at 0.
c) a question mark (if it is not known whether the intervention takes place).

In the case of a question mark, it must be determined whether the environmental intervention can reasonably occur at a level that can influence the results of the LCA. An estimate of the value will need to be made if an environmental intervention can potentially contribute more than 5% cumulatively over the functional unit.

### Completeness of sum parameters

Where available in the producer's data, sum parameters (such as NOx, CxHy, COD, BOD, P-total, N-total, PAH and heavy metals) should be broken down into individual components for characterisation. The standard list contains several sum parameters for which characterisation factors are also available. The intervention value of the sum parameters can be entered in two ways:
The intervention value of the sum parameter is known. This is entered.

a) One or more individual substances are known, but only a characteristic factor is available for the sum parameter. A sum parameter is a representative value for the sum of a group of substances for a particular impact, for example PAHs. The other substances' intervention values are then entered into the sum parameter pro rata. When data are available for several substances from the sum parameter, the sum parameter will be calculated for each substance and the results averaged.

*Note 4:* Emissions of substance groups may be translated into individual substance emissions by using relative proportions of (characterised) total emissions within a group as indicated in the normalisation report Oers et al. (2001).

*2.6.4.2 Calculation procedures*
EN 15804 applies.

*2.6.4.3 Allocation of input flows and output emissions*
EN 15804 applies.

Section 6.4.3.3 of EN 15804 prescribes how the net impact of module D
must be calculated. For the sake of readability, Appendix V reproduces the relevant text differently.

Section 6.4.4 of EN 15804/A2:2019 on biogenic carbon also 'automatically' enters into force via the Assessment Method because 'EN 15804 applies'.

**2.6.5 Life cycle impact assessment**
The objective of this Assessment Method version is to already implement the changes in chapter 2, in anticipation of the complete implementation of EN 15804/A2:2019 in the Assessment Method (including chapter 3). This working method enables the system to continue functioning based on EN 15804/A1:2013 ('set A1') while the environmental impact scores are already being determined according to A2:2019 ('set A2') as well. As soon as chapter 3 (including the weighting to the 1-point score) has been amended, data compiled according to this amendment can be used immediately.

EN 15804/A1:2013 is in force for set A1. EN 15804/A2:2019 is in force for set A2.

**Set A1 is supplied based on Ecoinvent version 3.6. Set A2 based on Ecoinvent version 3.9.1. Files containing A2 data based on Ecoinvent version 3.6 will still be accepted until 1-7-2025. It is mandatory to supply both sets.**

*Set A1:*
For set A1, in addition to EN 15804/A1:2013, the environmental impact categories Human Toxicity Potential and Eco-Toxicity Potential are also calculated.

For set A1, in addition to EN 15804/A1:2013, the characterisation factors are all sourced from the latest version of the (CML-NMD), available for download from the Stichting NMD website *www.milieudatabase.nl*. This is more extensive than the list of characterisation factors from EN 15804 annex A1. The most recent set of characterisation factors for the environmental indicators and environmental effects is available as download from the Stichting NMD website *www.milieudatabase.nl*.

The environmental impact categories are:
- Abiotic Depletion Potential for abiotic resources, excl. fossil energy carriers
- Abiotic Depletion Potential for fossil energy carriers
- Global Warming Potential
- Ozone Depletion Potential
- Photochemical Ozone Creation Potential (smog)
- Acidification Potential
- Eutrophication Potential
- Human Toxicity Potential
- Eco-Toxicity Potential, aquatic (freshwater)
- Eco-Toxicity Potential, aquatic (marine)
- Eco-Toxicity Potential, terrestrial.

The above-mentioned set of characterisation factors includes an interpretation of the CMLIA method for characterising substance groups (within Global Warming Potential, Ozone Depletion Potential, Photochemical Ozone Creation Potential, Acidification Potential and Eutrophication Potential). Guidelines have been included for several other practical matters that are important for the characterisation. These are part of the Assessment Method for unambiguous characterisation and classification.

*Set A2:*
The standard set with environmental footprint characterisation factors is used for set A2 to which EN 15804/A2:2019 refers ('EF characterisation factors'). Both the core environmental impact indicators as well as additional environmental impact indicators should be determined. The environmental impact categories are:
- Global Warming Potential - total
- Global Warming Potential - fossil
- Global Warming Potential - biogenic
- Global Warming Potential - land use and changes in land use
- Ozone Depletion Potential
- Acidification Potential
- Freshwater eutrophication
- Marine eutrophication
- Terrestrial eutrophication

- Smog formation
- Abiotic Depletion Potential for abiotic resources, minerals and metals
- Abiotic Depletion Potential for abiotic resources, fossil fuels
- Water (user) Deprivation Potential
- Particulate Matter Emissions Potential
- Ionising Radiation Potential
- Ecotoxicity Potential (freshwater)
- Human Toxicity Potential, carcinogenic environmental interventions from the inventory to be assigned to the environ mental impact categories.

*Calculations with set A1 and set A2:*

1) The values of the environmental impact categories are calculated by allocating the environmental interventions from the inventory to the environmental impact categories;
2) multiplying the interventions per environmental impact category by the characterisation factors from the CML-NMD (set A1) and EN 15804/A2:2019 (set A2) method;
3) adding up the values obtained per environmental impact category.

The scores for the various environmental impact categories together form the environmental profile.

### Non-characterised interventions

It should be verified that all environmental interventions have been characterised. If this is not the case, the following actions must be taken:

a) If the cause concerns a deviating name, correct the name so that the substance can be characterised as yet.
b) If the cause is a missing characterisation factor, the substance should be characterised according to a chemically and physically similar substance. If this is not available, include this in a list of non-characterised interventions, with an indication of the interventions of which an environmental impact can be expected.

### Aggregation of environmental profiles

If the producer of a construction product has multiple production locations that provide data, the data must be averaged. This aggregation can be implemented at environmental intervention level or at environmental profile level. An 'average' environmental profile of a process is obtained during aggregation of environmental profiles. The average environmental profiles are calculated according to the weighted production quantity[5] average of the selected production locations. The production quantities may be estimated with respect to size.

### 2.6.6 Life cycle interpretation

*2.6.6.1 Clarification of the results*

Interpretation is an important element in an LCA report's quality control. This is covered in the ISO14044 (section 4.5 and Annex B) and EN15804+A2 (section 8.2) standards, but no specific interpretation is prescribed. Therefore, this is defined in the Assessment Method. During interpretation, it is important that the relationship between the inventory data and the impact assessment results is analysed in a way that makes the results understandable and plausible.

[5] *Or production volume if that is a common unit.*

The following elements must at least be present in the interpretation chapter of the LCA report:

- Provide an overview of the contributions of the various modules to each impact category (A1-A3 may remain aggregated if necessary). Discuss which modules have the highest contribution for the most relevant impact categories. Provide an explanation for this.
- Provide an overview of ECI scores per module (A1-A3 may remain aggregated if necessary). Discuss which modules have the highest and lowest ECI scores. Provide an explanation for this.
- For the modules with the highest ECIs, indicate which raw materials, materials and/or processes have the most relevant contribution.
- Provide an overview of how the various impact categories contribute to the total ECI. This can be done per module, but can also be aggregated for the entire life cycle. Discuss which impact categories make the highest contribution. Provide an explanation for this.
- When module D is included in the LCA, discuss the relevance of this module's contribution to the total score and which material plays the biggest role in this.

*2.6.6.2 Sensitivity analysis*

A sensitivity analysis must be carried out for the most important choices and assumptions made and implemented in the LCA to ascertain the robustness of the LCA results. Choices and assumptions can relate to uncertainties in models, starting points and scenarios and uncertainties in the elaboration of the parameters within this. A sensitivity analysis must at least be carried out for (where applicable):

- the influence of geographical and technological distribution within a group of product locations. Use the highest and lowest values in the sensitivity analysis. Outliers may be removed from the data set if necessary;
- the distribution as a consequence of distribution in an average composition. Use the highest and lowest values in the sensitivity analysis. Outliers may be removed from the data set if necessary;
- the distribution due to averaging when establishing a group average. Use the highest and lowest values in the sensitivity analysis. Outliers may be removed from the data set if necessary;
- the distribution as a consequence of uncertainties in starting points within the allocation for recycling. If method 1) or 2) from 2.6.4.3 and the corresponding Appendix V is used, use method 3) for a sensitivity analysis. If method 3) is used, conduct a sensitivity analysis for the distribution in values;
- allocation of multi-input and multi-output processes if not using the standard distribution key (mass basis for multi-output processes and physical composition for multi-input processes). The standard distribution key should then be used for the sensitivity analysis.

The LCA must be revised if the results of the sensitivity analysis give reason to do so. The differences may not amount to more than +/-20% on one of the environmental impacts compared with the average or original value. If the sensitivity analysis shows that the differences amount to more than +/-20%, a split must be made in separate Environmental Product Declarations in which the differences remain within the 20% limit. If it can be demonstrated that a worst case scenario is chosen in the LCA, the sensitivity analysis may be omitted. A deviation exceeding 20% may be accepted if the contribution on the 1-point score of this distribution is less than 5% or if all the conditions below are met:

1. End users demonstrably have no choice of production locations (e.g. for category 1 data) or the data by definition represents a weighted average of a group with a higher distribution (e.g. for category 2 data).
2. No distinction can be made between the products from a product(ion) point of view; as a result, the different distribution will be due to energy use (background profile) and/or transport distance and transport method within A1-A3.
3. A precondition for the two aforementioned exceptions is that a representative weighted average has been used [Requirement Verification Protocol page 23). This ensures that it represents an average of deliveries in the Dutch market.
4. If the deviation based on the exceptions may exceed 20% on individual environmental impacts, the impact on the 1-point score may never exceed a deviation of 20%. If the impact deviates by more than 20%, the Environmental Product Declaration should either be split into multiple Environmental Product Declarations or be adjusted conservatively to meet this precondition.
5. The deviation from the 20% limit is specified in the LCA report and the Assessment Report and is transparent to users (as an explanation of the process in the process database and/or Environmental Product Declaration).

The requested interpretation and sensitivity analyses referred to in section 2.6.6.2 should be based on the environmental impacts from set A2, as well as the environmental impacts from set A1. Within set 2, for the contribution of the environmental impacts to the Global Warming Potential, only the total result 'Global Warming Potential – total' is considered.

## 2.7 Content of the EPD (EN 15804 7 Content of the EPD)

The EPD lists the environmental impacts from set A2 and the environmental impacts from set A1.
See also 2.8.2.2.

**Set A1 is supplied based on Ecoinvent version 3.6. Set A2 based on Ecoinvent version 3.9.1. Files containing A2 data based on Ecoinvent version 3.6 will still be accepted until 1-7-2025. It is mandatory to supply both sets.**

**2.7.1 Declaration of general information**
EN 15804 applies.

In addition to EN 15804, only an internal independent verification is not permitted: the EPD must be verified by an independent third party.

**2.7.2 Declaration of environmental indicators from the LCA**

*2.7.2.1 General*
EN 15804 applies.

*2.7.2.2 Regulations for declaring LCA information per module*
EN 15804 applies.

*2.7.2.3 Indicators that describe environmental impact (set A1 and set A2)*
EN 15804 applies.

In addition to EN 15804, the environmental impact categories should be presented as follows:

*Table 2: Indicators that describe environmental impact (set A1)*

| Environmental impact category | Indicator | Unit |
|---|---|---|
| Abiotic Depletion Potential for abiotic resources, excl. fossil energy carriers | ADP elements | kg antimony |
| Abiotic Depletion Potential for fossil resources | ADP fuel[6] | kg antimony |
| Global Warming Potential | GWP 100y | kg $CO_2$ |
| Ozone Depletion Potential | ODP | kg CFC 11 |
| Photochemical Ozone Creation Potential | POCP | kg ethylene |
| Acidification Potential | AP | kg $SO_2$ |
| Eutrophication Potential | EP | kg $(PO_4)^{3-}$ |
| Human Toxicity Potential | HTP | kg 1.4 dichlorobenzene |
| Freshwater Aquatic Eco-Toxicity Potential | FAETP | kg 1.4 dichlorobenzene |
| Marine water Aquatic Eco-Toxicity Potential | MAETP | kg 1.4 dichlorobenzene |
| Terrestrial Eco-Toxicity Potential | TETP | kg 1.4 dichlorobenzene |

*Table 3: Indicators that describe environmental impact (set A2)*

| Environmental impact category | Indicator | Unit |
|---|---|---|
| Global Warming Potential - total | GWP total | kg CO2-eq. |
| Global Warming Potential - fossil | GWP fossil | kg CO2-eq. |
| Global Warming Potential - biogenic | GWP biogenic | kg CO2-eq. |
| Global Warming Potential - land use and change in land use | GWP - luluc | kg CO2-eq. |
| Ozone Depletion Potential | ODP | kg CFC11-eq. |
| Acidification Potential | AP | mol H+-eq. |
| Eutrophication Potential freshwater | EP freshwater | Kg P-eq. |
| Eutrophication Potential marine | EP marine | kg N-eq. |
| Eutrophication Potential terrestrial | EP terrestrial | mol N-eq. |
| Photochemical Ozone Creation Potential | POCP | kg NMVOC-eq. |
| Abiotic Depletion Potential for non-fossil resources (minerals and metals) | ADP minerals & metals | kg Sb-eq. |
| Abiotic Depletion Potential for fossil fuels | ADP fossil | MJ, net cal. val. |
| Water consumption | WDP | m3 world eq. deprived |
| Particulate Matter Emissions Potential | Disease due to PM emissions | Health problems - incidence |
| Ionizing radiation, human health | Human exposure | kBq U235-eq. |
| Eco-Toxicity Potential (freshwater) (ETP fw) | CTU for ecosystems | CTUe |
| Human toxicity, carcinogenic | CTU human | CTUh |
| Human toxicity, non-carcinogenic | CTU human | CTUh |
| Land use-related impacts / Soil quality | Soil quality index (SQP) | Dimensionless |

[6] *If 'Abiotic Depletion Potential for fossil energy carriers' is available in the MJ unit, the conversion factor 4. 81E-4 kg antimony/MJ can be used [CMLIA, Part 2b: Operational annex, page 52]*

#### *2.7.2.4 Indicators that describe raw material use*

As well as the environmental impact categories from tables 2 and 3, parameters for raw material use, waste generation, and material and energy release are also reported in accordance with EN 15804. For purposes of readability, these tables are presented here.

*Table 4: Parameters that describe raw material use*

| Parameter | Unit |
|---|---|
| Use of renewable primary energy excluding renewable primary energy used as materials | MJ, net calorific value |
| Use of renewable primary energy used as materials | MJ, net calorific value |
| Total use of renewable primary energy (renewable primary energy and renewable primary energy used as materials) | MJ, net calorific value |
| Use of non-renewable primary energy excluding non-renewable energy used as materials | MJ, net calorific value |
| Use of non-renewable primary energy used as materials | MJ, net calorific value |
| Total use of non-renewable primary energy (non-renewable primary energy and non-renewable primary energy used as materials) | MJ, net calorific value |
| Use of secondary materials | kg |
| Use of renewable secondary fuels | MJ, net calorific value |
| Use of non-renewable secondary fuels | MJ, net calorific value |
| Net use of freshwater | $m^3$ |

^

*Table 5: Other environmental information: waste categories*

| Parameter | Unit |
|---|---|
| Hazardous waste | kg |
| Non-hazardous waste | kg |
| Radioactive waste | kg |

*Table 6: Other environmental information: output flows*

| Parameter | Unit |
|---|---|
| Materials for reuse | kg |
| Materials for recycling | kg |
| Materials for energy electric | kg |
| Exported energy | MJ |
| Exported energy thermal | MJ |

*Table 7: Calculation parameters primary energy use*

| Parameter | Unit | Abbreviation[7] | Calculation of parameters |
|---|---|---|---|
| 111 Use of renewable primary energy excluding renewable primary energy used as materials | MJ | PERE | PERE = PERT - PERM |
| 113 Use of renewable primary energy used as materials | MJ | PERM | $$PERM = \sum_{p=1}^{n} (Q_{M_{her;p}} * LHV)$$ $Q_{Mher;p}$ = number of units of renewable material, part of the construction material, per process;<br>LHV = Lower heating value of the process used (≥ 0);<br>$n_p$ = the number of processes used in the product component within the relevant wwmodule.<br><br>This parameter must be declared in the module in which the material is used and enters the system. This may be A1-A3, B1-B4, or D.<br><br>Energy used as materials not forming part of the construction product does not fall within this parameter. |
| 101 Total use of renewable primary energy (renewable primary energy and renewable primary energy used as materials) | MJ | PERT | $$PERT = PERM + \sum_{p=1}^{n} (Q_{E\_her;p} * LHV)$$ $Q_{E\_her;p}$ = number of units of energy used from renewable sources (biomass), per process;<br>LHV = Lower heating value of the process used (≥ 0);<br>$n_p$ = the number of processes used in the product component within the relevant module.<br><br>Is calculated based on Ecoinvent/ NMD background processes based on the method specified by NMD.<br><br>This parameter must be declared in the module in which the energy is used. |

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

[7] *Widely used, but not in EN 15804+A2.*

| | | | |
|---|---|---|---|
| 112 Use of non-renewable primary energy excluding non-renewable energy used as materials | MJ | PENRE | PENRE = PENRT - PENRM |
| 114 Use of non-renewable primary energy used as materials | MJ | PENRM | $$PENRM = \sum_{p=1}^{n}(Q_{M\_fossiel;p} * LHV)$$ $Q_{M\_fossiel;p}$ = number of units of fossil material, part of the construction material, per process;<br>LHV = Lower heating value of the process used (≥ 0);<br>$n_p$ = the number of processes used in the product component within the relevant module.<br><br>This parameter must be declared in the module in which the material is used. This may be A1-A3, B1-B4, or D.<br><br>Energy used as materials not forming part of the construction product does not fall within this parameter. |
| 102 Total use of non-renewable primary energy (non-renewable primary energy and non-renewable primary energy used as materials) | MJ | PENRT | $$PENRT = PENRM + \sum_{p=1}^{n}(Q_{E\_fossiel;p} * LHV)$$ $QE_{fossiel;p}$ = number of units of energy used from fossil sources, per process;<br>LHV = Lower heating value of the process used (≥ 0);<br>$n_p$ = the number of processes used in the product component within the relevant module.<br>Is calculated based on Ecoinvent/ NMD background processes |

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

## Use of secondary materials

This parameter is derived from the construction product inventory. Used secondary materials that are not part of the construction product do not fall within this parameter.

The mass of secondary materials used can be derived from the Ecoinvent background processes. Where secondary materials appear in the LCI in a unit other than 'mass', they must be converted to mass[8]. The total mass of secondary materials that are part of the construction product gives the result for the parameter 'secondary materials'. The mass of secondary materials in the construction product is the total mass of secondary material used minus production losses.

The parameter for the use of secondary materials must be declared in the module in which the secondary materials are used in the construction product.

*Comment:* a co-product is not part of the construction product; it should be considered as a separate flow (allocation). Secondary materials in the co-product are therefore not declared within the parameter use of secondary materials.

*Table 8: Calculation of the parameters for the use of secondary materials*

| Parameter | Unit | Abbreviation | Calculation of parameters |
|---|---|---|---|
| 108 Use of secondary materials | kg | SM | $$SM = \sum_{p=1}^{n} (Q_{SM;p})$$ $Q_{SM;p}$ = net number of kg secondary material use, by process, part of the building product;<br><br>$n_p$ = the number of processes used in the product component within the relevant module.<br><br>Used secondary materials that are not part of the construction product do not fall within this parameter.<br><br>This parameter must be declared in the module in which the secondary material is used. This may be A1-A3, B1-B4, or D. |

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

[8] *Mass of secondary material = share of secondary material * number of units used * mass per unit.*
*Example: You use 5 $m^2$ of sheet material with a secondary share of 30%. The sheet material has a mass of 4 kg per $m^2$.*
*Mass of secondary material = 30% * 5 * 4 = 6 kg*

### Net use of freshwater

The relevant parameter is automatically included with the environmental profile, based on Ecoinvent processes or any added water consumption in the processes and the CML-NMD method.

*Table 9: Calculation of the parameter net use of freshwater*

| Parameter | Unit | Abbreviation | Calculation of parameters |
|---|---|---|---|
| 104 Net use of freshwater | $m^3$ | FW | Is calculated based on Ecoinvent/ NMD background processes using the NMD calculation method |

### Waste

The parameters for waste (final hazardous waste, final non-hazardous waste and final radioactive waste) are derived from the inventory. Where underlying generic data is used and therefore no inventory has been taken up to input flows in the primary production, this parameter should be determined based on the underlying chain information.

The relevant parameters are automatically included with the environmental profile, based on Ecoinvent process cards and the CML-NMD method.

*Table 10: Calculation of parameters for waste*

| Parameter | Unit | Abbreviation | Calculation of parameters |
|---|---|---|---|
| 106 Hazardous waste | kg | HWD | Is calculated based on Ecoinvent/ NMD background processes using the NMD calculation method |
| 105 Non-hazardous waste | kg | NHWD | Is calculated based on Ecoinvent/ NMD background processes using the NMD calculation method |
| 107 Radioactive waste | kg | RWD | Is calculated based on Ecoinvent/ NMD background processes using the NMD calculation method |

## Parameters describing output flows

The parameters are derived from the inventory. Where underlying generic data is used and therefore no inventory has been taken up to input flows in the primary production, this parameter should be determined based on the underlying chain information. The parameters describing output flows refer to the actual outgoing output flows (mass), which is independent of any secondary materials used in the product system.

This is a declaration of all end-of-waste streams from A1-A3, A5, B1-B4, C1-C4. Output flow parameters are declared at the stage in which the materials have reached the end-of-waste status. If material already has end-of-waste status for incineration (with an efficiency higher than 60%), then it should also be declared in the parameter Materials for energy recovery (kg).

*Example 1: Grade A wood is included under parameter 122, 'Materials for energy recovery' and as exported energy (thermal and electrical); Grade B and C wood only as exported energy (thermal and electrical).*

*Table 11: Calculation of parameters for output flows*

| Parameter | Unit | Abbreviation | Calculation of parameters |
|---|---|---|---|
| 120 Materials for reuse kg | kg | CRU | $$CRU = \sum_{p=1}^{n} (Q_{M\ uit;p} * \%her)$$ $Q_{M\_uit;p}$ = number of units of outgoing material as waste, in kg, per process. May originate from modules A1-A5, B1-B4, or C1-C4. (≥ 0);<br><br>%her = the reuse percentage of the relevant material/product component;<br><br>$n_p$ = the number of processes used in the product component within the relevant module. |
| 121 Materials for recycling kg | kg | MFR | $$MRF = \sum_{p=1}^{n} (Q_{M\ uit;p} * \%recycling)$$ $Q_{M\_uit;p}$ = number of units of outgoing material as waste, in kg, per process. May originate from modules A1-A5, B1-B4, or C1-C4. (≥ 0);<br><br>%recycling = the recycling percentage of the relevant material/product component;<br><br>$n_p$ = the number of processes used in the product component within the relevant module. |

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

| | | | |
|---|---|---|---|
| 122 Materials for energy recovery kg | kg | MER | $$MER = \sum_{p=1}^{n} (Q_{SB\ uit;p})$$ $Q_{SB\ uit;p}$ = number of units of material for exported secondary fuels from the unit process used when reaching end-of-waste status, in kg, per process. May originate from modules A1-A5, B1-B4, or C1-C4. (≥ 0);<br><br>$n_p$ = the number of processes used in the product component within the relevant module. |
| 123 Exported energy, electric | MJ | EEE | $$EEE = \sum_{p=1}^{n} (Q_{M\ uit;p} * \%avi * LHV * 18\%\ elektrisch)$$ $Q_{M\ uit;p}$ = Number of units of outgoing material as waste, in kg, per process. May originate from modules A1-A5, B1-B5, or C1-C4. (≥ 0);<br><br>%avi = the AVI percentage in the waste processing scenario of the relevant material;<br>LHV = lower heating value of the process used (≥ 0);<br><br>$n_p$ = the number of processes used in the product component within the relevant module;<br><br>18% electric = based on average net electric efficiency of AVI in the Netherlands. |
| 124 Exported energy, thermal | MJ | EET | $$EET = \sum_{p=1}^{n} (Q_{M\ uit;p} * \%avi * LHV * 31\%\ thermisch)$$ $Q_{M\ uit;p}$ = number of units of outgoing material as waste, in kg, per process. May originate from modules A1-A5, B1-B4, or C1-C4. (≥ 0);<br><br>%avi = the AVI percentage in the waste processing scenario of the relevant material;<br><br>LHV = lower heating value of the process used (≥ 0);<br><br>$n_p$ = the number of processes used in the product component within the relevant module.<br><br>31% thermal = based on average net thermal efficiency of AVI in the Netherlands |

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*2.7.2.5 Information on biogenic carbon content*
EN 15804 applies.

*2.7.3 Scenarios and additional technical information*
EN 15804 applies.

*2.7.4 Additional information on the emission of hazardous substances into indoor air, soil and water in the use phase*
EN 15804 applies.

*2.7.5 Aggregation of information modules*
EN 15804 applies.

## 2.8 Project report (EN 15804 8 Project report)

### 2.8.1 General
EN 15804 applies.

The report must be produced in Dutch, German, French or English.

### 2.8.2 LCA elements from the project file
*2.8.2.1 General*
EN 15804 applies.

In addition to EN 15804, the following is added to the information for the LCI:

- a bill of materials (the names of substances do not need to be stated for the composition, but the structure of the construction product does);
- any additional function(s) that are not included in the functional unit and that relate to the use of the material, product or element in construction works;
- a description of how the composition of all construction products is determined in the bill of materials (e.g. via a definition of standards);
- a description of the process tree and the process tree demarcation, with substantiation;
- the adopted service life of the construction product, including a description and justification of the scenarios used;
- information that shows that the Assessment Method system boundaries have been followed, any deviations from this and why, and the impact this has on the end results;
- the data categories;
- the procedures for data collection (questionnaires, checklists. etc.);
- the calculation procedures (for example for estimates);
- which data originate from primary sources and which data from secondary sources;
- a substantiation of the choice made for generic data (National Environmental Database, Ecoinvent, other data);
- an acknowledgement of the source of the literature, including at least the title, author and year;
- if standard values have not been used, a description of the conversion efficiency of energy sources, of how the extraction and transport of fuels was handled, of the combustion values of energy carriers, of the fuel mix in electricity generation, and of the distribution of the energy flow;

- a description of how the extent of completeness per data category has been determined and how deviations have been handled;
- a list of process emissions relevant for the LCA study that are part of the environmental permit in accordance with the data quality requirements;
- a list of contracted suppliers in accordance with the data quality requirements;
- the way in which data has been validated;
- the outcomes of mass and energy balances, corrections and statements for deviations.

### 2.8.3 Documentation on additional information

EN 15804 applies.

### 2.8.4 Data available for verification

EN 15804 applies.

In addition to EN 15804:
A project file for the construction product's LCA research must be compiled that contains at least the following:

- a fully completed version of an Environmental Product Declaration in the input platform of Stichting NMD;
- the ingoing and outgoing environmental flows (environmental interventions) of the unit processes that have been used as input for the LCA calculations;
- the documentation (measurements, calculations, estimates, sources, correspondence, traceable references to origin, etc.) based which the process data for the LCA have been formulated. This includes documentation on the recipe used to determine the composition of the producer's construction product, energy consumption figures, emission data and waste production, as well as data substantiating completeness. In specific cases reference can be made to, for instance, standards or quality regulations;
- documentation that shows that the materials, products or elements (reference flow) can fulfil the desired function(s) and performance;
- the amounts of the materials, products or elements;
- documentation that shows that the selected processes and scenarios in the process tree comply with the requirements set by this Assessment Method;
- documentation substantiating the selected service life of the construction product;
- data with which the sensitivity analyses and internal checks on the collected data have been implemented. The internal check includes a mass balance per process step, a mass balance at company level and an energy balance at company level;
- documentation and substantiation of the percentages used to calculate in the end-of-life processing scenario;
- documentation and substantiation of the percentages and figures (number of cycles, prices, etc.) used to calculate in the allocation procedure;
- for an Environmental Product Declaration of a weighted average for more than one production site or producer:
  - the unweighted values;
  - documentation from which the weighting factors (production quantities) used were derived;
- documentation with which any qualitative information is substantiated in the Environmental Product Declaration;
- information that shows that all suppliers and any relevant buyers have been approached for the LCA study. If this has not happened, information must show that data have been used that can be considered as equivalent to data from suppliers (e.g. when the suppliers have jointly published data for use in LCAs);

- procedures according to which the data collection has been implemented (questionnaires, instructions, information material, agreements on confidentiality, etc.);
- the characterisation factors used and where these are applied to calculate environmental parameters, normalisation factors and weighting factors;
- the criteria and the substantiation that have been used to determine system boundaries and the selection of incoming and outgoing flows;
- the representativeness of the generic data used in the absence of specific data for the LCA study;
- documentation to substantiate any other choices, scenarios and assumptions.

*Example: Examples of documentation are: CPR 305/2011/EU, guidelines from the Standard RAW Provisions, regulations, guarantees, information from practice, publications, research, annual reports, audit opinions.*

If the environmental profiles are included in the NMD, the basic processes and the parameters for the Environmental Product Declarations should form part of the verification.

## 2.9 Weighting of environmental impact scores

Weighting environmental impact scores to one or a few scores is often desired by calculation tool users. The compilers of the Assessment Method are aware of the objections against weighting but consider that, if weighting takes place, it is better that it takes place in a clear way. Weighting factor users should be aware that there is less consensus over weighting and weighting factors than over such things as characterisation factors and that the method also still has its uncertainties.

The source of the figures is the RWS report by TNO-MEP 'Toxicity has its price: shadow pricing for ecotoxicity and other toxicity and depletion of abiotic resources within DuboCalc', 8 March 2004.[9] From the summary: 'Scores for ten used environmental impact categories need to be weighted and combined to arrive at a single indicator for environmental impact. Various options are available here. One of these options is detailed in this report: the shadow pricing methodology. The shadow price is the highest permissible cost level for the government (prevention cost) per unit of emission control.' Compared to this report, there was one difference in the calculation: the factor for abiotic depletion amounts to €0.16 (set at 0 in the final version of the RWS report)[10].

*Table 12: Weighting factors (for the environmental impact categories)*

| Environmental impact category | Equivalent unit | Weighting factor [€ / kg equivalent] |
|---|---|---|
| Abiotic Depletion Potential for raw materials (excluding fossil energy carriers) – ADP | Sb eq | € 0.16 |
| Abiotic Depletion Potential for fossil energy carriers - ADP | Sb eq[11] | € 0.16 |
| Global Warming Potential – GWP 100 years. | $CO_2$ eq | € 0.05 |
| Ozone Depletion Potential – ODP | CFK-11 eq | € 30 |
| Photochemical Ozone Creation Potential – POCP | $C_2H_4$ eq | € 2 |
| Acidification Potential – AP | $SO_2$ eq | € 4 |
| Eutrophication Potential – EP | $PO_4$ eq | € 9 |
| Human Toxicity Potential – HTP | 1.4-DCB eq | € 0.09 |
| Freshwater Aquatic Eco-Toxicity Potential – FAETP | 1.4-DCB eq | € 0.03 |
| Marine Aquatic Eco-Toxicity Potential – MAETP | 1.4-DCB eq | € 0.0001 |
| Terrestrial Eco-Toxicity Potential – TETP | 1.4-DCB eq | € 0.06 |

Raw materials

Emissions

1-point score

[9] *Toxicity has its price: shadow pricing for ecotoxicity and other toxicity and depletion of abiotic resources within DuboCalc', Harmelen, drs. A.K. van, et al., TNO-MEP (commissioned by Rijkswaterstaat), Apeldoorn, 2004*

[10] *Harmonisation normalisation/weighting and environmental data in Eco-Quantum, GreenCalc+ and DuboCalc, IVAM Amsterdam, 2004.*

[11] *If 'Abiotic Depletion Potential for fossil energy carriers' is available in the MJ unit, the conversion factor 4.81E-4 kg antimony/MJ can be used [CMLIA, Part 2b: Operational annex, page 52]*

The result per environmental impact category arises from the characterised impact scores being multiplied by the weighting factors per unit. So no normalisation takes place in advance.

**Calculation rules**

**Environmental profile of product component**

$MP_{pr\_o\_ref} = MP_{A1-A3}+MP_{A4}+MP_{A5}+MP_{B1}+MP_{B2}+MP_{B3}+MP_{B4}+MP_{C1}+MP_{C2}+MP_{C3}+MPC4+MP_{D}$

$MP_{pr\_o\_ref}$ = environmental profile of product component reference (total environmental profile across all modules and indicators)

$MP_{A1-A3}$ = environmental profile in module A1-A3

$MP_{A4}$ = environmental profile in module A4

$MP_{A5}$ = environmental profile in module A5

$MP_{B1}$ = environmental profile in module B1

$MP_{B2}$ = environmental profile in module B2

$MP_{B3}$ = environmental profile in module B3

$MP_{B4}$ = environmental profile in module B4

$MP_{C1}$ = environmental profile in module C1

$MP_{C2}$ = environmental profile in module C2

$MP_{C3}$ = environmental profile in module C3

$MP_{C4}$ = environmental profile in module C4

$M_{PD}$ = environmental profile in module D

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

## 2.10 Calculation and other rules for category 3 data

A surcharge factor is applied to category 3 environmental profiles, because experience has shown that unverified environmental profiles often indicate a too low environmental impact as the inventory data are less complete, and to stimulate the submission of category 1 and 2 data to the database. This surcharge factor ('SF') is set at 1.3. This surcharge factor can be changed by the NMD administrator, Stichting NMD. The surcharge factor applies at product component level per environmental indicator. If an environmental indicator for a product component in module D produces a negative value (benefits), no surcharge factor will be applied to this environmental indicator in module D.

The 30% surcharge factor does not apply to category 3a Environmental Product Declarations. This applies to Environmental Product Declarations from externally supplied energy carriers, such as electricity, gas, heat and fuels, and from standard data, for the material-related impact of the energy carriers. A surcharge factor of 1 applies to category 1, 2 and 3a Environmental Product Declarations.

Category 1 and category 2 environmental profiles that have been cancelled will be removed from the NMD. If no replacement non-proprietary data are available for these, they will be replaced by category 3 data managed by Stichting NMD. Where possible, input from the cancelled Environmental Product Declarations will be used in coordination with the data owner.

## 2.11 Scaling of environmental profile

In formulating an NMD Environmental Product Declaration, the data owner / LCA practitioner may or may not opt for scaling. The advantage of scaling is that it is not necessary to add a new Environmental Product Declaration to the NMD for each dimension (e.g. thickness in the case of floors). Scaling is linked to the product component's set of environmental data set (the environmental profile of the product component). For multiple product components, each environmental profile can be scaled in its own way. For example, an HSB element with a scaled insulation layer, but non-scaled cladding. A distinctive set of environmental data set (environmental profile) must be prepared for each product component. Scaling only applies to products and underlying environmental profiles. The scaling applies to all environmental indicators. This scaling always concerns the total life cycle. Variability in materials and processes (such as transport) do not fall within the physical scale.

**Scaling formulas**

- Option 1: product component has no scaling.
- Option 2: product component has a linear scaling. (Y = a * x + b)
- Option 3: product component has a non-linear scaling. (Y = a * x3 + b * x2 + c * x + d)

The 'Y' in the formula can equal the ECI, but 'Y' can also equal a parameter proportional to the ECI, such as mass.

**- S, the scaling factor:** the scaling factor is used to scale the environmental results of the product or the product component[12]. This follows the formula:

$$S = \frac{Y_{geschaald}}{Y_{def}}$$

$MP_{geschaald} = MP_{(pr\_o\_ref)} * S$

$MP_{geschaald}$ = scaled environmental profile across all life cycle stages.

$MP_{pr\_o\_ref}$ = environmental profile of product component reference (total environmental profile across all modules and indicators). Default value, unscaled

$Y_{def}$ = default Y-value. This is the Y value calculated from the scaling formula when entering the default scaling values.

$Y_{geschaald}$ = Y value at applied scaling. This is the Y value calculated from the scaling formula when entering the applied scaling values.

This formula applies to the full environmental profile of the product or product component (all indicators and all life stages).

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

12 *Expressed in three significant figures, rounded mathematically.*

**'x'**: The scaling formulas always have one variable 'x'. This variable comes from the applied scaling dimension(s). In case of one scaling dimension, this dimension equals 'x' in the scaling formula. In case of multiple scaling, the variable 'x' is calculated from a formula belonging to a geometry or a generic formula. For each variable, the unit, the scaling range and the default value must be specified. The default scaling degree is the dimension of the reference product. The environmental values of the default scaling degree are derived from the scaling formula in the same way as any other value.

**Multiple scaling**
The generic formula to calculate x:

$$x = x1 \times x2$$

$x_1$ = variable quantity
$x_2$ = variable quantity

The LCA practitioner should indicate the quantities and units for $x_1$ and $x_2$.

**Variability by scaling**
The deviation of environmental results due to scaling may not exceed 10% per environmental impact. This means that by applying scaling, the calculated environmental results may be 10% lower or higher than the actual environmental results. The minimum and maximum scaling dimensions should come from the included product variants with the smallest and largest variable dimension, respectively. The product variants used to determine the scaling formula should be a representative cross-section of all possible product variants. It is up to the LCA practitioner and the LCA reviewer to ensure that the product variants included are representative of the scope and the scaling domain used. In the LCA file, the LCA practitioner should explain that the product variants included are representative of the reality.

If non-linear scaling is applied, a minimum of five product variants must be included to establish the scaling formula. If there are less than five product variants on the market of 1 product or manufacturer that scale non-linearly (three or four variants), then these may only be applied to create a non-linear scalable Environmental Product Declaration if they are dimensionally stable products.[13] If there is a change in the product variants to be covered by a scalable environmental profile, scaling should be reconsidered.

[13] *Dimensionally stable products are products that are only manufactured in variations with fixed dimensions. They are not available in 'intermediate sizes'.*

## 2.12 Unforeseen reuse within C&U

In current practice, products that are entirely reused in a construction work are not considered in the environmental performance calculation. This also means that replacements after the product's end of life are not included over the service life of construction works, nor is any maintenance during the use phase and the final impact (and benefits) at the actual end of life. For generic improvements here, calculation rules have been introduced for unforeseen reuse;

This concerns reuse of products for which reuse was not initially considered in the environmental performance calculation, of which the remaining service life is unknown or for which anticipated reuse has already been fully allocated to the initial product system (environmental benefits in module D, according to EN 15804 environmental benefits are allocated to the system that produces them).

Unforeseen reuse is used at the level of an Environmental Product Declaration for which the product is used in the same functional application.

The calculation rule has been detailed in a generic factor for reuse (H). This factor is determined (expert judgement) based on the following starting points:
- simple and transparent;
- acceptable approach to the actual environmental impact on reuse (so not 0);
- on average, reused products will not yet have 'written off' all of the original environmental impact, but they will have 'written off' a substantial part of it. On this basis, the free of burden principle is not applied at product level in the case of unforeseen reuse;
- unforeseen reuse will further reduce in the future due to facilitation of Environmental Product Declarations for reuse based on foreseen reuse.

In unforeseen reuse, the reuse factor is set at 0.2 as standard. This means that the Environmental Cost Indicator (MKI) is multiplied by 0.2, applied to modules:

*A1-A3;*

*C3, C4* and *D*

Of the initial or the most representative product available in the NMD.

The environmental performance within the A4, A5, B, C1 and C2 modules will be calculated in the usual way. The service life of the reused product will be equated to the reference service life of the original product. The calculation instruments must clearly show a marking for unforeseen reuse in the results at product and construction work level.

The calculation rules for unforeseen reuse will of course not be applied to Environmental Product Declarations that have been formulated based on a reused product, such as a renovation portal (Reno portal). Unforeseen reuse shall never apply to Environmental Product Declarations of products originating from reuse.

The reuse factor will be evaluated annually.

## Example as illustration

Product; aluminium door comprising: aluminium frame, glass and door rubber.
The notional environmental performance in ECI of this product is as follows:

| Product | Material | A1-3 | B1 | C3 + C4 | D | ECI |
|---|---|---|---|---|---|---|
| | 1 rubber | 1.000 | 0.000 | 0.200 | 0.050 | 1.250 |
| | frame | 10.000 | 0.000 | 0.500 | -4.000 | 6.500 |
| | glass | 5.000 | 1.000 | 1.000 | -0.100 | 6.900 |
| | | | | | | 14.650 |

**Reuse factor (H)**

The notional environmental performance in the event of unforeseen reuse of the door without modifications:

| Material | A1-3 | B1 | C3 + C4 | D | ECI |
|---|---|---|---|---|---|
| 1 rubber | **0.200** | 0.000 | **0.040** | **0.010** | 0.250 |
| frame | **2.000** | 0.000 | **0.100** | **-0.800** | 1.300 |
| glass | **1.000** | 1.000 | **0.200** | **-0.020** | 2.180 |
| | | | | | **3.730** |

The reuse factor 0.2 is applied to modules: A1-A3; C3, C4 and D

**Reuse factor (H) + new production added**

The notional environmental performance in the event of unforeseen reuse of the door with modifications, in this example replacing a broken door rubber;

| Material | A1-3 | B1 | C3 + C4 | D | ECI |
|---|---|---|---|---|---|
| 1 rubber | **1.200** | 0.000 | **0.240** | **0.060** | 1.500 |
| frame | 2.000 | 0.000 | 0.100 | -0.800 | 1.300 |
| glass | 1.000 | 1.000 | 0.200 | -0.020 | 2.180 |
| | | | | | **4.980** |

The reuse factor 0.2 is applied to modules: A1-A3; C3, C4 and D
The new door rubber is added as new production in A1-A3 and also in a new end-of-life processing scenario in C and D.

**Impact on building service life**

When applied at building level, the comparison between new and reuse without modifications is as follows:

**Everything new**
Building service life ........................................ 75
Door service life ........................................ 15
ECI product 1 new ........................................ 14.65
ECI product 1 replacement ........................................ 58.6
TOTAL ........................................ 73.25

**Factor H applied to first cycle**
Building service life ........................................ 75
Door service life ........................................ 15
ECI door unforeseen reuse ........................................ 3.73
ECI door replacements ........................................ 58.6
TOTAL ........................................ 62.33

Example 1: reuse factor

**Calculation rules, environmental profile of product component including surcharge factor, scaling and unforeseen reuse.**

$$MP_{pr;o} = MP_{pr\_o\_ref} * OF * S * H$$

$MP_{pr;o}$ = environmental profile of product component after application of scaling, the surcharge factor and the unforeseen reuse factor (total environmental profile across all modules and indicators)

$MP_{pr\_o\_ref}$ = environmental profile of product component reference

OF = surcharge factor, as included in the Assessment Method

S = Scaling factor

H = Unforeseen reuse factor, as included in the Assessment Method

### Environmental profile of product

In some cases, a product is made up of different environmental profiles of product components.

$$MP_{pr} = \sum_{o=1}^{n_o} MP_{pr;o}$$

In which

$MP_{pr}$ = environmental profile of a product (environmental profile with all modules and indicators, aggregated from one or more environmental profiles of sub-products)

$n_o$ = number of product components used in a product;

### Weighting

$$MP_{pr.W} = \sum_{i=1}^{n} MP_{pr} * W_i$$

$MP_{pr.W}$ = Weighted environmental profile of a product. (Weighted environmental profile with all modules and indicators.)

$W_i$ = weighting factor, per environmental impact category.

Weighting is based on the weighting set applied to the environmental impact categories to be considered.

$n_i$ = number of environmental impact categories.

$$MKI_{pr} = \sum_{mic=1}^{n_{mic}} \sum_{mod=1}^{n_{mod}} MP_{pr.W}$$

$MKI_{pr}$ = MKI (=ECI) product (aggregate weighted environmental value)

$n_{mic}$ = the number of environmental impact categories used

$n_{mod}$ = the number of modules used

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

### 2.13 Verification and validity of an EPD (EN 15804 9 Verification and validity of an EPD)

EN 15804 applies.

In addition to EN 15804:
For the EPD environmental information to be admitted to the NMD, the verifier must be recognised by Stichting NMD, and the verification of the EPD, basic processes and Environmental Product Declaration must take place according to the NMD Verification Protocol.

Additional information can be found on *www.milieudatabase.nl* to assess whether supplied environmental data has been prepared in accordance with the Assessment Method. The MRPI®-EPD VERIFICATION Checklist on The PCR-NL, for instance, is a useful tool. However, this is a supplement and the most recent version of the Verification Protocol should always be followed for the final assessment.

# 3. Construction work calculation

## 3.1 Standards at construction work level

**At the product level, European standard EN 15804 is followed. In addition to EN 15804, there is a European standard EN 15978 for the construction work level. The scope of EN 15978 is limited to buildings, thus excluding other construction works. This means that EN 15978 cannot be used as the sole basis for the Environmental Performance Assessment Method for Construction Works. Additionally, for buildings, the Assessment Method also deviates from EN 15978 on certain points.**

1. Modules B6 and B7 not included
   EN 15978 also includes modules B6 and B7 at construction work level. In the Netherlands, however, the themes of Energy and Environment (Material-related impact) are treated as separate pillars within the Environment Buildings Decree (Bbl). Energy and water-related impacts are not included in the scope of the environmental performance of buildings.[14]
2. The review period is always equal to the building service life
   In EN 15978, the review period for the assessment can be shorter or longer than the building service life. For buildings, the review period is always equated to the building service life. For other construction works (Civil Engineering), a review period is set for each project, usually 50 or 100 years.
3. Fraction method rather than the Truncation method
   EN 15978 requires rounding up to an integer when determining
   replacements (truncation method). The Dutch Assessment Method chose to round off to 2 decimal places (fraction method). The reason for this is that it provides a more realistic modelling of Dutch practice. This ensures that optimisation will always be applied to replacement decisions. If demolition is anticipated in five years, people will decide not to replace a window frame, even if its theoretical service life has expired.

## 3.2 General explanation of the construction work level

### 3.2.1 Required characteristics of the construction work

The assessment of the environmental performance of a construction work requires characteristics of the construction work. With regard to the construction work as a whole, this involves a limited number of characteristics, for example, the GFA and the building service life. The main inputs concern the selection of products, materials and/or processes involved in construction. Since products, materials and processes are treated equally, the term 'product' and the code 'pr' will be used in the rest of this chapter, referring to both product, material and process. The number of units (quantity) is specified for each selected 'product'. During selection, it can be indicated that the dimensions in the specific construction work deviate from the default dimensions of the 'product' as included in the NMD. This option of 'scaling' is arranged at the product level (chapter 2). When used in C&U, it can also be indicated, that not a new, but a reused variant of the product is used in new construction. Whereas in C&U it is assumed to be new construction without an existing structure, in Civil Engineering this may be the case. In Civil Engineering, a 'product' can be marked as 'released material' for which only the demolition and processing phase is relevant.

[14] *Recently, the MEPG method (environmental and energy performance of buildings) was developed, which does involve an integrated approach based on material and energy-related impact.*

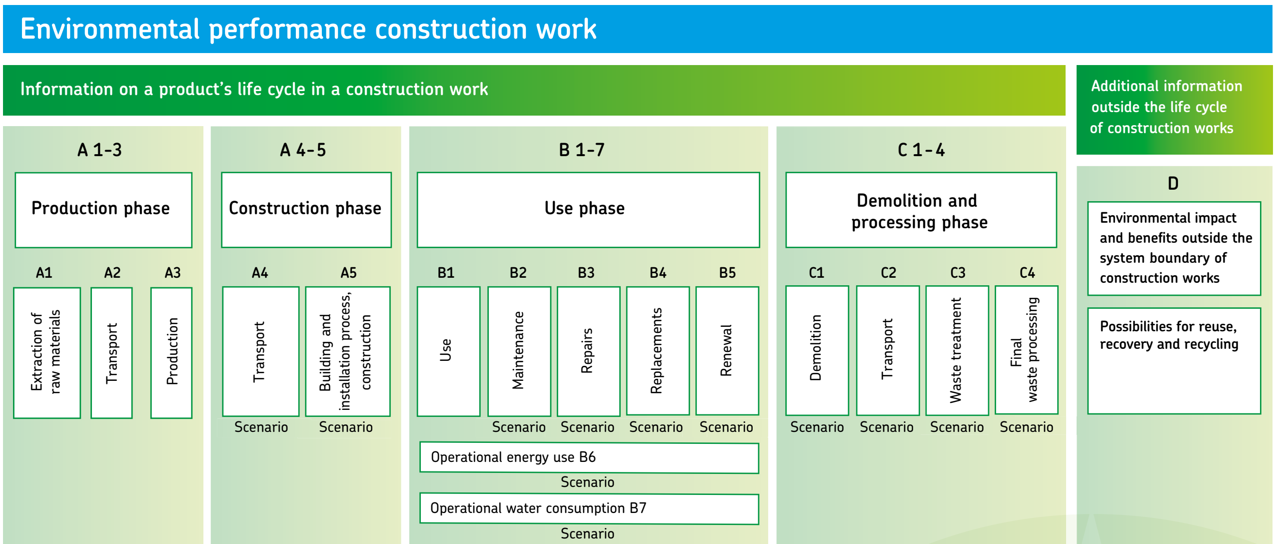
### 3.2.2 Construction work life cycle

The construction work is the context in which ‘products’ are used. Thereby, the construction work has the same modular structure in accordance with EN 15804 as the products (see Figure 3). Side note is that the impact, for a given module at product level, is not always included in the corresponding module at the construction work level. The modules are clustered into the phases of the life cycle below:

Phase A: Production and Construction
Phase B: Use
Phase C: Demolition and processing

In addition, a module D is distinguished, which includes all environmental costs and benefits not attributable to the system of the construction work. These environmental costs and benefits can occur in all other modules, except module A1-3.

*Figure 3: Construction work life cycle divided into phases and modules in accordance with EN 15804*




### 3.2.3 The duration of use phase B

The review period determines the duration of phase B, the use phase, and therefore also the impact in phase B. With a longer use phase, the number of product replacements will be higher.

In the case of the EPB (buildings), the greater number of replacements is offset by the fact that the building's ECI is divided by a greater number of years. Since there are also building elements that will never need to be replaced during the building service life, the net impact of a building life extension is positive.

For other (Civil Engineering) structures, a review period is set for each specific project, usually 50 or 100 years. The project may not deviate from this set review period.

For buildings, the review period is always equated to the building service life. Default life cycles are available for the building service life, linked to the building's use function:

Homes: 75 years

Utilities: 50 years (including schools, shops, sports halls).

Mixed use buildings: 75 years when combined with a residential function (e.g. homes over shops), otherwise 50 years

Given the long period between construction and demolition of a building, the building service life at the time of new construction can hardly be predicted with any certainty. Therefore, it is common to use the default building service lives. It is allowed to provide a specific service life. However, this is allowed only if there are clearly distinctive building characteristics that make a longer or shorter service life expectancy plausible. The research report "Specific Building Service Life Guideline" [W/E, 2020] provides indications (informative, not normative) for justified deviations from the reference building service life. This report can be found on the Stichting NMD website *www.milieudatabase.nl*.

## 3.3 Calculation per phase of the construction work life cycle

This section describes the calculation rules for the calculation at construction work level. As the environmental impact per phase is considered a valuable insight, the calculation rules are described per phase (sections 3.3.1 to 3.3.5). Section 3.3.6 follows the summation to the ECI of the construction work and, for buildings, the translation to the Environmental Performance of Buildings (EPB). As an additional result, each time, the impact per specific environmental impact category is also determined. Relevant at the construction work level is the selection of products[15] used in construction. For each product, the environmental impact during the life cycle of the construction work is determined, followed by the summation across all products. This is based on the number of units of product and the number of cycles during the life cycle (frequency). Chapter 2 explains how the environmental profile[16] per unit of product is determined (indicated by EPpr).

Note that this refers to the products as used in the construction work, including the scaling, surcharge factor and any unforeseen reuse.

### 3.3.1 Phase A of the construction work – Production and Construction

Phase A is further divided into the Production Phase and the Construction Phase.

- Module A1-A3
  The production phase comprises modules A1, A2 and A3, which are treated jointly as module A1-A3. This concerns the extraction, transport and (semi-finished) production of the products and/or processes as they will be used in the realisation of the construction work.
- Module A4
  The construction phase comprises modules A4 and A5. Module A4 concerns the transport of the products to the construction site.
- Module A5
  The construction phase comprises modules A4 and A5. Module A5 concerns the use of products and processes in the realisation of the construction work, including the resulting construction loss.

*15 The term 'product' and the code 'pr' refer to products, materials or processes. (See paragraph 3.2.1).*

*16 The environmental profile is a matrix based on the relevant environmental impact categories and the modules of the construction work. Reference is made to a part of the matrix via subscripts. The subscript 'mod' refers to a module, and the subscript 'eic' refers to an environmental impact category. The values in the matrix can be (weighted) summed in two directions, namely across the environmental impact categories (result is the ECI) and across the modules.*

**Frequency (number of cycles)**
Phase A of the construction work concerns phase A of the products that are installed during construction (initial products). Since construction always concerns the installation of a complete product, the frequency is always 1. Therefore, the formula does not include a correction for frequency.

**Determination of ECI for phase A of the construction work**
The starting point is the module profile[17] for each product (EPpr;mod). Phase A comprises modules A1–A3, A4, and A5. The module profile of the construction work is determined for these modules:

$$MP_{bw;mod} = \sum_{pr=1}^{n_{pr}} Q_{pr} * MP_{pr;mod}$$

Modules A1-A3, A4, A5

In which:
$MP_{bw;mod}$ = module profile of the construction work
$n_{pr}$ = the number of products in the construction work
$Q_{pr}$ = quantity of product used in the construction work
$MP_{pr;mod}$ = module profile of the product

The Environmental Cost Indicator (MKI) of the construction work of a module in phase A is described in the formula below:

$$MKI_{bw;mod} = \sum_{mic=1}^{n_{mic}} MP_{bw;mod;mic} * W_{mic}$$

In which:
$MKI_{bw;mod}$ = MKI (Environmental Cost Indicator=ECI) of the construction work of a module
$n_{mic}$ = the number of environmental impact categories in the environmental profile
$MP_{bw;mod;mic}$ = module profile of the construction work per environmental impact category
$W_{mic}$ = weighting factor per environmental impact category

The total ECI for phase A of the construction work is the sum of the ECI for the modules in phase A:

$$MKI_{(bw;A)} = MKI_{(bw;A1\text{-}A3)} + MKI_{(bw;A4)} + MKI_{(bw;A5)}$$

**Additional: scores per specific environmental impact category**
Mbw;mod;mic refers to the environmental impact value of the construction work per module for a specific environmental impact category from MPbw;mod. Summation over the modules in phase A provides the environmental impact value for a specific environmental impact category for phase A (Mbw;A;mic).

$$M_{(bw;A;mic)} = MP_{(bw;A1\text{-}A3;mic)} + MP_{(bw;A4;mic)} + MP_{(bw;A5;mic)}$$

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

*17 The module profile is a cross-section of the environmental profile for one specific module. The module profile is a row containing the relevant environmental impact values.*

### 3.3.2 Phase B of the construction work – Use

Contrary to phase A, phase B is not divided into sub-phases. Phase B distinguishes between the product used during construction (initial product) and replacement products during the rest of the service life of the construction work (replacement products). Modules B1, B2, B3 only consider the impact of the initial product. B4 considers the impact of the initial product as well as the impact of the replacement products.
Phase B comprises the following modules:

- Module B1
  Module B1 involves the (continuous) emissions, which occur in the use phase of the initial product. Emissions from replacement products are allocated to Module B4.
- Module B2
  This refers to product maintenance, which, like B1, involves only the initial products.
- Module B3
  This refers to product repair, which, like B1, involves only the initial products.
- Module B4
  Module B4 involves the replacement of components (environmental profiles) in the initial products as well as subsequent product replacements during the service life of the construction work.
- Module B5
  This concerns renovation interventions. In practice, at the time of new construction, no prediction can be made of any renovation. It is therefore impossible to draw up a meaningful scenario. Therefore, B5 is not operationalised and not included in the calculation rules.
- Module B6
  This refers to the operational energy use during the use of the construction work. In C&U, environmental performance is delimited to the material-related impact[18]. Module B6 is therefore out of scope. In Civil Engineering, the client indicates for each specific project whether B6 is or is not included in the scope.
- Module B7
  This refers to the operational water consumption during the use of the construction work. Module B7 is out of scope. Unlike module B6, there is no method available yet, by which operational water consumption can be uniformly determined.

**Frequency (number of cycles)**

The product used in construction (initial product) will last until the first replacement, which takes place when the standard product service life has expired. This is followed by one or more replacements until the end of the review period (usually the demolition of the construction work), where it is assumed that the replacement products are always the same as the initial product.

*Initial product*

The first part of phase B of the construction work is completed using the initial product. So the impact in phase B of that product, for example maintenance, contributes to the impact in the phase B of the construction work.

For products that are replaced one or more times during the use phase of the construction work / review period, the frequency in phase B of the initially installed product Fpr;ini always equals 1. But in the case where the product service life exceeds the service life of the construction work within the review period, this would lead to an overestimation of the impact. In that case, the frequency in phase B is smaller than 1.

[18] *Module B6 is included in the Assessment Method for the MEPG.*

The frequency at the initial product is determined using the formula below, based on the fraction method (no rounding to an integer).

$$F_{pr;ini} = \min\left(\frac{L_{bw}}{L_{pr}}; 1\right)$$

In which

$F_{pr;ini}$ = frequency of use of the initial product in phase B of the construction work
$L_{bw}$ = service life of the construction work within the review period [years]
$L_{pr}$ = service life of the product [years]

*Replacement products*

The first replacement starts with the removal and processing (phase C/D) of the initial product. With the last replacement, only the production and construction (phase A) and use (phase B) of the replacement product are relevant. The removal and processing (phase C/D) of these products are addressed in phase C/D of the construction work.

The replacement frequency is determined by dividing the service life of the structure within the review period by the service life of the product. This is based on the fraction method (no rounding to an integer). Since phases A and B of the initial product and phases C and D of the final replacement product are included elsewhere (together, these comprise all phases of 1 product cycle), after the division, 1 (cycle) is subtracted from the result of the division. The number of replacements cannot be negative.

$$F_{pr;ver} = \max\left(\left(\frac{L_{bw}}{L_{pr}} - 1\right); 0\right)$$

For construction work module B4. For the other construction work modules, Fpr;ver has the value zero.

In which

$F_{pr;ver}$ = replacement frequency of a product in the construction work
$L_{bw}$ = service life of the construction work within the review period [years]
$L_{pr}$ = service life of the product [years]

**Determination of ECI for phase B of the construction work**

In modules B1, B2, B3, only the initial product is relevant. Module B4 also considers the impact of the replacement products.

For the initial product, as in phase A, the module profile per product (MPpr;mod) is the starting point. Phase B involves modules B1 to B4. The module profile of the construction work is determined for these modules. Unlike phase A, the frequency can be other than 1, namely Fpr;ini.

Replacement products do not only involve modules B1 to B4, but all modules of the product (MPpr). This environmental profile is multiplied by the replacement frequency Fpr;ver. In module B4 of the construction work, this result is added to the impact in module B4 by the initial product.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

$$MP_{bw;mod} = \sum_{pr=1}^{n_{pr}} Q_{pr} * \left(F_{pr;ini} * MP_{pr;mod} + F_{pr;ver} * MP_{pr}\right)$$

This applies to modules B1, B2, B3, B4

In which:

$MP_{bw;mod}$ = module profile of the construction work
$n_{pr}$ = the number of products in the construction work
$Q_{pr}$ = quantity of product used in the construction work
$F_{pr;ini}$ = frequency of use of the initial product in phase B of the construction work
$MP_{pr;mod}$ = module profile of the product
$F_{pr;ver}$ = replacement frequency of a product in the construction work. Fpr;ver is 0 for B1, B2, B3.
$MP_{pr}$ = environmental profile of the product

The ECI of the construction work per module in phase B is described in the formula below.

$$MKI_{bw;mod} = \sum_{mic=1}^{n_{mic}} MP_{bw;mod;mic} * W_{mic}$$

In which:

$MKI_{bw;mod}$ = MKI (Environmental Cost Indicator=ECI) of the construction work of a module
$n_{mic}$ = the number of environmental impact categories in the environmental profile
$W_{mic}$ = weighting factor per environmental impact category
$MP_{bw;mod;mic}$ = module profile of the construction work per environmental impact category

The total ECI for phase B of the construction work is the sum of the ECI for the modules in phase B:

$$MKI_{(bw;B)} = MKI_{(bw;B1)} + MKI_{(bw;B2)} + MKI_{(bw;B3)} + MKI_{(bw;B4)}$$

**Additional: scores per specific environmental impact category**

Mbw;mod;mic refers to the environmental impact value per module for a specific environmental impact category from MPbw;mod. Summation over all modules in phase B provides the environmental impact value for a specific environmental impact category for phase B (Mbw;B;mic).

$$M_{(bw;B;mic)} = MP_{(bw;B1;mic)} + MP_{(bw;B2;mic)} + MP_{(bw;B3;mic)} + MP_{(bw;B4;mic)}$$

### 3.3.4 Phase C of the construction work – Demolition and Processing

Phase C is not divided into sub-phases. Phase C comprises the following modules:

- Module C1
  This refers to product removal, involving only the products present at the time of demolition of the construction work. The impact related to the removal of product replacements during the use period is allocated to Module B4.
- Module C2
  This concerns the disposal of the removed products to processing sites. Like module C1, this refers only to the products present at the time of demolition of the construction work.

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

- Module C3
  This concerns the processing of the removed products. The distribution across the different processing options can differ per product. Like module C1, this refers only to the products present at the time of demolition of the construction work.
- Module C4
  This concerns the final waste processing (landfill) of the removed products. Like module C1, this refers only to the products present at the time of demolition of the construction work.

**Frequency (number of cycles)**
At the end of the life cycle of the construction work, all products then present are removed (demolition). This refers to the products installed during the last replacement or products already present from construction onwards (initial products). Since demolition always concerns the removal of a complete product, the frequency is always 1, just like in phase A (Construction).

**Determination of ECI for phase C of the construction work**
As in phase A, the module profile of the product (MPpr;mod) is the starting point. Phase C involves modules C1 to C4. The module profile of the construction work is determined for these modules. As in phase A, the frequency is always 1, and therefore not included in the formula.

$$MP_{bw;mod} = \sum_{pr=1}^{n_{pr}} Q_{pr} * MP_{pr;mod}$$

This applies to modules C1, C2, C3, C4.

In which:
$MP_{bw;mod}$ = module profile of the construction work
$n_{pr}$ = the number of products in the construction work
$Q_{pr}$ = quantity of product used in the construction work
$MP_{pr;mod}$ = module profile of the product

The ECI of the construction work of a module in phase C is described in the formula below:

$$MKI_{bw;mod} = \sum_{mic=1}^{n_{mic}} MP_{bw;mod;mic} * W_{mic}$$

In which:
$MKI_{bw;mod}$ = MKI (=ECI) of the construction work of a module
$n_{mic}$ = the number of environmental impact categories in the environmental profile
$MP_{bw;mod;mic}$ = module profile of the construction work per environmental impact category
$W_{mic}$ = weighting factor per environmental impact category

The total ECI for phase C of the construction work is the sum of the ECI for the modules in phase C:

$$MKI_{(bw;C)} = MKI_{(bw;C1)} + MKI_{(bw;C2)} + MKI_{(bw;C3)} + MKI_{(bw;C4)}$$

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

**Additional: scores per specific environmental impact category**

Mbw;mod;mic refers to the environmental impact value per module for a specific environmental impact category from MPbwmod. Summation over all modules in phase C provides the environmental impact value for a specific environmental impact category for phase C (Mbw;C;mic).

$$M_{(bw;C;mic)} = MP_{(bw;C1;mic)} + MP_{(bw;C2;mic)} + MP_{(bw;C3;mic)} + MP_{(bw;C4;mic)}$$

### 3.3.5 Module D of the construction work – Outside the system boundary

Module D is not a phase in the life cycle of the construction work, but a module where environmental costs and benefits that fall outside the system boundary of the construction work are allocated. Module D is not further divided into modules.

**Frequency (number of cycles)**

In module D at the construction work level, only the environmental costs and benefits resulting from the last installed entire product cycle are included, as in phase C. Therefore, the frequency is corresponding to phase C, i.e. always 1.

**Determination of ECI for module D of the construction work**

As in phase A, the environmental profile (the matrix of numbers) of the product adapted to the specific construction work (MPpr) is the starting point. The values for module D are selected from the environmental profile. This produces the module profile per product (MPpr;mod), which consists of the relevant environmental impact values. As in phase A, the frequency is always 1, and therefore not included in the formula.

$$MP_{bw;mod} = MP_{bw;D} = \sum_{pr=1}^{n_{pr}} Q_{pr} * MP_{pr;mod}$$

This applies to module D

In which:

$MP_{bw;mod}$ = module profile of the construction work
$MP_{bw;D}$ = environmental profile of the construction work in module D
$n_{pr}$ = the number of products in the construction work
$Q_{pr}$ = quantity of product used in the construction work
$MP_{pr;mod}$ = module profile of the product

This environmental profile contains the individual environmental impact values per environmental impact category for the construction work in module D, which does not require summing across multiple modules. Therefore, no separate formula has been included for Mbw;D;mic.

The ECI of the construction work of module D is described in the formula below:

$$MKI_{bw;mod} = MKI_{bw;D} = \sum_{mic=1}^{n_{mic}} MP_{bw;D;mic} * W_{mic}$$

This applies to module D

In which:

$MKI_{bw;mod}$ = MKI (=ECI) of the construction work of a module
$MKI_{bw;D}$ = MKI (=ECI) of the construction work in module D

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

$n_{mic}$ = the number of environmental impact categories in the environmental profile
$MP_{bw;D;mic}$ = environmental profile of the construction work in module D per environmental impact category
$W_{mic}$ = weighting factors per environmental impact category

**Additional: scores per specific environmental impact category**
Mbw;D;mic refers to the environmental impact value for module D at a specific environmental impact category from MPbw;D.

### 3.3.6 ECI of construction work and EPB

The ECI of the construction work can be calculated by summing over the ECI values for each phase.

$$MKI_{bw} = MKI_{(bw;A)} + MKI_{(bw;B)} + MKI_{(bw;C)} + MKI_{(bw;D)}$$

In which:
$MKI_{bw}$ = MKI (=ECI) of the construction work
$MKI_{bw;A}$ = MKI (=ECI) of the construction work in phase A
$MKI_{bw;B}$ = MKI (=ECI) of the construction work in phase B
$MKI_{bw;C}$ = MKI (=ECI) of the construction work in phase C
$MKI_{bw;D}$ = MKI (=ECI) of the construction work in module D

For C&U (buildings) the ECI can be converted into the EPB - Environmental Performance of Buildings. The total impact is converted back to a functional unit. This is not applied in Civil Engineering.

$$MPG = \frac{MKI_{bw}}{L_{bw} * A_{BVO}}$$

In which
MPG = the environmental performance of the building
$MKI_{bw}$ = MKI (=ECI) of the construction work
$L_{bw}$ = service life of the construction work within the review period [years]
$A_{BVO}$ = the gross floor area of the building [m2]

The building service life to be used is described in section 3.2.3.

**Additional: scores per specific environmental impact category**
As an additional result, the environmental impact values for each environmental impact category are summed up to a total value over the entire cycle of the construction work:

$$M_{(bw;mic)} = M_{(bw;A;mic)} + M_{(bw;B;mic)} + M_{(bw;C;mic)} + M_{(bw;D;mic)}$$

In which:
$M_{bw;mic}$ = environmental impact value of the construction work of an environmental impact category
$M_{bw;A;mic}$ = environmental impact value of the construction work in phase A of an environmental impact category
$M_{bw;B;mic}$ = environmental impact value of the construction work in phase B of an environmental impact category
$M_{bw;C;mic}$ = environmental impact value of the construction work in phase C of an environmental impact category
$M_{bw;D;mic}$ = environmental impact value of the construction work in module D of an environmental impact category

Note: The notations for the terms used in these formulas are based on Dutch definitions and standards.

## 3.4 Existing buildings

The ‘Environmental performance assessment of existing buildings that are to be renovated or transformed’ [W/E, 2014] gives instructions on how to handle the residual value and depreciation of environmental impact, for calculating the environmental performance of the renovation or transformation. See the website. This only applies to buildings and not to civil engineering structures.

# 4. Environmental performance of operational energy use (B6)

**Under EN 15978, operational energy use must be declared in phase B6.1, B6.2 and B6.3. The substitution processes of exported energy are declared in module D2. Operational energy use is also declared in BENG (Nearly Energy Neutral Buildings), based on the methods stated in NTA 8800. Within the European harmonised LEVEL(s) framework, operational energy use has a place within indicator 1.1 and 1.2.**

This chapter provides the procedure to include building-related energy use in addition to the EPB calculation for C&U and the ECI calculation for civil engineering structures.

## 4.1 System boundaries for the environmental performance of operational energy use B6

For buildings, the system boundary of the materialisations and energy generation to be considered corresponds to the system boundary as stated in the Buildings Decree: the plot boundary constitutes the system boundary. All energy generators at the system boundary connected to the construction work are considered, even if more energy generators than required for BENG are used.

For other construction works, the system boundary is according to the scope of the tender for which the B6 calculation is made.

## 4.2 Life stages of operational energy use, B6

Building-related regulated operational energy use is declared in line with EN 15978 in life cycle stage (module) B6.1. Module B6.1 is a mandatory component for the environmental performance of operational energy use. For C&U, B6.1 contains the total regulated energy demand for heating, cooling, humidification, dehumidification and lighting. The regulated energy demand is determined according to NTA 8800.

Building-related non-regulated energy use is declared in accordance with EN 15978 in B6.2. Module B6.3 set within EN 15978 is not building-related and therefore falls outside the scope of the Environmental Performance Assessment Method for Construction Works for the environmental performance of operational energy use. In summary:

**B 6.1 Mandatory for the environmental performance of operational energy use**
The energy use of regulated[19] building-integrated systems (services) (such as lighting, heating and ventilation)

**B 6.2 Not part of the environmental performance of operational energy use for C&U, but it is for Civil Engineering**
The energy use of building-integrated systems (services) that are not regulated (such as lifts, security systems and communication systems). If the NTA prescribes a harmonised method, this part is added to the mandatory part.

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[19] *'Regulated' means the energy demand of integrated systems (services) covered by the EU Energy Performance of Buildings Directive (2018/844/EU) and its national implementations.*

**B 6.3 Not part of the environmental performance of operational energy use**
Other energy use related to user activities of the building.

In compliance with EN 15978, exported energy is declared in module **D2**.

*For Civil Engineering, the use functions are highly variable and energy use is not regulated (B6.1). The Civil Engineering client sets the requirements (on lighting, (tunnel) ventilation, movement of bridges or lock gates, etc.). As a result, the operational energy use of the entire Civil Engineering sector falls in category B6.2. The assessment of module B6.2 must be based on the usage scenario established by the client.*

## 4.3 Use of Environmental Product Declarations for energy carriers

Multiple category 3a Environmental Product Declarations are available for operational energy use from supplied energy[20].

**Operational energy in construction work calculations (external supply)**
Construction work calculations (EPB) must be based on the external supply cards. The external supply is declared in the production phase of the construction work (A1-A3). For supplied electricity, the Environmental Product Declaration 'Electricity, at consumer, materialisation of external supply, average grid mix, per kWh' is used. For EPB, no distinction can be made in the type of electricity used. For electricity produced from on-site generation, the Environmental Product Declaration 'Materialisation electricity grid, external supply, per kWh' should be applied for construction works connected to the grid, when energy storage is unavailable or insufficient. With this declaration, the electricity grid is added for building-related electricity generation. All Environmental Product Declarations contain supply to consumers in low voltage[21].

**Environmental performance of operational energy (B6)**

**Supplied energy**
Calculations of the environmental performance of operational energy use B6 require the Environmental Product Declarations for each energy carrier. These Environmental Product Declarations contain the environmental profile of the energy carrier for conversion and transmission, and declared benefits for the substitution of capital goods through recycling. The energy carriers must be included in calculation tools in module B6. External supply is part of the energy carriers' Environmental Product Declarations for supplied electricity. External supply does therefore not need to be added separately.

*20 'Category 3' environmental profiles of energy carriers fall under category 3a, non-proprietary, non-assessed, data owned and managed by Stichting NMD based on generic data, without a 30% surcharge factor.*

*21 The Environmental Product Declarations for electricity are based on low-voltage supply to consumers. Non-converted electricity from the grid applied at high voltage results in less conversion loss. Compared to low-voltage electricity from the grid, medium voltage saves 1.4% in losses and high voltage saves 1.8%. The Environmental Product Declarations included also apply to medium and high voltage applications.*

The Environmental Product Declaration 'Electricity, Dutch mix (73% grey, 27% renewable), at consumer, per kWh' must be used for calculations of the environmental performance of operational energy use B6 with respect to the used electricity. The user of the construction work can choose their own energy supplier, as a result of which no specific electricity sources can be selected when calculating the environmental performance of operational energy use B6. Long-term energy supply contracts are already available in the construction phase for civil engineering structures. Within Civil Engineering, the applicable energy carrier can be selected for supplied energy in B6.

**Energy from on-site generation**
The materialisation of energy generation resources within the system boundaries must be included in the production phase of the construction work (A1-A3). The external supply for on-site generated electricity must be included in module B6, including the Environmental Product Declaration 'Materialisation of electricity grid, external supply, per kWh'. For off-grid construction works, or construction works with sufficient energy storage capacity, no record of the materialisation of external supply from the electricity grid is required.

## 4.4 Energy demand of the construction work

The energy demand of a construction work can be derived from the results of the BENG study. The data required for the operational energy use B6 and their use are indicated in table 13.

*Table 13: Data required for the environmental performance of operational energy use B6 and applicable Environmental Product Declarations.*

| Data required for the environmental performance of operational energy use B6 (available from data output for BENG) | Unit | Application for the environmental performance of operational energy use B6 |
|---|---|---|
| Total non-primary energy demand for natural gas | $nm^3$/year | **Natural gas**<br>Used for the product card natural gas: 'Natural gas, combusted, at consumer' |
| Total non-primary heat supply, high temperature | MJ / year | **Heat supply, delivery, high temperature**<br>Specified value – 'Heat supply, non-primary, high temperature, from building-related renewable energy generation' = delivered high-temperature heat supply.<br><br>To this end, use product card:<br>- 'Heat supply via heat network, high temperature, grey, at consumer, per MJ', or<br>- 'Heat supply via heat network, high temperature, renewable, at consumer, per MJ'<br>The product card to be used depends on the situation |
| Heat supply, non-primary, high temperature, from building-integrated renewable energy generation | MJ / year | **Heat supply from building-related energy generation, high temperature**<br>The installations used are included in module A1-A3 and the environmental performance of operational energy use B6. |

| | | |
|---|---|---|
| Total non-primary heat supply, low temperature | MJ / year | **Heat supply, delivery, low temperature**<br>Specified value – 'Heat supply, non-primary, low temperature, from building-related renewable energy generation' = delivered low-temperature heat supply.<br><br>To this end, use product card:<br>- 'Heat supply via heat network, low temperature, grey, at consumer, per MJ'<br>- 'Heat supply via heat network, low temperature, renewable, at consumer, per MJ' |
| Heat supply, non-primary, low temperature, from building-related renewable energy generation | MJ / year | **Heat supply from building-related energy generation, low temperature**<br>The installations used are included in the EPB and the environmental performance of the operational energy use B6. |
| Total electricity consumption from delivery, non-primary energy use.<br>(Final energy use) | kWh/ year | **Final delivered electricity consumption**<br>To this end, use:<br>Electricity, Dutch mix, at consumer, per kWh<br>(73% grey, 27% renewable)<br>Within Civil Engineering, other electricity mixes can also be used. |
| Electricity from building-related renewable, non-primary energy generation | kWh/ year | **Electricity from building-related energy generation**<br>The installations used must be included in EPB / the environmental performance of the operational energy use B6.<br>External supply must be added based on:<br>'Materialisation of electricity grid, external supply, per kWh'<br><br>External supply for building-related energy generation does not need to be declared if the construction work is off-grid or has sufficient energy storage capacity. |
| Total non-primary energy use of the construction work, building-related energy use. | kWh/ year | **Exported electricity**<br>Used for calculating the energy balance.<br>Exported electricity = 'Electricity from building-related renewable, non-primary energy generation' - 'Total non-primary energy use of the construction work, building-related energy use'.<br>If the calculated value is greater than 0, electricity is exported. This is declared in module D2 with substitution benefits equal to the exported energy equivalent. The following product cards with a negative value can be used for the substitution:<br>- Electricity, grey, at consumer, per kWh<br>- Electricity, renewable mix, at consumer, per kWh<br>- Electricity, renewable, from biomass, at consumer, per kWh<br>- Electricity, renewable, from offshore wind turbines, at consumer, per kWh<br>- Electricity, renewable, from onshore wind turbines, at consumer, per kWh<br>- Electricity, renewable, from PV, at consumer, per kWh |

## 4.5 Energy balance

The energy balance shows the incoming and outgoing energy flows per energy carrier. The energy balance is calculated by subtracting the building-related renewable energy generated from the total final energy demand per energy carrier.

When more electricity is generated than used within the annual interval, we refer to this as net feed-in to the electricity grid. The exported energy benefits are declared in module D2.

## 4.6 Energy storage

The following procedure should be used to position energy storage systems within the environmental/energy performance:

The materialisation of energy storage systems is part of the construction work and must be included in module A1-A3.
If energy storage systems are used, no external supply (materialisation of the electricity grid) needs to be included in module B6 for electricity generated on site. It must be demonstrated that the energy storage systems prevent feed-in for an average day. There are no standards for the required storage capacity. The required capacity depends on the installed capacity and the energy use scenario. If no specific data are available, the following rule of thumb can be used to calculate the required storage capacity: 1 to 1.5 kWh of storage capacity per kWp of installed capacity. For environmental/energy performance, it must be demonstrated that the energy storage system can buffer its own production. This is plausible with an installed storage capacity of 1.5 kWh per kWp of installed capacity.

## 4.7 Exported energy, D2

For exported energy, substitution benefits equal to the exported energy equivalent apply in module D2.
In other words, when energy from PV is exported, it substitutes energy from PV in module D2. The technically most equivalent Environmental Product Declaration for energy carriers must be used for this substitution[22].
This is in line with the calculation in module D for materials within the NMD Assessment Method. It is possible that not all exported energy can be used by the energy supplier, in which case the energy will be ‘lost’.
For the time being, the environmental/energy performance will not be adjusted accordingly.

[22] *Example: A construction work generates 1000 kWh of electricity via PV panels on the roof. The consumption of the construction work is 800 kWh, the other 200 kWh is fed back into the grid.*

## 4.8 Declared unit of use function, m2 GFA & m2 UA

EN 15978 does not provide guidelines for the reference unit to be used for the assessment of the environmental performance of buildings. The EPB system is based on the reference unit GFA (Gross Floor Area). BENG and Level(s) are based on the reference unit UA (Usable Area), as referred to in NEN 2580.

The usable area is calculated by subtracting the following areas from the total floor area (GFA) within the walls of the home:

Floor area of load-bearing walls.

Area of voids and stairwells, if larger than 4 $m^2$.

Area of rooms with a clear height lower than 1.5 metres.

Floor area of individual structures larger than 0.5 $m^2$.

Floor area of pipe shafts, if larger than 0.5 $m^2$.

The reference units for B6 for the environmental performance of operational energy use and the EPB must be the same in order to be assessed in conjunction. This is based on a service life of 75 years and the GFA.

To ensure uniformity with BENG and Level(s), the reference unit per $m^2$ UA must also be used for the environmental performance of operational energy use. When comparing the environmental performance of operational energy use B6 with Level(s), the difference in building service life must be taken into account. The EPB and the environmental performance of operational energy use B6 are based on 75 years for homes, while Level(s) is based on 50 years as standard.

*Table 14: Overview of Environmental Product Declarations of energy carriers and applicability*

| Name of Environmental Product Declaration | Applicability Environmental/ energy performance | Applicability within EPB |
|---|---|---|
| Natural gas, combusted, at consumer, per $m^3$ | B6 | - |
| Electricity, grey, at consumer, per kWh | B6 for Civil Engineering and D2 (substitution feed-in) | - |
| Electricity, renewable, at consumer, per kWh | B6 for Civil Engineering and D2 (substitution feed-in) | - |
| Heat supply via heat network, high temperature, grey, at consumer, per MJ | B6 | - |
| Heat supply via heat network, high temperature, renewable, at consumer, per MJ | B6 | - |
| Heat supply via heat network, low temperature, grey, at consumer, per MJ | B6 | - |
| Heat supply via heat network, low temperature, renewable, at consumer, per MJ | B6 | - |
| Natural gas, combusted, at consumer, materialisation of external supply, per m3 | - | A1-A3 |
| Electricity, at consumer, materialisation of external supply, average grid mix grey and renewable, per kWh | - | A1-A3 |
| Heat supply via heat network, high temperature, grey, at consumer, materialisation of external supply, per MJ | - | A1-A3 |
| Heat supply via heat network, high temperature, renewable, at consumer, materialisation of external supply, per MJ | - | A1-A3 |
| Heat supply via heat network, low temperature, grey, at consumer, materialisation of external supply, per MJ | - | A1-A3 |
| Heat supply via heat network, low temperature, renewable, at consumer, materialisation of external supply, per MJ | - | A1-A3 |
| Electricity, Dutch mix, at consumer, per kWh (73% grey, 27% renewable) | B6, all supplied electricity | - |
| Electricity, renewable, from biomass, at consumer, per kWh | D2 (substitution feed-in) | - |
| Materialisation of electricity grid without energy generators, external supply, at consumer, per kWh | B6, for electricity from on-site generation (excluding off-grid construction works and where sufficient energy storage is available) | - |
| Electricity, renewable, from offshore wind turbines, at consumer, per kWh | B6 for Civil Engineering and D2 (substitution feed-in) | - |
| Electricity, renewable, from onshore wind turbines, at consumer, per kWh | B6 for Civil Engineering and D2 (substitution feed-in) | - |
| Electricity, renewable, from PV, at consumer, per kWh | B6 for Civil Engineering and D2 (substitution feed-in) | - |

# 5. Literature


| | |
|---|---|
| **CMLIA** | LCA methodology developed by the Center of Environmental Science (CML) of Leiden University in The Netherlands, version August 2016 |
| **CML-NMD** | Characterisation factors according to the NMD Assessment Method, available via www.milieudatabase.nl |
| **Specification DuboCalc** | Functional specification DuboCalc, NWP0800100-FS, Rijkswaterstaat, March 2010 |
| **MRPI Verification checklist** | MRPI®-EPD VERIFICATION PROTOCOL, Stichting MRPI, May 2011 |
| **NEN-EN 15804:2012+A2** | Sustainability of construction works – Environmental Product Declarations – Basic rules for the product group construction products |
| **NEN-EN 15978** | Sustainability of structures – Assessment of the environmental performance of buildings – Calculation method |
| **Oers et al. (2001)** | LCA normalisation factors for the Netherlands, Europe and the world. RIZA working document 2000.059x, RIZA/CML, Lelystad/Leiden. |
| **NMD Verification Protocol** | NMD Verification Protocol for inclusion of data in the National Environmental Database. Available via www.milieudatabase.nl |
| **SBR Service life** | Service life of construction products, methods for reference values, SBR, dated December 2011 |
| **TNO shadow pricing** | Toxicity has its price: shadow pricing for (eco-)toxicity and other toxicity and depletion of abiotic resources within DuboCalc', Harmelen, drs. A.K. van, et al., TNO-MEP (commissioned by Rijkswaterstaat), Apeldoorn, 2004 |
| **W/E (2020)** | Specific Building Service Life Directive - intended for application with the environmental performance calculation "Specific Building Service Life Guideline" [W/E, 2020] |

# Appendix I. Terms, definitions and abbreviations

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Additional technical information**<br>Information that is part of the EPD by providing a basis for developing scenarios. | EN 15804 (3.1) | Additional technical information |
| **Background process**<br>Process over which the producer or supplier of the product/process being assessed has no direct influence and that takes place elsewhere in the chain (the production of electricity or a raw material, for instance). See also: 'front-end process'. | – | |
| **Waste**<br>Substance or object that the owner discards or intends or is required to discard.<br>NOTE: Adapted from the definition in the European Waste Directive 2008/98/EC. | EN 15804 (3.34) | Waste |
| **Allocation**<br>Allocation of incoming and outgoing process or product system flows if one process generates or processes several materials or products. | EN 14044 (3.17) | |
| **Basic process**<br>Process in the NMD Process Database. There are two types of processes: A description of inputs and outputs of a unit process. And those of just an environmental profile. | | |
| **Basic profile**<br>Environmental profile of a Basic process. The profile is the result of the calculation of a Basic process in LCA software. | – | |
| **Co-product**<br>One of two or more marketable materials, products or fuels from the same unit process that is not the subject of assessment.<br>NOTE: Co-products, by-products and products have the same status and are used to identify a number of main product flows from the same unit process. Waste is the only co-product, by-product and product output that is distinguished as not being a product. | EN 15804 (3.7) | Co-product |
| **Biogenic carbon**<br>Carbon obtained from or captured in biomass. | Derived from ISO/ DIS 14067 | |

| Term (if applicable: translation from EN 15804) and explanation | Source | ‘Terms’ (EN 15804) |
|---|---|---|
| **Biomass**<br>Material of biological origin, excluding material embedded in geological formations and material transformed into fossil material. | ISO/DIS 14067 | |
| **Construction waste**<br>The totality of:<br>• Product loss due to breakage during transport<br>• Product loss due to damage/breakage at the construction site<br>• Sawing waste at the construction site<br>• Additionally ordered material (to ensure a smooth process)<br>Losses due to incidents during the use phase (roof tiles blown off, broken glass) are NOT included. | - | |
| **Construction element**<br>Part of a construction work (building or civil engineering structure) with a certain combination of products.<br>EXAMPLES: foundation, floor, roof, wall, systems. | EN 15804 (3.9) | Construction element |
| **Construction product**<br>Item manufactured or processed for incorporation in construction works<br>NOTE 1: Construction products are items supplied by a single responsible body.<br>NOTE 2: Adapted from the definition in 6707-1:2004 according to the recommendation of ISO/TC 59/AHG Terminology.<br>[prEN 15643-1]<br>NOTE 3: Construction products are made from one or more materials. A distinction is made between generic and specific construction products. | EN 15804 (3.5) | Construction product |
| **Construction works**<br>All construction works or structures that are constructed or result from construction activities.<br>NOTE: This includes buildings and structures in earthworks, roadworks and hydraulic engineering. | [NEN-ISO 6707-1:2004] | |
| **Construction service**<br>Activities that support the construction process or subsequent maintenance. | EN 15804 (3.6) | Construction service |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Bulk material**<br>Material that is delivered to the construction site separately (not formed, unpackaged) and poured or stored in a silo. EXAMPLES: sand, gravel, soil, concrete mortar, etc. | - | |
| **GFA**<br>Gross Floor Area | [NEN 2580] | |
| **Product information categories**<br>Category 1: proprietary data, verified<br>Category 2: non-proprietary data, verified<br>Category 3: non-proprietary data, not verified<br>30% surcharge factor applies<br>Category 3a: non-proprietary data, not verified, surcharge factor does not apply<br>See also: 'generic product' and 'specific product' | - | |
| **Third party**<br>Person or body recognised as independent from the parties involved, with respect to the topic in question.<br>NOTE: 'Involved parties' are usually the supplier ('first party') and buyer ('second party') and therefore have an interest.<br>[EN ISO 14024:1999] | EN 15804 (3.31) | Third party |
| **Ecoinvent**<br>Extensive database at intervention level, with a huge amount of data on production processes, energy generation and transport in Europe.<br>NOTE: Developed and maintained by the Ecoinvent Center in Switzerland. Version 3.6 was published in September 2019. | - | |
| **Unit process**<br>The smallest element considered in the LCIA (Life Cycle Inventory Analysis) in which the incoming and outgoing flows are quantified [EN ISO 14040:2006]. | EN 15804 (3.35) | Unit process |
| **Element group code (NL-SfB), element code and product code**<br>The first two digits of the elements in construction works are coded according to NL-SfB (e.g. element group code 31: exterior wall openings).<br>The NL-SfB code has been supplemented with its own coding (31.XX.YYY) for further subdivision into elements and products. | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Functional equivalent**<br>Quantified functional requirements and/or technical requirements for a building or an assembled system (parts of structures) for use as a basis for comparison.<br>NOTE: Adapted from the definition in ISO 21931-1:2010. | EN 15804 (3.11) | Functional equivalent |
| **Functional unit**<br>Quantified performance of a product for use as a reference unit [ISO 14040:2006].<br>NOTE: See also declared unit. | EN 15804 (3.12) | Functional unit: |
| **Aggregated process**<br>A process that describes various unit processes. | - | |
| **Average data**<br>Data representative of a product, product group or construction service, provided by more than one supplier.<br>NOTE The product group or the construction process may contain similar products or construction processes. | EN 15804 (3.3) | Average data |
| **Generic data**<br>Data considered representative for the relevant product (group) and established by the administrating organisation. These data are based on public data sources, but can also be based on verified data from producers or sectors, as long as they have given consent for the use of these data.<br>See also 'specific data' and 'product information categories'. | - | |
| **Raw material equivalent**<br>The raw material equivalent indicates how much and which primary production process (input module A, which can also contain secondary raw materials) can replace the relevant *secondary raw material* as they are technically equivalent. | - | |
| **Reuse**<br>Reusing construction products or construction components/ elements in the same function, whether or not after processing. Examples are the reuse of insulation material as insulation material, a door as a door, a roof as a roof. | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | ‘Terms’ (EN 15804) |
| --- | --- | --- |
| **Renewable energy**<br>Energy from renewable, non-fossil sources<br>EXAMPLES Wind, sun, aerothermal, geothermal, hydrothermal and tidal energy, hydropower, biomass, landfill gas, gas from wastewater treatment plants and biogas.<br>NOTE: Adapted from the definition in Directive 2009/28/EC. | EN 15804 (3.23) | Renewable energy |
| **Renewable resource**<br>Raw material from a source that is grown, naturally replenished or naturally cleaned on a human time scale.<br>NOTE: A renewable resource can be depleted, yet continue to exist indefinitely with good stewardship. Examples include: trees in forests, grasses in pastures, fertile soil. [ISO 21930:2007]<br>A renewable resource can be of either abiotic or biotic origin. | EN 15804 (3.24) | Renewable resource |
| **Horizontal aggregated process**<br>Averages of processes with the same function. | [Verification protocol] | |
| **Ancillary material**<br>Material or product used by the unit process when producing the product, but which is not part of the product. [ISO 14040]. | EN 15804 (3.2) | Ancillary material |
| **Information module**<br>Collection of data to be used as the 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. [ISO 14025].<br>NOTE: In EN 15804, an information module is part of Figure 2, a part of a life cycle phase. For example: ‘A1 Raw material supply’ | EN 15804 (3.13) | Information module |
| **Capital goods**<br>Resources, such as relief supplies, equipment and buildings required to carry out an activity and which are used repeatedly and the depreciation of which takes place over several products.<br>EXPLANATION: factories and machinery are examples of capital goods. | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Quality factor K product reuse**<br>A measure of a product's remaining quality (not material flows) compared to the initial product. The K factor is expressed in a % between 1 and 100. | - | |
| **Reuse factor H**<br>Generic factor set in the Assessment Method for calculating the ECI of a product during unforeseen reuse. | - | |
| **Life Cycle Assessment (LCA)**<br>The identification and evaluation of incoming and outgoing flows, and potential environmental impacts of a product system during its life cycle [EN ISO 14044:2006]. | EN 15804 (3.14) | Life cycle assessment |
| **Life Cycle Inventory Analysis (LCIA)**<br>Phase in life cycle analysis where an inventory is made of the nature and quantity of all incoming and outgoing flows for a product throughout its life cycle [ISO 14040].<br>NOTE: In addition to economic flows (purchase of raw materials, energy and waste processing and sale of products), this also includes environmental interventions (extractions from the environment and emissions to the environment). | EN 15804 (3.15) | Life cycle inventory analysis |
| **Materials for recycling**<br>EN 15804 does not provide a specific definition for ***materials for recycling***. However, a definition is given by the fact that *materials for recycling* must be declared as output flow (from the system) and that the system boundary for waste processing is at the end-of-waste phase.<br><br>Based on this, the following specific definition can be given:<br>- *Materials for recycling* are materials that result from a waste or other treatment process and have reached the end-of-waste phase. *Materials for recycling* can be used in another product system as *Secondary material.*<br><br>The modular approach of EN 15804 states that all impacts resulting from processing waste until the end-of-waste phase must be declared in module C3. This is the specific module of the waste phase (module C) in which the *materials for recycling* leave the system as output flow. | - | |
| The efficiency of a treatment process means that not all materials are actually released as materials for recycling. The non-usable waste and other flows from the treatment process should also be declared in module C3. | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Environmental impact category**<br>Category representing an environmental aspect, to which results from an LCI can be assigned.<br>EXAMPLES: depletion of raw materials, increased greenhouse effect, human toxicity. | ISO 14044 (3.39) | |
| **Environmental intervention**<br>A flow that has been extracted from the environmental system and enters an economic system unprocessed, or a flow that leaves an economic system and enters the environmental system unprocessed.<br>EXAMPLE: Examples include: extraction of raw materials, extraction of land, emissions, noise emissions. | NEN 8006 | |
| **Environmental performance**<br>Performance with respect to environmental impact and environmental aspects [ISO 15392:2008]; [ISO 21931-1:2010]. | EN 15804 (3.10) | Environmental performance |
| **Environmental profile**<br>The outcome of an LCA is an environmental profile: a kind of score list of environmental impact. The environmental profile shows which environmental impacts play the most important role in the life cycle. The environmental profile comprises the environmental impact categories that are mentioned in Assessment Method section 2.6.5. | - | |
| **Environmental Product Declaration**<br>Information about a product or process (materials, quantities per FU, service life (cycles), emissions during use phase, construction waste and end-of-life processing scenario). | - | |
| **National Environmental Database (NMD)**<br>Database with Environmental Product Declarations and the associated environmental profiles that are used to determine the environmental performance of construction works (buildings and structures). | - | |
| **Non-renewable energy**<br>Energy from sources that are not defined as renewable energy sources. | EN 15804 (3.16) | Non-renewable energy |
| **Non-renewable resource**<br>Raw materials that exist in finite amounts that cannot be replenished in a human timescale [21930:2007]. | EN 15804 (3.17) | Non-renewable resource |
| **Surcharge factor**<br>Factor by which environmental data (results) not verified according to the Verification Protocol are given a surcharge. See § 2.10 | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Unforeseen reuse**<br>Reuse of products for which reuse was not initially considered in the environmental performance, of which the remaining service life is unknown or for which anticipated reuse has already been fully allocated to the previous product system (environmental benefits in module D, according to EN 15804 environmental benefits are allocated to the system that produces them). | - | |
| **Performance**<br>Indication of the size of a particular aspect of the considered product, related to certain requirements or goals.<br>NOTE: Adapted from the definition in ISO 6707-1:2004 according to the draft recommendation of ISO/TC 59 Terminology. | EN 15804 (3.18) | Performance |
| **Primary raw material**<br>Raw material that is produced by the earth and is used by people for the production of materials and products. | - | |
| **Primary material**<br>Construction material that is produced from primary raw materials. | - | |
| **Primary production**<br>A production process based on primary raw materials. | - | |
| **Process database**<br>A database with a collection of basic processes managed by Stichting NMD. The category 3 basic processes are generated via the process database. | - | |
| **Product**<br>That which is marketed by the supplier and purchased by the buyer for use during a construction work's life cycle. A product can be a physical product (e.g. 1 $m^2$ of window frame), but also an activity (e.g. 1 tkm of rail transport). | - | |
| **Producer**<br>The producer, or its representative, or the importer of a product for the Dutch market. | - | |
| **Product category**<br>Group of construction products that can fulfil equivalent functions.<br>NOTE: Adapted from ISO 14025:2006 | EN 15804 (3.19) | Product category |
| **Product system**<br>Collection of unit processes with interventions (emissions and extractions) and product flows, which fulfils one or more defined functions, and describes the life cycle of a product [ISO 14040]. | EN 15804 (3.21) | Product system |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Product category rules (PCR)**<br>Set of specific regulations, requirements and guidelines for the development of type III environmental declarations for one or more product categories [ISO 14025]. | EN 15804 (3.20) | Product category rules |
| **Declared unit**<br>Amount of a construction product for use as reference unit in an EPD for an environmental declaration based on one or more information modules.<br>EXAMPLE Mass (kg), volume ($m^3$) [Taken from ISO 21930]<br>See also: functional unit. | EN 15804 (3.8) | Declared unit |
| **Programme operator**<br>Body or bodies that run a Type III environmental declaration programme.<br>NOTE: A programme operator can be a company or a group of companies, industrial sector or industry organisation, governments or governmental agencies, or an independent scientific institute or other organisation. Stichting MRPI and Stichting NMD run a Type III environmental declaration programme in the Netherlands. | EN 15804 (3.22) | Programme operator |
| **Recycling**<br>Recovering materials and raw materials from discarded products and reusing them to make products. | - | |
| **Reference service life of a construction product or building system**<br>A construction product's or building system's service life that is known under certain conditions, meaning a reference of conditions for use that can serve as a basis for estimating the service life under other use conditions<br>[ISO 21930:2007]. | EN 15804 (3.25) | Reference service life (RSL) |
| **Reference service life of a construction work**<br>A standard [default] for a building service life generally associated with the function | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Reference service life of data**<br>Information containing the reference service life and any qualitative and quantitative data for which this service life is valid.<br>EXAMPLE Characteristic data describing the validity of the RSL include the description of the component (3.10) to which it applies, the reference conditions of use under which it applies, and its quality. [ISO 15686-8] | EN 15804 (3.26) | Reference service life data (RSL data) |
| **Scenario**<br>Collection of assumptions and information about an expected range of possible future events. | EN 15804 (3.27) | Scenario |
| **Scaling**<br>When scaling products, dimensions (measurements) other than the standard (default) dimensions specified in the product card are given when assessing construction works.<br>NOTE: The type of scaling is indicated for each Environmental Product Declaration.<br>The following options are possible:<br>• None<br>• Linear<br>• Exponential<br>• Logarithmic | - | |
| **Secondary material**<br>All material that replaces primary materials and originates from previous use or from waste.<br>NOTE 1: Secondary material is measured at the point at which the secondary material enters the system from another system.<br>NOTE 2: Materials originating from previous use or from waste from one product system and used as input in another product system are secondary materials.<br>NOTE 3: Examples of secondary materials (to be measured at the system boundary) include recycled scrap metal, crushed concrete, broken glass, recycled wood chips and recycled plastic.<br>As the system boundary of waste streams is at the point that 'end-of-waste' is achieved, a *secondary material* enters a product system as an input without environmental impact. | EN 15804 (3.29) | Secondary material |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **Secondary fuel**<br>Any fuel recovered from previous use or from waste that replaces primary fuels.<br>NOTE 1: Processes from which a secondary fuel is produced are considered from the point at which the secondary fuel enters the system from the previous system.<br>NOTE 2: Every combustible material originating from previous use or from waste from the previous product system and used as fuel in a subsequent product system is a secondary fuel.<br>NOTE 3: Examples of primary fuels are:<br>coal, natural gas, biomass, etc.<br>NOTE 4: Examples of secondary fuels originating from previous use or waste include solvents, used wood, used tyres, used oil and animal fats. | EN 15804 (3.28) | Secondary fuel |
| **Secondary production**<br>A production process based on secondary material. | - | |
| **Specific data**<br>Data about one specific producer.<br>NOTE: These data are verified in accordance with the Verification protocol and are submitted to the management organisation.<br>See also 'generic data' and 'product information categories'. | - | |
| **Specific data**<br>Data that are representative for a product, product group or construction process, delivered by one supplier. | EN 15804 (3.30) | Specific data |
| **Substance group**<br>Group of substances, such as nitrogen oxides (NOx). This is in contrast to nitrogen dioxide (NO2).<br>NOTE: Some measurement methods present a quantity of a certain substance group. Substance groups cannot always be characterised properly. | - | |
| **System process**<br>Process card within Ecoinvent that describes the environmental interventions of all process steps up to the current 'aggregated' step (= vertical aggregation).<br>NOTE: Compare unit process. | - | |

| Term (if applicable: translation from EN 15804) and explanation | Source | 'Terms' (EN 15804) |
|---|---|---|
| **TYPE III environmental declaration (synonymous with: EPD)**<br>Environmental declaration that provides quantified environmental data based on parameters determined in advance and, if applicable, additional environmental information.<br>NOTE: The calculation of predetermined parameters is based on the ISO 14040 series of standards, which consists of ISO 14040 and ISO 14044. The selection of the predefined parameters is based on ISO 21930 (adapted from ISO 14025). | EN 15804 (3.32) | Type III environmental declaration |
| **Unit process**<br>Process card within Ecoinvent that describes the environmental interventions of a single process step.<br>NOTE: Compare system process. | - | |
| **Comparative assertion**<br>Environmental claim related to the superiority or equivalence of a product compared to a competitive product that performs the same function.<br>[ISO 14044] | EN 15804 (3.4) | Comparative assertion |
| **Vertical aggregated process**<br>Sum of the various related processes (vertically in the chain). | - | |
| **End-of-Life processing scenario**<br>Division according to waste processing/destination of a material/ application combination.<br>COMMENT: Processing options include landfill, incineration and recycling (with or without reprocessing). | - | |
| **Volume transport factor**<br>Most transport models assume mass transport (mass x distance; tonne x km). Products with a low density should be corrected for this.<br>NOTE: In the case of mass transport the volume transport factor is 1. | - | |
| **Upstream, downstream process**<br>Process that either precedes (upstream) or follows (downstream) a certain life cycle phase. | EN 15804 (3.33) | Upstream, downstream process |
| **Front-end process**<br>Process over which the producer or supplier of the product/process being assessed has direct influence (at least its own production). See also 'background process'. | - | |

## Abbreviations

| Abbreviations | |
|---|---|
| AVI | Waste incineration plant (WIP=AVI) |
| C&U | Civil and Utility construction |
| c-PCR | Complementary Product Category Rules |
| EPD | A product's Environmental Product Declaration |
| ESL | Estimated service life |
| Civil Engineering | Civil engineering structures |
| LCA | Life Cycle Assessment |
| LCI | Life Cycle Inventory Analysis |
| LCIA | Life Cycle Impact Assessment |
| LHV | Lower Heating Values |
| ECI | Environmental Cost Indicator |
| EPB | Environmental Performance of Buildings (EPB=MPG) |
| MRPI® | Environmentally Relevant Product Information |
| NMD | National Environmental Database |
| PCR | Product Category Rules |
| RSL | Reference service life |
| Stichting NMD | Stichting National Environmental Database |
| TIC | Technical Committee (advisory body for Stichting NMD) |

| Environmental impact abbreviations | |
|---|---|
| ADP | Abiotic Depletion Potential<br>*Depletion of abiotic resources. Measure of scarcity of raw material with respect to reference resource antimony (Sb)* |
| AP | Acidification Potential<br>*Acidification in $SO_2$ equivalents* |
| CTU | Comparative Toxic Units<br>*Used to quantify the interactions of toxicants in binary mixtures of chemicals* |
| EP | Eutrophication Potential<br>*Eutrophication in $PO_4$ equivalents* |
| FAETP | Freshwater Aquatic Ecotoxicity potential<br>*Freshwater aquatic ecotoxicity relative to 1.4-Dichlorobenzene* |
| GWP 100 years | Global Warming Potential<br>*Global warming potential expressed in $CO_2$ equivalents The addition of 100 years relates to the timescale* |
| GWP - luluc | Global Warming Potential – land use and land use change<br>*Global warming due to land use and changes in land use, expressed in $CO_2$ equivalent* |
| HTP | Human Toxicity Potential<br>*Human toxicity relative to 1.4-Dichlorobenzene* |
| MAETP | Marine Aquatic Ecotoxicity Potential<br>*Marine aquatic ecotoxicity relative to 1.4-Dichlorobenzene* |
| ODP | Ozone Depletion Potential<br>*Measure of ozone layer depletion, in CFC-11 equivalents* |
| PM | Particulate Matter<br>*Particulates* |
| POCP | Photo-Oxidant Creation Potential<br>*Photochemical Ozone Creation Potential (smog formation), in ethylene (C2H4) equivalents* |
| TETP | Terrestrial Ecotoxicity Potential<br>*Terrestrial ecotoxicity relative to 1.4-Dichlorobenzene* |
| WDP | Water Deprivation Potential<br>*Potential water shortage* |

# Appendix II. System boundary information

**This appendix contains an overview of the processes that fall within the system boundaries.**
**The following checklist does not claim to be complete. System boundaries are determined in accordance with NEN-EN 15804+A2 and the Assessment Method.**

## Production phase (A1-A3)

**Processes at the companies of the involved producer(s)**

- all processes at the companies that are needed for production[23];
- ancillary materials, maintenance materials, additives and similar;
- production losses; gross process data are used;
- internal transport;
- internal storage and breakdown;
- water and air cleaning processes (also when these take place externally);
- recycling/processing of production waste;
- the 'packaging' process with the packaging material as raw material;
- production, maintenance and end-of-life of capital goods (equipment).
  If the contribution of capital goods to each individual environmental impact category of the production phase module (A1-A3) is less than 5%, based on substantiation, this may be disregarded.
- overhead processes (offices and similar) can generally be omitted.

**Processes of direct suppliers**

- all processes at the direct suppliers[24];
- transport from the supplier to the producer;
- return transport (empty) for trucks and vessels, not for rail transport. Return transport may only be omitted if it can be demonstrated that a truck or vessel will return loaded;
- the production, use and end-of-life processing of packaging materials of resources required for production;
- ancillary materials, maintenance materials, additives and similar;
- packaging materials at the direct suppliers;
- external cleaning and treatment processes.

**Processes of the 'suppliers of the suppliers'**

- transport of the most important substances and materials between all locations;
- return transport (empty) for trucks and vessels, not for rail transport. Return transport may only be omitted if it can be demonstrated that a truck or vessel will return loaded.
- For the rest, the same as direct suppliers as far as possible.

[23] *Materials that make up less than 1% by weight of the average composition of the product covered by the Environmental Product Declaration may be disregarded. An exception to this rule applies when the production of the constituent material that is omitted is expected to contribute more than an estimated 5% to one of the environmental impacts of the product. In that case, the relevant material does need to be included. As an additional requirement, the sum of environmental impact not taken into account in this way may not exceed 5% of the total per environmental impact category.*

[24] *All processes fall within the system boundaries. This means that they will be mentioned. At 'data collection' a description is given of how the data were collected.*

## Transport phase and building/installation/construction (A4- A5)

### Transport to the construction site (A4)

- Transport of all materials, products or elements to the construction site. Return transport is considered as empty unless demonstrated otherwise.[25]
- If products are transferred, this should be included within module A4.

### Building/installation/construction (A5)

- The processes to apply the materials/products/elements to the work.
- The disposal with return transport and processing of residual material, including packaging material, generated during application. As minimum percentage for packaging material the percentage stated in the National Waste Management Plan (LAP3) applies, unless demonstrated otherwise.
- Production, maintenance and end-of-life processing of capital goods (equipment). If it can be demonstrated that the contribution to the functional unit is negligible (<<1% based on well-founded estimate), then production, maintenance and end-of-life processing of capital goods can be omitted.
- The installation phase (A5) contains the loss rate for the delivered product from A1-A3. In addition, processes can be added in module A5 (installation). No materials can be added in A5. All materials in the product, including fasteners, are included in module A1-A3.
- For installation losses, the production phase (modules A1-A3), transport (module A4) and processing phase (modules C2-C4) must be included in module A5. Any module D benefits and costs arising from the waste processing of construction waste or packaging should not be included in module A5, but in module D.
- Installation losses may be subject to different waste processing than the end-of-life processing scenario for the product in C2-C4. Category 1 and 2 Environmental Product Declarations must include the most applicable processing scenario. Category 3 Environmental Product Declarations are based, by default, on the same processing scenario as for the product at the end of its life.

## Use and maintenance phase (B1-B5)

### Use (B1)

- Chemical and physical reactions in which materials change, and mechanical processes (such as erosion or leaching) are included in the use phase if part of a material from the bill of materials dissipates into the environment and if this can be measured and thus verified;
- Intake of substances from and release of substances to the environment are included if this intake can be measured and/or this release can be demonstrably measured and thus verified.[26]

[25] *Delivery and removal of staff may be omitted.*

[26] *Demonstrable means that an Assessment Method in accordance with a NEN standard must be available, which can be used to determine the intake or release.*

**Maintenance and replacements (B2-B4)**

- Maintenance processes needed to retain the functional performance requirements from the functional unit for the duration of the function[27];
- The production of maintenance materials;
- Delivery and removal, including return transport, of maintenance material (such as products to the construction site) and waste (such as construction waste);
- The maintenance waste processing processes;
- Cleaning maintenance if this is functionally important;
- The production of replacement products;
- Delivery and removal of replacement products (such as products to the construction site) and waste (such as construction waste);
- Installation of replacement products in the work and demolition of parts to be replaced;
- Waste processing processes;
- Module D benefits and costs for maintenance and replacements are not included in module B, but in module D;
- Modules B5, B6 and B7 must be declared with '0' values in a product's Environmental Product Declaration.

## Demolition and processing phase (C1-C4)

**Demolition phase (C1)**

- Demolition processes and dismantling[28].
- No materials are added in the demolition phase. However, equipment and processes are used during demolition. In some cases, emissions may be released, such as particulate matter and metal emissions.

**Transport from the construction site to the processing site (C2)**

- Transport from the construction site to the waste processing site of all materials / products / elements, including return transport

**Processing phase (C3-C4)**

- If applicable: product reuse;
- The disposal process if a material is disposed of in a landfill;
- If applicable: recycling processes, up to end-of-waste;
- In this phase, modelling continues until the end-of-waste status is reached. AVI is included in C3 when energy recovery takes place and its efficiency exceeds 60%. In the Netherlands, all AVIs have an efficiency exceeding 60%.

**Environmental costs and benefits of recycling and product reuse (D)**

- If applicable: energy recovery. This is considered as closed-loop recycling, in which all related environmental interventions are included (see Assessment Method under 1.3.2);
- If applicable: construction elements and installations that can be reused in their entirety. In principle, the regulations described in chapter 2 apply to this.

*27 Unforeseen repairs due to incidents and emergencies fall outside the system boundary.*

*28 Manual processes can be omitted.*

# Appendix III. Step-by-step plan to determine end-of-waste

## Step-by-step plan to determine end-of-waste

1. Use the general criteria as also stated under NEN-EN 15804+A2 6.3.5.5 end-of-waste status to determine whether there is no (more) waste[29]. All four points must be met:
- The material[30] is commonly used for specific objectives.
- There is a market for or there is demand for the substance or material.
- The substance or the material meets the technical requirements for the specific objectives and complies with the legislation and standards that apply to products.
- Using the substance or material will generally not have any negative effects on the environment or human health.

If there is clearly no (more) waste, it stops here. Otherwise:

2. Determine whether end-of-waste criteria have already been determined for the relevant flow (in so-called Technical proposals) by JRC via https://publications.jrc.ec.europa.eu/repository/handle/JRC532381[31]. If this is not the case:
3. Determine whether criteria have been developed at national level. In the Netherlands this is currently the case only for 'Recycling granulates from brick-like waste substances: Regulation No. IENM/BSK-2015/18222 dated 5 February 2015.'
4. Check whether product category rules (c-PCRs) exist for the product.

If so, determine whether the relevant (waste) flow is mentioned and whether there is an indication of how to handle this. If this is not the case:

5. Use the four main criteria (see under 1) to determine as precisely as possible if there is waste. If it is not practically possible to determine this using these four criteria, the principle of economic allocation can be used. The system boundary is determined by the economic tipping point. If the economic tipping point is reached in a processing process, this process will still have to be attributed entirely to the product system in which the waste is generated. The obtained secondary raw material can therefore be used in the production phase of a new product system, free from any environmental costs.

*29 Dutch source text: https://www.afvalcirculair.nl/afval/kaderrichtlijn/*

*30 'Material' appears to be a better term in this connection than 'object'.*

*31 https://www.afvalcirculair.nl/onderwerpen/afval/ provides:*
*- Iron, steel and aluminium scrap: Regulation (EU) No. 333/2011 of 31 March 2011*
*- Recycled glass: Regulation (EU) No. 1179/2012 of 10 December 2012*
*- Copper scrap: Regulation (EU) No. 715/2013 of 25 July 2013, but not waste paper, waste plastic, biodegradable waste*

***NOTE:*** Please note that the term end-of-waste can be misleading. From the flow diagram in Annex B 'Waste', NEN-EN 15804+A2 shows that in any event modelling must continue until the waste is removed (in the form of incineration or landfill) or is used in another product system. An example of this is IBC construction materials, which are formally still waste, but which are put to good use. The step-by-step plan can be used to substantiate that the IBC construction materials have reached end-of-waste status in the context of the LCA when they are collected at an earth bank. In this way the construction material:

1) is commonly used for a specific purpose (IBC application),
2) is offered on the market that exists for this (it has a positive market value),
3) meets the technical and statutory requirements (from the Soil Quality Decree), and
4) under the condition of the Soil Quality Decree, has generally no adverse effects on the environment or human health during use (primary raw materials are even saved).

# Appendix IV.

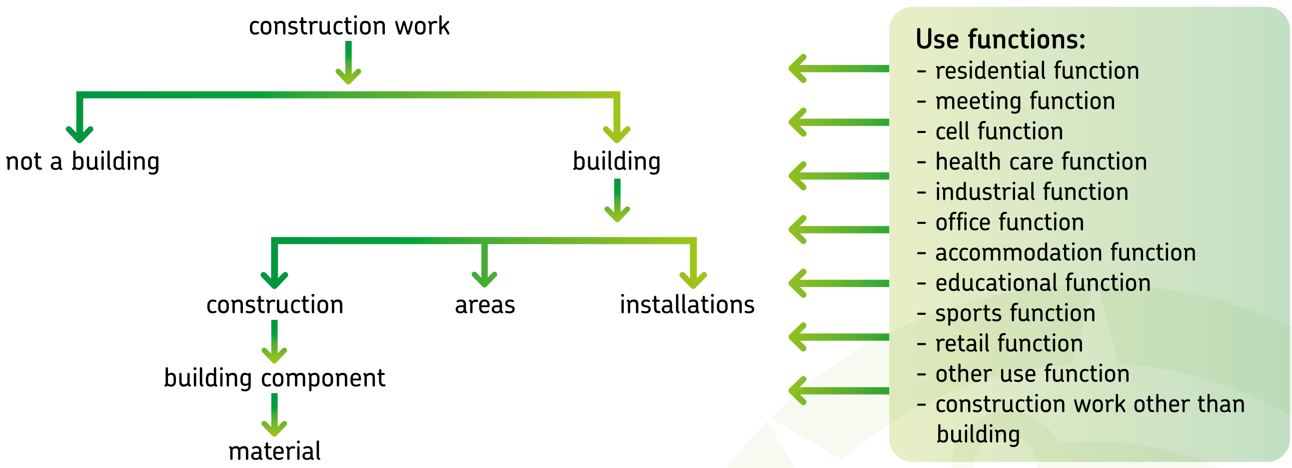
## Information indicating which structures and installations must be taken into account in assessing the environmental performance of a use function or building and an overview of the scope of a construction calculation

### Introduction on indication

The Assessment Method only indicates how the environmental performance of a building or structure should be determined. In itself, the method does not determine which collections of materials must be considered. This takes place in the regulations that set quality requirements for construction works with reference to the Assessment Method.

The Assessment Method is suitable for calculating the environmental performance of construction works. And therefore also of a use function.

Construction works can be divided into buildings and other construction works (other than buildings). The diagram below indicates how the Buildings Decree uses the use functions to set requirements on construction works and components of these. The division of construction works into use functions determines the requirements that apply under the Buildings Decree for the relevant parts of the construction works.




For example, the Building Decree sets requirements for the environmental performance of the residential function and the (office) building. It also indicates that calculations for the environmental regulation in the Buildings Decree only need to take into account of the environmental impact of the complete constructions and installations to which other technical regulations of the Buildings Decree are associated; for example, regulations relating to construction and fire safety, health, energy performance, installations, etc. Use and presence regulations are not included.

The Buildings Decree sets requirements on both a use function and on a building. An essential difference in the definitions is that, to meet the environmental performance of a residential function, constructions and installations of auxiliary functions are not taken into account, while for a building they are.

The explanation in the Buildings Decree for the regulation on environmental performance states that:

1. The set limit values relate to an environmental performance expressed in a 1-point score as referred to in table 8 (weighting factors) of the Assessment Method;
2. In determining the environmental performance, in this case, only the construction components and installations to which other technical requirements of the Building Decree are associated are included.
3. As stated in the Assessment Method section 3.7, the environmental performance of building functions is converted back to $m^2$ of gross floor area.

This means that the environmental performance of the residential function and (office) building is determined by dividing the environmental impact of the materials allocated to that use function by the gross floor area (GFA in $m^2$) allocated to the residential and office function and expressing this in a 1-point score per $m^2$.

Under the building regulations, all permit-free construction services that are included in the construction of a new building or structure must also comply with the new-build requirements applicable to that building or structure. The end result must meet the new-build requirements on delivery. This means that if, for example, a dormer is placed on a new-build house without a permit, it must be included in the environmental performance calculation.

As a rule, schemes such as Sustainable Purchasing, MIA/VAMIL and certification of sustainable real estate according to BREEAM-NL follow this categorisation. In theory, this categorisation is comprehensive. However, a pragmatic mode of demarcation has developed in daily practice. This informative section of the Appendix provides an overview of the elements that are mainly considered in the environmental performance calculation in practice.

Information for calculating the environmental performance of a residential function and (office) building.
The gross floor area of the building of which the use or auxiliary function is a part is determined in accordance with NEN 2580.

In the case of buildings with several use functions, an environmental performance calculation is made of the entire building, after which the environmental impact or environmental performance is divided proportionally over the percentage gross floor area of a use function and the total of that of the present use and auxiliary functions.

To determine the environmental performance of a use function, the LCA environmental value of construction and other products and installations that are reused in their entirety in new-build construction works can be offset against:

- an Environmental Product Declaration for the reused product or if this is not available;
- the reuse factor (H) included in Assessment Method for unforeseen reuse.

Information on which constructions and installations must generally be considered in the environmental performance of construction works.

The NMD includes an overview of the scope of the construction calculations for the various use functions from the Buildings Decree. All products and process cards managed by Stichting NMD are coded according to the use functions for which the products apply.

The products marked with an 'x' indicate the scope of an Energy Performance of Buildings (EPB) calculation in line with the Buildings Decree. The products marked with an 'O' indicate the scope of an Environmental Cost Indicator (ECI) or EPB calculation in a broader application (above and alongside statutory requirements).

## Construction work – building – example table to illustrate the structure

| | | Use functions | | | | | | | | Type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Office building | | | | | | | | | |
| Code | Functional building elements / Element method 2005 | Residential function | Office function | Meeting function | Industrial function | Educational function | Accommodation function | Health care functionfunctie | Retail function | New construction | Renovation | Temporary construction |
| 1- | FOUNDATIONS | | | | | | | | | | | |
| 11.1 | Soil facilities; soil | | | | | | | | | | | |
| 11.10 | Soil facilities; soil, general (aggregate level) | x | x | x | o | o | o | o | o | x | | x |
| 11.2 | Soil facilities; water | x | x | x | o | o | o | o | o | x | | x |
| 13.1 | Floors on foundation; non-structural | x | x | x | o | o | o | o | o | x | o | x |
| 13.2 | Floors on foundation; structuralf | x | x | x | o | o | o | o | o | x | o | x |
| 16.1 | Foundation structures; footings and beams | x | x | x | o | o | o | o | o | x | o | x |
| 16.2 | Foundation structures; retaining walls | x | x | x | o | o | o | o | o | x | o | x |
| 17.1 | Pile foundations; non-driven | x | x | x | o | o | o | o | o | x | | x |
| 17.2 | Pile foundations; driven | x | x | x | o | o | o | o | o | x | | x |
| 2- | STRUCTURAL WORK | | | | | | | | | | | |
| 21.1 | Exterior walls; non-structural | x | x | x | o | o | o | o | o | x | o | x |
| 21.10 | Exterior walls; non-structural, general (aggregate level) | x | x | x | o | o | o | o | o | x | o | x |
| 21.11 | Exterior walls; non-structural, solid walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.12 | Exterior walls; non-structural, cavity walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.13 | Exterior walls; non-structural, modular walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.14 | Exterior walls; non-structural, curtain walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.15 | Exterior walls; non-structural, parapets | x | x | x | o | o | o | o | o | x | o | x |
| 21.16 | Exterior walls; non-structural, gutter boards | x | x | x | o | o | o | o | o | x | o | x |
| 21.2 | Exterior walls; structural | x | x | x | o | o | o | o | o | x | o | x |
| 21.20 | Exterior walls; structural, general (aggregate level) | x | x | x | o | o | o | o | o | x | o | x |
| 21.21 | Exterior walls; structural, solid walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.22 | Exterior walls; structural, cavity walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.23 | Exterior walls; structural, modular walls | x | x | x | o | o | o | o | o | x | o | x |
| 21.24 | Exterior walls; structural, parapets | x | x | x | o | o | o | o | o | x | o | x |
| 4- | FINISHES | | | | | | | | | | | |
| 43.2 | Floor finishes; non-raised | o | x | x | o | o | o | o | o | x | o | x |
| 43.20 | Floor finishes; non-raised, general (aggregate level) | o | x | x | o | o | o | o | o | x | o | x |
| 43.21 | Floor finishes; non-raised, finishing layers | o | x | x | o | o | o | o | o | x | o | x |
| 43.22 | Floor finishes; non-raised, coverings | o | x | x | o | o | o | o | o | x | o | x |
| 43.23 | Floor finishes; non-raised, false floor finishes | o | x | x | o | o | o | o | o | x | o | x |

### Construction work – not a building – example table to illustrate the structure

| | | Type | | |
|---|---|---|---|---|
| Code | RAW 2015 | New construction | Renovation | Temporary construction |
| 17.00 | Contaminated Soil and Contaminated Water | o | o | o |
| 17.51 | Contaminated Soil and Contaminated Water, Sealing Layer | o | o | o |
| 22.00 | Earthworks | x | o | o |
| 22.03 | Earthworks; Soil Processing | x | o | o |
| 22.41 | Earthworks; Light Filling Materials | x | o | o |
| 22.45 | Earthworks; Plastic Filling Material | x | o | o |
| 22.46 | Earthworks; Soil Reinforcement and Soil Separation | x | o | o |
| 22.51 | Earthworks; WIP Bottom Ash | x | o | o |
| 22.80 | Earthworks; Banks and Verges | o | o | o |
| 23.00 | Drainage | x | o | o |
| 23.51 | Drainage; Vertical Drainage | x | o | o |
| 23.80 | Drainage; Drainage Sand | x | o | o |
| 25.00 | Piping | o | o | o |
| 25.21 | Piping; Concrete Pipes | o | o | o |
| 25.22 | Piping; Plastic Pipes | o | o | o |
| 25.23 | Piping; Metal Pipes | o | o | o |
| 25.24 | Piping; Ceramic Pipes | o | o | o |
| 25.26 | Piping; Wells and Drains, Sewage System | o | o | o |
| 25.51 | Piping; Culverts | o | o | o |

# Appendix V. Allocation of input flows and output emissions

**Section 6.4.3.3 of EN 15804 prescribes how the net impact of module D must be calculated. For readability purposes, we have chosen to present the relevant text below in a different form than the original:**

Calculation of net output flows of secondary materials or fuel:

**Add up:** All output flows of a secondary material or fuel (as 'materials for recycling', 'materials for energy recovery' or 'exported energy').

**Subtract:** All input flows of this same secondary material or fuel (as 'secondary material use', 'renewable secondary fuel use' or 'non-renewable secondary fuel use').

**Do this:** First per sub-module (for example B1-B5, C1-C4, etc.), then for the modules (for example B, C) and finally for the total product system, which will ensure that you arrive at the net output flow of the product system.

*Example 1a:*
*Rebars are processed at the end of a building service life in accordance with the standard scenario (see www.milieudatabase.nl). The standard scenario shows that 5% of rebars is lost through disposal in a landfill and 95% is recycled. In the case of rebars it can be assumed that 100% of the steel that is recycled also actually reaches end-of-waste status after processing. Therefore, for each kg of steel processed, 0.95 kg of steel scrap (95% x 100% x 1 kg) leaves the current system as material for recycling (and therefore becomes available as secondary material for a subsequent system). Suppose the data inventory shows that 25% of the rebars actually used in the building was produced from steel scrap. For every 1 kg of steel, 0.25 kg (25% x 1 kg) of steel scrap therefore entered the current system as secondary material. The net output flow in this product system is therefore 0.7 kg (0.95 kg - 0.25 kg) of steel scrap.*

Calculating substitution effects when using secondary material or fuel:

**Add up:** All environmental impact related to the recycling and/or treatment process (after the end-of-waste phase) across the entire material flow up to the moment of functional equivalence, where the secondary material or energy saves primary production.

**Subtract:** All environmental impact related to the production of the material or energy that is saved (net flow) from primary sources.

**Apply:** A justified/substantiated 'value-adjusted factor' that represents the difference between the differences in functional equivalence when the output flows do not reach the functional equivalence of the primary production that is saved.

*Example 1b:*
*In line with example 1a, benefits can be calculated for the module D product system for the net output of 0.7 kg of steel scrap as material for recycling. Steel scrap, once it has reached end-of-waste status, can be used almost immediately in a new production process. The steel scrap only has to be transported to a production location for it to directly replace raw iron (step: add up). In this example, transporting 0.7 kg of steel scrap to any production location saves 0.7 kg of raw iron from primary sources (step: subtract). In this example, there is functional equivalence, so no value-adjusted factor needs to be applied.*
- *Note: It is important to carefully examine the material for recycling that is transferred in relation to the selected primary process that is saved. In this example, the transport of steel scrap to the production location was consciously included in the calculation, as the transport of primary raw materials is also part of the saved primary process.*

### Declaration module D

As stated above, for correct declaration of module D credits, EN 15804 must expressly be followed.
The substantiation of the following aspects is of key importance here:
1. A mass balance must be formulated, derived from the LCI, that includes all the product system's individual secondary input flows (Secondary materials, Secondary fuel) and all individual secondary output flows (Products for reuse, Materials for recycling, Materials for energy recovery and exported energy).
   a. The secondary input flows are important as these enter the product system free from environmental impact, while module D credits have been declared for this in a previous product system.
   b. The secondary output flows are important because they become available in a subsequent product system. Environmental benefits for these output flows can be declared in module D.
2. The raw material equivalent must be determined quantitatively and qualitatively for all these secondary input and output flows. The raw material equivalent (see also 2.6.3.4.) indicates how much and which primary production process (input module A, which can also contain secondary raw materials) the relevant secondary flow can replace because they are technically equivalent.

The raw material equivalent (see also 2.6.3.4) will be used to calculate any benefits or impact in module D.

3. In module D, costs are calculated for the processes required to make the material suitable for the same application as the primary raw material equivalent. This concerns all process steps that are necessary after end-of-waste (of the previous life cycle) to achieve an equivalent raw material equivalent. Any waste flows from the recycling process as a consequence of degradation or efficiency of the recycling process must also be included.
4. Module D is calculated using the sum of the net output of the individual secondary raw material flows.
   a. If the net output of the secondary flows is positive, this will result in a reduced environmental impact in module D.
   b. If the net output of the secondary flows is negative, this will be set equal to 0 in module D.

Verified environmental profiles, for which inclusion in the process database is desirable, must be provided with all relevant information regarding representativeness, use of secondary raw materials and system boundaries in relation to the waste processing phase, the Lower Heating Value (LHV) and any raw material equivalent as used in Module D credits.

Several examples of how the above rules are applied are given below.

**Example 1a** **Secondary steel**
A steel construction profile that is produced from 100% secondary steel. Of this steel, 95% of the iron becomes available again as material for recycling in a new product system at the end of its technical service life. This results in a net loss of secondary raw materials. In module D, this net loss will be set to 0 and will therefore not result in any environmental impact.

**Example 1b** **Primary steel**
The same as example 1a, but now the steel is produced from 100% primary steel. The end-of-life scenario is the same, with 95% of the iron being released for recycling. For the 95% net output, the benefits are declared in module D based on the raw material equivalent for iron.

**Example 2a** **Primary concrete (standard recycling as gravel)**
When concrete is demolished, it reaches its waste status once it has been broken down into granules. The concrete granulate then has ‘gravel’ as its raw material equivalent for the coarse particles and sand for the fine particles. If 99% of the concrete is recycled (standard value), 99% enters a new product system, resulting in a net gain in secondary raw materials, the raw material equivalent of which consists partly of ‘gravel’ and partly of ‘sand’.

**Example 2b** **Primary concrete (recycling with the smart crusher))**
As in example 2a, 99% of the concrete is recycled and 99% of the output consists of secondary raw materials. However, in this example, the concrete granulate is also smartly crushed afterwards. This separates gravel, sand and the (partially) unbound cement. The additional processes required for the smart crushing of concrete (such as energy and transport) are modelled as costs in module D. The raw material equivalents are determined for the products released during smart crushing (in this case, gravel, sand, hydrated cement and non-hydrated cement) and these are modelled as benefits in module D.

**Example 2c** **Secondary concrete (standard recycling as gravel)**
The same as example 2a, however, this time not with primary concrete but with 100% secondary concrete (e.g. a hollow core slab floor salvaged from a building designated for demolition). If 99% is recycled, 1% of secondary material is lost, resulting in a net loss of secondary raw materials. In module D, this net loss will be set to 0 and will therefore not result in any environmental impact.

**Example 2d** **Secondary concrete (recycling with the smart crusher)**

The same as example 2b, however, this time with 100% secondary concrete as input. This is also recycled at a rate of 99%, resulting in a loss of 1% of secondary material. This results in a net loss of secondary raw materials. In module D, this net loss will be set to 0 and will therefore not result in any environmental impact. Smart crushing is a deviation from the standard end-of-life scenario. To include this requires drawing up a hardship clause. The additional processes required for smart crushing must be included in module D.

**Example 3a** **Primary wooden beam**

At the end of its life, a primary wooden beam is 80% incinerated, 5% landfilled and 15% recycled (standard values at the time of drafting, see *www.milieudatabase.nl* for a current list of standard end-of-life processing scenarios). The environmental benefits are declared in module D for the products saved for the 15% recycling based on the raw material equivalent, which is a net gain in secondary material. The energy recovery for the incineration of 80% of the wooden beam is modelled in module D.

**Example 3b** **Secondary wooden beam**

A wooden beam is removed manually from a demolition site. Nails are removed, the beam is shortened and brushed. The beam is now ready for reuse in a new construction. At the end of the service life of this reused beam, 80% is incinerated, 5% goes to landfill and 15% is recycled. This therefore results in a net loss of 85% of secondary raw material, causing a net loss in secondary raw materials. In module D, this net loss will be set to 0 and will therefore not result in any environmental impact. The environmental benefits of energy recovery from incineration of 80% of the material are included. Due to the low costs in the production, use and demolition phases, it is possible that the benefits in module D from energy recovery during incineration will exceed the total costs of the previous modules.

**Example 4** **Secondary biofuel**

When using 100% secondary biofuel (such as HVO), only the production and use phases are included, as the fuel is burned during the use phase. The negative net output flow (i.e. the loss of this fuel) is equated to 0 and does not result in any environmental impact.

Module D specifically includes the benefits and costs of an examined product outside the system boundaries. Reuse of products and/or construction work(s) or construction work elements outside the scope of the LCA study, for example due to earlier dismantling, is not part of this LCA study and therefore also not part of module D.

### Secondary raw material use quality

Within a product system, nothing can be said about the material use quality of materials released for recycling at the end of the service life (as secondary raw materials) but we can say something about the quality of this flow (raw material equivalent). Chapter 2 applies in full when producing an environmental profile for construction elements/installations that are to be reused in their entirety.

More or less materials are released for recycling depending on the specific end-of-life processing scenario and the recycling process efficiency. This has a direct impact on the module D credits that are awarded to the product system. All rules from 2.6.4.1 apply here.

The impact of the quality of the application in which secondary raw materials are used results from a comparison of different product systems. The alternative solutions that are available to meet a specific functional unit are important here.

This is illustrated using one example: asphalt. This example also clarifies how important it is that a secondary material's raw material equivalent is substantiated properly and in the right way. For example, milled asphalt crushed into asphalt granulate can be used in two ways, (1) again in asphalt or (2) in a road foundation as asphalt granulate cement. Reusing this again in asphalt has the potential to avoid both crushed stone, sand and part of the bitumen fraction as primary product. Used in asphalt granulate cement, the asphalt granulate only replaces a primary extracted crushed stone or gravel fraction as filling material. This means that, in determining the raw material equivalent, the inherent properties and exact composition of the secondary material and its use need to be examined carefully. All rules from 2.6.4.1. apply equally to this and form part of the verification of the file.

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