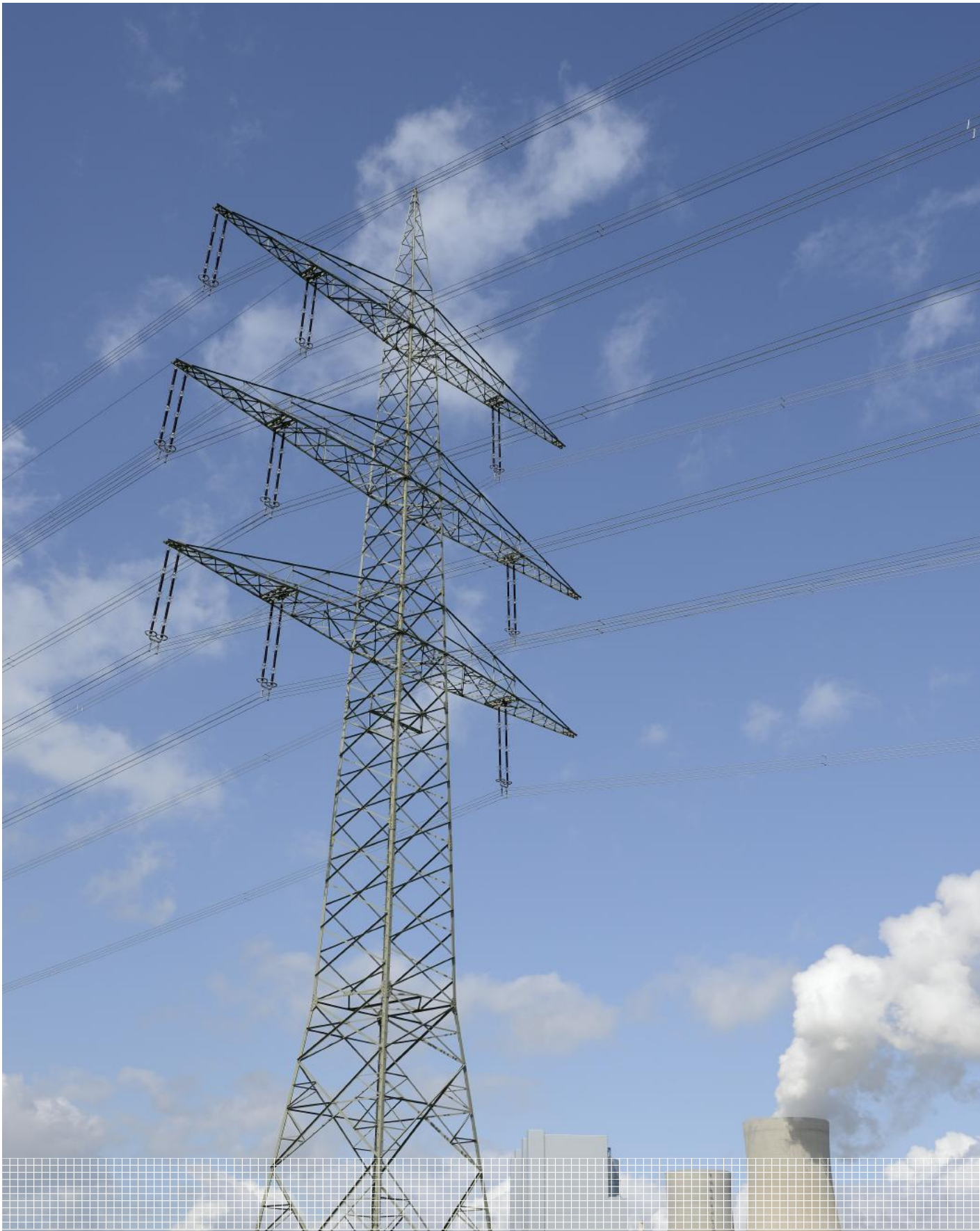
PRODUCT CATEGORY RULES (PCR)
DATE 2024-12-02

ELECTRICITY, STEAM AND HOT/COLD WATER GENERATION AND DISTRIBUTION

PRODUCT CATEGORY CLASSIFICATION: UN CPC 171, 173

PCR 2007:08
VERSION 5.0.1

VALID UNTIL: 2028-07-02



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1 INTRODUCTION

This document constitutes Product Category Rules (PCR) developed in the framework of the International EPD System: a programme for type III environmental declarations[1] according to ISO 14025:2006. Environmental Product Declarations (EPD) are voluntary documents for a company or organisation to present transparent information about the life cycle environmental impact for their goods or services.

The rules for the overall administration and operation of the programme are the General Programme Instructions, publicly available on www.environdec.com. A PCR complements the General Programme Instructions and the standards by providing specific rules, requirements, and guidelines for developing an EPD for one or more specific product categories (see Figure 1). A PCR should enable different practitioners using the PCR to generate consistent results when assessing products of the same product category.

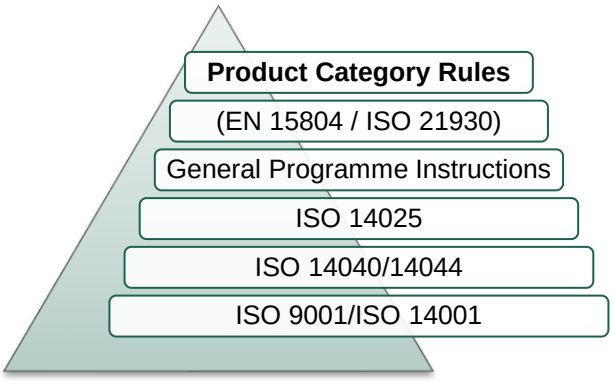

Figure 1 Illustration PCR in relation to the hierarchy of standards and other documents.

Within the present PCR, the following terminology is adopted:

- The term “shall” is used to indicate what is obligatory.
- The term “should” is used to indicate a recommendation, rather than a requirement.
- The term “may” or “can” is used to indicate an option that is permissible.

For the definition of terms used in the document, see the normative standards.

A PCR is valid for a pre-determined period of time to ensure that it is updated at regular intervals. The latest version of the PCR is available on www.environdec.com. Stakeholder feedback on PCRs is very much encouraged. Any comments on this may be sent directly to the PCR Moderator and/or the Secretariat during its development or during the period of validity.

Any references to this document should include the PCR registration number, name, and version.

The programme operator maintains the copyright of the document to ensure that it is possible to publish, update when necessary, and available to all organisations to develop and register EPDs. Stakeholders participating in PCR development should be acknowledged in the final document and on the website.

[1] Type III environmental declarations in the International EPD System are referred to as EPD, Environmental Product Declarations.

2 GENERAL INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Name:	Electricity, steam and hot/cold water generation and distribution
Registration number and version:	2007:08, version 5.0.1
Programme:	The International EPD System
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: support@environdec.com
PCR moderator:	Lena Landström, Vattenfall AB, lena.landstrom@vattenfall.com Karin Lundmark, Vattenfall AB
PCR Committee:	Celsio, EDF, Norsus, Vattenfall AB, Ørsted A/S, Stockholm Exergi, Göteborg Energi, Boverket, IVL Svenska miljöinstitutet, Dalemarken AB
Date of publication and last revision:	2024-12-02 (version 5.0.1) Version 1.0 was published in 2007. See Section 8 for a version history.
Valid until:	2028-07-02
Schedule for renewal:	A PCR is valid for a pre-determined time period to ensure that it is updated at regular intervals. When the PCR is about to expire, the PCR Moderator shall initiate a discussion with the Secretariat how to proceed with updating the PCR and renewing its validity. A PCR may also be updated without prolonging its period of validity, provided significant and well-justified proposals for changes or amendments are presented. See www.environdec.com for the latest version of the PCR. When there has been an update of the PCR, the new version should be used to develop EPDs. The old version may however be used for 90 days after the publication date of the new version, as long as the old version has not expired.
Standards conformance:	▪ General Programme Instructions of the International EPD System, version 4.0, based on ISO 14025 and ISO 14040/14044 ▪ ISO/TS 14067, Carbon footprint of products -- Requirements and guidelines for quantification and communication
PCR language(s):	This PCR was developed and is available in English. In case of translated versions, the English version takes precedence in case of any discrepancies.

2.2 SCOPE OF PCR

2.2.1 PRODUCT CATEGORY DEFINITION AND DESCRIPTION

This document provides Product Category Rules (PCR) for the assessment of the environmental performance of electricity, steam and hot/cold water generation and distribution, and the declaration of this performance by an EPD. The product category corresponds to UN CPC 171 and 173.

The product group in the scope of this PCR includes electricity, steam and hot/cold water generated with any technology such as:

- Combustion technologies based on fossil and renewable fuels and peat.
- Nuclear technologies
- Hydropower technologies (including pumped storage)
- Wind power technologies
- Ocean technologies (wave, tide)
- Solar technologies (photovoltaic and thermal electric)
- Electrochemical processes (fuel cells)
- Ambient heat, waste heat from other processes and electricity (geothermal technologies, heat pumps and electric boilers)
- District cooling

Any EPDs for other or new technologies shall follow the idea and principles of this PCR and comply with relevant parts and the EPD producer should ask for amendments to this PCR via the process to update PCRs in the General Programme Instructions. Suggestions may be submitted to the PCR moderator.

An EPD can be produced for one conversion plant or a defined set of conversion plants. Examples are:

- Electricity from an individual production facility, e.g. a hydropower plant
- Typical electricity from a type of facility, e.g. a company's portfolio of wind power plants
- An electricity mix typical for a company
- Heat from a district heating system with several heat producing sources
- Cold water from a liquid cooling machine with a wet cooling tower in a standalone production facility

2.2.2 GEOGRAPHICAL REGION

This PCR may be used globally.

2.2.3 EPD VALIDITY

An EPD based on this PCR shall be valid for a 5-year period starting from the date of the verification report ("approval date"), or until the EPD has been de-registered from the International EPD System.

An EPD shall be updated and re-verified during its validity if changes in technology or other circumstances have led to:

- an increase of 10% or more of any of the declared indicators of environmental impact,
- errors in the declared information, or
- significant changes to the declared product information, content declaration, or additional environmental information.

If such changes have occurred, but the EPD is not updated, the EPD owner shall contact the Secretariat to de-register the EPD.

3 PCR REVIEW AND BACKGROUND INFORMATION

This PCR was developed in accordance with the process described in the General Programme Instructions of the International EPD System, including PCR review and open consultation.

3.1 PCR REVIEW

3.1.1 VERSION 1.0–3.0

Previous versions of the PCR were reviewed by the Technical Committee of the International EPD System.

3.1.2 VERSION 4.0

PCR review panel:	The Technical Committee of the International EPD System. A full list of members available on www.environdec.com. The review panel may be contacted via support@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR moderator or PCR committee, and were excused from the review.
Chair of the PCR review:	Claudia A. Peña
Review dates:	2019-12-06 – 2020-02-19

3.1.3 VERSION 5.0.0

PCR review panel:	The Technical Committee of the International EPD System. A full list of members available on www.environdec.com. The review panel may be contacted via support@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR moderator or PCR committee and were excused from the review.
Chair of the PCR review:	Lars-Gunnar Lindfors
Review dates:	2023-08-30 until 2023-10-24

3.2 OPEN CONSULTATION

3.2.1 VERSION 1.0

Version 1.0 was available for open consultation in March 2007, including meeting in Brussels on 2007-03-07.

3.2.2 VERSION 2.0

Version 2.0 was available for open consultation from 2011-09-22 until 2011-11-03.

3.2.3 VERSION 3.0

Version 3.0 was available for open consultation from 2014-09-17 until 2014-11-17.

3.2.4 VERSION 4.0

Version 4.0 of this PCR was available for open consultation from 2019-05-27 until 2019-07-27.

3.2.5 VERSION 5.0.0

Version 5.0 of this PCR was available for open consultation from 2022-12-20 until 2023-02-19, during which any stakeholder was able to provide comments by posting on the PCR forum on www.environdec.com or by contacting the PCR moderator.

Stakeholders were invited via e-mail or other means to take part in the open consultation and were encouraged to forward the invitation to other relevant stakeholders. The following stakeholders provided comments during the open consultation, and agreed to be listed as contributors to the PCR and at www.environdec.com:

- Raziyeh Khodayari, Swedenergy (Energiföretagen Sverige)
- Jon Iver Bakken, Hafslund Oslo Celsio
- Erik Dotzauer, Stockholm Exergi
- Lars Holmquist, Göteborg Energi AB

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this PCR, existing PCRs and other internationally standardized methods that could potentially act as PCRs were considered to avoid unnecessary overlaps in scope and to ensure harmonisation with established methods of relevance for the product category. The existence of such documents was checked in the public PCR listings of the following programmes based on ISO 14025 or similar:

- International EPD System, www.environdec.com
- EPD Norge, https://www.epd-norge.no
- Product Environmental Footprint (PEF), http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm#final
- EPD China, www.epdchina.cn
- PEP ecopassport® progam, www.pep-ecopassport.org
- EPD Danmark, www.epddanmark.dk
- EPD Italy, www.epditaly.it
- UL Environment, https://www.ul.com/services/environmental-product-declaration-certification

No PCRs covering all types of electricity or steam were identified.

There is a PCR, “Product category rules for life cycle assessments of electronic and electrical products and systems” (EN 50693), which is implemented in multiple EPD programmes, but does not cover electricity produced.

EPD China has a PCR for battery energy storage (EPDCN-PCR-2022-0005), but it does not cover electricity production and distribution.

There is a Product Environmental Footprint Category Rules (PEFCR) report for photovoltaic modules used in photovoltaic power systems for electricity generation, developed as part of the pilot phase of PEF[2]. The PEFCR is in version 1.1, the date of publication was 2019-02-12, and it was valid until 2020-12-31. There are some inherent differences between PEFs and EPDs, including allocation methods and requirements on datasets for generic data.

EPD-Norge has published “PCR– Part B for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials”,

[2] Product Environmental Footprint Category Rules (PEFCR): Photovoltaic modules used in photovoltaic power systems for electricity generation. Version: 1.1 Published: 2019-02-12; Time validity: 2020-12-31. Available at: https://wayback.archive-it.org/org-1495/20221004164603mp_/https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm.

which has been adopted by the International EPD System, and which is valid until 2025. This PCR, however, is for the PV modules generating electricity, and not for electricity as supplied to a customer.[3]

3.4 REASONING FOR DEVELOPMENT OF PCR

This PCR was developed to enable publication of Environmental Product Declarations (EPD) for this product category based on ISO 14025, ISO 14040/14044, and other relevant standards to be used in different applications and target audiences.

3.5 UNDERLYING STUDIES

The methodological choices made during the development of this PCR (functional unit/declared unit, system boundary, allocation methods, impact categories, data quality rules, etc.) in this PCR were primarily based on the following underlying studies:

- Previous versions of this PCR and questions and comments given to the PCR moderator since 2007.
- The development of the first EPD for electricity (Electricity from the river Lule Älv S-P-00001, Vattenfall AB, 1998).
- The development of the first EPD for district cooling under this PCR (Fjärrkyla från Hyllie kylcentral S-P-03590, E.ON Energiinfrastruktur AB 2021).
- The development of an EPD for district heating (Fjärrvärme från Linköpings fjärrvärmenät S-P-08296, Tekniska verken i Linköping AB, 2023)

[3] PCR – Part B for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials" (NPCR 029 version 1.2) Adopted by the International EPD-system as PCR 2019:14-c-PCR-016 c-PCR-016 Photovoltaic modules and parts thereof (adopted from EPD Norway 2022-04-27). Registered 2022-03-31. Valid until 2025-06-11. Available at: https://www.epd-norge.no/pcr/pcr-register/npcr-029-2022-part-b-for-photovoltaic-modules-references-to-en-15804-a2.

4 GOAL AND SCOPE, LIFE CYCLE INVENTORY AND LIFE CYCLE IMPACT ASSESSMENT

The goal of this section is to provide specific rules, requirements and guidelines for developing an EPD for the product category as defined in Section 2.2.1.

4.1 FUNCTIONAL UNIT

The functional unit shall be defined as 1 kWh of electricity, steam or hot/cold water distributed to the customer.

The functional unit shall be stated in the EPD. In some cases, the product includes several functions, for example both electricity and heat, or regulatory functions. The function(s) of the product shall be described and explained in the EPD, separated into bullets.

The description of the function shall include a description of the customer. In the case of electricity, the customer shall be defined related to the voltage level where the meter is found. In case of multiple customers, additional results may be declared in additional scenarios. For each scenario, the customer shall be described.

In the case of pumped storage hydropower, it shall be pointed out in the EPD that the function of pumped storage is to regulate and balance the electricity network, i.e. like a short-term energy storage, rather than to produce electricity.

The environmental impact shall be given per functional unit during the technical service life of the energy conversion plant based on the status of the plant in the defined reference period.

In the distribution of electricity, steam and water, there will be losses. Production corresponding to these losses shall be assigned to the downstream stage, and not to the upstream and core stages, so that the total results of the upstream and core stages reflect the generation of 1 kWh net[4] of electricity or the generation of 1 kWh of steam or water. See Section 4.3.1.3.

4.2 TECHNICAL SERVICE LIFE

Table 1 lists typical technical service lives for different technologies, which shall be used when specific data is not available. Note that it is possible to set a technical service life other than listed in this table given supporting documentation.

[4] 1 kWh net means that electricity or heat used within the power plant is subtracted from the amount of kWh generated in that plant.

Table 1 Typical technical service lives for different technologies, to use when specific data is not available.

Technology		**Typical technical service life (years)**
Combustion technologies		40
Ignition motor technologies		30
Nuclear technologies		60
Hydropower technologies	Machinery (turbine, generator, etc)	60
	Pumping system in case of pumped storage	50
	Power station building	100
	Dams and waterways	100
Wind power technologies		25
Ocean technologies		20
Solar technologies		30
Electrochemical technologies	Fuel cells	20
Ambient heat, waste heat from other processes and electricity	Geothermal technologies	40
	Heat pumps	20
	Electric boilers	30

4.3 SYSTEM BOUNDARY

The International EPD System uses an approach where all attributional processes from “cradle to grave” should be included using the principle of “limited loss of information at the final product”. This is especially important in the case of business-to-consumer communication.

The scope of this PCR and EPDs based on it is cradle-to-grave.

4.3.1 LIFE CYCLE STAGES

For the purpose of different data quality rules and for the presentation of results, the life cycle of products is divided into three different life cycle stages:

- Upstream processes (from cradle-to-gate)
- Core processes (from gate-to-gate)
- Downstream processes (from gate-to-grave)

In the EPD, the environmental performance associated with each of the three life-cycle stages above shall be reported separately. The processes included in the scope of the PCR and belonging to each life cycle stage are described in Sections 4.3.1.1–4.3.1.3.

Specific considerations for different technologies are outlined in Section 4.7.3

4.3.1.1. Upstream processes

The upstream stage comprises cradle-to-gate environmental information on production and transportation of fuel and auxiliary substances such as e.g. chemicals necessary for energy conversion. The gate is defined as when entering the conversion plant site.

- The following unit processes are part of the product system and shall be classified as upstream processes:
  - Production of fuels
  - Production of auxiliary inputs

Upstream processes not listed may also be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section 4.5.

Specific considerations for different technologies are outlined in Section 4.7.3.1.

4.3.1.2. Core processes

The core processes consist of core operation and core infrastructure.

Core operation comprises gate-to-gate environmental information on the operation stage of the energy conversion plant (system) until the delivery point to the distribution system. The handling/treatment/transportation of operational waste and residues is included according to the polluter pays principle, see Section 4.6.2. The following unit processes of the operation stage are part of the product system and shall be classified as core processes:

- Energy conversion process
- Handling/preparation/storage processes of any inputs or outputs of the energy conversion performed by the company
- Maintenance
- Any operations of reserve power and reserve heat
- Transportation on site and inspection trips

The technical system shall not include:

- Business travel of personnel
- Travel to and from normal workplace by personnel
- Research and development activities

Core infrastructure, i.e., construction, reinvestments and decommissioning of the energy conversion plant (system) including also other buildings, fuel preparation equipment, waste storages, roads, etc., on site shall be included. Reinvestment and decommissioning shall be based on scenarios. Scenarios shall be technically and economically practicable and compliant with current regulations in the relevant geographical region based on the geographical scope of the EPD. Key assumptions regarding the scenarios shall be documented in the LCA report.

Manufacturing processes not listed may also be included. The production of the raw materials used for production of all product parts shall be included. A minimum of 99% of the total mass of materials used for the infrastructure shall be included.

Specific considerations for different technologies are outlined in Section 4.7.3.2.

4.3.1.3. Downstream processes

The downstream processes comprise distribution of the products to the customer. The processes after the power plant transforming process to the customer meter, or for thermal energy from delivery point to the distribution system of steam or hot/cold water to the customer central unit, shall be included.

In case of results for multiple downstream scenarios for multiple customers (see Section 4.1), the main scenario shall be clearly denoted along with a description of the differences between the declared scenarios.

The downstream processes include construction, reinvestment and decommissioning of distribution infrastructure as well as operation and maintenance of the distribution network. It also includes the share of production of electricity/steam/water (i.e., the same processes as in the upstream and core stages) that corresponds to the distribution losses. In this way, the total life-cycle results correspond to the distribution of 1 kWh to the customer (the functional unit), while the results for upstream and core correspond to the generation of 1 kWh net[5] of electricity or the generation of 1 kWh of steam/water.

Reinvestment and decommissioning shall be based on scenarios. Scenarios shall be technically and economically practicable and compliant with current regulations in the relevant geographical region based on the geographical scope of the EPD. Key assumptions regarding the scenarios shall be documented in the LCA report.

[5] 1 kWh net means that electricity or heat used within the power plant is subtracted from the amount of kWh generated in that plant.

The use stage of electricity, steam and hot/cold water fulfils various functions in different contexts and therefore processes after distribution to customer shall not be included.

4.3.1.4. Infrastructure and capital goods

This section provides rules on how to model infrastructure and capital goods, which here is defined as products used in the studied product system that are not consumed (e.g., in the production or the product use) and retains their function for more than three years. Examples are the building in which the studied product or upstream materials or components are produced, machinery used in the manufacturing of the product or its materials or components, or vehicles used in transports in the product system.[6]

In general, the production and end-of-life processes of infrastructure or capital goods used in the product system should not be included within the system boundaries. They may be included when infrastructure and capital goods are known to be relevant in terms of their environmental impact, or when a generic LCI dataset includes infrastructure/capital goods, and it is not possible, within reasonable effort, to subtract the data on infrastructure/capital goods from this dataset. If an infrastructure/capital good is produced with the intention to be used one or a few times only (e.g., a manufacturing plant or machinery constructed to produce only one product), this infrastructure/capital good shall be included.

The inclusion or exclusion of infrastructure/capital goods shall be transparently described for upstream, core and downstream processes in the LCA report and in the EPD.

If infrastructure/capital goods are included within the system boundaries, this shall be described in the EPD, unless they contribute less than 10% to the cradle-to-gate results to all of the environmental impact indicators declared in the EPD (in such cases, it is still permitted to describe the inclusion of infrastructure/capital goods). The description shall include which life-cycle stages, or processes, that infrastructure/capital goods are included for. Furthermore, the description should[7] include the type of infrastructure/capital goods included (e.g., factory building, manufacturing machinery, transport vehicles, transport infrastructure, energy infrastructure). If infrastructure/capital goods are included in a generic LCI dataset used, the name of the dataset (including the database it has been derived from) shall be declared in the EPD if the full dataset (i.e., not just the infrastructure/capital goods) contributes more than 5% to the cradle-to-gate results of any of the environmental impact indicators.

The above rule to, in general, exclude infrastructure/capital goods is primarily because LCI data on infrastructure/capital included in generic datasets often are of inadequate and inconsistent quality, for example in terms of technical, geographical, and temporal representativeness, which may significantly increase the uncertainty of the results declared in the EPD. The rule may change in the future if the quality of LCI data on infrastructure/capital goods improves.

4.3.2 OTHER BOUNDARY SETTING

4.3.2.1. Boundary towards nature

Boundaries to nature are defined as where the flows of material and energy resources leave nature and enter the technical system (i.e. the product system). Emissions cross the system boundary to nature when they are emitted to air, soil or water.

4.3.2.2. Boundary towards other technical systems

Boundaries towards other technical systems define the flow of materials and components to/from the product system under study and from/to other product systems. If there is an inflow of recycled material to the product system in the production/manufacturing stage, the transport from the scrapyard/collection site to the recycling plant, the recycling process, and the transportation from the recycling plant to the site where the material is being used shall be included. If there is an outflow of material or component to recycling, the transportation of the material to the scrapyard/collection site shall be included. The material or component going to recycling is then an outflow from the product system.

See Section 4.6 for further guidance.

[6] For example, if the EPD is on wind power, the power plant itself is considered the studied product and not infrastructure/capital goods. However, the buildings and machinery that make the wind turbine components are considered infrastructure/capital goods. Similarly, if the EPD is on a means of transport, the vehicle is considered the studied product and not infrastructure/capital goods.

[7] A reason not to declare this information can, for example, be that this information is not available in the LCI dataset documentation.

4.3.2.3. Temporal boundary

The temporal boundary defines the time period for which the life cycle inventory data is recorded, e.g. for how long emissions from waste deposits are accounted. As default, the time period over which inputs to and outputs from the product system is accounted for shall be 100 years from the year that the LCA model best represents, considering the representativeness of the inventory data. This year shall, as far as possible, represent the year of the publication of the EPD.

4.3.2.4. Geographical boundaries

The geographical boundary defines the geographical coverage of the LCA. This shall reflect the physical reality of the product under study, accounting for the representativeness of technology, input materials and input energy.

4.3.2.5. Risk assessment

Environmental impacts due to accidents and undesired events are not part of the LCA but part of the environmental risk assessment to be reported under additional environmental information, see Section 5.4.5.

Environmental burdens in conjunction with mishaps occurring more often than once in three years are considered to belong to normal operation and are part of the LCA (example: smaller frequent oil spills from hydropower stations to the river due to leaking packings). Events with environmental impact that happen less frequent than once in three years belong to the environmental risk assessment (example: the rupture of a Kaplan turbine hub leading to a sudden larger oil emission).

4.4 SYSTEM DIAGRAM

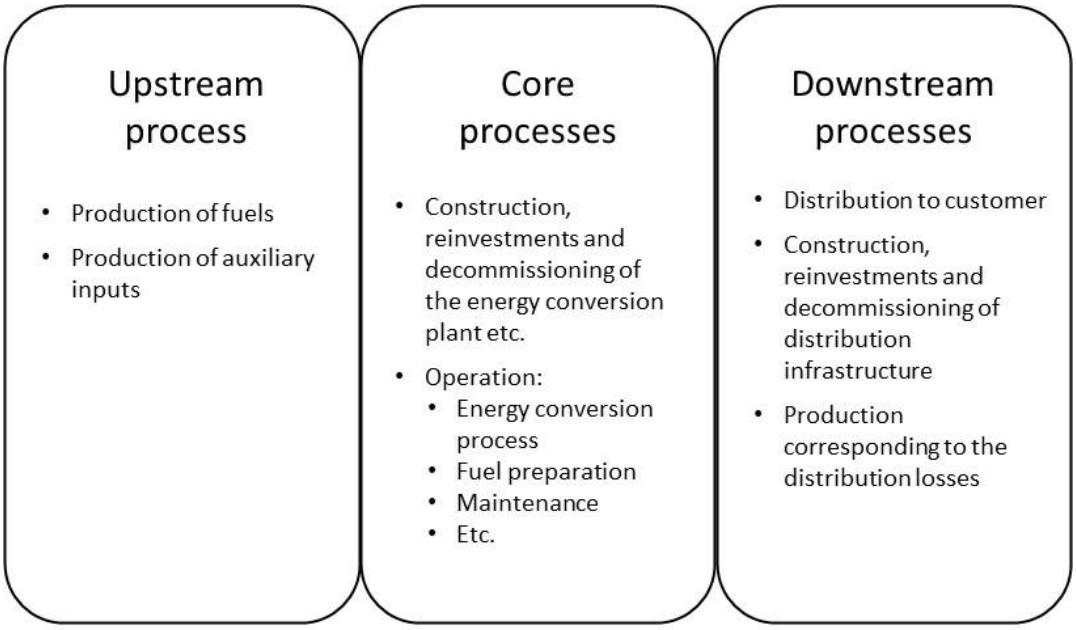

Figure 2 System diagram illustrating the processes that are included in the product system, divided into upstream, core and downstream processes.

4.5 CUT-OFF RULES

A cut-off rule of 1% shall be applied. In other words, the included inventory data (not including inventory data of processes that are explicitly outside the system boundary as described in Section 4.3) shall together give rise to at least 99% of the results of any of the environmental impact categories. Also, 99% of the mass of the product content and 99% of the energy use of the product life cycle shall be accounted for. The cut-off of inventory data should, however, be avoided, and all available inventory data shall be used.

The cut-off of inventory data, based on the above cut-off rule, should be an output of a sensitivity analysis, alone or in combination with expert judgment based on experience of similar product systems. Further, the cut-off shall be possible to verify in the verification

process, hence the exclusion of inventory data based on the cut-off rule shall be documented in the LCA report, and the EPD developer shall provide the information the verifier considers necessary to verify the cut-off.

Note that infrastructure for many technologies covered by this PCR does not fall under the cut-off, and shall be included unless it can be justified it falls under the cut-off.

4.6 ALLOCATION RULES

Allocation can be divided into allocation of co-products, i.e. allocation of unit processes that generate several products, and allocation of waste, i.e. allocation of unit processes that generate materials that are, for example, landfilled recovered, recycled or reused, and which require further processing to cease being waste and become products (see criteria for end-of-waste state in Section 4.6.2).

The principles for allocation of co-products and allocation of waste are described separately in the following subsections.

In all cases of allocation, the 100% rule should be followed, thus the sum of impacts for all single products of a process should equal the total burden of this process.

4.6.1 CO-PRODUCT ALLOCATION

In co-product allocation, the sum of the allocated inputs and outputs to the products shall be equal to the total inputs and outputs from the same unit process, and consistent allocation procedures shall be uniformly applied to similar inputs and outputs of the system under consideration. This means that no double counting or omission of inputs or outputs through allocation is permitted (unless a conservative assumption is made, see below).

The following hierarchy of allocation methods shall be followed for co-product allocation when specific allocation rules are not provided in Table 2.

1. Allocation shall be avoided, if possible, by dividing the unit process into two or more sub-processes and collecting LCI data for each sub-process. This option shall not be used for joint co-production processes, which ISO 21930 describes as follows: "…if each of the co-products can be produced without the other(s) or the ratio of the co-products typically varies in normal production, then it is not a joint co-production process. By-products cannot be avoided and processes producing by-products are therefore joint co-production processes."
2. Allocation shall be based on physical properties (e.g., mass, volume) when (i) there is a relevant underlying physical relationship between the products and co-products, and (ii) the difference in revenue per mass (or per energy unit in case of electricity, heat or similar) from the products and co-products is low. A relevant underlying physical relationship exists when the amounts of inputs and outputs are changed by quantitative changes in the amounts of products or functions delivered by the system.
3. In all other cases, allocation shall be based on economic values of the products and co-products when they leave the unit process. Economic values may, for example, be the revenue generated by each product and co-product. The revenue is the price multiplied by the output. For both price and output, representative values should be identified (e.g., rolling annual averages). If economic allocation is used, a sensitivity analysis exploring the influence of the choice of economic value shall be included in the LCA report.

In co-product allocation, conservative assumptions may be made when the effort of allocation is disproportionate to any improvement in accuracy. For example, flows leaving the studied product system can be assumed to have no economic value and thereby allocated no environmental burden (which yields the same results as if cut-off were used but note that the EPD shall still describe the applied allocation method as co-product allocation). Furthermore, if a co-product of a previous product system is an input to the product system under study, the conservative assumption is that it comes with an environmental burden. In the end, a conservative assumption shall always allocate more environmental burdens to the product that is the object of the EPD than would have been allocated with a strict application of the allocation procedure.

An example of when a conservative assumption is reasonable is when it is unknown whether an input from a previous product system left that system as a co-product or as waste (that ceased to be waste at the system boundary). Then the conservative assumption is to assume the input is a co-product that is assigned an environmental burden. This may, for example, be the case when the input is an unknown mix of pre- and post-consumer scrap, where pre-consumer scrap will often be allocated as co-products (e.g., if it has a positive economic value) while post-consumer scrap shall be allocated as waste. Note that the allocation of waste incineration follows the polluter pays principle and is covered by Section 4.6.2.

For allocation rules for specific processes, see Table 2.

Table 2 Specific allocation rules for nuclear, hydropower technologies and combined heat and power.

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION INSTRUCTION
Nuclear technologies	Nuclear waste	Nuclear fuel reprocessing is a waste treatment service stabilizing spent nuclear fuel and shall be allocated to the nuclear power plant operator. The plutonium and MOX fuel are additional assets leaving the reprocessing plant without any burdens. Because most of the depleted uranium is currently stocked, all requirements and emissions of the enrichment step are attributed to the enriched uranium. Because only a small amount of the total depleted uranium produced will ever be used, depleted uranium shall be considered as a waste and listed as such in the inventory.
Hydropower technologies	Dams	In a river there might be several water reservoirs and hydropower stations and it may be difficult to allocate the emissions due to inundation to a specific station. The allocation should be done by looking at the whole river and take all emissions due to inundation and spread over all kWh generated in the river. The chosen method and allocation approach shall be clearly described and discussed in the EPD.
Combined heat and power (all technologies)	Electricity, heat	Alternative Generation Method, see Annex 1.

Note that heat generated in industrial installations or in the tertiary sector (often referred to as excess heat or waste heat), that is subsequently utilised (e.g., in a district heating/cooling system) shall be allocated as a co-product, normally using economic allocation at the point of sale. This means that for users of such heat, the heat comes with an environmental burden.

Results calculated with other allocation methods than the mandatory ones listed above may be reported in a subsection of the environmental performance section, see Section 5.4.4.

In case there are several products from an energy conversion plant (system) such as electricity and steam, or a waste treatment service and district heat, the LCA results of all products and services provided by this plant, to which impacts have been allocated, shall be reported in the EPD in a subsection of the environmental performance section.

4.6.2 ALLOCATION OF WASTE TREATMENT PROCESSES

Allocation of waste shall follow the polluter pays principle and its interpretation in EN 15804: “processes of waste processing shall be assigned to the product system that generates the waste until the end-of-waste state is reached.” The end-of-waste state is reached when all the following criteria for the end-of-waste state are fulfilled (adapted from EN 15804):

- the recovered material, component or product is commonly used for specific purposes.
- a market or demand, identified e.g. by a positive economic value, exists for such a recovered material, component or product;
- the recovered material, component or product fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and
- the use of the recovered material, product or construction element will not lead to overall adverse environmental or human health impacts.

The above outlined principle means that the generator of the waste shall carry the full environmental impact until the point in the product life cycle in which the end-of-waste criteria are fulfilled. Waste may have a negative economic market value, and then the end-of-waste stage is typically reached after (part of) the waste processing and further refinement, at the point at which the waste no longer has a negative market value. This allocation method is (in most cases) in line with a waste generator’s juridical and financial responsibilities.

For waste incineration with energy recovery, the end-of-waste state is reached *after* the incineration if the waste incinerator gets paid for incinerating the material (i.e., the material has a negative economic value), which means that the environmental impact of collection, pre-processing and incineration of the waste shall be attributed to the product system generating the waste. Impacts

related to making use of the energy, if any, shall however be attributed to the product system using the energy. If the end-of-waste state is reached *before* the incineration/combustion of the waste, the waste shall be considered a secondary fuel and further processing and incineration/combustion of the secondary fuel shall be attributed to the product system using the energy. For example, this is the case if the waste incinerator pays for the material (i.e., the economic value of the material is positive) and all other criteria for the end-of-waste state are fulfilled as well.

Figure 3 gives a general illustration of the various types of waste treatment options and their allocation. This is just for guidance; the above allocation rules always apply. The area in light green indicates the environmental burden that shall be carried by the waste generator. It is important to note that some flows can be legally defined as waste but have reached the end-of-waste state as defined above and are no longer defined as waste from an allocation standpoint. These can for example be secondary fuels for incineration where the environmental burden (of the incineration) shall be allocated to the product system using the energy produced.

See the GPI for further information and examples.

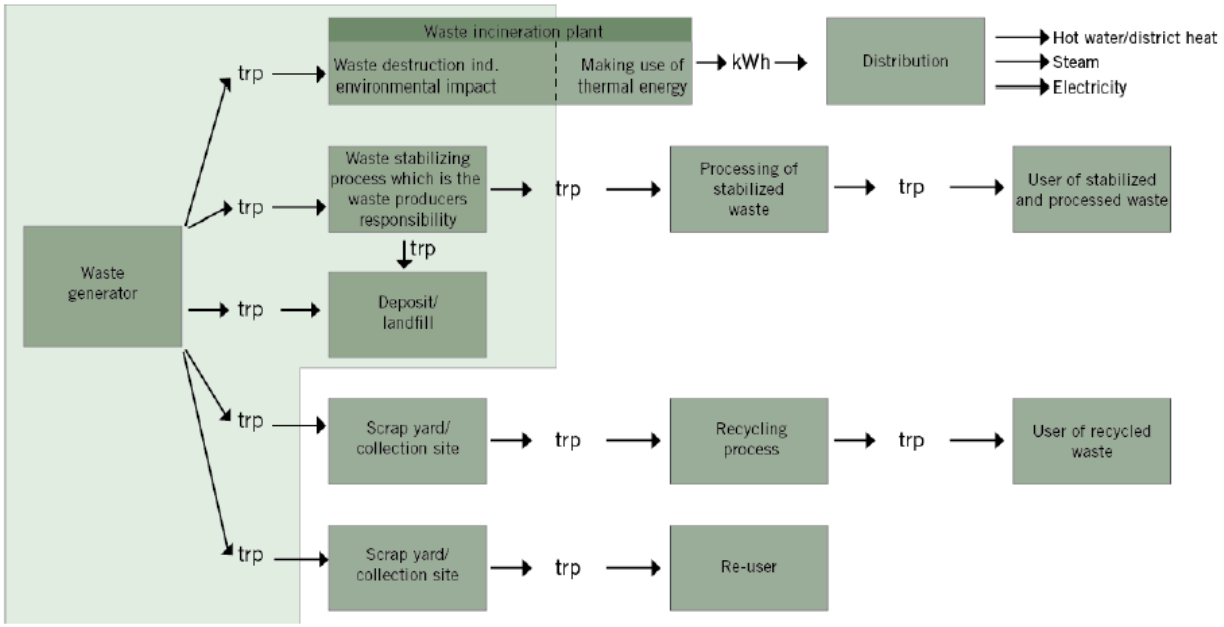

Figure 3 Illustration of the polluter pays allocation principle. Note that some wastes that are still legally defined as waste may have reached the end-of-waste state and then this figure does not apply.

4.7 DATA QUALITY REQUIREMENTS AND SELECTION OF DATA

Life cycle inventory data are classified into specific data and generic data, where the latter can be selected generic data or proxy data. The data categories are defined as follows:

- specific data (also referred to as “primary data” or “site-specific data”):
  - data gathered from the actual manufacturing plant where product-specific processes are carried out;
  - actual data from other parts of the life cycle traced to the product under study, for example site-specific data on the production of materials or generation of electricity provided by contracted suppliers, and transportation data on distances, means of transportation, load factor, fuel consumption, etc., of contracted transportation providers; and
  - LCI data from databases on transportation and energy ware that is combined with actual transportation and energy parameters as listed above.
- generic data (sometimes referred to as “secondary data”), divided into:
  - selected generic data: data (e.g. commercial databases and free databases) that fulfil prescribed data quality requirements for precision, completeness, and representativeness (see below Section 4.7.1),
  - proxy data: data (e.g. commercial databases and free databases) that do not fulfil all of the data quality requirements of “selected generic data”.

Specific data shall be used for the core processes. Specific data shall be used for upstream and downstream processes, when available, otherwise generic data may be used. Generic data should be used in cases in which they are representative for the purpose of the EPD, e.g. for bulk and raw materials on a spot market, if there is a lack of specific data on the final product or if a product consists of many components.

4.7.1 RULES FOR USING GENERIC DATA

For generic data to be classified as “selected generic data”, the following requirements apply:

- datasets shall be based on attributional LCA modelling (e.g., not be based on marginal data and not include credits from system expansion),
- the reference year shall be as current as possible and should be representative for the validity period of the EPD,
- the 1% cut-off rule (as described in Section 4.5) shall be met on the level of the product system,
- datasets shall represent average values for a specific reference year; however, how data are generated could vary, e.g. over time, and then they should have the form of a representative annual average value for a specified reference period (such deviations shall be justified and declared in the EPD), and
- the representativeness of the data shall be assessed to be better than ±5%, in terms of the environmental impact calculated on the basis of the data, of data that is fully representative for the given temporal, technological and geographical context.

If selected generic data that meets the above data quality requirements are not available, proxy data may be used. The environmental impacts associated with proxy data shall not exceed 10% of the overall environmental impact of the product system.

The EPD may include a data quality declaration to demonstrate the share of specific data, selected generic data and proxy data contributing to the results of the environmental impact indicators.

4.7.2 EXAMPLES OF DATABASES FOR GENERIC DATA

No examples of databases are given for generic data. Data should be used that fulfil the data quality requirements in Sections 4.7.1 and 4.7.3

4.7.3 DATA QUALITY REQUIREMENTS AND OTHER MODELLING GUIDANCE PER LIFE-CYCLE STAGE

Below are further data quality requirement per life-cycle stage. Exceptions to the requirements may be accepted, if justified in the EPD; such exceptions are subject to the approval by the verifier on a case-to-case basis.

4.7.3.1. Upstream processes

The following requirements apply to the upstream processes:

- Data referring to processes and activities upstream in a supply chain over which an organisation has direct management control shall be specific and collected on site.
- Data referring to contractors that supply fuel (for the conversion plant), main parts, packaging, or main auxiliaries should be requested from the contractor as specific data.
- Specific data should be used for large input flows to the core life cycle stage. Deviations shall be justified.
- The transport of main parts and components along the supply chain to a distribution point (e.g. a stockroom or warehouse) where the final delivery to the manufacturer can take place should be based on the actual transportation mode, distance from the supplier, and vehicle load.
- In case specific data is lacking, selected generic data may be used. If this is also lacking, proxy data may be used.
- For upstream processes modelled with specific data, generation of electricity used shall be accounted for in this priority:
    1. Specific electricity mix as generated, or purchased from an electricity supplier, demonstrated by a Guarantee of Origin or similar as provided by the electricity supplier.
    2. Residual electricity mix of the electricity supplier on the market.

3. Residual electricity mix on the market[8].
4. Electricity consumption mix on the market[9].

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total consumption mix. If the composition of the residual grid mix on the market has not been publicly disclosed, it may conservatively be estimated by subtracting renewables from the consumption mix on the market.

"The market" in the above hierarchy shall be defined as being the (residual or consumption) grid mix of the country where the electricity is used, with exceptions for specified countries for which a sub-national electricity grid mix shall be used: Australia, Brazil, Canada, China, India, and USA.

The mix of electricity used in upstream processes shall be documented in the EPD, where relevant.

Within an entity (e.g., a manufacturing site) covered by one electricity contract, that produces more than one product, contractual instruments are not allowed to be assigned to a subset of the products produced.

Processes that shall be included:

Fuel production (fuel used in the energy conversion plant in question)

- Extraction of natural energy resources
- Processing of fuel
- Preparation of fuel
- Fuel storage process
- Transportation: extraction → processing → energy conversion plant

Production of auxiliary inputs to the energy conversion plant(s) operation:

- Extraction of natural resources for auxiliary inputs (fuels and electricity used by suppliers, materials, chemicals)
- Production of fuels and electricity used by suppliers producing auxiliary inputs
- Storage of auxiliary inputs at energy conversion site
- Transportation: extraction → processing → energy conversion plant

4.7.3.2. Core processes

The following requirements apply to the core processes:

- Data regarding core operation i.e. the operation of the energy conversion plant or system of energy conversion plants can be gathered from reports to authorities and from the environmental management system or other similar documents as well as from expert estimates (e.g. on processes that will be performed in the future such as dismantling or reinvestment rates). The reference flow shall be an annual average of generated kWh for one year or a period of years and be representative during the validity of the EPD. It shall be described in the EPD how the reference flow was calculated.
- For electricity used in the core processes, generation of electricity used shall be accounted for in this priority:
    1. Specific electricity mix as generated, or purchased from an electricity supplier, demonstrated by a Guarantee of Origin or similar as provided by the electricity supplier.
    2. Residual electricity mix of the electricity supplier on the market.
    3. Residual electricity mix on the market[10].

[8] The composition of the residual grid mixes on the market are available for all EU countries and a few additional European countries through the Association for Issuing Bodies (AIB) at https://www.aib-net.org/facts/european-residual-mix.

[9] For electricity markets without trade of Guarantees of Origin (or similar), the residual mix will, however, be identical to the consumption mix.

[10] The composition of the residual grid mixes on the market are available for all EU countries and a few additional European countries through the Association for Issuing Bodies (AIB) at https://www.aib-net.org/facts/european-residual-mix

4. Electricity consumption mix on the market[11]. This option shall not be used for electricity used in processes over which the manufacturer (EPD owner) has direct control,

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total consumption mix. If the composition of the residual grid mix on the market has not been publicly disclosed, it may conservatively be estimated by subtracting renewables from the consumption mix on the market.

"The market" in the above hierarchy shall be defined as being the (residual or consumption) grid mix of the country where the electricity is used, with exceptions for specified countries for which a sub-national electricity grid mix shall be used: Australia, Brazil, Canada, China, India, and USA.

The mix of electricity used in the core processes shall be documented in the EPD, where relevant.

Within an entity (e.g., a manufacturing site) covered by one electricity contract, that produces more than one product, contractual instruments are not allowed to be assigned to a subset of the products produced.

- Transport from the final delivery point of raw materials, chemicals, main parts, and components (see above regarding upstream processes) to the manufacturing plant/place of service provision shall be based on the actual transportation mode, distance from the supplier, and vehicle load, if available.
- Waste treatment processes of manufacturing waste shall be based on specific data, if available.
- Regarding the core infrastructure the material composition can be gathered, e.g., from the documentation from the construction process, such as plans, invoices, project reports, environmental impact assessments, etc. The need for reinvestments during the technical service life shall be estimated and documented. The reference flow for infrastructure shall be an annual average of produced kWh multiplied by the expected technical service life of the system, i.e. the expected lifetime production of the system. See Section 4.2 on typical technical service life for different technologies.
- If heat, e.g., for use in as district heating is purchased and the conversion technology is unknown, any assumption on the sources shall be conservative. If this has a significant contribution to the results, this shall be clearly stated in the EPD.

Data referring to processes and activities which an organisation has direct management control shall be specific with the following clarifications.

Core operation

Specific data shall be used for amounts of inputs and outputs in following activities/issues:

- operation of energy conversion plant (system of energy conversion plants)
- amounts of fuel and other auxiliary operational inputs
- fuel preparation processes at energy conversion site e.g. drying and grinding
- maintenance activities e.g. inspection trips, lubrication
- operation (also test operation) of reserve power and reserve heat
- distances for the transportation of fuel related waste and type of vehicles
- handling/treatment/storage of fuel related waste
- amounts and type of treatment of other waste

Core infrastructure

Specific data should be used for

- material composition of energy conversion plant
- material composition of fuel preparation equipment /e.g. mill, dryer) and storages
- material composition of facilities for handling of fuel-related waste
- reinvestment rates

Selected generic data may be used for

[11] For electricity markets without trade of Guarantees of Origin (or similar), the residual mix will, however, be identical to the consumption mix.

- manufacture of construction materials and chemicals
- transportation distances
- transportation services (fuel use and emissions in conjunction with transportation)
- construction services
- dismantling services
- waste treatment processes
- national or regional mixes for electricity generation
- resource use and emissions in conjunction with electricity and fuels used during the construction/reinvestment/dismantling processes

Typical technical service time may be taken from Section 4.2.

Processes that shall be included for each technology is listed below:

Combustion technologies based on fossil and renewable fuels and peat[12]

Core operation:

- Energy conversion process of plant(s)
- Direct emissions of air, water and soil pollutants, e.g. main air pollutants like CO, NOx, SOx, etc.
- Maintenance (for example lubrication but not reinvestment of components)
- Reserve power and reserve heat including test operation.
- Transportation by-products
- Handling/treatment/deposition of fuel-related waste such as ash or by-products from flue gas cleaning
- Handling/treatment/deposition of other operational waste.

Core infrastructure:

- Energy conversion plant building and other infrastructure including, digging, foundations, roads, etc., within the site, and respective construction processes.
- Machinery, cables, flue gas cleaning and waste water treatment equipment and other equipment and reserve power
- CO_2 absorber, air separator, compressor etc. in case of CCS
- Gasifier in the case of gasification
- Pipeline and injection station in case of CCS
- Fuel preparation equipment (e.g. mill, dryer) and fuel storage facilities at energy conversion plant site
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs
- Facilities for handling of waste, residues and wastewater
- Reinvestments of material and components during the estimated technical service life

Biogas plants based on energy crops, organic waste, dung and manure

Core operation:

- Energy conversion process of plant(s)

[12] For further information on waste incineration, see chapter 4.6.1 and 4.6.2

- Direct emissions of air, water and soil pollutants, e.g. main air pollutants like CO, NOx, SOx, etc.
- Maintenance (for example lubrication but not reinvestment of components)
- Reserve power and reserve heat including test operation.
- Transportation inputs and outputs
- Handling/treatment/deposition of other operational waste

Core infrastructure:

- Energy conversion plant building and other infrastructure including, digging, foundations, roads, etc., within the site, and respective construction processes.
- Machinery, cables, flue gas cleaning and waste water treatment equipment and other equipment and reserve power
- Power plant transformer
- Gas cleaning
- Connection to the power grid, district heating network
- Facilities for handling of incoming biomass, waste, residues, and wastewater
- Reinvestments of material and components during the estimated technical service life

Nuclear technologies

Core operation:

- Energy conversion process of plant(s)
- Direct emissions of air, water and soil pollutants (e.g. nuclear emissions)
- Maintenance (for example lubrication but not reinvestment of components)
- Reserve power and reserve heat including test operation.
- Transportation of waste
- Handling/treatment/deposition of spent nuclear fuel and other radioactive waste.
- Handling/treatment/deposition of other operational waste

Core infrastructure:

- Reactor building and other infrastructure including digging, foundations, roads etc within the site, and respective construction processes.
- Reactor, machinery, cables, tubes and other equipment for the conversion process and reserve power
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs
- Facilities for handling of radioactive waste (on site and elsewhere) and facilities on site for handling of waste, residues and wastewater
- Reinvestments of material and components during the estimated technical service life

Hydropower technologies

Core operation:

- Energy conversion process of plant(s) including estimated need of oil, hydraulic liquids and fat as well as potential emissions thereof to the waterways based on the technical standard of the hydropower plant during the validity of the EPD.
- Direct emissions of air, water and soil pollutants (e.g. methane from storages)
- Maintenance (for example lubrication, reinvestment of components is part of the core infrastructure).
- Pump electricity in case of pumped storage

- Inspection trips
- Reserve power including test operation.
- Transportation of waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Energy conversion plant building and other infrastructure including, digging, foundations, roads, etc., on site.
- Machinery, cables and other equipment for the conversion process and reserve power
- Dams, water reservoirs and water ways
- Pump station (in case of pumped storage)
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs
- Emissions from inundated land (CO_2, CH_4, COD)

If dismantling is not probable (for example large-scale hydropower) the end of life including dismantling and restoration of land, dams and waterways to some natural conditions may be excluded. In such case the estimated technical service life is the time after which 100% of upgrading and reinvestment has taken place, i.e. 100 % of the machinery and 100 % of concrete in waterways and dams have been replaced including the need for refurbishing groundwork, digging, and transportation of filling material etc. This means that a functional plant is an output of the life cycle.

Wind power technologies

Core operation:

- Energy conversion process of plant(s) including estimated need of oil, hydraulic liquids and fat based on the technical standard of the wind power plant during the validity of the EPD
- Maintenance (for example lubrication but not reinvestment of components) including inspection trips.
- Reserve power including test operation.
- Transportation of operational waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Tower incl. cables and transformer
- Nacelle incl. rotor and blades, generator and gear box
- Foundation including groundwork.
- Farm internal power network
- Wind farm transformer station
- Connection to the power network incl. off and onshore sub stations and cables
- Transportation of inputs and outputs
- Facilities for handling of waste, residues, and wastewater
- Reinvestments of material and components during the estimated technical service life

Ocean technologies (wave, tide)

Core operation:

- Energy conversion process of plant(s) including estimated need of oil, hydraulic liquids and fat as well as potential emissions thereof to the water based on the technical standard of the ocean power plant during the validity of the EPD.
- Maintenance (for example lubrication but not reinvestment of components) including inspection trips.

- Reserve power including test operation.
- Transportation of operational waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Main body, including housing, absorber and ballast.
- Moorings (lines, buoys, anchor, foundation)
- Power take off
- Power plant transformer
- Internal power network
- Wave farm transformer
- Connection to the power network incl. off and onshore sub stations and cables
- Transportation of inputs and outputs
- Facilities for handling of waste, residues and wastewater
- Reinvestments of material and components during the estimated technical service life

Solar technologies (photovoltaic and thermal electric)

Core operation:

- Energy conversion process of plant(s)
- Maintenance (for example cleaning and inspection but not reinvestment of components)
- Electricity for operation of solar collectors
- Reserve power including test operation
- Transportation of operational waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Solar cells, solar collectors, mirrors
- Machinery (motors) and cables
- Mechanical BOS (Balance of system) such as frames, fastening devices, support racks, mounting structures, water storage tanks etc.
- Electrical BOS such as inverter, wiring, switches, batteries etc.
- Other infrastructure including, ground preparation, foundations, roads etc.
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs

Electrochemical processes

Core operation:

- Energy conversion process of plant(s)
- Fuel preparation at energy conversion site e.g. for marine application:
- Fuel bunkering (e.g. pumping, lifting tanks, etc.).
- Fuel storage (e.g. tank used, necessary adjustments to vessel configuration compared to conventional vessels, etc.)
- Maintenance (for example changing filters in the fuel system, lubrication)

- Test operations of reserve power and reserve heat (if relevant)
- Transportation of operational waste
- Handling/treatment/storage of operational waste

Core infrastructure:

- Energy conversion unit (stack, reformer, methanator, etc.)
- Energy conversion plant building and other infrastructure including, digging, foundations, roads etc. within the site, and respective construction processes
- Enclosure of the fuel cell unit
- Machinery, cables and other equipment for the conversion process and reserve power
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs
- Facilities for handling of waste, residues or wastewater

Ambient heat, waste heat from other processes and electricity (geothermal technologies, heat pumps and electric boilers)

Core operation:

- Energy conversion process of plant(s)
- Direct emissions of air, water and soil pollutants (e.g. refrigerants)
- Maintenance (for example lubrication or refill of cooling media but not reinvestment of components)
- Reserve power and reserve heat including test operation
- Transportation of waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Energy conversion plant building and other infrastructure including, digging, foundations, roads etc. within the site, and respective construction processes
- Machinery, cables and other equipment for the conversion process and reserve power
- Hot/cold water preparation equipment
- Power plant transformer
- Connection to the power network
- Transportation of inputs and outputs
- Facilities for handling of waste, residues and wastewater
- Reinvestments of material and components during the estimated technical service life

Cooling

Core operation:

- Energy conversion process of plant(s)
- Direct emissions of air, water and soil pollutants (e.g. refrigerants)
- Maintenance (for example lubrication or refill of cooling media but not reinvestment of components)
- Reserve power and reserve heat including test operation
- Transportation of waste
- Handling/treatment/deposition of operational waste

Core infrastructure:

- Energy conversion plant building and other infrastructure including, digging, foundations, roads etc. within the site, and respective construction processes
- Machinery, cables and other equipment for the conversion process and reserve power
- Equipment
- Power plant transformer
- Connection to the cooling network
- Transportation of inputs and outputs
- Facilities for handling of waste, residues and wastewater
- Reinvestments of material and components during the estimated technical service life

4.7.3.3. Downstream processes

For downstream processes modelled with specific data, generation of electricity used shall be accounted for in this priority:

1. Specific electricity mix as generated, or purchased from an electricity supplier, demonstrated by a Guarantee of Origin or similar as provided by the electricity supplier.
2. Residual electricity mix of the electricity supplier on the market.
3. Residual electricity mix on the market[13].
4. Electricity consumption mix on the market[14].

The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total consumption mix.

"The market" in the above hierarchy shall be defined as being the (residual or consumption) grid mix of the country where the electricity is used, with exceptions for specified countries for which a sub-national electricity grid mix shall be used: Australia, Brazil, Canada, China, India, and USA.

The mix of electricity used in downstream processes shall be documented in the EPD, where relevant.

The technical service life of the infrastructure shall be defined. The reference flow for infrastructure shall be calculated, as the technical service lifetime multiplied by the amount of kWh distributed in the system during an annual average of a reference period.

Input data may be collected from databases or other sources.

The customer of the EPD shall be defined (see Section 4.1) and in the downstream stage it shall be verified how losses to the customer are calculated. A sensitivity analysis shall be made to justify the chosen voltage level for the intended customer.

Downstream operation

Specific data shall be used for distribution losses in steam and hot/cold water distribution systems.

Specific data should be used for typical transmission and distribution losses in the power networks used for delivery of electricity to different customers, defined with respect to connection voltages.

Generic data may be used for operation and maintenance of the distribution systems including transportation and specific emissions of e.g. oil, Zn, Cd, SF_6, and transportation.

Downstream infrastructure

The need for reinvestments for downstream processes during the technical service life should be estimated and included in the LCA.

Infrastructure of the distribution system, construction, reinvestments and decommissioning (end-of-life) shall be included. Examples include:

[13] The composition of the residual grid mixes on the market are available for all EU countries and a few additional European countries through the Association for Issuing Bodies (AIB) at https://www.aib-net.org/facts/european-residual-mix.

[14] For electricity markets without trade of Guarantees of Origin (or similar), the residual mix will, however, be identical to the consumption mix.

- Power lines and power poles
- Cables
- Switch yards and transformer stations
- Pipes and pumps
- Ground work

Generic data may be used for:

- material composition of distribution system,
- reinvestment rates normally applied,
- manufacture of construction materials and chemicals,
- transportation distances,
- transportation services (fuel use and emissions in conjunction with transportation),
- construction services,
- dismantling services,
- waste treatment processes,
- national or regional mixes for electricity generation, and
- resource use and emissions in conjunction with electricity used during the construction/reinvestment/dismantling processes.

4.7.4 DATA QUALITY DECLARATION

EPDs may include a declaration of the quality of data used in the LCA calculations.

4.8 ENVIRONMENTAL PERFORMANCE INDICATORS

The EPD shall declare the default environmental performance indicators and their methods as described at the website (www.environdec.com/indicators), which includes both inventory indicators and indicators of potential environmental impact. The source and version of the impact assessment methods and characterisations factors used shall be reported in the EPD. Also other indicators may be declared, if justified, see Section 5.4.5.

If the default list of environmental performance indicators and methods on www.environdec.com/indicators is updated, the previous version of the list is valid in parallel to the new version during a transition period of at least 90 days, as described at the website.

In addition to the default environmental performance indicators listed at the website, the indicator Particulate Matters (PM) shall be declared, see Section 5.4.4.1.

In case of results for multiple downstream scenarios for multiple customers (see section 4.1), the main scenario shall be clearly denoted along with a description of the differences between the declared scenarios.

Apart from inventory indicators (such as the required and optional inventory indicators listed on www.environdec.com/indicators), other inventory data may also be declared in the EPD, if relevant and useful for EPD users. Such data shall not be declared in the main body of the EPD, but in an annex. In addition to above, results according to the version 1.0 of the default list of environmental performance indicators on www.environdec.com/indicators may be presented in a subsection of the environmental performance section of the EPD to assist EPD users in understanding the differences due to the change in indicators. It shall be made clear that these results have been calculated using an old version of the default list of indicators.

4.8.1 SPECIFIC CALCULATION RULES FOR GHG EMISSIONS

4.8.1.1. Land use and land use change (GWP-luluc)

Carbon emissions and removals due to land use change, e.g. from high carbon stock land (forest) to lower carbon stock land, shall be modelled following the guidelines of PAS 2050:2011 (BSI 2011). Unless specific land use change values are available, default values for different countries according to PAS 2050:2011 Annex C shall be used. There is a lot of research going on in this area and other

references may be more relevant later on. For countries[15] not listed in PAS 2050:2011, default values provided by the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) may be applied. Values used and source of data shall be documented and made available to the verifier.

For infrastructure, however, the following 20-year rule of PAS 2050:2011 does not apply: "Where it can be demonstrated that the land use change occurred more than 20 years prior to the assessment being carried out in accordance with this PAS, no emissions from land use change should be included in the assessment as all emissions resulting from the land use change would be assumed to have occurred prior to the application of the PAS."

For guidance on calculation of GHG emissions due to impoundment and inundation, see Annex 2.

4.8.1.2. The analysed period for LULUC shall at least cover the crops rotation period, but not longer than 100 years.Carbon capture and sequestration or replacement

If CO_2 is captured and sequestered or sold to be used as a replacement of CO_2 produced with other methods, this shall follow guidance in the General Programme Instructions and/or on www.environdec.com. If used, this shall be clearly stated in the EPD.

Future versions of this PCR may provide additional rules.

4.9 INCLUDING MULTIPLE PRODUCTS IN THE SAME EPD

4.9.1 MULTIPLE PRODUCTS FROM THE SAME COMPANY

Several sets of results, reflecting different products, are not allowed to be declared in the same EPD. However, similar products from a single or several manufacturing sites covered by the same PCR and manufactured by the same company with the same major steps in the core processes may be grouped and thereby included in the same EPD. For such an EPD, there are three options:

- For each indicator, declare the average results of the included products. This average shall be weighted according to the production volumes of the included products, if relevant. In this option, the average content shall be declared in the content declaration.
- Declare the results of one of the included products – a representative product. The choice of the representative product shall be justified in the EPD, using, where applicable, statistical parameters. For example, the choice may be based on production volumes. In this option, the content of the representative product shall be declared in the content declaration.
- For each indicator, declare the highest result of the included products (i.e., the results of a "worst-case product", which may be the results of one or several of the included products). In this option, the content declaration shall include the lowest amounts of recycled and biogenic content of the included products and their packaging, respectively, and the information on environmental and hazardous properties of substances shall reflect the highest share and most hazardous such substances contained in the any of the included products.

The first two options are only possible if none of the declared environmental impact indicator results differ by more than 10% between any of the included products. The third option is possible also if variations are larger than 10%.

The option chosen shall be clearly described in the EPD.

Note that above paragraphs concern grouping of similar products, but not grouping of identical products (e.g., produced at different manufacturing sites or at different production lines at one site). Identical products here refer to products which are not marketed as different products and/or are in no other way distinguishable by a downstream customer (e.g., by colour, size, content or configuration). For identical products, variations due to, for example, manufacturing at several sites shall be treated as any other variation in production, by averaging over a production period and in such cases, variations above 10% are allowed.

4.9.2 SECTOR EPDS

The International EPD System allows for an industry association to develop an EPD in the form of a Sector EPD. A Sector EPD declares the average product of multiple companies in a clearly defined sector in a clearly defined geographical area. Products covered in a sector EPD shall follow the same PCR and the same declared/functional unit shall be applied.

[15] PAS 2050:2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

Any communication of the results from a Sector EPD should contain the information that the results are based on averages obtained from the sector as defined in the EPD. The communication shall not claim that the sector EPD results are representative for a certain manufacturer or its product.

The following information shall also be included in a Sector EPD:

- a list of the contributing manufacturers that the Sector EPD covers,
- a description of how the selection of the sites/products has been done and how the average has been determined, and
- a statement that the document covers average values for an entire or partial product category (specifying the percentage of representativeness) and, hence, the declared product is an average that is not available for purchase on the market.

5 CONTENT AND FORMAT OF EPD

EPDs based on this PCR shall contain the information described in this section. Flexibility is allowed in the formatting and layout provided that the EPD still includes the prescribed information. A generic template for EPDs is available at www.environdec.com.

The EPD content shall:

- be in line with the requirements and guidelines in ISO 14020 (Environmental labels and declarations – General principles),
- be verifiable, accurate, relevant and not misleading, and
- not include rating, judgements or direct comparison with other products[16].

An EPD should be made with a reasonable number of pages for the intended audience and use.

The content of EPDs published in machine-readable format shall correspond with the content of the underlying EPD.

5.1 EPD LANGUAGES

EPDs should be published in English, but may also be published in additional languages. If the EPD is not available in English, it shall contain an executive summary in English including the main content of the EPD. This summary is part of the EPD and thus subject to the same verification procedure.

5.2 UNITS AND QUANTITIES

The following requirements apply for units and quantities:

- The International System of Units (SI units) shall be used, e.g., kilograms (kg), Joules (J) and metres (m). Reasonable multiples of SI units may be decided in the PCR to improve readability, e.g., grams (g) or megajoules (MJ). The following exceptions apply:
  - Resources used for energy input (primary energy) should be expressed as kilowatt-hours (kWh) or megajoules (MJ), including renewable energy sources, e.g., hydropower, wind power and geothermal power.
  - Water use should be expressed in cubic metres (m^3)
  - Temperature should be expressed in degrees Celsius (°C),
  - Time should be expressed in the units most practical, e.g., seconds, minutes, hours, days or years.
  - Results of the environmental performance indicators shall be expressed in the units prescribed by the impact assessment methods, e.g. kg CO_2 equivalents.
- Three significant figures[17] should be adopted for all results, The number of significant digits shall be appropriate and consistent.
- Scientific notation may be used, e.g. 1.2E+2 for 120, or 1.2E-2 for 0.012.
- The thousand separator and decimal mark in the EPD shall follow one of the following styles (a number with six significant figures shown for illustration):
  - SI style (French version): 1 234,56
  - SI style (English version): 1 234.56

  In case of potential confusion or intended use of the EPD in markets where different symbols are used, the EPD shall state what symbols are used for thousand separator and decimal mark.
- Dates and times presented in the EPD should follow the format in ISO 8601. For years, the prescribed format is YYYY-MM-DD, e.g., 2017-03-26 for March 26th, 2017.

[16] Therefore, results of normalization are not allowed to be reported in the EPD.

[17] Significant figures are those digits that carry meaning contributing to its precision. For example with two significant digits, the result of 123.45 shall be displayed as 120, and 0.12345 shall be displayed as 0.12. In scientific notation, these two examples would be displayed as $1.2*10^2$ and $1.2*10^{-2}$.

- The result tables shall:
  - Only contain values or the letters “ND” (Not Declared). It is not possible to specify ND for mandatory indicators. ND shall only be used for voluntary parameters that are not quantified because no data is available.[18]
  - Contain no blank cells, hyphens, less than or greater than signs or letters (except “INA”).
  - Use the value 0 only for parameters that have been calculated to be zero.
  - Footnotes shall be used to explain any limitation to the result value.

5.3 USE OF IMAGES IN EPD

Images used in the EPD, especially pictures featured on the cover page, may in themselves be interpreted as an environmental claim. Images such as trees, mountains, wildlife that are not related to the declared product should therefore be used with caution and in compliance with national legislation and best available practices in the markets in which the EPD is intended to be used.

5.4 EPD REPORTING FORMAT

The reporting format of the EPD shall include the following sections:

- Cover page (see Section 5.4.1)
- Programme information (see Section 5.4.2)
- Product information (see Section 5.4.3)
- Environmental performance (see Section 5.4.4)
- References (see Section 5.4.8)

The following information shall be included, when applicable/relevant:

- Additional environmental information (see Section 5.4.5)
- Differences versus previous versions (see Section 5.4.7)
- Executive summary in English (see Section 5.4.9)

The following sections may be included:

- Additional social and economic information (see Section 5.4.6)

5.4.1 COVER PAGE

The cover page shall include:

- Product name and image,
- Name and logotype of EPD owner,
- The text “Environmental Product Declaration” and/or “EPD”
- *Programme: The International EPD System, www.environdec.com,*
- *Programme operator: EPD International AB*
- Logotype of the International EPD System,
- EPD registration number as issued by the programme operator[19],
- *Date of publication (issue): 20XX-YY-ZZ,*

[18] This requirement does not intend to give guidance on what indicators are mandated (“shall”) or voluntary.

[19] The EPD shall not include a “registration number” if such is provided by the certification body, as this may be confused with the registration number issued by the programme operator.

- *Date of revision: 20XX-YY-ZZ*, when applicable,
- *Date of validity; 20XX-YY-ZZ*
- A note that "*An EPD should provide current information, and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com*."
- A statement of conformity with ISO 14025,
- For EPDs covering multiple products: a statement that the EPD covers multiple products and a list of all products covered by the EPD.
- For Sector EPDs: a statement that the EPD is a Sector EPD.

In the case of EPDs registered through a regional hub (a regional or national programme based on and fully aligned with the International EPD System through an agreement with the programme operator), "Programme", "Programme operator", and "Logotype" shall be expanded to include a reference to the regional programme and the organisation responsible for it.

Where applicable, the cover page shall also include the following information:

- Information about dual registration of EPD in another programme, such as registration number and logotype.
- A statement of conformity with other standards and methodological guidelines.

5.4.2 PROGRAMME INFORMATION

The programme information section of the EPD shall include:

- Address of programme operator: *EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden, E-mail: info@environdec.com*
- The following statement on the requirements for comparability of EPDs, adapted from ISO 14025: *"EPDs within the same product category but from different programmes may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison."*
- A statement that the EPD owner has the sole ownership, liability and responsibility of the EPD
- Information about verification[20] and reference PCR in a table with the following format and contents:

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
PCR: *<name, registration number, version and UN CPC code(s)>*
PCR review was conducted by: *<name and organisation of the review chair, and information on how to contact the chair through the programme operator>*
Life Cycle Assessment (LCA)
LCA accountability: *<name, organization>*
Third-party verification

[20] If the EPD has been verified by an approved individual verifier who has received contractual assistance from a certification body that is not accredited, this certification body shall not be included in this table.

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☐ EPD verification by individual verifier Third-party verifier: *<name, organisation, and signature of the third-party verifier>* Approved by: The International EPD System
OR
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☐ EPD verification by accredited certification body Third-party verification: *<name, organisation>* is an approved certification body accountable for the third-party verification The certification body is accredited by: *<name of accreditation body & accreditation number, where applicable>*
OR
Independent third-party verification of the declaration and data, according to ISO 14025:2006 via: ☐ EPD verification by EPD Process Certification* Internal auditor: *<name, organisation>* Third-party verification: *<name, organisation>* is an approved certification body accountable for third-party verification Third-party verifier is accredited by: *<name of accreditation body & accreditation number, where applicable>* *For EPD Process Certification, an accredited certification body certifies and reviews the management process and verifies EPDs published on a regular basis. For details about third-party verification procedure of the EPDs, see GPI v4, Section 7.5.
Procedure for follow-up of data during EPD validity involves third-party verifier: ☐ Yes ☐ No

5.4.3 PRODUCT INFORMATION

The product information section of the EPD shall include:

- Address and contact information to EPD owner,
- Description of the organisation. This may include information on products- or management system-related certifications (e.g. ISO 14024 Type I environmental labels, ISO 9001- and 14001-certificates and EMAS-registrations) and other relevant work the organisation wants to communicate (e.g. SA 8000, supply-chain management and social responsibility),
- Name and location of production site,
- Product identification by name, and an unambiguous identification of the product by standards, concessions or other means,
- Identification of the product according to the UN CPC scheme system. Other relevant codes for product classification may also be included, e.g.
    - Common Procurement Vocabulary (CPV),
    - United Nations Standard Products and Services Code® (UNSPSC),
    - Classification of Products by Activity (NACE/CPA) or

- Australian and New Zealand Standard Industrial Classification (ANZSIC), or
- Global Trade Item Number (GTIN).

- a description of the product,
- a description of the technical purpose of the product, including its function (see Section 4.1),
- a description of the background system, including the main technological aspects, Geographical scope of the EPD, i.e., for which geographical location(s) of use and end-of-life the product's performance has been calculated,
- the functional unit and technical service life,
- declaration of the year(s) covered by the data used for the LCA calculation and other relevant reference years,
- reference to the main database(s) for generic data and LCA software used, where relevant,
- system diagram of the processes included in the LCA, divided into the life cycle stages,
- description that the EPD system boundary is "cradle-to-grave",
- information on which life cycle stages are not considered (if any), with a justification of the omission, and
- references to any relevant websites for more information or explanatory materials

This section may also include:

- Name and contact information of organisation carrying out the underlying LCA study, and
- additional information about the underlying LCA-based information, such as assumptions, cut-off rules, data quality and allocation.

5.4.4 ENVIRONMENTAL PERFORMANCE

Below subsections list the mandatory environmental performance indicators to declare in the EPD. LCA results based on additional indicators may be declared, if they are relevant for the product category, their inclusion is justified in the EPD, appropriate methods[21] are used, and the results are verifiable. If the additional indicators appear to the reader to display duplicate information, the EPD shall contain an explanation of the differences between the declared indicators.

In addition to the main environmental performance results, this section may declare additional LCA results using an alternative allocation method. The subsection with additional LCA results shall clearly describe the method used to calculate the results, including how it differs from the method of the main environmental performance results.

The EPD shall state the following in the environmental performance section (the statement shall be adjusted to fit the scope EPD, i.e. whether it is on electricity, steam and/or water): "The total results for the product life cycle are expressed per functional unit, i.e. the delivery of 1 kWh electricity [or: steam/water] to the customer. But as production of distribution losses are assigned to the downstream stage, the cradle-to-gate (upstream and core) results reflect the generation of 1 kWh net of electricity [or: the generation of 1 kWh of steam/water]."

5.4.4.1. Environmental impact indicators

The EPD shall declare the environmental impact indicators, per functional unit, per life-cycle stage and in aggregated form, using the default impact categories, impact assessments methods and characterisation factors available at www.environdec.com/indicators. The source and version of the impact assessment methods and characterisation factors used shall be reported in the EPD.

Alternative regional life cycle impact assessment methods and characterisation factors may be calculated and displayed in addition to the default list. If so, the EPD shall contain an explanation of the difference between the different sets of indicators, as they may appear to the reader to display duplicate information.

Particulate matter (PM) based on ReCiPe 2016 v1.1 Midpoint (H), Fine Particulate Matter Formation, shall be included as an additional indicator for combustion technologies.

[21] If any of the following impact categories are declared in the EPD, the corresponding characterisation methods listed in EN 15804 should be used: particulate matter emissions, ionizing radiation (human health), eco-toxicity (freshwater), human toxicity (cancer effects), human toxicity (non-cancer effects) and land use related impacts/soil quality. If these impact categories and characterisation methods are used, the corresponding disclaimers listed in EN 15804 shall be declared in the EPD.

5.4.4.2. Use of resources

The EPD shall declare the mandatory (with the below possible exception), and may declare the optional, indicators for resource use listed at www.environdec.com/indicators per functional unit, per life-cycle stage (upstream, core and downstream) and in aggregated form.

Notes:

- If indicators for primary energy use are assessed as not relevant, these indicators can be set as ND (not declared). The assessment shall be explained in the EPD.
- Nuclear power shall be reported among the non-renewable primary energy resources.

5.4.4.3. Waste production and output flows

Waste generated along the whole life cycle production chains shall be treated following the technical specifications described in the GPI. The indicators in Table 3 and Table 4 shall be reported per functional unit, and per life cycle stage and in aggregated form. In addition to the indicators in the below tables, the additional optional indicators for waste production and output flows listed on www.environdec.com/indicators may be included in the EPD.

Table 3 Indicators describing waste production for core processes.

PARAMETER	UNIT	CORE
Hazardous waste disposed total	kg	
- including depleted uranium (UF_6) in case of nuclear power	g	
Non-hazardous waste disposed total	kg	
- including ash, in case of combustion technologies	kg	
- including gypsum, in case of combustion technologies	kg	
- Including inert (rock, sand etc.)	kg	
Radioactive waste disposed[22] total	kg	
- including high-level radioactive waste in case of nuclear power	kg	
- including low and medium-level radioactive waste in case of nuclear power	kg	

Table 4 Indicators describing waste production for upstream and downstream processes.

PARAMETER	UNIT	UPSTREAM	DOWNSTREAM	TOTAL
Hazardous waste disposed total	kg			
- including Depleted uranium (UF6) in case of nuclear power	g			
Non-hazardous waste disposed	kg			
- including Inert (rock, sand etc.)	kg			
Radioactive waste disposed	kg			
- including low-level, no treatment (such as mining/milling wastes), in case of nuclear power	kg			
Volume of final repository necessary to deposit radioactive waste emanating from nuclear electricity used in up-and downstream processes, in case of nuclear power	m3			

[22] Defined according to the relevant international, European and national legislation (EURATOM, IAEA, etc.). The legal definition of the different categories of nuclear waste shall be given.

Notes:

- If the waste indicators in above tables are assessed as not relevant, the parameters can be set to ND (not declared). The assessment shall be explained in the EPD.
- The indicators include waste after disposal or waste that remains after 100 years.

Section Notes:

- Some of the LCI indicators listed at www.environdec.comIndicators, such as exported energy, are generally not applicable for this product category. If so, the results should be set to ND (not declared)
- The indicators are calculated on the gross amounts leaving the system boundary of the product system in the LCI. If, e.g., there is no gross amount of "exported energy, electricity" leaving the system boundary, this indicator is set to 0 while if not applicable it is set to ND (not declared).
- The indicator "Materials for energy recovery" does not include waste for incineration, but only secondary fuels meeting end of waste criteria.

5.4.5 ADDITIONAL ENVIRONMENTAL INFORMATION

Under this heading, information that is not part of the LCA but identified as an important environmental aspect of the product or information asked for by customers and other stakeholders, shall be declared. Any literature reference or methodology used to acquire and describe additional environmental information shall be openly accessible and made available to the verifier.

For the product category UN CPC 171 the following issues shall be addressed.

- Radiology: in the case of nuclear power, during normal operation in the reference year/period in the main life cycle stages fuel production, operation of energy conversion plant, and management of fuel residues expressed as dose in mSv.
- Risk related issues:
  - Radiology and human toxicological risks
  - Environmental risks:
    - Mishaps with environmental impact, that happen less frequent than once in three years should be identified and the impacts quantified.
    - Potential undesired events with high or very high impact but low or minute probability (e.g. nuclear reactor meltdown, dam bursts, etc.) shall be identified and described qualitatively.
- Electro Magnetic Fields:
  - Description of the producer's measures to keep fields low and some information on limits and recommendations by different bodies.
- Noise
- Land use:
  - Land use and land use change expressed in square meters of specified land category according to Corine Land Cover Classes, level one at a minimum (5 classes) (https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html) before and after exploitation where before is the area in the situation before the start of the activities within the lifecycle and after is the area in the time period corresponding to the validity of the EPD. Focus is on the core stage meaning that all core stage land use shall be classified but also land exploited by fuel suppliers (mining, forestry or agriculture) shall be quantified and classified. Other significant land use in up- and downstream processes should be included.
  - Number of years that the areas are occupied expressed as the area occupied per year of operation.
  - Description of activities on the occupied areas.
- Impacts on biodiversity:
  - Direct regional impacts concerning nature conservation issues like biodiversity and visual impact connected to land use.

For the product category UN CPC 171 and 173 the following issues should be addressed:

- Radiology:

- In case of power technologies other than nuclear power, radiology should be addressed qualitatively, at a minimum, where relevant (for example coal extraction).

- Acidification due to use of forest residues:
  - Should be addressed qualitatively where relevant.

For the product category UN CPC 171 and 173 the following issues may be addressed:

- Land use:
  - Qualitative description of potential impacts on indigenous people and their traditional activities as hunting, reindeer breeding, etc.
  - Esthetical issues
- Impacts on biodiversity:
  - Measures for ecological compensation.
- Radiology:
  - Proliferation precautions may be addressed.

An EPD may declare additional environmentally relevant information, in addition to the LCA results of the section on environmental performance results. The additional environmental information may cover various aspects of specific relevance for the product, for example a more detailed description of an organisation's overall environmental work, in addition to the information listed under Section 5.4.3, such as:

- the existence of any type of organised environmental activity, and
- information on where interested parties may find more details about the organisation's environmental work.

5.4.6 ADDITIONAL SOCIAL AND ECONOMIC INFORMATION

The EPD may also include other relevant social and economic information as additional and voluntary information. This may be product information or a description of an organisation's overall work on social or economic sustainability, such as activities related to supply chain management or social responsibility.

Any additional social and economic information declared shall be substantiated and verifiable, and be derived using appropriate methods and be specific, accurate, not misleading, and relevant to the specific product. Quantitative information is preferred over qualitative information.

5.4.7 DIFFERENCES VERSUS PREVIOUS VERSIONS

For EPDs that have been updated, the following information shall also be included:

- a description of the differences versus previously published versions, e.g. a description of the percentage change in results and the main reason for the change, and
- a revision date on the cover page.

5.4.8 REFERENCES

A reference section shall be included, including a list of all sources referred to in the EPD, including the GPI (including version number), and PCR (registration number, name, and version) used to develop the EPD.

5.4.9 EXECUTIVE SUMMARY IN ENGLISH

The executive summary, if included (see Section 5.1), shall contain relevant summarised information related to the programme, product, environmental performance, information related to pre-certified EPDs, and information related to sector EPDs. Besides this, further information may be added such as additional environmental, social or economic information, references as well as differences versus previous EPD versions.

6 LIST OF ABBREVIATIONS

ANZSIC	Australian and New Zealand standard industrial classification
CCS	Carbon capture and storage
CBG	Compressed biogas
COD	Chemical oxygen demand
CPC	Central product classification
CPV	Common procurement vocabulary
EPD	Environmental product declaration
GHG	Greenhouse gas
G-Res	Greenhouse gas reserve
GPI	General programme instructions
GWP	Global warming potential
IHA	International Hydropower Association
INA	Indicator not assessed
ISO	International Organization for Standardization
IPCC	Intergovernmental Panel on Climate Change
LBG	Liquid biogas
LCA	Life cycle assessment
LCI	Life cycle inventory
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
LULUC	Land Use and Land Use Change
NACE/CPA	Classification of products by activity
ND	Not declared
NGL	Natural gas liquids
PCR	Product category rules
PEF	Product environmental footprint
PEFCR	Product environmental footprint category rules
PM	Particulate matter
PPP	Polluter pays principle
RSL	Reference service life
SI	The international system of units
UAS	Unrelated anthropogenic sources
UN	United Nations
UNSPSC	United Nations Standard Products and Services Code®

7 REFERENCES

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EC (2019) Product Environmental Footprint Category Rules (PEFCR): Photovoltaic modules used in photovoltaic power systems for electricity generation. Version: 1.1 Published: 2019-02-12; Time validity: 2020-12-31. Available at: https://wayback.archive-it.org/org-1495/20221004164603mp_/https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm.

EPD China (2022) PCR for Energy Storage Battery, EPDCN-PCR-2022-0005

EPD Norway (2022) PCR − Part B for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials" (NPCR 029 version 1.2). Adopted by the International EPD-system as PCR 2019:14-c-PCR-016 c-PCR-016 Photovoltaic modules and parts thereof (adopted from EPD Norway 2022-04-27). Registered 2022-03-31. Valid until 2025-06-11. Available at: https://www.epd-norge.no/pcr/pcr-register/npcr-029-2022-part-b-for-photovoltaic-modules-references-to-en-15804-a2,

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IPCC (2011) IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

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ISO (2006a) ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures

ISO (2006b) ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework

ISO (2006c) ISO 14044: 2006, Environmental management – Life cycle assessment – Requirements and guidelines

ISO (2018) ISO/TS 14067:2018, Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification and communication

ISO (2017) ISO 21930:2017, Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and services

PAS (2011) PAS 2050:2011. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services, Annex C (normative) Default land use change values for selected countries
http://shop.bsigroup.com/upload/Shop/Download/PAS/PAS2050.pdf

Tekniska verken i Linköping AB (2023) EPD Fjärrvärme från Linköpings fjärrvärmenät. S-P-08296.

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8 VERSION HISTORY OF PCR

VERSION 1.0, 2007-10-31

- Original version.

VERSION 2.0, 2011-12-05

- Major revision according to the General Programme Instructions version 1.0.
- Extended validity
- New template used

VERSION 2.01, 2011-12-05

- Minor editorial changes

VERSION 2.02, 2013-07-17

- Minor editorial changes and use of the latest PCR template.

VERSION 3.0, 2015-02-05

- Renewed validity
- Compliance with version 2.01 of the General Programme Instructions
  - Updated General introduction
  - Updated General information
  - Updated environmental indicators
  - etc.
- Updated Special Technology specific Allocation rules for Hydro power, enabling allocation to other products and services.
- Updated requirements for updating of core infrastructure data in relation to a renewed EPD.
- Geographical scope
- Specification of GWP calculations
- Editorial changes

VERSION 3.1, 2019-01-14

- Prolonged validity

VERSION 4.0, 2020-03-15

- Renewed and prolonged validity
- Adaptation to new basic module
- Removed town gas from list of products
- Compliance with version 3.01 of the General Programme Instructions
- Updated allocation rules for combustion plants and hydro power
- Biogas plants included and allocation principles set

- Updated reference values in appendices
- Removed appendix (Annex 4: Efficiency reference values for separate production of electricity and heat)
- Editorial changes

VERSION 4.1, 2020-11-10

- Clarifications regarding the calculation of GWP-luluc in Section 4.8.1.1.
- Changed requirements regarding the calculation of greenhouse gas emissions due to impoundment and inundation in Annex 4.

VERSION 4.11, 2020-11-16

- Corrected error in Section 4.10.4.2, that the exception to the 20-year rule of PAS 2050:2011 applies for all infrastructure, and not only core infrastructure.

VERSION 5.0.0, 2024-07-02

- Compliance with GPI version 4.0, with new headings, new standard texts and restructuring of the PCR.
- Clarified functional unit, see Section 4.1.
- Changes and clarifications on the rules for modelling of infrastructure and capital goods have been made, see Section 4.3.1.4.
- Reference to “Basic module” removed.
- Text on “Requirements for comparability between EPDs” added.
- Environmental impact categories and indicators are removed and instead referenced to the website (www.environdec.com/indicators).
- Co-product allocation now in line with the proposed coming GPI 5 and more similar to EN15804.
- Annex 1 on energy wares has been removed.
- Clarification that technical service lifetimes are not mandatory to use if documentation shows other service life.
- Priority for modelling of electricity in downstream included, similar to core and upstream as downstream processes in the PCR may be under the control of the EPD owner and a supplier specific mix needs to be allowed.
- Old sections 4.7.3 and 4.9 were merged into Section 4.7.3 to remove inconsistencies and make the PCR easier to read.

VERSION 5.0.1, 2024-12-02

- Clarification statement on multiple scenarios for customers and their declaration of results. See sections 4.1, section 4.3.1.3 and section 4.8.
- Update of references and missing links.

ANNEX 1: ALLOCATION BY THE "ALTERNATIVE GENERATION METHOD"

This Annex provides a description of the allocation method for the distribution of the environmental impact associated with the generation of electricity and heat in a combined heat and power plant. The facility parameters to be used for this allocation are also specified.

1.1 Description of the "Alternative Generation Method"

The Finnish District Heating Association originally developed this allocation method as a proposal for a new and uniform reporting method for European combined heat and power plant generation statistics. The method is still being discussed within Euroheat, Eurostat and Eurelectric. At present there is no uniform standard for the selection of facility parameters.

The method is available in different versions, with varying degrees of complexity of the calculation process. The simplest version is used in this application.

The allocation method is based on the fact that benefits gained from improved fuel utilisation as well as the environmental impacts connected to combined heat and power generation, are distributed between the two products – electricity and heat – in the same proportion as the fuel needed for separate electricity and heat generation processes. The relationship of distribution is expressed as percentage of the fuel needed for each alternative process with respect to the total quantity needed.

The principle behind the allocation method is illustrated below:

Example.

Existing combined heat and power generation plant for which the allocation is to be made:

Electricity generation, net *30 units*

Heat generation, net *60 units*

Alternative generation facilities:

Heat generation η_h *= 90% (no flue gas condensation)*

Electricity generation η_e *= 40%*

Fuel used by alternative electricity generation	*30/0.4 = 75*	
Fuel used by alternative heat generation	*60/0.9 = 67*	
Total fuel used by alternative generation	*142*	
Allocate to electricity:	*75/142*	*=> 53%*
Allocate to heat:	*67/142*	*=> 47%*

Allocate total emissions and divide by the kWh produced of electricity and heat respectively to get specific emissions.

The choice of parameters for the alternative generation facilities has a direct impact on how the environmental impact is distributed. Various alternative approaches exist for the selection of facility data for alternative generation. The following principle shall apply to allocations upon which Environmental Product Declarations are to be based:

- Facility data for the best possible facility performance
- For the same type of technology and fuel as the facility studied.

In the case of co-combustion of several fuels in a facility, it is up to the author of the Life Cycle Assessment to select facility data and to provide justification for the allocation calculations.

1.2 Specific considerations for internal electricity use and infrastructure

The electricity used, internally, in the CHP shall also be split between the products according to the Alternative Generation Method, which means that the net electricity generation is calculated as the gross electricity generation minus the – to electricity allocated - portion of the internally used electricity.

Parts or components of infrastructure exclusively used for the generation of one of the products is allocated to that product to 100 %, e.g. the generator is allocated to electricity and district heat exchanger is allocated to district heat. Infrastructure, necessary for the generation of all products is allocated to the different products according to the Alternative Generation Method.

1.3 Efficiency reference values for separate production of electricity and heat

The below values can be used as default values for allocation.

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ANNEX I

Harmonised efficiency reference values for separate production of electricity

(referred to in Article 1)

In the table below the harmonised efficiency reference values for separate production of electricity are based on net calorific value and standard atmospheric ISO conditions (15 °C ambient temperature, 1,013 bar, 60 % relative humidity).

Category		Type of fuel	Year of construction		
			Before 2012	2012-2015	From 2016
Solids	S1	Hard coal including anthracite, bituminous coal, sub-bituminous coal, coke, semi-coke, pet coke	44,2	44,2	44,2
	S2	Lignite, lignite briquettes, shale oil	41,8	41,8	41,8
	S3	Peat, peat briquettes	39,0	39,0	39,0
	S4	Dry biomass including wood and other solid biomass including wood pellets and briquettes, dried woodchips, clean and dry waste wood, nut shells and olive and other stones	33,0	33,0	37,0
	S5	Other solid biomass including all wood not included under S4 and black and brown liquor.	25,0	25,0	30,0
	S6	Municipal and industrial waste (non-renewable) and renewable/biodegradable waste	25,0	25,0	25,0
Liquids	L7	Heavy fuel oil, gas/diesel oil, other oil products	44,2	44,2	44,2
	L8	Bio-liquids including bio-methanol, bioethanol, bio-butanol, biodiesel and other bio-liquids	44,2	44,2	44,2
	L9	Waste liquids including biodegradable and non-renewable waste (including tallow, fat and spent grain).	25,0	25,0	29,0
Gaseous	G10	Natural gas, LPG, LNG and biomethane	52,5	52,5	53,0
	G11	Refinery gases hydrogen and synthesis gas	44,2	44,2	44,2
	G12	Biogas produced from anaerobic digestion, landfill, and sewage treatment	42,0	42,0	42,0
	G13	Coke oven gas, blast furnace gas, mining gas, and other recovered gases (excluding refinery gas)	35,0	35,0	35,0
Other	O14	Waste heat (including high temperature process exhaust gases, product from exothermic chemical reactions)			30,0
	O15	Nuclear			33,0
	O16	Solar thermal			30,0
	O17	Geothermal			19,5
	O18	Other fuels not mentioned above			30,0

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ANNEX II

Harmonised efficiency reference values for separate production of heat

(referred to in Article 1)

In the table below the harmonised efficiency reference values for separate production of heat are based on net calorific value and standard atmospheric ISO conditions (15 °C ambient temperature, 1,013 bar, 60 % relative humidity).

Category		Type of fuel:	Year of construction					
			Before 2016			From 2016		
			Hot water	Steam (*)	Direct use of exhaust gases (**)	Hot water	Steam (*)	Direct use of exhaust gases (**)
Solids	S1	Hard coal including anthracite, bituminous coal, sub-bituminous coal, coke, semi-coke, pet coke	88	83	80	88	83	80
	S2	Lignite, lignite briquettes, shale oil	86	81	78	86	81	78
	S3	Peat, peat briquettes	86	81	78	86	81	78
	S4	Dry biomass including wood and other solid biomass including wood pellets and briquettes, dried woodchips, clean and dry waste wood, nut shells and olive and other stones	86	81	78	86	81	78
	S5	Other solid biomass including all wood not included under S4 and black and brown liquor.	80	75	72	80	75	72
	S6	Municipal and industrial waste (non-renewable) and renewable/bio-degradable waste	80	75	72	80	75	72
Liquids	L7	Heavy fuel oil, gas/diesel oil, other oil products	89	84	81	85	80	77
	L8	Bio-liquids including bio-methanol, bioethanol, bio-butanol, biodiesel and other bio-liquids	89	84	81	85	80	77
	L9	Waste liquids including biodegradable and non-renewable waste (including tallow, fat and spent grain).	80	75	72	75	70	67
Gaseous	G10	Natural gas, LPG, LNG and biomethane	90	85	82	92	87	84
	G11	Refinery gases hydrogen and synthesis gas	89	84	81	90	85	82
	G12	Biogas produced from anaerobic digestion, landfill, and sewage treatment	70	65	62	80	75	72
	G13	Coke oven gas, blast furnace gas, mining gas, and other recovered gases (excluding refinery gas)	80	75	72	80	75	72

ANNEX 2: GHG EMISSIONS DUE TO IMPOUNDMENT AND INUNDATION

1.1 Water reservoirs

The conversion of a river into a reservoir is often a relevant landscape transformation. The resulting freshwater reservoirs are active sites of carbon processing, such as exchanges from one carbon species to another, mineralisation to different end-products, gas emissions at the air-water interface, sedimentation, and transport to downstream reaches of the hydrological network. From a biogeochemical perspective, the true GHG footprint resulting from the conversion of a river to a reservoir is the difference in net fluxes occurring between the landscape and the atmosphere before and after the landscape transformation, i.e. net GHG footprint. The concept of the net GHG impact of a reservoir is not new but it is important to understand its full meaning.

Net GHG emissions from inundation of freshwater reservoirs shall be estimated following one of the provided methods below. If onsite measurement data are available, this might be used, but the methodological principle given by either of the equations below must be applied. The chosen method shall be specified and use of data and made assumptions described.

ALTERNATIVE 1: G-Res Tool

The GHG Reservoir (G-res) Tool was developed by the International Hydropower Association (IHA) in collaboration with the UNESCO Chair for Global Environmental Change (https://www.hydropower.org/gres). The tool allows companies, investors, consultants, decision-makers and other stakeholders to report on the net GHG emissions from a reservoir. Hence, only the GHG emissions that are attributable to the introduction of the reservoir in a catchment are assessed. This approach is based on the recommendation from the Intergovernmental Panel on Climate Change (IPCC, 2011) that net emissions should be evaluated in determining the impact of reservoir systems.

Net GHG footprint in the G-res tool is defined by the equation below.

Net GHG emissions =

[Post-impoundment GHG balance of the reservoir]

– [Pre-impoundment GHG balance of the reservoir area before its introduction]

– [Emissions from the reservoir due to unrelated anthropogenic sources (UAS)]

GHG emissions due to construction of the dam is also included in the G-res tool, but this is calculated separately according to this PCR (see Core infrastructure in this chapter).

The G-res tool is an open online system and does not require onsite measurements to be undertaken for either the pre- or post-impoundment conditions; instead it uses parameters and data that should be known by project developers and environmental professionals; for example, when planning new reservoirs or assessing existing reservoirs. The tool and supporting guidance and documentation can be accessed at: www.hydropower.org/gres-tool. This includes access to the *G-res tool itself*, *The GHG Reservoir Tool (G-res) GHG status of freshwater reservoirs Technical documentation* (Prairie et al., 2017a) and *The GHG Reservoir Tool (G-res) GHG status of freshwater reservoirs User guide* (Prairie et al., 2017b).

ALTERNATIVE 2: Simplified calculation method using carbon content values

A very simplified method to quantify GHG emissions added through impoundment implies

- measuring of land area inundated due to the construction of the reservoir,
- an estimation of the carbon content of the inundated soil
- an estimation of the degree of degradation of the carbon in the inundated land during 100 years
- an estimation of the share of CO2 formation through capture of O2 in the water by the degraded carbon and an estimation of the share of CH4.formation respectively
- emissions of N2O are neglected

The following formulas should be used:

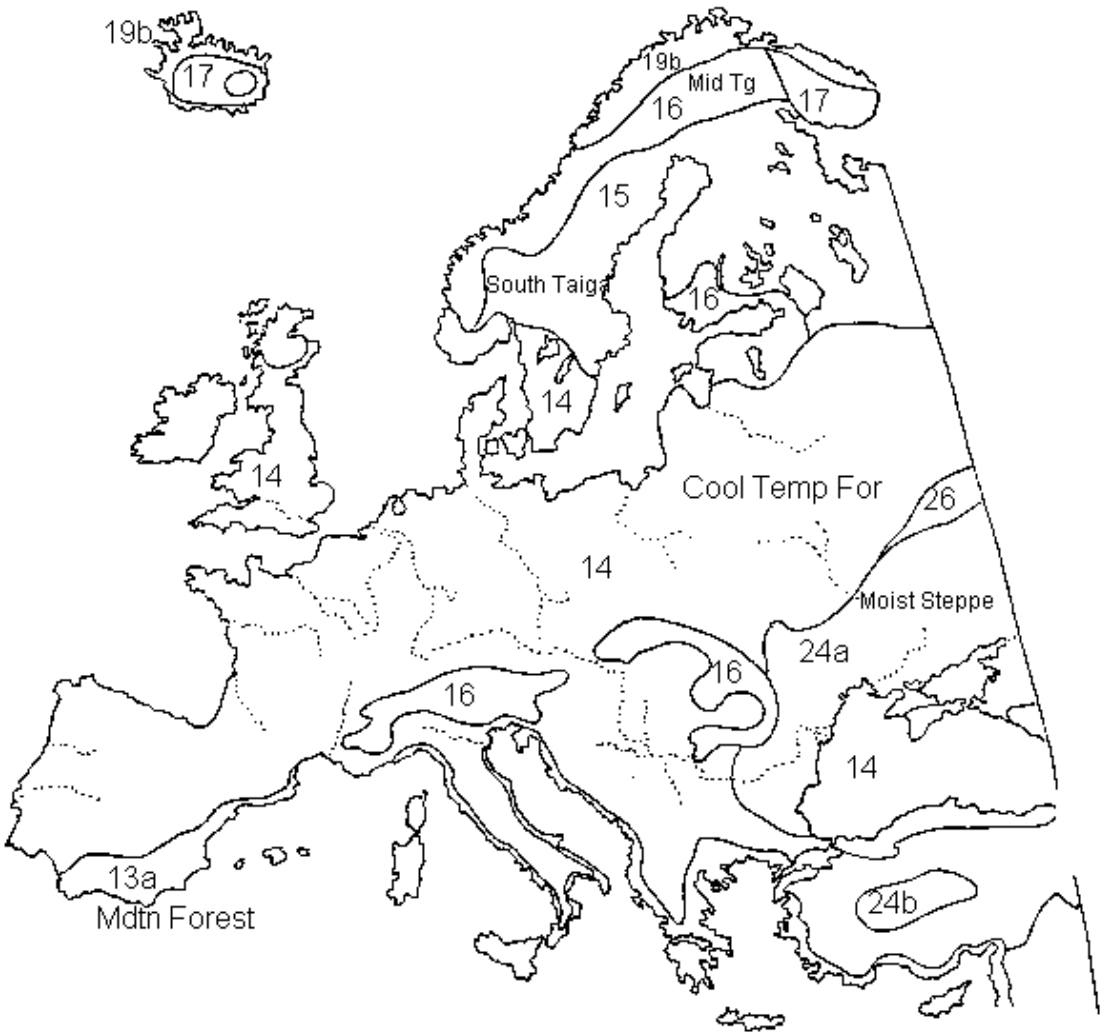
$E_{CH4} = S_{CH4} * C_{degr} * D_{degr} * A_{inund} * m_{CH4}/m_C$ [g]

$E_{CO2} = (100\% – S_{CH4}) * C_{degr} * D_{degr} * A_{inund} * m_{CO2}/m_C$ [g]

$E_{GHG} = E_{CH4} * Characterizationfactor_{CH4} + E_{CO2}$ [g CO_2 equivalents]

Where

E_{CH4}	Emission of CH_4 during 100 years
E_{CO2}	Emission of CO_2 during 100 years
E_{GHG}	Emission of greenhouse gases during 100 years
S_{CH4}	the share in % of the carbon degraded in inundated land that is assumed to form CH_4., depending on carbon content and water depth, see Table B
C_{degr}	the carbon content (g/m^2) of inundated land, See map in Figure A of hypothetical potential ecosystem distribution in Europe for present climates in the absence of anthropogenic disturbance and Table A A summary of suggested average carbon storage in preanthropogenic ('prehistoric') ecosystems. Since vegetation normally is removed before inundation the carbon in soil and litter/debris should be used (source Oak Ridge National Laboratory ORNL, http://www.esd.ornl.gov/projects/qen/carbon1.html)
D_{degr}	the degree of carbon degradation assumed during 100 years, depending on latitude see Table B.
A_{inund}	the area (m^2) of land inundated at the retention water level
m_{CH4}	molar weight CH_4 (16 g/mole)
m_C	molar weight of carbon (C) (12 g/mole)
m_{CO2}	molar weight of CO_2 (44 g/mole)



Reconstructed vegetation cover for both 5000 C14 years ago and present potential.

Figure A See http://www.esd.ornl.gov/projects/qen/eur5_p.gif, also for other parts of the world

Ecosystem type	Vegetation g carbon/m^2	Soil g carbon/m^2	Litter/Debris g carbon/m^2	Total g carbon/m^2
13a) Mediterranean Forest	10 000	8 000	800	18 800
14. Cool Temperate Forest	16 000	14 000	2 500	32 500
15. Southern Taiga	14 000	13 500	1 500	29 000
16. Main Taiga	8 200	21 900	1 500	31 600
17. Open Boreal Woodland	5 000	12 900	1 500	19 400
19b) Lowland Tundra	1 000	21 000	0	22 000
24a) Moist Steppe	1 000	25 000	0	26 000
24b) Dry Steppe	600	7 000	0	7 600
26. Forest-Tundra	1 100	16 600	2 000	19 700

Table A A summary of suggested average carbon storage in preanthropogenic ('prehistoric') ecosystems in Europe. Note that modern-day ecosystems are often depleted in carbon relative to this reconstructed state, due to agriculture and wood-cutting. An error range of approximately +/- 30% is suggested on each value. See http://www.esd.ornl.gov/projects/qen/carbon3.html also for other parts of the world.

Carbon content (g · m^{-2})	Latitude (°N or °S)	Degree of decomposition 100 yrs after flooding (%)	Average reservoir depth (m)	Relative amount of methane of total GHG emissions (%)
<10	>30	50	n/a	0
	<30	80		
10-25	>30	50	>5	0
			<5	1
	<30	80	>5	0
			<5	1
>25	>30	50	>5	0
			<5	1
	<30	80	>5	2
			<5	5

Table B anticipated features of decomposition of carbon at different latitudes http://www.rheoconsult.com/Exp/Rio2005.pdf (All ecosystem types in table A are of the type >25 g carbon/m^2)

References:

- Oak ridge national laboratory ORNL http://www.esd.ornl.gov/projects/qen/carbon1.html

Greenhouse gas emissions from hydroelectric reservoirs: A global perspective, Björn Svensson, SwedPower AB, P.O. Box 527, SE-162 16 Stockholm, Sweden, pp. 25-37, In: dos Santos, M.A. & Rosa, L.P. (Eds.) Global warming and hydroelectric reservoirs. Proceedings of International Seminar on Greenhouse Fluxes from Hydro Reservoirs & Workshop on Modeling Greenhouse Gas Emissions from Reservoir at Watershed Level. Rio de Janeiro, Brazil, 8-12 August 2005. COPPE/UFRJ, Eletrobrás 2005. 197 pp., http://www.rheoconsult.com/Exp/Rio2005.pdf.

ELECTRICITY, STEAM AND HOT/COLD WATER GENERATION AND DISTRIBUTION
PRODUCT GROUP CLASSIFICATION: UN CPC 171 AND 173