PRODUCT CATEGORY RULES (PCR)
DATE 2024-05-03

ELECTRICITY, STEAM AND HOT/COLD WATER GENERATION AND DISTRIBUTION

PRODUCT CATEGORY CLASSIFICATION: UN CPC 171, 173

2007:08
VERSION 4.2.1

VALID UNTIL: 2024-07-16

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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 at 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.

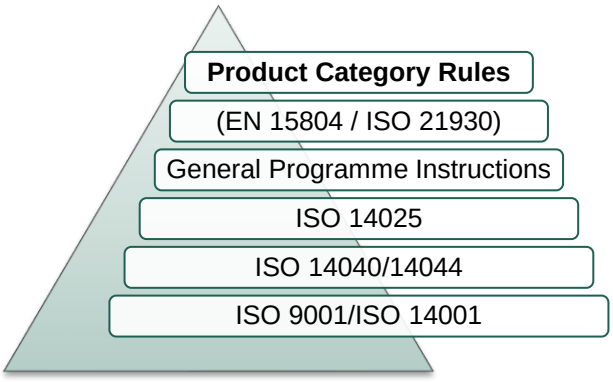


Figure 1 Illustration PCR in relation to the hierarchy of standards and other documents.

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 via www.environdec.com. Stakeholder feedback on PCRs is very much encouraged. Any comments on this PCR document may be given via the PCR Forum at www.environdec.com or sent directly to the PCR moderator 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 4.2.1
Programme:	The International EPD® System
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: info@environdec.com
PCR moderator:	Karin Lundmark, Vattenfall AB, karin.lundmark@vattenfall.com Sara McGowan, Vattenfall AB, sara.mcgowan@vattenfall.com
PCR Committee:	ESU-services Ltd, Axpo, Fortum Oslo Varme AS, EDF, Östfoldforskning, Vattenfall AB
Date of publication and last revision:	2024-05-03 (Version 4.2.1) Version 1.0 was published in 2007. See Section 8 for a version history.
Valid until:	2024-07-16
Schedule for renewal:	A PCR is valid for a pre-determined period of time 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 document and renewing its validity. A PCR document may be revised during its period of validity provided significant and well-justified proposals for changes or amendments are presented. See www.environdec.com for up-to-date information and the latest version.
Standards conformance:	▪ General Programme Instructions of the International EPD® System, version 3.01, based on ISO 14025 and ISO 14040/14044 ▪ PCR Basic Module, CPC Division 17 Electricity, town gas, steam and hot water, version 3.0, dated 2018-05-03 ▪ 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/cool 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)

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/cold water from a district heating/cooling system with several heat/cold water 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 is applicable to be used globally.

2.2.3 EPD VALIDITY

An EPD based on this PCR shall be valid from its registration and publication at www.environdec.com and for a five 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 indicators listed in Section 5.4.4.1,
- 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 info@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

3.2 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, 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:

- *Sara Nilsson, WSP*
- *Sergio Rodriguez, IK Ingenieria*
- *Rob Rouwette, Start2see*
- *Ulla-Karin Wendt, Solvina*
- *Marcus Wendin, Miljögiraff*

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this PCR, existing PCRs were considered in order to avoid overlaps in scope. 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
- Product Environmental Footprint (PEF) http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm#final

No PCRs covering all types of electricity or steam were identified. 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 a pilot project. The PEFCR is in version 1.1, the date of publication was 12 February 2019 and it is valid until 31st December 2020. There are some inherent differences between PEFs and EPDs, including indicators and characterisation factors for environment impacts and requirements on datasets for generic data.

3.4 REASONING FOR DEVELOPMENT OF PCR

This PCR was developed in order 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:

- *See reference list.*

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 net[2] of electricity generated and thereafter distributed to the customer and/or 1 kWh of steam or hot/cold water generated and thereafter 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 functions of the product should be described and explained in the EPD®, separated into bullets.

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 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.

4.2 REFERENCE SERVICE LIFE (RSL)

Reference service life is given for different technologies in Annex 3

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 Sections 4.10.1-4.10.2.10

4.3.1.1. Upstream processes

The upstream module 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 the fence of the conversion plant site.

The following attributional processes are part of the product system and classified as upstream processes:

- Production of fuels
  - Extraction of energy resources from nature

[2] 1 kWh net means that electricity or heat used within the power plant is subtracted from the amount of kWh generated in that plant.

- Processing of fuels
- Preparation of fuels
- Fuel storage operation
- Transport of fuels

- Production of auxiliary inputs
  - Extraction of natural resources for auxiliary inputs (fuels and electricity used by suppliers, materials, chemicals)
  - Production of fuels and electricity used by suppliers and auxiliary materials and chemicals
  - Storage of auxiliary materials and chemicals at energy conversion site
  - Transports 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.

The infrastructure associated with the upstream processes comprise construction and decommissioning of and reinvestments in fuel preparation equipment at the site of the energy conversion plant (dryer, mill, etc.) and suppliers' facilities should be included – exclusion shall be motivated according to cut-off rule described in Section 4.5.

Specific considerations for different technologies are outlined in Sections 4.10.1.

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.

The following attributional processes are part of the product system and classified as core operation:

- Energy conversion process
- Handling/preparation/storage processes of any inputs or outputs of the energy conversion performed by the company
- Maintenance (for example lubrication. Reinvestment of components is included in core infrastructure, see below)
- 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.

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 4.10.2.

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 are included or for thermal energy from delivery point to the distribution system of steam or hot water to the customer central unit.

The use stage of electricity, steam and hot water fulfils various functions in different contexts and is therefore excluded from the downstream module as well as the end-of-life of the products.

4.3.2 OTHER BOUNDARY SETTING

4.3.2.1. Boundary towards nature

Boundaries to nature are defined as flows of material and energy resources from nature into the system. Emissions to air, water and soil cross the system boundary when they are emitted from or leaving the product system.

4.3.2.2. Time boundaries

Input and output data of the core module shall reflect one reference year or an annual average of a defined reference period and be representative during the validity of the EPD.

4.3.2.3. Geographical boundaries

Data for core operation shall be site-specific. Data for core infrastructure should be site-specific.

4.3.2.4. 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.

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).

4.3.2.5. Boundaries in the life cycle

See Section 4.3.1. The EPD may present the information divided into additional sub-divisions.

4.3.2.6. Boundaries towards other technical systems

See Section 4.6.2.

4.4 SYSTEM DIAGRAM

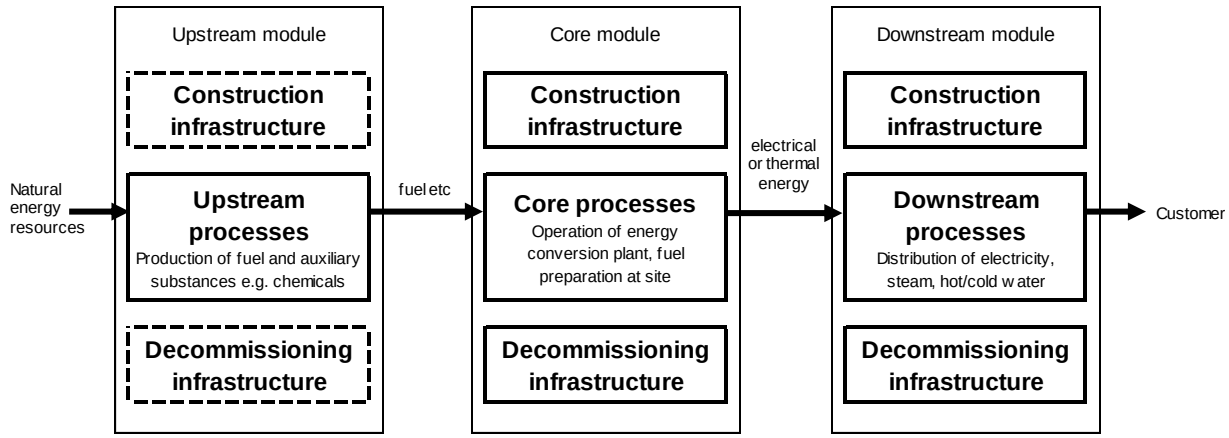


Figure 2 System diagram illustrating the processes that are included in the product system, divided into upstream, core and downstream processes. Full lines indicate processes that shall be included and dotted those that should be included.

4.5 CUT-OFF RULES

Data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included (not including processes that are explicitly outside the system boundary as described in Section 4.3).

The check for cut-off rules in a satisfactory way is through the combination of expert judgment based on experience of similar product systems and a sensitivity analysis in which it is possible to understand how the un-investigated input or output could affect the final results.

4.5.1 SPECIFIC CONSIDERATIONS FOR THE CORE MODULE

Core operation

LCI data for a minimum of 99% of total inflows in terms of impact to the core operation shall be included. Inflows not included in the LCA shall be documented in the EPD

Core infrastructure

Regarding core infrastructure the maximum cut-off shall be set to 1%, especially for technologies where the infrastructure causes the main part of the environmental impact. In the case of thermal technologies based on combustion the infrastructure has a minor impact in comparison with the operation and the fuel production and hence construction and dismantling can be handled more roughly.

4.6 ALLOCATION RULES

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

The following step-wise procedure shall be applied for multifunctional products and multiproduct processes:

1. Allocation shall be avoided, if possible, by dividing the unit process into two or more sub-processes and collecting the environmental data related to these sub-processes.
2. If allocation cannot be avoided, the inputs and outputs of the system shall be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.
3. Where physical relationships alone cannot be established or used as the basis for allocation (or it is too time consuming), Table 1 shall be consulted for key processes. For processes not listed, the most suitable allocation procedure shall be used and documented.

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION INSTRUCTION
Combined heat and power (all technologies)	Electricity, heat	Alternative Generation Method, see Annex 2.
Combustion plants	Fuels which are waste or by-products from other processes	In the case it is difficult to decide if a fuel used in the energy conversion plant is a waste or a by-product from another party and the case is not described in this PCR the verifier should be very careful in checking the selected allocation method according to the general principles in the General Programme Instructions of the International EPD® System and according to the examples mentioned in the following paragraphs.
Combustion plants	Blast furnace gas used for energy conversion	Blast furnace gas has a quite low calorific value and consists mainly of carbon monoxide and it must be flared if not sold. It accounts for a minor part of the industry's revenues and the industry's process is not affected whether it is used for energy conversion or not and hence it should be considered a waste. Accordingly, the user gets the gas

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION INSTRUCTION
		without environmental burdens and the emissions from combustion are allocated to the gas destruction service
Combustion plants	Energy rich gases used for energy conversion	Energy rich gas from industries is considered as a product of these industries and a portion of the industries' environmental burdens shall be allocated to this gas based on an energy analysis of the industry's processes.
Combustion plants	Waste incineration plant	The burdens of the incineration process that destructs the waste shall be allocated to the waste generator (according to the Polluter Pays allocation method) whereas equipment and processes needed to recover and make use of the recovered heat/cold water, used for e.g. district heating/cooling, electricity production, steam production etc. energy ware shall be allocated per kWh of these products[3]. See Figure 3 in chapter 4.6.2.
Combustion plants	Industrial waste steam or hot water used for energy conversion	Industrial waste steam or hot/cold water that would have been emitted to a recipient (if it were not used in an energy conversion process) is free of environmental burden i.e. only transportation from the industry shall be allocated to the energy conversion system using the steam or hot water. The environmental performance of the industry is in this case not affected whether the energy in the wastewater is used or not. Sometimes the industry changes its process to make the waste steam or hot water usable for energy conversion. In that case a portion of the industries environmental burden shall be allocated to the energy conversion system based on an energy analysis of the industry's processes.
Combustion plants	Ash and by-products from flue gas cleaning	If the ash or by-products from combustion plants are deposited, the deposition process shall be allocated to the combustion plant operator i.e. the core processes. If ash or by-products are reused as for instance road filling or as raw material in the construction sector transports to collection site shall be allocated to the core processes and further refinement and transportation to the site of use is allocated to the next user. If ash from biomass fuels is spread in the forest all processes needed to spread the ash shall be allocated to the core processes.
Combustion plants	Production of solid and gaseous biomass fuels and bioliquids	Solid and gaseous biomass and bioliquids originate from agricultural crops and residues (e.g. maize, wheat, straw, animal manure), from forestry (e.g. logs, stumps, branches) and wood-processing industry (e.g. bark, off-cuts, planning shavings, saw dust) and from organic waste (e.g. municipal waste, post-consumer recovered wood, refuse-derived fuels, sewage sludge). Biomass fuel cultivation e.g. short rotation forestry or cereals cultivation aimed at electricity/steam/hot water production is

[3] The main purpose of a waste incineration plant is destruction of fractions that cannot or should not be recycled, not energy production. The Polluter Pays Principle has a strong logical core, and classification of a plant shall be done based on what fuels are incinerated.

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION INSTRUCTION
		included from sowing or plantation till harvest and transportation. If biomass fuel is made from primary forest products, such as logs, all the processes in conjunction with forestry shall be included and allocated to the energy wares in a reasonable way. If solid or gaseous biomass fuel and bioliquids are acquired from residues from agriculture or forestry or from food, feed or wood-processing industry or from organic waste the upstream burdens to be included derive from its collection, processing and transportation i.e. burdens from cultivation, felling, livestock keeping etc. are not included neither emissions due to carbon stock change. Emissions from combustion are allocated to the energy conversion process. Co-products with an economical value may arise or gainful services may be performed in the processing of organic material to produce solid, gaseous or liquid fuels, examples are: • Animal feed • Heat for district heating • Cold water for district cooling • Fertilizer • Electricity • Glycerine • Organic waste treatment services Since physical allocation is hard to establish, the environmental burdens shall be allocated to those co-products based on economic value in line with the following approaches in order of prioritization: 1. The suppliers revenues (€) from the different products and co-products 2. The share (%) of the suppliers overall revenues from products and co-products that the supplier receives for the biomass fuel or bioliquid in question. 3. The market prices for the products and co-products in question. Prices might change and the EPD will be updated at least every third year with up-to-date prices.
Biogas digestion plants	Production of thermal products (heat, steam and electricity) and digestate	If the biogas produced from waste recourses is utilised as thermal energy products (e.g. steam, heat, electricity), the burdens of the digestion plant shall be allocated to the waste generator (according to the Polluter Pays allocation method and Figure 3) whereas the burdens relating to the equipment and processes needed to convert biogas into heat, process steam or electricity (e.g. gas burner and turbine, storage and digester) shall be allocated per kWh of these thermal products. If, however, the sale of digestate as fertilizer contributes substantially to the economic success of the plant, the burdens of the digestion plant shall be allocated to the fertilizer (according to Figure 3 as this is a recycled product).

PROCESS	MAIN PRODUCT AND CO-PRODUCTS	ALLOCATION INSTRUCTION
		• If energy crops are added to maximize the biogas production output, the environmental burdens of the cultivation of the energy crops, transport to the plant as well as the burdens from the biogas plant from converting energy crops to biogas (based on dry matter or expected biogas yield), shall be allocated to the thermal energy products. • If manure is added to the biogas plant, the transport to the plant as well as the burdens from the biogas plant from converting manure to biogas (based on dry matter or expected biogas yield), shall be allocated to the thermal energy products or the digestate if this is sold/utilised. In complex cases with multiple products to which the environmental impacts cannot be physically allocated, economic allocation is acceptable.
Nuclear technologies	Uranium mining	If uranium comes from a mine extracting also other metal products, e.g. copper, economical allocation shall be used.
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	The construction of dams is a prerequisite for regulation of water flows in a water course. Large dams may also represent reservoirs with multipurpose functions, such as irrigation, flood control, and water supply, in addition to hydropower generation. In such cases, allocation of the burdens from the dam infrastructure between the different functions (irrigation, flood control, water supply and hydropower generation) should therefore be considered. The allocation approach shall be described and motivated in the EPD. 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.
Cooling facilities	Cold and hot streams	The allocation approach shall be described and motivated in the EPD.

Table 1 Allocation procedure for key processes in the product system, if steps 1 and 2 are not possible.

Results calculated with other allocation methods than the mandatory ones listed above can be reported and discussed under the heading *Additional Environmental Information* in the EPD.

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.

4.6.2 REUSE, RECYCLING, AND RECOVERY

In the framework of the International EPD® System, the methodological choices for allocation for reuse, recycling and recovery have been set according to the polluter pays principle (PPP). This means that the generator of the waste that pays for its disposal shall carry the full environmental impact until the point in the product's life cycle at which the waste is transported to a scrapyard or the gate of a waste processing plant (collection site). The subsequent user of the waste shall carry the environmental impact from the processing and refinement of the waste but not the environmental impact caused in the "earlier" life cycles. For waste incineration, gasification or other means of energy recovery treatment, the burdens of the process that destructs the waste shall be allocated to the waste generator (according to the Polluter Pays allocation method) whereas equipment and processes needed to recover and make use of the heat as e.g. district heat, process steam or for generating electricity shall be allocated per kWh of these products. Figure 3 below, taken from the General Programme Instructions (Annex A6, Figure 4), illustrates the principles described above.

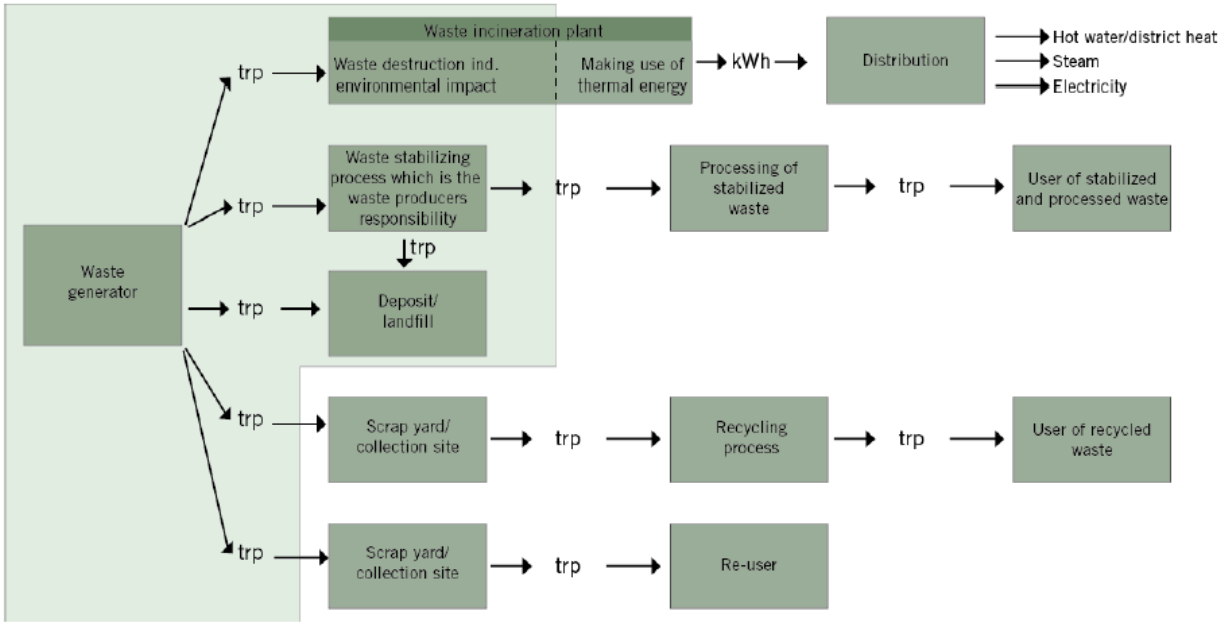


Figure 3 - The "polluter pays (PP) allocation method"

The "PP allocation method" in Figure 3 illustrates the various types of waste treatment options included in different process stages. The area in light green indicates the environmental impact that shall be carried by the waste generator.

4.7 DATA QUALITY REQUIREMENTS

An LCA calculation requires two different kinds of information:

- data related to the **environmental aspects** of the considered system (such materials or energy flows that enter the production system). These data usually come from the company that is performing the LCA calculation.
- data related to the **life cycle impacts** of the material or energy flows that enter the production system. These data usually come from databases.

Data on environmental aspects shall be as specific as possible and shall be representative of the studied process.

Data on the life cycle of materials or energy inputs are classified into three categories – specific data, selected generic data, and proxy data, 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, and data from other parts of the life cycle traced to the specific product system under study, e.g. materials or electricity provided by a contracted supplier that is able to provide data for the actual delivered services, transportation that takes place based on actual fuel consumption, and related emissions, etc.,
- **generic data** (sometimes referred to as “secondary data”), divided into**:**
  - **selected generic data** – data from commonly available data sources (e.g. commercial databases and free databases) that fulfil prescribed data quality characteristics for precision, completeness, and,
  - **proxy data** – data from commonly available data sources (e.g. commercial databases and free databases) that do not fulfil all of the data quality characteristics of “selected generic data”.

As a general rule, specific data shall always be used, if available, after performing a data quality assessment. It is mandatory to use specific data for the core processes as defined above. For the upstream processes, downstream processes, and infrastructure, generic data may also be used if specific data are not available.

4.7.1 UPSTREAM PROCESSES

Production of fuel for the energy conversion plant

Specific data should be used for amounts of inputs and outputs in following activities:

- production of main fuels, and
- distances for the transportation within the fuel production chain and to the energy conversion plant and type of vehicles.

Selected generic data may be used for

- production of fuels bought on the spot market,
- transportation services (fuel use and emissions in conjunction with transportation),
- resource use and emissions in conjunction with electricity used in suppliers’ processes,
- national or regional mixes for electricity generation,
- resource use and emissions in conjunction with production of auxiliary materials and chemicals used in suppliers’ processes,
- resource use and emissions in conjunction with treatment of operational waste from suppliers’ processes, and
- suppliers’ infrastructure.

Production of electricity and fuels used by suppliers and production of input auxiliary material and chemicals for the energy conversion plant

Specific data should be used for large input flows to the core module. Deviations shall be justified. Generic data may be used for production and transportation of input chemicals and auxiliaries as well as for transportation of operational waste from the energy conversion plant and the following waste treatment, destruction, or deposition services.

Upstream infrastructure

Generic data may be used.

4.7.2 CORE PROCESSES

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

- 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

Any data used should preferably represent average values for a specific reference year. However, the way these data are generated could vary, e.g. over time, and in such cases, they should have the form of a representative annual average value for a specified reference period. Such deviations should be declared.

4.7.3 DOWNSTREAM PROCESSES

Specific data shall be used for

- distribution losses in steam and hot 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
- transportation

Downstream infrastructure

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
- resource use and emissions in conjunction with electricity used during the construction/reinvestment/dismantling processes

4.7.4 RULES FOR USING GENERIC DATA

The attributional LCA approach in the International EPD® System forms the basic prerequisites for selecting generic data. To allow the classification of generic data as "selected generic data", they shall fulfil selected prescribed characteristics for precision, completeness, and representativeness (temporal, geographical, and technological), such as:

- the reference year must be as current as possible and preferably assessed to be representative for at least the validity period of the EPD,
- the cut-off criteria to be met on the level of the modelled product system are the qualitative coverage of at least 99% of energy, mass, and overall environmental relevance of the flows,
- completeness in which the inventory data set should, in principle, cover all elementary flows that contribute to a relevant degree of the impact categories, and
- the representativeness of the resulting inventory in the given temporal, technological, and geographical reference should, as a general principle, be better than ±5% of the environmental impact of fully representative data.

Section 4.8 provides a list of recommended databases/data sets to be used for generic data.

If selected generic data that meets the requirements of the International EPD® System are not available as the necessary input data, proxy data may be used and documented. The environmental impacts associated with proxy data shall not exceed 10% of the overall environmental impact from the product system.

4.8 RECOMMENDED DATABASES FOR GENERIC DATA

No specific databases are recommended for generic data. Data should be used that fulfil the data quality requirements in Section 4.7.

4.9 IMPACT CATEGORIES AND IMPACT ASSESSMENT

The EPD shall declare the default impact categories as described in the General Programme Instructions. The characterisation models and factors to use for the default impact categories are available on www.environdec.com and shall be updated on a regular basis based on the latest developments in LCA methodology and ensuring the market stability of EPDs. The source and version of the characterisation models and the factors used shall be reported in the EPD. Alternative regional life cycle impact assessment methods and characterisation factors are allowed to 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.

4.10 OTHER CALCULATION RULES AND SCENARIOS

4.10.1 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 main parts, packaging, or main auxiliaries should be requested from the contractor as specific data, as well as infrastructure, where relevant.
- 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 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 the electricity used in the upstream processes, electricity production impacts shall be accounted for in this priority when specific data are used in the upstream processes:
    1. Specific electricity mix as generated, or purchased, from an electricity supplier, demonstrated by a Guarantee of Origin (or similar, where reliability, traceability, and the avoidance of double-counting are ensured) as provided by the electricity supplier. If no specific mix is purchased, the residual electricity mix from the electricity supplier shall be used.[4]
    2. National residual electricity mix or residual electricity mix on the market
    3. National electricity production mix or electricity mix on the market.

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

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

The following should be included:

Upstream infrastructure

- Suppliers' factory buildings
- Suppliers' machines

4.10.2 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. It shall be described in the EPD how the reference flow was calculated.
- For the electricity used in the core processes, electricity production impacts 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, where reliability, traceability, and the avoidance of double-counting are ensured) as provided by the electricity supplier. If no specific mix is purchased, the residual electricity mix from the electricity supplier shall be used.[5]
    2. National residual electricity mix or residual electricity mix on the market
    3. National electricity production mix or electricity mix on the market.

[4] 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 production mix of the electricity supplier.

[5] 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 production mix of the electricity supplier.

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

- 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 should be based on the actual transportation mode, distance from the supplier, and vehicle load, if available.
- Waste treatment processes of manufacturing waste should 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 informative Annex 3 on typical technical service life for different technologies.

4.10.2.1. Combustion technologies based on fossil and renewable fuels and peat[6]

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

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

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 inputs and outputs

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

- 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

4.10.2.3. 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

4.10.2.4. 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
- 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.

Typical technical service time may be taken from Appendix 3.

For calculations of emissions from water reservoirs and calculation rules for pumped storage hydropower, see Appendix 4.

4.10.2.5. 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

4.10.2.6. 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

4.10.2.7. 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

4.10.2.8. 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

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

Core operation:
- Energy conversion process of plant(s)
- 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 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

4.10.2.10. Cooling

Core operation:
- Energy conversion process of plant(s)
- Direct emissions of air, water and soil pollutants (e.g. refrigerants). For leakages of refrigerants, if not known it should be assumed that leakages corresponds to the annual refill of refrigerants. Emission factors should be applied in accordance with EU 517/2014
- 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

4.10.3 DOWNSTREAM PROCESSES

For distribution (of generated electricity, steam and hot water) the following items shall be included in the LCA calculations:

- Average transmission/distribution losses associated with the transmission and distribution of electricity to a customer, defined with respect to connection voltage.
- For heat, steam and hot water, average distribution losses in the distribution system used.

The following items should be included in the LCA calculations

- Operation and maintenance of the distribution systems including transportation and specific emissions of e.g. oil, Zn, Cd, SF_6.

Infrastructure of the distribution system, construction, reinvestments and dismantling (end of life) should be included in the LCA.

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

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

4.10.4 SPECIFIC CALCULATION RULES FOR GHG EMISSIONS

4.10.4.1. Bio-derived fuels and greenhouse gases

The question of CO_2 or climate neutrality of bio-derived fuels is debated. Apart from emissions from machines in conjunction with gathering, harvesting, processing and from drying, milling and transportation etc., there are several issues such as:

- The time gap between combustion emission and uptake in growing biomass leading to a climate impact through an increased radiative forcing.
- The release of CO_2 due to degradation of the underground of biomass such as roots.
- The release of carbon bound in the soil caused by water drainage or mechanical or other ground disturbances before or during felling, cultivation, harvesting etc. forming CO_2 or CH_4.
- The release of CH_4 from the fermentation process, pre-treatment of biomass and post-composting.
- Release of N_2O due to fertilizing.
- Release of N_2O from the soil due to ground preparation.

It is difficult to address the time gap with current LCA methodologies, but all biogenic emissions of CO_2 shall be separately reported unless other recommendations are given at www.environdec.com (see Section 5.4.4.1). It shall however not be accounted for in the GWP-biogenic results provided the fuel is acquired from:

- residues from agriculture or forestry or from food, feed or wood-processing industry or from organic waste, or

- continuous plantations or cultivated areas or from thinning of continuously forested areas.

In continuous plantations and cultivated areas or continuously forested areas the release of CO_2 from underground vegetation and soil as a result of felling or harvesting may be neglected if continuity can be proved, since the CO_2 is assumed to be sequestered again in the next generation of vegetation grown on the area.

Release of N_2O due to fertilizing shall be included, calculated as a share of input nitrogen based on the most recent recommendations of the IPCC (Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories). Release of N_2O from the soil due to land use may be neglected since this is a smaller fraction of the overall N_2O emission.

4.10.4.2. 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 coun[7]tries not listed in PAS 2050:2011, default values provided by the IPCC Guidelines for National Greenhouse Gas Inventories 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.”

Any assumptions made regarding use of biomass in long-lived products must be justified and verified with literature and/or official statistics.

4.10.4.3. 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 the stored or replaced amount shall be subtracted from the GWP-fossil results. The amount shall however be reported separately as a separate row in the Ecoprofile.

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

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 via www.environdec.com

As a general rule the EPD content:

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

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

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.
- Three significant figures[8] should be adopted for all results, The number of significant digits shall be appropriate and consistent.
- 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.
- The result tables shall:
  - Only contain values or the letters “INA” (Indicator Not Assessed). It is not possible to specify INA for mandatory indicators. INA shall only be used for voluntary parameters that are not quantified because no data is available.[9]
  - Contain no blank cells, hyphens, less than or greater than signs or letters (except “INA”).

[8] 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 $1.2*10^{-2}$.

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

- 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)
- Additional environmental information (see Section 5.4.5)
- References (see Section 5.4.8)

The following information shall be included, when applicable:

- Information related to Sector EPDs (see 5.4.6)
- Differences versus previous versions (see Section 5.4.7)
- Executive summary in English (see Section 5.4.9)

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[10],
- *Date of publication (issue): 20XX-YY-ZZ,*
- *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,

[10] 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.

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 mandatory statement from ISO 14025: "*EPDs within the same product category but from different programmes may not be comparable*."
- A statement that the EPD owner has the sole ownership, liability and responsibility of the EPD
- Information about verification[11] and reference PCR in a table with the following format and contents:

Product category rules (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>*
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☐ EPD verification
Third party verifier: *<name, organisation and signature of the third party verifier>* *In case of certification bodies:* Accredited by: *<name of the accreditation body and accreditation number, if applicable>.* *In case of individual verifiers:* Approved by: The International EPD® System Technical Committee, supported by the Secretariat
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),

[11] 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.

- Description of the product, its application/intended use and technical functions, e.g. expected service life time,
- 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,
- Functional unit,
- Reference service life (RSL), if applicable,
- 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, if relevant,
- System diagram of the processes included in the LCA, divided into the life cycle stages,
- Description if the EPD system boundary is "cradle-to-gate", "cradle-to-gate with options" or "cradle-to-grave",
- Information on which life cycle stages are not considered (if any), with a justification of the omission,
- 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,
- Additional information about the underlying LCA-based information, such as assumptions, cut-off rules, data quality and allocation.

5.4.4 ENVIRONMENTAL PERFORMANCE

5.4.4.1. Environmental impact indicators

The indicators related to potential environmental impact shall be declared per functional unit and per life cycle stage. The characterisation models and factors that shall be used for the default impact categories are available on www.environdec.com. At the date of publication of version 4.0 of this PCR, the default impact categories and characterisation methods were as listed in Table 2.

PARAMETER		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Global warming potential (GWP)	Fossil (GWP-fossil)	kg CO_2 eq.				
	Biogenic (GWP-biogenic)	kg CO_2 eq.				
	Land use and land transformation (GWP-luluc)	kg CO_2 eq.				
	TOTAL	kg CO_2 eq.				
Acidification potential (AP)		kg SO_2 eq.				
Eutrophication potential (EP)		kg PO_4^{3-} eq.				
Photochemical oxidant formation potential (POFP)		kg NMVOC-eq.				
Particulate matter		kg PM2.5 eq.				
Abiotic depletion potential – Elements		kg Sb eq.				
Abiotic depletion potential – Fossil fuels		MJ, net calorific value				
Water scarcity footprint		m^3 H_2O eq.				

Table 2 Indicators describing potential environmental impacts.

Notes:

- Abiotic depletion potential is calculated and displayed as two separate indicators. ADP-fossil fuels include all fossil resources, while ADP-elements include all non-renewable material resources.
- Particulate matter (PM) refers to emissions to air and quantifies the potential effect of fine dust emissions on human health. It is expressed in PM2,5 equivalents, and includes the assessment of primary PM (PM10 and PM2.5), secondary PM (incl. creation of secondary PM due to SOx, NOx and NH_3 emissions) and CO (ILCD, 2011).

5.4.4.2. Use of resources

The indicators for resource use based on the life cycle inventory (LCI) listed in Table 3 shall be declared per functional unit or declared unit, and per life cycle stage.

PARAMETER		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value				
	Used as raw materials	MJ, net calorific value				
	TOTAL	MJ, net calorific value				
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value				
	Used as raw materials	MJ, net calorific value				
	TOTAL	MJ, net calorific value				
Secondary material		kg				
Renewable secondary fuels		MJ, net calorific value				
Non-renewable secondary fuels		MJ, net calorific value				
Net use of fresh water		m^3				

Table 3 Indicators describing use of primary and secondary resources.

Notes:

- In order to identify the primary energy used as an energy carrier (and not used as raw materials), the parameter may be calculated as the difference between the total input of primary energy and the input of energy resources used as raw materials.
- If energy resources are assessed as not relevant, the parameters can be set as ND (not declared). The assessment shall be explained in the EPD.
- All parameters shall not be aggregated but reported separately.
- Nuclear power shall be reported among the non-renewable primary energy resources
- The net use of fresh water does not constitute a “water footprint” as potential environmental impacts due to the water use in different geographical locations is not captured. For this indicator:
  - Evaporation, transpiration, product integration, release into different drainage basins or the sea, displacement of water from one water resource type to another water resource type within a drainage basin (e.g. from groundwater to surface water) is included.
  - In-stream water use is not included.
  - For water used in closed loop processes (such as cooling system) and in power generation only the net water consumption (such as reintegration of water losses) should be considered.

- Seawater shall not be included[12].
- Tap water or treated water (e.g. from a water treatment plant), or wastewater that is not directly released in the environment (e.g. sent to a wastewater treatment plant) are not elementary water flows, but intermediate flows from a process within the technosphere.
- Additional transparency in terms of geographical location, type of water resource (e.g. groundwater, surface water), water quality and temporal aspects may be included as additional information.
- It is voluntary to also state the parameters in kWh.

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 General Program Instructions. When the amount of waste or the output flows from the life cycle inventory (LCI) are declared, the indicators in Table 4 and Table 5 shall be reported per functional unit or declared unit, and per life cycle stage

PARAMETER	UNIT	CORE	TOTAL
Hazardous waste disposed	kg		
Depleted uranium (UF_6) in case of nuclear power	g		
Non-hazardous waste disposed	kg		
Ash, in case of combustion technologies	kg		
Gypsum, in case of combustion technologies	kg		
Radioactive waste disposed[13]	kg		
High-level radioactive waste in case of nuclear power	kg		
Low and medium-level radioactive waste in case of nuclear power	kg		

Table 4 Indicators describing waste production for core processes.

PARAMETER	UNIT	UPSTREAM	DOWNSTREAM	TOTAL
Hazardous waste disposed	kg			
Depleted uranium (UF6) in case of nuclear power	g			
Non-hazardous waste disposed	kg			
Ash	kg			
Inert (rock, sand etc.)	kg			
Radioactive waste disposed	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			

[12] It may be relevant to include seawater if it is used to obtain energy from it, or it is the only source of water in a definite site. This may be displayed separately, e.g. as “seawater for desalinization”.

[13] 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.

Low-level, no treatment (such as mining/milling wastes), in case of nuclear power	kg			

Table 5 Indicators describing waste production for upstream and downstream processes.

Notes:

- If waste sources are assessed as not relevant, the parameters can be set to ND (not declared). The assessment shall be explained in the EPD.
- Waste generated in the up- or downstream processes and where the treatment is not known shall be reported as inventory data in the categories below (reported separately for up- and downstream processes). When LCI-data from databases is used, the waste is followed to the grave in most cases and generated amounts are not recorded. When specific data has been retrieved from a subcontractor however, it might be that no information has been given regarding treatment of its wastes.

PARAMETER	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Components for reuse	kg				
Material for recycling	kg				
Materials for energy recovery	kg				

Table 6 Indicators describing output flows.

Notes:

- Some of the above LCI indicators taken from the generic EPD template, such as exported energy, are generally not applicable for this product category. If so, the results should be displayed as 0 in the EPD.
- The parameters 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 ND (not declared).
- The parameter “Materials for energy recovery” does not include materials for waste incineration in plants with R1<60% (European Guideline on R1 energy interpretation) and is allocated within the system boundary.
- In case there are never any flows of these types leaving the system boundary for a product category, the indicators may be removed by the PCR.

5.4.4.4. Other environmental indicators

If additional indicators and/or characterization factors are used they shall follow the ILCD[14]. Indicators and characterization factors shall be clearly described in the EPD and results shall be reported divided into core, upstream and downstream processes.

5.4.5 ADDITIONAL INFORMATION

5.4.5.1. Additional environmental information based on LCA

Under this heading LCA-based information may be provided for example results calculated with other allocation methods than required by the mandatory rules.

5.4.5.2. Additional environmental information not based on LCA

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.

[14] Available at: https://eplca.jrc.ec.europa.eu/uploads/ILCD-Handbook-LCIA-Framework-Requirements-ONLINE-March-2010-ISBN-fin-v1.0-EN.pdf

- 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 module meaning that all core module 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.

5.4.6 INFORMATION RELATED TO SECTOR EPDS

For sector EPDs, the following information shall also be included:

- 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.

5.4.7 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 list of references shall be included, including references e.g. the General Programme Instructions (including version number), standards, PCR (registration number, name and version), databases used, and methods used for impact assessment

5.4.9 EXECUTIVE SUMMARY IN ENGLISH

For EPDs published in another language than English, an executive summary in English shall be included.

The executive summary should contain relevant summarised information related to the programme, product, environmental performance, additional information, information related to sector EPDs, references and differences versus previous versions.

6 GLOSSARY

ANZSIC	Australian and New Zealand standard industrial classification
AP	Acidification potential
CCS	Carbon capture and storage
CBG	Compressed biogas
COD	Chemical oxygen demand
CPC	Central product classification
CPV	Common procurement vocabulary
EP	Eutrophication potential
EPD	Environmental product declaration
GHG	Greenhouse gas
G-Res	Greenhouse gas reserve
GPI	General programme instructions
GWP	Global warming potential
IHA	International Hydropower Association
ILCD	International reference life cycle data system
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
NACE/CPA	Classification of products by activity
ND	Not declared
NGL	Natural gas liquids
NMVOC	Non-methane volatile organic compounds
PCR	Product category rules
PEF	Product environmental footprint
PEFCR	Product environmental footprint category rules
PM	Particulate matter
POFP	Photochemical oxidant formation potential
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

CEN (2013), EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

EPD International (2017) General Programme Instructions for the International EPD® System. Version 3.0, dated 2017-12-11. www.environdec.com

European Commission (2020), Results and deliverables of the Environmental Footprint pilot phase http://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm#final

European Information and Observation Network, https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/html

European Parliament (2014), Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006, http://data.europa.eu/eli/reg/2014/517/oj

ILCD Handbook (2011): European Commission, Joint Research Centre and Institute for Environment and Sustainability (2011). International Reference Life Cycle Data System (ILCD) Handbook - Recommendations for Life Cycle Impact Assessment in the European context - based on existing environmental impact assessment models and factors. EUR 24571 EN, Luxemburg, retrieved from: http://eplca.jrc.ec.europa.eu/uploads/ILCD-Recommendation-of-methods-for-LCIA-def.pdf. International Copper Association, copperalliance.org

International Hydropower Association (IHA), G-Res Tool https://www.hydropower.org/gres

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.

ISO (1997), ISO 13600, Technical energy systems – Basic concepts, Annex A Energywares

ISO (2000), ISO 14020:2000, Environmental labels and declarations – General principles

ISO (2004), ISO 8601:2004 Data elements and interchange formats – Information interchange – Representation of dates and times

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 (2013), ISO/TS 14067:2013, 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 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

Product Environmental Footprint Category Rules (PEFCR): Photovoltaic modules used in photovoltaic power systems for electricity generation. Version: 1.1 Published: 12 February 2019; Time validity: 31st December 2020.
http://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_PV_electricity_v1.1.pdf

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 4.10.4.2.
- 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 4.2, 2021-04-26

- Expanded scope to include district cooling

VERSION 4.2.1, 2024-05-03

- Validity period of the PCR prolonged with four months while awaiting the updated version (version 5.0.0). When the updated version is published, version 4.2.1 will remain valid in parallel until 2024-07-16.

ANNEX 1: ENERGYWARES

The following list of energyware has been taken from Annex A of ISO 13600, Technical energy systems – Basic concepts (1997)

Definition of energyware: Tradable commodity used mainly to produce mechanical work or heat, or to operate chemical or physical processes, and listed in annex A (of ISO 13600)

	Comments on the selected energyware
Solid fuels	
Energy coal	All coal extracted from the ground except metallurgical coal and filter carbon
Energy peat	Energy peat is distinguished from peat used for soil improvement or other purposes.
Commercial fire-wood	Wood chips and pulverised woods are sub-items of commercial firewood used as energywares.
Other biomass	Other biomass is harvested “energy forests”, straw, reeds, dried cow dung, bush and seed pods etc. grown and collected for the purpose of being marketed as fuel.
Fuel briquettes and pellets	Burnable substances of fossil or biological origin, in the form of powder, grains or chips, which are compacted into blocks to produce a fuel which is easy to handle.
Charcoal	Charcoal is the solid residue of the destructive distillation and pyrolysis of wood and is traded old in many countries. Filter charcoal is excluded.
Coke	Coke is a solid fuel obtained from coal by heating in the absence of air.

Table A1a: Solid fuels. Description of different energywares, according to ISO 13600

	Comments on the selected energyware
Liquid fuels	
Crude oil	Crude oil, unextracted, is not an energyware. Once extracted it becomes an energyware.
Liquid fuels for heating and transportation: Motor gasoline Aviation gasoline Aviation kerosene Other kerosene's Diesel fuel Heating gas oil Fuel oils 2-5 LPG (Liquefied Petroleum Gas)	Liquid fuels for heating and transportation can be classified as different types of energyware. Any of several liquid mixtures of the volatile hydrocarbons butane and propane. LPGs are found in the gaseous state at atmospheric pressure and become liquefied at 15° C under low pressures of 0.17 MPa to 0.75 MPa.
Semi-finished products	Semi- finished products (liquid hydrocarbons) are included in the list whether they are used for the manufacturing of fuels or as petrochemical feedstock. Petroleum coke is not energyware, even if a substantial amount is used as fuel.
Motor alcohols	Motor alcohols are ethanol and methanol with additives and mixtures of compounds or groups of organic oxygenated compounds (ethers and alcohols) with petroleum fuels.
NGL (Natural Gas Liquids)	Natural gas liquids are those portions of natural gas, which are recovered as liquids in separators, field facilities or gas processing plants.
Fuels obtained from vegetable or animal oils	Vegetable and animal oils are oils extracted from various oleaginous plants and from animals.

Table A1b: Liquid fuels. Description of different energywares, according to ISO 13600

	Comments on the selected energyware
Gaseous fuels	
Natural gas fuels	
Natural gas	Methane or higher C_n gas mixtures.
LNG (Liquefied Natural Gas)	Natural gas stored, transported and handled in liquid form at low temperatures.
Converted gaseous fuels	
Coal-derived gas	
Furnace gas	Manufactured from metallurgical coal.
Gasified biomass	
Refinery gas	Separated from natural gas.
Town gas (city gas)	Gas manufactured for public supply.
Biogas (biomass)	Composed principally of a mixture of methane and carbon dioxide produced by anaerobic digestion of biomass; methane separated out of this mixture is called “biomethane”. Manure and liquid manure gas, marsh gas, dump gas, etc. are produced and more or less regulated and exploited.
Hydrogen gas	In gaseous or liquid form from fossil or renewable sources.
Fissile material	Uranium, thorium and plutonium.
Grid electricity	Electrical energy is an energyware when it is produced in power plants and distributed over a public or similar network.
Commercial heat, district heat	Hot liquid or steam used in commercial heat distribution systems produced either from other energywares, reclaimable resources including waste heat, or from natural resources such as solar radiation and geothermal heat.

Table A1c: Gaseous Fuels. Description of different energywares, according to ISO 13600

ANNEX 2: ALLOCATION BY THE "ALTERNATIVE GENERATION METHOD"

This Appendix 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.

19.12.2015 EN Official Journal of the European Union L 333/57

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

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

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 (**)
Other	O14	Waste heat (including high temperature process exhaust gases, product from exothermic chemical reactions)	—	—	—	92	87	—
	O15	Nuclear	—	—	—	92	87	—
	O16	Solar thermal	—	—	—	92	87	—
	O17	Geothermal	—	—	—	92	87	—
	O18	Other fuels not mentioned above	—	—	—	92	87	—

(*) If steam plants do not account for the condensate return in their calculation of CHP heat efficiencies, the steam efficiencies shown in the table above should be increased by 5 percentage points.
(**) Values for direct use of exhaust gases should be used if the temperature is 250 °C or higher.

ANNEX 3: TYPICAL TECHNICAL SERVICE LIFE FOR DIFFERENT TECHNOLOGIES

Technology		**Typical technical service life (years)**
Combustion technologies		40
Ignition motor technologies		30
Nuclear technologies		40-60
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		20
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

ANNEX 4: 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:

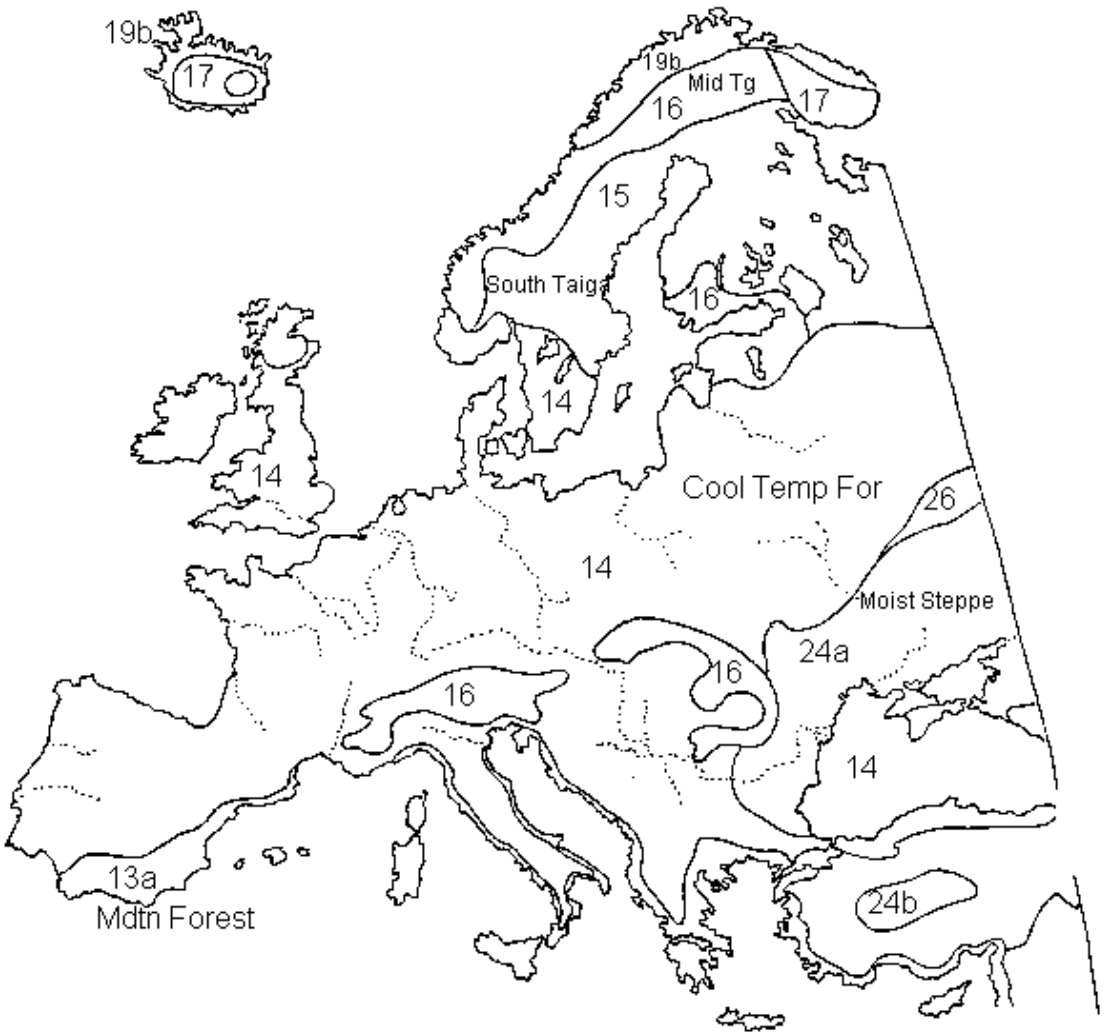
$E_{CH4} = S_{CH4} * C_{degr} * D_{degr} * A_{inund} * m_{CH4}/m_C$ [g]

$E_{CO2} = (100\% – S_{CH4}) * C_{degr} * D_{degr} * A_{inund} * m_{CO2}/m_C$ [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 ($g \cdot m^{-2}$)	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

1.2 Pumped storage hydropower

- For the electricity used in the process, there are two alternatives: the company buys the electricity from the electricity mix on the actual market or from a specific supplier. While in the first case the national residual electricity mix shall be adopted, in the second case a specific electricity mix could be used if available.
- For the electricity used in the processes, electricity production impacts 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, where reliability, traceability, and the avoidance of double-counting are ensured) as provided by the electricity supplier. If no specific mix is purchased, the residual electricity mix from the electricity supplier shall be used.[15]

[15] 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 production mix of the electricity supplier.

2. National residual electricity mix or residual electricity mix on the market
3. National electricity production mix or electricity mix on the market.

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