Danfoss Product Category Rules: Environmental Product Declarations for Danfoss Products

Introduction

Danfoss Product Category Rules or 'Danfoss PCR' for conducting Life Cycle Assessments (LCAs) and producing Environmental Product Declarations (EPDs) of Danfoss Group products.

Scope

Danfoss PCR apply to all Environmental Product Declarations which claim conformance with Danfoss PCR for Danfoss Products.

Field of application

The Core Rules apply to the Danfoss Group, i.e. Danfoss A/S and each of its subsidiaries which are under Danfoss A/S direct or indirect control, e.g. through ownership of the majority of shares, or the right to appoint the majority of its directors.

Content

1. Introduction

1.1 Background

In the absence of environmental product declaration (EPD) programmes with consistent product category rules (PCR) that cover Danfoss' full product range, the company has decided to create its own core PCR and EPD template. As harmonization between EPD programmes and PCR documents increases, Danfoss will reconsider whether to follow the PCR documents of another EPD programme.

1.2 Purpose

EPDs published under the Core Rules for Danfoss Products are intended to provide customers with information on the environmental performance of Danfoss' products. These EPDs can be aggregated to the level of an installed system of many products, e.g. a building or manufacturing plant; however, system-level assessment is not the focus of this document.

1.3 Normative References

These Core Rules follow the requirements of **ISO 14025:2006** on environmental declarations supplemented with additional detail from **EN 15804+A2:2019** which provides core product category rules for construction products. Other standards, such as **EN 50598-3** and the GHG Protocol Product Standard, are also referenced where relevant.

Deviations from these standards are documented and justified. Perhaps most importantly, these Core Rules are designed for Danfoss products only and have not been presented for public consultation. While other companies may follow these Core Rules, *Danfoss has no intention of fulfilling the responsibilities of a programme operator under ISO 14025*. EPDs published under these Core Rules are essentially a self-declaration and, as such, the requirements of **ISO 14021:2016** have also been included.

While many of Danfoss' products are not intended for buildings, **EN 15804** and its sister standard **ISO 21930** represent best practice towards international standardization of PCR documents at the time of writing. Both standards use a modular approach, making it possible to combine EPDs for many components together in order to create a system- or site-level environmental assessment. Danfoss EPDs are based on full-scale LCA in accordance with **ISO 14044** and **ISO 14040**. This approach is well suited to Danfoss' product range.

1.4 Product Category Definition

This document provides core product category rules (PCR) for any Danfoss Group product. This includes, but is not limited to:

- Refrigeration and air conditioning products, such as compressors and automation tools
- Heating products, such as heat pumps, thermostats and burner nozzles
- Variable frequency drives
- Industrial automation products

- High-pressure pumps
- Solar inverters
- Silicon power modules

As there is considerable variation between these products, these Core Rules may be supplemented with additional product-specific rules, as provided in Annex A.

1.5 Abbreviations

CAS	Chemical Abstracts Service
CML	Institute of Environmental Sciences, Leiden University
EPD	Environmental product declaration
EoL	End of Life
ErP	Energy-requiring product (Directive 2009/125/EC)
GHG	Greenhouse gas
INA	Indicator not assessed
kW	Kilowatt
kWh	Kilowatt-hour
LCA	Life cycle assessment
MJ	Megajoule
PCR	Product category rules
REACH	Registration, evaluation, authorisation and restriction of chemicals (EC 1907/2006)
RoHS	Restriction of hazardous substances (Directive 2011/65/EU)
RSL	Reference service life
SVHC	Substances of very high concern (EC 1907/2006)

2. Types of Environmental Product Declaration

2.1 Life Cycle Stages

These Core Rules follow the modular structure of EN 15804+A2:2019 shown in Table 1. Four life cycle stages are defined within the system boundary: production, installation, use and end-of-life. These four stages are made up of 16 modules: A1-A3 (production), A4-A5 (installation), B1-B7 (use) and C1-C4 (end-of-life). EN 15804+A2:2019 also includes an additional module (D) for benefits and burdens that may occur beyond the system boundary if scrap is reused, recovered or recycled. However, as these benefits are allocated to future products, they are reported separately within the EPD.

The "Data Type" column in Table 1 indicates where the data used in each stage should come from. The data used for the scenario based data shall be documented in the EPD.

The most environmentally relevant modules for Danfoss products are modules A1-A3 and B6. Modules from EN 15804+A2:2019 in which Danfoss' products have negligible or no impacts (and are not mandatory) have been included in Table 1, but are not expected to be reported on. Specifically, these modules are: B1, which, for example, would include emissions during use that affect indoor air quality, contamination of water running over a roof, etc.; B2, which includes impacts from maintenance, mostly cleaning; B5, which includes impacts when a whole building is refurbished; and B7, which includes operational water use. A fuller description of all modules included in the EPD can be found in section 3.2.2.

Table 1: Life cycle stages to be included for different types of EPD (adapted from Figure 1 of EN 15804+A2:2019)

Life Cycle Stage	Information Module	Required in EPD?	Data Type
A1-A3 Product stage	A1) Raw material supply	Mandatory	Manufacturer data (specific or average) for product manufacture. Generic data for upstream processes
	A2) Transport		
	A3) Manufacturing		
A4-A5 Construction process stage	A4) Transport to site	Optional	Scenario based data
	A5) Construction installation		
B Use stage	B1) Use	Optional[1]	Scenario based data
	B2) Maintenance		
	B3) Repair		
	B4) Replacement		
	B5) Refurbishment		
	B6) Operational energy use		
	B7) Operational water use		
C End of Life (EoL) Stage	C1) Deconstruction, demolition	Mandatory[2]	Scenario based data
	C2) Transport to EoL		

	C3) Waste processing		
	C4) Disposal		
Benefits and loads beyond the system boundary	D) Reuse, recovery, recycling potential	Mandatory[2]	Scenario based data

[1] If any part of module B is included, there must be the inclusion of the reference service life (RSL).

[2] An EPD may exclude the declaration of modules C1-C4 and module D if certain requirements are met. Please refer to section 2.2 Types of EPD for details.

2.2 Types of EPD

Following EN 15804+A2:2019, an EPD may be either:

- Cradle to gate with options (Modules A1-A3 + C +D + additional modules). The additional modules may be one or more selected from A4–A5 and/or B1–B7.
- Cradle to grave (Modules A + B + C + D).
- Cradle to gate (Modules A1-A3. Certain requirements must be met (see below for details).

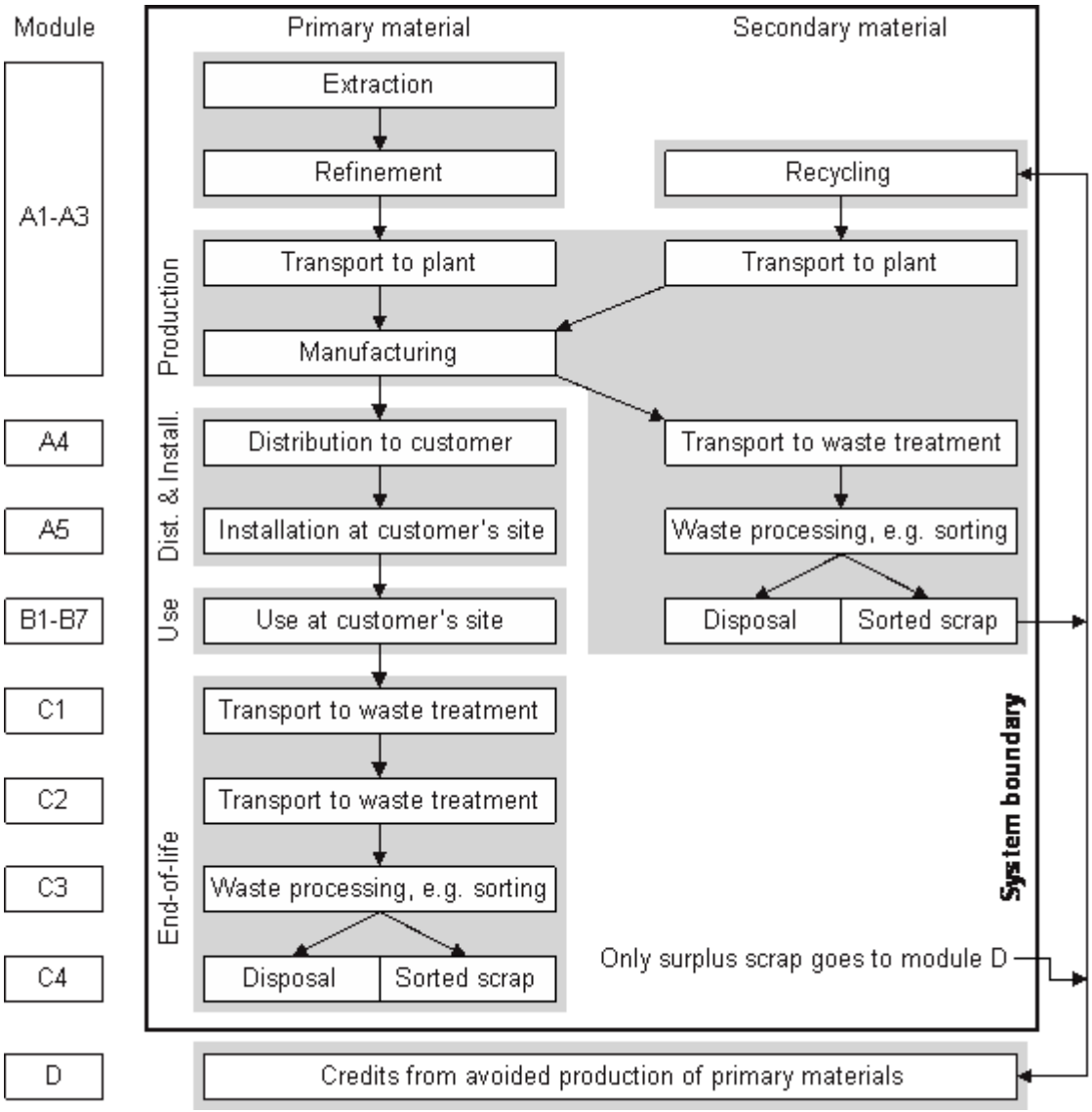
A cradle to gate EPD shall only be used if the following three conditions are valid:

- the product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life, and
- the product or material is no longer identifiable at end of life as a result of a physical or chemical transformation process, and
- the product or material does not contain biogenic carbon.

See section 5.2 of EN 15804 for more details.

3. Goal and Scope of the Life Cycle Assessment

Figure 1 System boundary for the life cycle assessment



3.1 Functional/ Declared Unit

An EPD requires either a functional unit or a declared unit. This is the reference unit against which inputs from and outputs to the natural environment are related. It provides a common basis for making comparisons between different technologies and systems (ISO 14040:2006, §5.2.2).

A cradle to grave EPD shall use a functional unit. All other EPDs shall use a declared unit.

A functional unit is the "quantified performance of a product system for use as a reference unit" (ISO 14040:2006, §3.13). It should be generic enough that competing technologies for meeting the same need can be compared. For example, if the need to be met is drying hands, the functional unit might be the number of pairs of hands dried. This would allow different technologies – air dryer, paper towels and a roller towel –

to be compared fairly. The functional unit shall be based on (EN 15804+A2:2019, §6.3.1):

- The quantified functional use of the product when incorporated into a system (e.g. a building or manufacturing plant)
- The product's reference service life (RSL) or the service life of the system (e.g. a building or manufacturing plant) into which it is incorporated (EN 15804+A2:2019, §6.3.4).

A declared unit represents the quantity of product used rather than the function that the product fulfils (EN 15804+A2:2019, §3.9). EPDs for components that may be used in different applications will commonly use a declared unit as it is difficult to define a functional unit (EN 15804+A2:2019, §6.3.2). A declared unit shall be one of the following types (EN 15804+A2:2019, §6.3.3):

- Pieces of product, e.g. 1 x 3 kW VLT® drive
- Mass (kg)
- Length (m), e.g. 1 m of ventilation ducting
- Area (m2), e.g. 1 m2 of heating mat
- Volume (m3)
- Product-specific unit from Annex A

When the declared unit is not mass, a conversion to mass shall be specified.

3.2 System Boundary

The system boundary shall be based on the following general principles (EN 15804+A2:2019, §6.3.5.1):

- The modularity principle: "where processes influence the product's environmental performance during its life cycle, they shall be assigned to the module of the life cycle where they occur; all environmental aspects and impacts are declared in the life cycle stage where they appear"
- The polluter pays principle: "processes of waste processing shall be assigned to the product system that generates the waste until the end-of-waste state is reached"

3.2.1 End-of-Waste State

The end-of-waste state is the point at which waste stops being treated as waste under law and instead starts being treated as a product. Following Article 6 of the Waste Framework Directive (2008/98/EC), a waste material reaches its end-of-waste state if it meets all of the following criteria:

- A market or demand, exists for such a recovered material, product or construction element (e.g. identified by a positive economic value)
- It is commonly used for specific purposes
- It meets the technical and legal requirements for these specific purposes
- It will not cause adverse environmental or human health impacts

EN 15804+A2:2019 §6.3.5.5 and §B.1 interprets the final point to mean that waste must not contain any hazardous substances exceeding

the limits or showing one or more properties as listed in existing applicable legislation. E.g. The product must not contain any substances on the Candidate List of Substances of Very High Concern for Authorisation that are used in quantities exceeding the thresholds set by the European Chemicals Agency under the REACH Regulation (EC 1907/2006). Other interpretations are possible, but must be justified in the Study Report.

The end-of-waste state can vary by country due to differing national legislation and differing demand for secondary products. Also, while the waste must have been transformed into a product for which there is a market, it can be a low-grade product that requires further refining before it can be used to replace a primary material in the product system included in the EPD. For example, a metal or plastic might reach its end-of-waste state when it is sorted by type and grade, wood waste once it is chipped and concrete waste once it is crushed. However, taking metal as an example, it will usually need to be re-melted and possibly refined before it can be reused in other products. See section 4.3 for more information.

3.2.2 Life Cycle Stages

Based on the modularity and polluter pays principles, the modules in Table 1 and Figure 1 shall include the following steps:

Product Stage A1-A3: (EN 15804+A2:2019, §6.3.5.2)

Manufacturing the product and its packaging including all upstream steps. This includes, but is not limited to:

- Extraction/processing of primary materials
- Reuse of products or materials from a previous product system
- Processing of secondary materials used as input, including all steps after the end-of-waste state of the previous system
- Manufacturing of components, sub-assemblies, packaging and the product itself
- Testing, packing and warehousing on the manufacturing site
- Transport to and between factories
- Energy generation and transmission
- Processing of production scrap up to the end-of-waste state

Valuable flows leaving the product system in the product stage shall be allocated as co-products (EN 15804+A2:2019, §6.3.5.5). The impacts and benefits of these co-products should not be declared in Module D.

Construction Stage A4-A5: (EN 15804+A2:2019, §6.3.5.3)

- A4: Transportation from the manufacturing site to the customer, including warehousing of products by wholesalers, retailers or other intermediaries
- A5: Installation of the product into the location where it will be used, e.g. a building or manufacturing plant, including the

production and processing of any waste generated during installation (e.g. waste packaging or cut-offs) up to the end-of-waste state.

Use Stage B: (EN 15804+A2:2019, §6.3.5.4)

As most modules in the Use Stage are not relevant to Danfoss products, only modules B3, B4 and B6 have been included below.

- B3: Repair of any part of the product so long as the whole product is not replaced (replacement is module B4). This includes production of the spare part, transport of the spare part to the customer, installation of the spare part, and waste processing of the old part up to the end-of-waste state.
- B4: Replacement: Similar to repair, but used when the product covered by the EPD is replaced in its entirety. This includes production of the replacement product, transport of the replacement product to the customer, installation of the replacement product, and waste processing of the old product and any packaging from the replacement product up to the end-of-waste state.
- B6: Energy used to operate the product over the reference service life.

Note: If modules from the use stage are specified, these must relate to a reference service life.

End of Life Stage C: (EN 15804+A2:2019, §6.3.5.5)

- C1: The deconstruction/demolition of the product from the building site.
- C2: Transportation of the discarded product at end-of-life to a landfill, incinerator or other waste processing facility.
- C3: Processing of waste materials until the end-of-waste state has been reached or they are sent for final disposal (which occurs in C4). The possible benefits of reuse and recycling occur in other product systems and shall be declared in module D.
- C4: Waste disposal in landfill or incinerator including pre-treatment. The benefits of energy generated from this process shall be declared in module D. Energy recovery processes with efficiencies less than 60% must be considered as incineration, i.e. the burdens associated with incinerating the waste must be included in C4 (EN 15804+A2:2019, §6.3.5.5). If the energy recovery process is more than 60% efficient, these materials may be considered for energy recovery. In this case, the burdens associated with combustion shall be declared in module C3, while the benefits shall be declared in module D. Only in cases where processing in C3 leads to the waste reaching its end-of-waste state and becoming a secondary fuel (e.g. if the incineration plant pays for the processed waste product; see §3.2.1) should the burdens associated with incineration be declared in module D.

For solid waste disposal of products containing biogenic carbon declared as GWP-biogenic, the release of biogenic carbon shall be calculated without time limit and all remaining biogenic carbon must be treated as an emission to air as biogenic carbon dioxide in module C3 when a

product (or packaging) is reused or recycled or in module C4 when it is landfilled (EN 15804+A2:2019, §6.3.5.5).

Benefits and loads beyond the system boundary D: Potential net benefits to other product systems, calculated as the difference between primary and secondary production, due to reuse, recovery or recycling of materials from the scrapped product. For information on calculating Module D, refer to section 4.3.

3.3 Cut-off Criteria for Inclusion of Inputs and Outputs

Cut-off criteria are intended to help speed up the development of EPDs. They shall not be used to hide data and, as such, all inputs and outputs to a unit process for which data are available shall be included in the calculation. When cut-off criteria are applied, they may be justified on the basis of mass, energy or relevance to a particular environmental indicator, e.g. global warming potential (ISO 14044:2006, §4.2.3.3.3).

At the unit process level, flows accounting for less than 1% of total mass and energy of inputs may be omitted. At the module level (i.e. A1-D), the sum of all flows excluded from unit processes in that module must be less than 5% of the total mass and energy flows entering that module (EN 15804+A2:2019, §6.3.6). Where possible, a cut-off threshold of 1% should also be applied at the module level. If a stricter cut-off limit is used than is required, this must be stated in the Study Report and may be stated on the EPD.

Capital goods (such as infrastructure, production equipment, and tools) that are not directly consumed in the production process can be excluded if these items are known not to cause a significant impact at the product level (e.g., because the same equipment is used to produce many thousand products). Personnel-related processes like transportation to and from work, and use of kitchens and bathrooms, shall not be accounted in the LCI.

Excluding the upstream packaging of components used in electronic products is an acceptable cut-off due the low impact this has and difficulties with collecting data. If it is known that this packaging may meet the criteria listed above, it shall be included in the LCI. This is a common exclusion in LCA, but is not part of EN 15804+A2:2019.

Care shall be taken not to cut off flows that have a small mass or energy but have significant impact on one or more of the environmental indicators included in the EPD. Precious metals are a common example of this. A conservative approach together with plausibility considerations and expert judgment can show compliance with the above criteria.

3.4 Data Quality Requirements

Regarding use of specific (primary) versus generic (secondary) data (EN 15804+A2:2019, §6.3.7):

- Data shall be calculated using representative average data where the EPD describes a representative average product
- Data shall be specific (i.e. primary data) for all processes over which Danfoss has significant influence. This shall include all processes where Danfoss owns greater than 50% of the facility

where the process takes place and should include processes where Danfoss is not the majority shareholder but has significant influence over the supplier.

- Data may be generic (i.e. secondary data) for processes over which Danfoss has very little influence, e.g. production of commodities and waste incineration

Furthermore, data shall be (EN 15804+A2:2019, §6.3.8):

- Complete according to the system boundary (§3.2) and cut-off criteria (§3.3)
- No more than 5 years old for specific data
- No more than 10 years old for generic data
- Based on a 1-year average
- Representative of the real technologies used to produce the product

This list above sets the minimum requirements. It is recommended that specific (primary) data be no more than 3 years old and generic (secondary) data be no more than 5 years old.

The time period over which inputs and outputs from the system must be considered is 100 years (EN 15804+A2:2019, §6.3.8.2). For solid waste disposal of products containing biogenic carbon declared as GWP-biogenic, the release of biogenic carbon should be calculated over an unlimited time horizon (§3.2.2 & EN 15804+A2:2019, §6.5.5). Areas where this is important include emissions from landfill and uptake of carbon by biomass.

Any deviations from the requirements stated above shall be justified in the Study Report. The source and representativeness of all data shall be documented in the Study Report. Further guidance is provided in §7.

3.5 Scenarios

As indicated in Table 1, only modules A1-A3 are based on directly measured information. Products leaving the factory gates will potentially be used and disposed of in many different ways. All modules after A3 must therefore be based on scenarios.

As stated in EN 15804+A2:2019 §6.3.9, "A scenario shall be realistic and representative of one of the most probable alternatives. (If there are, e.g. three different applications, the most representative one, or all three scenarios shall be declared). Scenarios shall not include processes or procedures that are not in current use or which have not been demonstrated to be practical."

3.6 Units

Resource flows shall be expressed in kilograms, with the exception of water which shall be expressed in cubic metres (m^3) and energy resources which shall be expressed in either kilowatt-hours (kWh) or megajoules (MJ). Power shall be expressed in kilowatts (kW) and all energy flows shall be expressed in either kWh or MJ. Degrees Celsius should be used in preference over kelvin for temperature. Time shall be expressed in a practical combination of years, months, days, hours, minutes and seconds.

Scientific notation may be used and is recommended if the value in the EPD or Study Report is not within three orders of magnitude of these standard units.

4. Life Cycle Inventory Analysis

4.1 Data Collection

Data shall be obtained for each unit process within the system boundary. A name and description for each unit process shall be included in the Study Report together with the source of the data. The source of all secondary data, such as data from standard databases or published articles, must be stated together with its age and regional representativeness. Primary data (i.e. data collected directly by Danfoss) shall be documented in greater detail. Any data that do not meet the quality requirements in section 3.4 shall be clearly identified. Further information is provided in section 7.3.

4.2 Calculation Procedures

A reference output flow shall be determined for each unit process. All inputs and outputs from the unit process shall then be related to this flow. The choice of reference flow should consider the main purpose of the unit process and its relationship to the functional/declared unit of the EPD.

"When determining the elementary flows associated with production, the actual production mix should be used whenever possible, in order to reflect the various types of resources that are consumed. As an example, for the production and delivery of electricity, account shall be taken of the electricity mix, the efficiencies of fuel combustion, conversion, transmission and distribution losses." (ISO 14044:2006, §4.3.3.1).

Inputs and outputs of combustible material can be transformed into inputs and outputs of energy by multiplying by the net calorific value (also known as the lower heating value or the lower calorific value) of the fuel (EN 15804+A2:2019, §6.4.2).

The same procedures for calculating data, e.g. in taking averages between production sites, shall be applied throughout the study. These processes are described in EN 15804+A2:2019, §6.4.2. These procedures and any assumptions made shall be documented in the Study Report. The validity of data shall be checked, e.g. through a mass balance or energy balance, to confirm that the data quality requirements in section 3.4 have been met.

4.3 Allocation of Material and Energy Flows and Releases

Allocation involves "partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems" (ISO 14044:2006, §3.17). When the same unit process produces two or more products, these are called co-products (ISO 14044:2006, §3.10).

ISO 14044:2006 §4.3.4.2 requires that allocation be avoided wherever possible by dividing a unit process into two or more sub-processes and

dividing the inputs and outputs between these sub-processes accordingly. Where the unit process cannot be subdivided, allocation must "reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system." If the difference in revenue obtained from the co-products is low (25% or less), an appropriate physical relationship (mass, volume, etc.) shall be used to allocate the resources and wastes to each co-product (EN 15804+A2:2019, §6.4.3.2). If the difference in revenue exceeds 25%, economic value shall be used instead. No inputs or outputs shall be allocated to wastes (ISO 14044:2006, §4.3.4.2).

Avoiding allocation through system expansion, as advocated in ISO 14040:2006, is not appropriate due to the principle of modularity and the need to attribute impacts to specific products, which may be manufactured from products, co-products and/or material recovered from waste (IEPDS, 2019, §A.6.1).

The use of secondary data that do not follow these allocation rules shall be justified in the Project Report. However, all secondary data must follow the requirements of ISO 14044:2006.

4.3.1 Allocation from Reuse and Recycling

When end-of-life material from a previous product system (i.e. secondary material) is used, or part of the product under study is recovered at its end-of-life, allocation of burdens and benefits between product systems (i.e. allocation between past and current, or current and future life cycles) is necessary. When this happens, the scenario considered is to based on a specified scenario which is based on current average technology and practices (EN 15804+A2:2019, §6.4.3.3).

Please refer to §6.4.3.3 of EN 15804+A2:2019 for the allocation procedure and Annex D for the detailed calculation methodology for Module D.

5. Required Indicators

5.1 Application of Other PCR

Different product category rules require different indicators. The indicators from EN 15804+A2:2019, as specified in this section, are required where there is not a third-party PCR for the product type of interest that Danfoss wishes to apply. Where such a PCR does exist and Danfoss does wish to apply it, the indicators specified in that PCR shall apply instead. This must be documented in Annex A.

It is recommended that the EN 15804+A1 indicators are also shown in the EPD results.

5.2 Life Cycle Impact Assessment Indicators

The following life cycle impact assessment indicators are required on the EPD (EN 15804+A2:2019, Table 3). all indicators mentioned in this section, the characterization factors from EC-JRC shall be applied.

The characterization factors are available at the following web-link:

http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml.

Indicator	**Methodology [Unit]**
Global Warming Potential total (GWP-total)	Baseline model of 100 years, based on IPCC 2013 [kg CO2 equivalent]
Global Warming Potential fossil fuels (GWP-fossil)	Baseline model of 100 years, based on IPCC 2013 [kg CO2 equivalent]
Global Warming Potential biogenic (GWP-biogenic)	Baseline model of 100 years, based on IPCC 2013 [kg CO2 equivalent]
Global Warming Potential land use and land use change (GWP-luluc)	Baseline model of 100 years, based on IPCC 2013 [kg CO2 equivalent]
Acidification potential for soil and water	Accumulated Exceedance, Seppälä et al. 2006, Posch et al., 2008 [mol H+ equivalent]
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe [kg P eq.]
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	EUTREND model, Struijs et al., 2009b, as implemented in ReCiPe [kg N eq.]
Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	Accumulated Exceedance, Seppälä et al. 2006, Posch et al. [mol N eq.]
Formation potential of tropospheric ozone (POFP);	LOTOS-EUROS ,Van Zelm et al., 2008, as applied in ReCiPe [kg NMVOC eq.]
Abiotic depletion potential for nonfossil resources (ADP-minerals&metals)	CML 2002, Guinée et al., 2002, and van Oers et al. 2002. [kg Sb-equivalent]
Abiotic depletion for fossil resources potential (ADP-fossil)	CML 2002, Guinée et al., 2002, and van Oers et al. 2002. [MJ, net calorific value]
Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	Available WAter REmaining (AWARE) Boulay et al., 2016 [m3 world eq. deprived]

The following additional environmental impact indicators shall be calculated and included in the report (EN 15804+A2:2019, Table 4). It is recommended that they are included in the EPD to allow for that EPD to be used in the creation of other EPDs which require these indicators (IEPDS, 2021, §5.3.5).

Indicator	**Methodology [Unit]**
Potential incidence of disease due to PM emissions (PM)	SETAC-UNEP, Fantke et al. 2016 [Disease incidence]
Potential Human exposure efficiency relative to U235 (IRP)	Baseline model of 100 years, based on IPCC 2013 [kBq U235 eq.]
Potential Comparative Toxic Unit for ecosystems (ETP-fw)	USEtox version 2 until the modified USEtox model is available from EC-JRC [CTUe]
Potential Comparative Toxic Unit for humans (HTP-c)	USEtox version 2 until the modified USEtox model is available from EC-JRC [CTUh]
Potential Comparative Toxic Unit for humans (HTP-nc)	USEtox version 2 until the modified USEtox model is available from EC-JRC [CTUh]
Potential Soil quality index (SQP)	Soil quality index based on LANCA [dimensionless]

5.3 Life Cycle Inventory Indicators

For all indicators mentioned in this section, the characterization factors from EC-JRC shall be applied. (http://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml)

The following life cycle inventory indicators are required on the EPD (EN 15804+A2:2019, Table 6):

Indicator	**Unit**
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value

Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value
Use of secondary materials	kg
Use of renewable secondary fuels	MJ, net calorific value
Use of non-renewable secondary fuels	MJ, net calorific value
Net use of fresh water	m^3

Net use of fresh water shall be calculated as the input of fresh water minus the output of fresh water (that may be warmed or treated) to the same watershed. That is, it should only include losses on a watershed level caused by evaporation, evapotranspiration (from plants), freshwater integration into products, and release of freshwater into sea (e.g. from wastewater treatment plants located at the coast line). This figure is sometimes known as the blue water footprint.

Where there is uncertainty regarding these inventory metric, it is recommended that guidance be sought from the ISO 21930 Guidance Document (ACLCA, 2019), unless other guidance becomes available.

5.4 Additional Indicators

The following additional indicators are required on the EPD (EN 15804+A2:2019, Table 7 & Table 8):

Indicator	**Unit**
Hazardous waste disposed	kg
Non-hazardous waste disposed	kg
Radioactive waste disposed	kg
Components for reuse	kg
Materials for recycling	kg
Materials for energy recovery	kg
Exported energy	MJ per carrier

Note: Most radioactive waste declared on an EPD is likely to occur upstream due to the use of nuclear power plants in the production of electricity.

6. Requirements for the Environmental Product Declaration

6.1 General Information

The following general information shall be included:

- Danfoss EPD number and revision number
- A reference to these Core Rules, e.g. "Environmental Product Declaration according to the Danfoss Product Category Rules (Rev. 2021-10-01)", and any product-specific standards defined in Annex A
- Date of issue/publication of the EPD
- Date of expiry (typically 5 years from issue)
- Year of study
- Name and physical address of the division making the declaration
- Name and physical address of the product manufacturing plant
- Contact person – Author of the LCA
- Verification, i.e. external verification, internal verification or no verification (see §8.1)

The following may be included:

- Cut-off criteria, if above the minimum required standard (see §3.3)

6.2 Disclaimers

The following statements shall be included directly.

On comparability:

- If registered under Program Operator (PO) "Environmental product declarations from different programmes may not be comparable."
- If not registered under PO and for publication on Danfoss website "A comparison or evaluation of Danfoss EPD data is only possible if compliant with Danfoss PCR and same set of rules, assumptions, product-specific characteristics of performance and application context are taken into account"

On product representativeness:

- If the EPD is for an average or representative product rather than a specific product: "This declaration is for a representative product and indicates average performance for its product class. There may be no specific product within this class that has the exact performance described in this environmental declaration."

On verification and ISO 14025 compliance:

If the EPD has not been externally verified and registered under an EPD programme operator:

- "The EPD was prepared to the best of Danfoss A/S knowledge. The life cycle assessment calculations were performed in accordance with ISO 14040 and 14044 and EN15804+A2. All results were internally reviewed by independent experts.
- "While this declaration has followed the guidance of ISO 14025, it has not been externally verified or registered by an EPD

programme and therefore does not fully comply with the ISO 14025 standard"

- The EPD is published by Danfoss A/S. For questions, feedback or requests please contact your sales representative.

The three last bullets shall be included in a visible font on the front page of the Danfoss published EPD to provide full transparency.

6.3 Product-Specific Information

The following product-specific information shall be included:

- Product name
- Model number
- A picture of the product (or a picture of a representative product in the range)
- Product mass excluding packaging (kg)
- Product dimensions excluding packaging (mm or m)
- Technical data. This might include, for example, voltage rating and power rating. If any product-specific rules are provided in Annex A, these rules shall apply.
- The functional unit or declared unit to which the EPD relates
- The reference service life, if the use stage is declared in the EPD
- Type of EPD: "Cradle to Gate", "Cradle to Gate with Options" or "Cradle to Grave"
- If the EPD declares figures for the use stage, a reference service life shall be specified

If modules from Table 1 are omitted only because they are not relevant to the product, the following statement shall be included on the EPD: "All relevant life cycle stages and information modules have been included." If modules are omitted not because they are irrelevant but instead because it is problematic to supply data, this shall be stated. For example, if the use stage has been omitted because it is highly variable, a statement explaining this shall be included on the EPD. If possible, information explaining how the customer can calculate the use stage impacts should also be included or cited.

The following details may be included on the EPD:

- Product mass including packaging (kg)
- Dimensions of boxed product (mm or m)
- The country where the final manufacturing steps took place

6.4 Content Declaration

A content declaration shall be included on the EPD which states the substances included in the product and packaging, including any ancillary materials remaining on the product after manufacturing. At a minimum, this must declare any substances subject to legal restrictions in the European Union when used in quantities above the legal threshold (EN 50598-3). This includes the substances listed in the RoHS Directive (2011/65/EU) and the Candidate List of Substances of Very High Concern for Authorisation of the REACH Regulation (EC 1907/2006). For SVHC, the declaration shall include the name of each substance and its mass, both in kilograms and as a percentage of the total mass of the

product without packaging. The CAS number of each substance may also be included. A separate declaration in the same format shall be made for the product's packaging. Batteries must also be declared (see Directive 2006/66/EC).

It is recommended that wherever possible a full material declaration should be included. An example of such a declaration is provided in Table 2. However, if the full material composition is not known and is difficult to estimate, substances may be declared in the groups defined by IEC 62474:2012 (EN 50598-3, §5.4.4). For substances that are not SVHC and for which there are commercial confidentiality concerns, a range may be used, e.g. 0.2-0.4 kg or 2-4%. Regardless of which option is chosen, the EPD shall state the source of the data. For example, "Data based on material declarations from suppliers" or "Data based on representative averages from Sphera's GaBi Databases 2021".

Table 2: Example content declaration for 1 m of electrical wire with PVC sheathing (excl. packaging)

Material	**Mass (kg)**	**Mass (%)**
Copper	2.00E-02	40.0
Polyvinyl chloride (PVC)	1.35E-02	27.0
Calcium carbonate	7.50E-03	15.0
Diisononyl phthalate (DINP)	7.50E-03	15.0
Calcium stearate	6.00E-04	1.20
Bisphenol A	7.50E-04	1.50
Carbon black	1.50E-04	0.300
Not declared	0.00E+00	0.000
Total mass	5.00E-02	100

6.4 Results of Life Cycle Inventory and Life Cycle Impact Assessment

The required indicators in section 5 shall be shown on the EPD. Information modules must be presented separately on the table and must not be summed together (EN 15804+A2:2019, §7.5), unless allowed in Annex A. The EPD shall not make comparative claims against competitor's products. Only life cycle stages that contain information relevant to the type of EPD chosen must be shown on the table. Modules not included in the EPD shall not be regarded as having an indicator result of zero and shall not be shown in the results table. Table 3 provides an example of how the main results should look.

6.5 Additional Environmental Information

The following additional environmental information may be included if they apply to the product:

- Self-declaration of RoHS compliance, including any exemptions relied upon

- Self-declaration of REACH compliance including the publication date of the Candidate List of Substances of Very High Concern used to make the assessment
- Statement of exceeding minimum standards of relevant implementing measures under the Ecodesign Directive (2009/125/EC)
- Certification of the factory (or factories) that produced the product to ISO 9001, ISO 14001 and/or EMAS. If included, a statement stating how interested parties can find out further information shall also be included.
- Environmentally relevant activities carried out by Danfoss or its suppliers in producing the product, such as internal eco-design activities and participation in recycling programmes. If included, a statement stating how interested parties can find out further information shall also be included.
- Instructions regarding how to use the product as efficiently as possible
- Estimated saved (avoided) energy/emissions based on substantiated and verified information
- Preferred waste management option for used products including any possibilities for reuse, recycling and/or energy recovery
- Information on any environmentally relevant substance in the product not already declared
- Potential for incidents, e.g. due to breakage or fire, that may lead to environmentally harmful emissions
- Other information on possible product-related environmental impacts, such as toxicity or geographically-specific impacts

Information that does not relate to the environmental performance of the product shall not be included.

Table 3 Main results table for EPD showing all life cycle modules (with some Module B stages not included)

	Production stage	Use stage			End-of-life stage				Credit
Life cycle impact assessment indicators	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3**	**C4**	**D**
Global warming potential (kg CO_2 eq.)									
Global warming potential (fossil) (kg CO_2 eq.)									
Global warming potential (biogenic) (kg CO_2 eq.)									
Global warming potential (land use change) (kg CO_2 eq.)									
Stratospheric ozone depletion potential (kg CFC-11 eq.)									
Acidification potential (land and water) (Mole of H+ eq.)									
Eutrophication potential – freshwater (kg P eq.)									
Eutrophication potential – marine (kg N eq.)									
Eutrophication potential – terrestrial (Mole of N eq.)									
Photochemical ozone formation potential (kg NMVOC eq.)									
Abiotic depletion potential, elements (kg Sb eq.)									
Abiotic depletion potential, fossil resources (MJ)									
Water scarcity (m^3 world eq.)									

Resource indicators	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3**	**C4**	**D**
Renewable primary energy, as energy (MJ)									
Renewable primary energy, as material (MJ)									
Renewable primary energy, total use (MJ)									
Non-renewable primary energy, as energy (MJ)									
Non-renewable primary energy, as material (MJ)									
Non-renewable primary energy, total use (MJ)									
Use of secondary materials (kg)									
Use of secondary fuels, renewable (MJ)									
Use of secondary fuels, non-renewable (MJ)									
Consumption of fresh water (i.e. net use) (m^3)									
Wastes and other outputs	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3**	**C4**	**D**
Waste disposed, hazardous(kg)									
Waste disposed, non-hazardous (kg)									

Waste disposed, radioactive (kg)									
Components for reuse (kg)									
Materials for recycling (kg)									
Materials for energy recovery (kg)									
Exported energy, electricity (MJ)									
Exported energy, process steam (MJ)									
Biogenic carbon content	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3**	**C4**	**D**
Biogenic carbon content – product (kg)									
Biogenic carbon content – packaging (kg)									
Additional Indicators	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3**	**C4**	**D**
Respiratory inorganics (Disease incidences)									
Ionizing radiation - human health (kBq U235 eq.)									
Ecotoxicity freshwater (CTUe)									
Human toxicity, cancer (CTUh)									
Human toxicity, non-canc. (CTUh)									
Land use (Pt)									

7. Requirements for the Study Report

7.1 General

A report (the Study Report) shall be produced that provides information regarding how the life cycle assessment was conducted and how the data and other information included on the EPD were produced (ISO 14025:2006, § 8.1.3). The Study Report is intended for the verifier and not for public communication.

The Study Report shall contain the following general information (EN 15804+A2:2019, §8.2):

- Date of the report
- Commissioner of the LCA and EPD
- Practitioner (including position and organisation) who carried out the LCA and filled out the EPD template. The practitioner may be from Danfoss or another organisation.
- Statement that the LCA has been conducted according to the requirements of these Core Rules. If other standards have been applied, this shall also be stated.

7.2 Goal and Scope of the Study

Following ISO 14040:2006 §5.2.1.1, the Study Report must state the goal of the study including the reasons for conducting it, its intended application and its intended audience (i.e. business-to-business or business-to-consumer communication). For example, the goal of the study might be to produce an EPD for business-to-business communication.

"The scope includes the following items:

- the product system to be studied
- the functions of the product system or, in the case of comparative studies, the systems
- the functional unit
- the system boundary
- allocation procedures
- impact categories selected and methodology of impact assessment, and subsequent interpretation to be used
- data requirements
- assumptions
- limitations
- initial data quality requirements
- type of critical review, if any
- type and format of the report required for the study." (ISO 14040:2006, §5.2.1.2)

The Study Report shall provide information for each of these requirements where they are not adequately specified by these Core Rules. Specifically, the Study Report shall include (EN 15804+A2:2019, §8.2):

- Functional/declared unit, including:

- A specification of the product and its main functionality
- A statement of whether the LCA is of a single product or multiple products within the same family
- If the LCA is for multiple products, a statement of how average have been calculated or how a representative product has been chosen
- The mass of the product
- If the use stage is included, a statement supporting the choice of reference service life (RSL)

- A summary of which life cycle stages and modules have been included within the system boundary and which have been excluded. If environmentally relevant modules have been excluded, these exclusions must be justified.
- Choice of allocation procedures and a justification of these procedures if they deviate from the Core Rules
- Data requirements and assumptions:
  - Reference year(s) for LCA
  - Choice of background database(s)
  - Choice of electricity grid mix(es), including their reference year(s)
- Cut-off criteria and assumptions shall be described and a list of excluded flows and processes shall be documented

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7.3 Life Cycle Inventory Analysis and Documentation of Data

The life cycle inventory analysis shall document the unit processes needed to model the life cycle stages included within the system boundary as defined in the scope (EN 15804+A2:2019, §8.2). This can be tabular or as a chart. Each unit process included requires documentation.

Following ISO 14044:2006 (Annex A), documentation of primary data (i.e. data collected by Danfoss) shall state at minimum:

- Name and description of the unit process
- Person collecting the data
- Time period over which data were collected
- Inputs:
  - Raw materials, including water and ancillary materials (e.g. lubricants and packaging)
  - Energy inputs by type, e.g. electricity, light fuel oil and natural gas
- Emissions:
  - Emissions to air
  - Emissions to water
  - Emissions to land including fate, e.g. mineral waste, mixed industrial waste, municipal solid waste
  - Other emissions, e.g. noise

If averages are taken across multiple sites, the procedure for calculating these averages shall be specified. Any allocation procedures used shall be stated. If allocation procedures differ from these Core Rules, the difference must be justified. In all cases, allocation must be applied consistently in the LCA.

Documentation of secondary data (i.e. data from standard databases or other publicly available sources) shall state at minimum:

- Name of unit process
- Source of the data
- Technological representativeness
- Geographical representativeness
- Time period for which data is valid

Any discrepancies between the data used from these databases and the requirements of these Core Rules must be justified. This includes, but is not limited to, choice of allocation procedures and geographical and time representativeness.

When scenarios are used, the choice of scenario must be stated and justified. As shown on Table 1, all modules except A1-A3 are based on scenarios.

The results of the life cycle inventory analysis shall be included in the Study Report. It is recommended that these results be presented by module from Table 1 (EN 15804+A2:2019, §8.4). If data are for several products, the results should be split by product. If data are for several manufacturing plants, the results should be split by manufacturing plant.

7.4 Life Cycle Impact Assessment

The life cycle impact assessment shall include (EN 15804+A2:2019, §8.2):

- The results separated by module as shown in Table 1
- References to the characterisation factors used (complying with section 5)
- A statement equivalent to the following: "LCIA results are relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks."

If data are for several products, the results should be split by product. If data are for several manufacturing plants, the results should be split by plant. The results do not need to be split by product or manufacturing plant if the aim of the EPD is to provide data for an average product within a product range. If the product range is homogeneous, a single representative product can be used as the basis of the EPD. If there is some variation, a representative sample of products should be assessed and then an average taken.

7.5 Life Cycle Interpretation

Interpretation of the results shall include (EN 15804+A2:2019, §8.2):

- A summary of the results
- Any limitations or assumptions that must be considered when interpreting the results
- "[Full] transparency in terms of value-choices, rationales and expert judgements"
- Assessment of data quality, considering data precision, completeness, consistency and representativeness
- If the LCA considers several products or several manufacturing plants, the deviation from the mean must be described
- If sensitivity analyses have been performed, their significance for interpretation of the results must also be discussed.

7.6 Documentation of Additional Environmental Information

For any additional environmental information declared in the EPD, supporting information that describes how this was derived shall be included in the Study Report (EN 14025:2006, §8.1.3). Where measurable data are provided, data should be based on measurements according to defined standards and/or laboratory test results wherever possible.

8. Additional requirements

8.1 Verification

- Verification of the EPD and supporting background information is optional under these Core Rules. This deviates from the requirements of ISO 14025:2006 and EN 15804+A2:2019 where verification is compulsory. However, for EPDs to be published on Danfoss site, internal critical review and verification is mandatory under these Core Rules. Internal verification shall be performed against these Core Rules.
- If verification is conducted, the verifier(s) must be both independent such that verification is impartial and have sufficient expertise such that verification is thorough. "Independent verifiers, whether internal or external to the organization, shall not have been involved in the execution of the LCA or the development of the declaration, and shall not have conflicts of interests resulting from their position in the organization." (ISO 14025:2006, §8.2.1)

A verifier shall be judged to have sufficient expertise to conduct the review if they have (ISO 14025:2006, §8.2.2):

- "knowledge of relevant sector, product and product-related environmental aspects,
- process and product knowledge of the product category,

- expertise in LCA and methodology for LCA work,
- knowledge of relevant standards in the fields of environmental labelling and declarations and LCA,
- knowledge of the regulatory framework within which requirements for Type III environmental declarations have been prepared, and
- knowledge of [these Core Rules]."

The verifier "shall as a minimum confirm the following:" (EN 14025:2006, §8.1.3):

- "conformance with [these Core Rules];
- conformance with the ISO 14040 series of standards;
- that data evaluation includes coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty;
- the plausibility, quality and accuracy of the LCA-based data;
- the quality and accuracy of additional environmental information;
- the quality and accuracy of the supporting information."

8.2 Business-to-consumer Communications

No part of these Core Rules shall be omitted for business-to-consumer communication. Furthermore, all life cycle stages must be considered unless these stages are insignificant or it is not possible to model reasonable scenarios for some stages (ISO 14025:2006, §9.2.1).

ISO 14025 states that all EPDs used for business-to-consumer communication should be both verified and registered through an EPD programme set up in accordance with ISO 14025, and that the verifier shall be external to the organisation providing the EPD. This means that an EPD created according to these Core Rules and used for business-to-consumer communication can only comply with ISO 14025 if it is also registered with an EPD programme and it has been externally verified.

8.3 Updating an EPD

When updating an EPD, the same requirements shall be met as those met in developing the original EPD. However, if the underlying data have not changed significantly (by more than ±10%) on any of the declared parameters then the results of the EPD do not have to be recalculated (EN 15804+A2:2019, §9).

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9. References

9.1 Directive sources

2006/66/EC Directive 2006/66/EC on batteries and accumulators. Brussels, Belgium: European Parliament and European Council.

2008/98/EC Directive 2008/98/EC on waste (Waste Framework Directive). Brussels, Belgium: European Parliament and European Council.

2009/125/EC Directive 2009/125/EC establishing a framework for the setting of ecodesign requirements for energy-related products. Brussels, Belgium: European Parliament and European Council.

2011/65/EU Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast). Brussels, Belgium: European Parliament and European Council.

9.2 Standards

ACLCA 2019 Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017. American Centre for Life Cycle Assessment. United States.

EC 1907/2006 Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Brussels, Belgium: European Parliament and European Council.

EN 15804:2012 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. Brussels, Belgium: European Committee for Standardization.

EN 15804+A2: 2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. Brussels, Belgium: European Committee for Standardization.

EN 50598-1 Ecodesign for power drive systems, motor starters, power electronics & their driven applications - Part 1: Procedure for setting energy efficiency requirements of motor driven applications by using the extended product approach and semi analytic models. Brussels, Belgium: European Committee for Standardization.

EN 50598-3 Ecodesign for power drive systems, motor starters, power electronics & their driven applications - Part 3: Environmental aspects and product declaration for power drive systems and motor starters. Brussels, Belgium: European Committee for Standardization.

GHG Protocol (2011) Greenhouse Gas Protocol Product Life Cycle Accounting and Reporting Standard. WRI & WBCSD: Washington, DC, USA and Geneva, Switzerland.

IEC 62430:2009 Environmental conscious design for electrical and electronic products. Geneva, Switzerland: International Electrotechnical Commission.

IEC 62474:2012	Material Declaration for Products of and for the Electrotechnical Industry. Geneva, Switzerland: International Electrotechnical Commission.
IEC TR 62650	Guidelines for End of Life information provision from manufacturers and recyclers, and for recyclability rate calculation of Electrical and Electronic Equipment. Geneva, Switzerland: International Electrotechnical Commission.
IEPDS, 2019	General Programme Instructions, Version 3.01. 2019-09-18. The International EPD® System: Stockholm, Sweden.
IEPDS, 2021	PCR 2019:14 Construction Product, Version 1.11. 2021-02-05. The International EPD® System: Stockholm, Sweden.
ISO 14021:2016	Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling). Geneva, Switzerland: International Organization for Standardization.
ISO 14025:2006	Environmental labels and declarations – Type III environmental declarations – Principles and procedures. Geneva, Switzerland: International Organization for Standardization.
ISO 14040:2006	Environmental management – Life cycle assessment – Principles and framework. Geneva, Switzerland: International Organization for Standardization.
ISO 14044:2006	Environmental management – Life cycle assessment – Requirements and guidelines. Geneva, Switzerland: International Organization for Standardization.
ISO 21930:2017	Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services
ISO 25745-1:2012	Energy performance of lifts escalators and moving walks — Part 1 — Energy measurement and verification

10. Changes

Changes in relation to previous issue

Issue	Change	Approved Date/Name

11. Annex A: Product-Specific Rules

A.1 Variable Frequency Drives

A.1.1 Functional/Declared Unit

The functional/declared unit shall be one device (EN 50598-3, §7.6). The mass per device shall be stated as per section 3.1.

Following EN 50598-3, the EPD may be for a product family rather than a single product. Where a technical parameter (e.g. power rating in kW or mass in kg) can be used to scale the impacts (e.g. kg CO2-eq. per kW product) with a low loss of accuracy, the EPD can provide a scaling function and a single EPD can be used for the whole product family.

Following EN 50598-3, the scaling function may only be declared if it is linear, i.e. $f(x) = m*x + t$, and if it has an accuracy of $R^2 \geq 0.97$. The scaling function must be calculated based on life cycle assessment of at least three devices in the product family based on the technical parameter chosen. For example, if the scaling factor is based on kW, a life cycle assessment of the products with the lowest, middle and highest kW ratings must be conducted and the results used to justify the scaling factor. All life cycle assessments can be documented in a single Study Report.

A.1.2 Product-Specific Information

The following technical information shall be specified on the EPD (see §6.2 and EN 50598-3, §C.3.2):

- Rated apparent power (kVA)
- Rated voltage (V)
- Rated frequency (Hz)
- Cooling method
- International Efficiency (IE) class if specified in EN 50598-1

If the above information is inadequate to define the product, additional technical information may be added until the product is clearly specified. However, it is important to remember that the main purpose of the EPD is to provide environmental information and not technical performance or sales information.

A.1.3 Cut-off Rules

The stricter cut-off threshold of 1% by mass, energy and environmental relevance (see §3.3) must be applied at both the module and unit process levels (EN 50598-3, §7.7).

A.1.4 Production (Module A1-A3)

A location-specific electricity grid mix should be used as far as possible. In the case of production within the European Union, the EU27 electricity grid mix should be used (EN 50598-3, §7.16.2). The approach taken shall be documented in the Study Report.

A.1.5 Shipping to Customer (Module A4)

When no detailed information on shipping is available, the product shall be assumed to be transported 2000 km in a 7.5t (gross vehicle weight) Euro 3 truck with the following parameters (EN 50598-3, §7.1.1):

- Load: 5 t
- Load factor (mass-based): 85 %
- Sulphur in diesel: 50 ppm
- Biogenic carbon in fuel: 0.05 %
- Division of journey: 32% on motorway (average speed 82 km/h), 40% out of town (average speed 70 km/h), 28% in town (average speed 27 km/h)

A.1.6 Additional Environmental Information

If the EPD is to be verified against EN 50598-3, Danfoss must apply the principles of environmentally conscious design from IEC 62430:2009 and document this within its management system, e.g. ISO 14001.

In addition, the location of the plant that performs the last major manufacturing step shall be stated. Relevant certifications of that plant (e.g., ISO 9001, ISO 14001 and OSHAS 18001) shall also be stated.

A.1.7 Reference Service Life (Modules B3-B6)

EN 50598-3 requires the use stage to be declared in the EPD using on the table below. Calculations for the use stage must follow the calculation rules specified in EN 50598-1 and be explained in detail in the Study Report. If use is not declared, this must be justified in the EPD and Study Report and the EPD cannot be verified against EN 50598-3.

Operating time per year (hours)	5000
Product life (years)	15
Input power / efficiency	Measured / data sheet
Energy consumption (W)	Measured / data sheet
Operating points	3-4 x operating points with an efficiency and power calculation for each point
Load profile	Alterative to operating points

A.1.8 Repair (Module B3)

If the use stage is included in the EPD, any standard repairs or routine maintenance shall be included. This includes, but is not limited to, replacement of contactor pins, grease sealings and ball bearings (EN 50598-3, §C.3.2).

A.1.9 Operational Energy (Module B6)

If the use stage is included in the EPD, the EU27 electricity grid mix shall be used for calculating the impacts due to operational energy consumption (EN 50598-3, §7.16.3). When the product is used in a specific country, a country-specific grid mix can be used for observations specific to that country (EN 50598-3, §7.16.3). The chosen grid mix(es) must be documented in the EPD and the Study Report (EN 50598-3, §7.16.3). All upstream electrical losses must also be included when calculating operational energy (EN 50598-3, §7.16.3.1).

A.1.10 End-of-Life (Modules D)

EN 50598-3 states, "The manufacturer shall provide information to facilitate end of life treatment for the products in the scope of the environmental declaration, e.g. dismantling, disposing, and recycling instructions compliant to IEC/TR 62635. This information shall include a list of components and their location in the product in accordance with IEC/TR 62650, B.1 and if applicable necessary requirements concerning waste management (e.g. necessary competencies, technologies and type or level of security required for the treatment or landfill)."

The end-of-life scenario below from EN 50598-3 §7.16.4 shall be applied. The product must first be dismantled through manual disassembly and/or shredding. Of the materials fractions:

- Ferrous metals are sent for recycling.
- Non-ferrous metals are sent for recycling.
- Materials with a high energy content are recycled and/or thermally recycled with energy recovery.
- The mineral fraction is landfilled.

A.1.11 Environmental Indicators

Compliance with EN 50598-3 requires only that the production, use and end-of-life stages be included on the EPD. Transportation to the customer is included in the production stage (EN 50598-3, §7.11) and end-of-life credits are included in the end-of-life stage (§7.13). Compliance with these Core Rules allows a reduced set of life cycle stages to those in section 6.4 for variable frequency drives in accordance with EN 50598-3; however, transport must be separated from production and end-of-life credits must be separated from end-of-life burdens. The life cycle stages that must be included on the EPD are: production, transport, use, end-of-life and credits.

A.1.12 Additional Information

For compliance with EN 50598-3, the EPD shall refer to the following standards:

- EN 50598-3
- The environmentally conscious design process used
- The LCA Study Report and life cycle inventory database on which the EPD is based
- ISO 14040:2006
- ISO 14044:2006
- ISO 14025:2006

A.1.13 Verification

EN 50598-3 requires environmentally conscious design to be integrated into Danfoss' internal management systems (ISO 9001, ISO 14001, etc.). Certification of these systems is considered to be a review according to EN 50598-3, third-party review is thus optional, implying compliance with ISO14025

In any case, Clause 6.2 on disclaimers requirements shall be followed.

12. Annex B: LCA Model Governance

Danfoss EPDs are based on the results derived from an LCA Model created in GaBi Software. The LCA model was created by external consultancy Thinkstep-anz in collaboration with Danfoss A/S and reviewed by internal experts to comply with this Danfoss Product Category Rules and the corresponding standards mentioned in this Danfoss Product Category Rules for LCA calculations and to best represent Danfoss products.

The model is universal and covers a wide range of Danfoss products. The results for specific product or product family are derived by specifying the input parameters without any modification of the model. That is done to secure harmonisation and quality across Danfoss EPDs and to allow for comparability.

The model is protected by internally assigned model administrator. If at any point of time changes shall apply to the model (e.g. to improve representativeness of certain material or process based on newly gained knowledge or change in technology), the change shall be presented to the model administrator and reviewed again by internal experts. If the change is approved, the model is modified and the new version is protected and used in the future work. The changes and model versions are documented by the administrator. If a proposed change is fundamental to the model, rather than an ad-on, it shall be considered whether the previous EPDs need to be recalculated using a modified model or are no longer comparable.

The software and background database shall be updated at least once a year to the latest released version. The update is first tested by model administrator. If the update affects the model's functionality (e.g. broken flows, expired processes), these shall be documented. The administrator notifies / LCA practitioners/specialists when they shall perform updates, in order to assure the same software/database version is used across Danfoss by all LCA experts.

The LCA model is used explicitly by internal LCA experts /specialists. The model contains Danfoss confidential information and can only be shared externally with NDA in place for e.g. external verification purposes.

The model administrator is responsible for ensuring that the latest approved model version is available on a SharePoint that LCA experts have access to. When model is updated, administrator is responsible for notifying the LCA experts, who in turn shall import the latest model version into their software. The model shall be exported/stored/imported as a database file.