ENGINEERING TOMORROW

Environmental **Product Declaration**

Aveo and Aero

self-acting mechanical radiator thermostats with remote gas-filled sensor

EPD issued	2023-04-17
EPD expires	2028-04-17
EPD author	Danfoss Climate Solutions
EPD type	Cradle-to-grave
Declared unit	One thermostat over its 10 years of Reference Service Life
Products included	Product range of Aveo and Aero models of self-acting mechanical radiator thermostats with remote gas-filled sensor
Manufacturing Location	Silkeborg, Denmark
Use Location	EU-27
Application	Manual thermostatic radiator valve for water-based heating system
Mass	0,228 kg without packaging 0,245 kg with packaging
Dimensions (H×W×D)	Ø56 mm x 83 mm without packaging (015G4092)
Verification	[ ] External [X] Internal [ ] None
Produced to	Danfoss Product Category Rules (2022-09-20)
Internal independent verifier	Danfoss Power Electronic & Drives A/S

Introduction

This Environmental Product Declaration (EPD) follows the Danfoss Product Category Rules (PCR) (2022-09-20). These rules provide a consistent framework for calculating and reporting the environmental performance of Danfoss' products and is aligned with relevant international standards, particularly ISO 14025:2006, EN 15804+A2:2019 and EN 50598-3:2015.

This document has been produced by Danfoss A/S following an internal verification process, but it is not a third-party verified document.

What is an EPD?

An EPD is a document used to communicate transparently, the quantified environmental impacts of a product over its lifecycle stages. This quantification is done by performing a Life Cycle Assessment (LCA) in line with a consistent set of rules known as a PCR (Product Category Rules).

An EPD provides:

- A product's carbon footprint together with other relevant environmental indicators, including air pollution, water use, energy consumption and waste, over its own life cycle (Modules A-C), as well as the expected benefits of reuse and recycling in reducing the impact of future products (Module D). See Table 1 for module descriptions.
- Environmental data allowing customers to calculate LCAs and produce EPDs for their own products.

Type of EPD

This EPD is of the type 'cradle-to-grave' and includes all relevant modules: production (A1-A3), shipping (A4) and installation (A5); operational energy use (B6); deconstruction (C1), waste collection and transport (C2), treatment (C3) and disposal (C4). It also includes potential net benefits to future products from recycling or reusing post-consumer waste (D). The codes in brackets are the module labels from EN 15804+A2. Modules concerning use, maintenance, repair, replacement, refurbishment (B1-B5) and operational water use (B7) are excluded, following the cut-off rules from EN 15804.

Table 1: Modules of the product's life cycle included in the EPD

Product stage			Installation		Use stage							End-of-life stage				Benefits
Raw materials	Transport	Manufacture	Transport	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-install.	Transport	Waste processing	Disposal	Benefits and loads outside system boundaries
A1	**A2**	**A3**	**A4**	**A5**	B1	B2	B3	B4	B5	**B6**	B7	**C1**	**C2**	**C3**	**C4**	**D**
X	**X**	**X**	**X**	**X**	MNR	MNR	MNR	MNR	MNR	**X**	MNR	**X**	**X**	**X**	**X**	**X**

(X = declared module; MNR = module not relevant)

Product Description

The products studied in this report is the Aveo and Aero new generation of mechanical radiator thermostats with remote gas-filled sensor that is part of the thermostatic radiator valve for water-based heating system.

The radiator thermostats help people to obtain comfort in their homes. By maintaining constant desired room temperatures, individually or room by room, and by helping to reduce energy consumption.

The thermostat optimizes the energy use via its gas charging media with which it maintains a high regulating capacity and reactivity to temperature changes. The production location is Silkeborg, Denmark. See more information about the product on the Product Store.

The EPD covers the entire product range of Aveo and Aero with remote gas-filled sensor with the following product types:

Aveo and Aero RA click	Aveo and Aero RA/VL	Aveo and Aero RA/V	RA click grey & theft

Figure 1: Picture of the Aveo remote gas-filled sensor product with RA click socket.

Reference Service Life

For the purpose of this EPD the reference service life (RSL) of the product is considered to be 10 years.

Intended market

The intended market of this study is EU-27 member states, and the baseline scenario involves the distribution, installation, and end-of-life in EU-27 member states. With regards to the use stage and the end-of-life stage, this EPD is not representative of regions other the EU-27 member states.

Product Description

Table 2: Product composition

Material	Mass (kg)	%
Metals	**0,132**	**57,9%**
Steel (excl. stainless steel)	0,0775	34,0%
Stainless steel	0,0059	2,6%
Copper and its alloys	0,0112	4,9%
Zinc and its alloys	0,0372	16,3%
Plastics	**0,0849**	**42,3%**
ABS (unreinforced)	0,0381	16,7%
Polycarbonate (unreinforced)	0,0004	0,2%
Other reinforced thermoplastics	0,0335	14,7%
Other unreinforced thermoplastics	0,0244	10,7%
Total product	**0,228**	**100,0%**

*the EPD values are calculated for this compositions (015G4092). All the other sales codes are within +/- 10%. The sales codes of all products covered in this EPD, are presented in Annex 1.

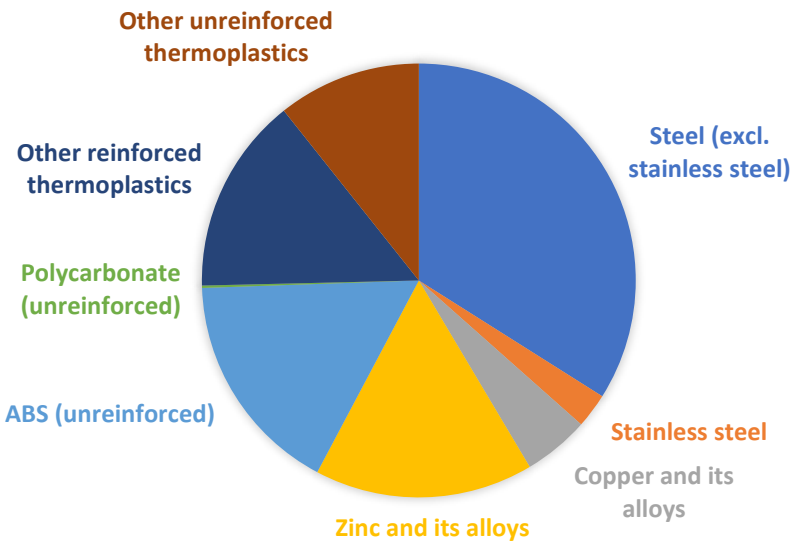

Figure 2: **Material Composition Overview**

Overview of LCA study

Data quality

Data quality of the selected datasets is generally assessed as good and very good in terms of geographical, time and technology representativeness and applicability. Background data is from GaBi database version 2022.

Allocation and cut-off criteria

The allocation is made in accordance with the provisions of EN 15804+A2. All major raw materials and all the essential energy are included. All hazardous materials and substances are considered in the inventory. Data sets within the system boundary are complete and fulfil the criteria for the exclusion of inputs and output criteria.

System boundaries

The results in this EPD are split into life cycle modules following EN 15804 (Figure 1): production (A1-A3), distribution (A4), use (B6) and the end of the product's life (C1-C4). Module D represents environmental benefits and loads that occur beyond the system boundary (i.e., in future products).

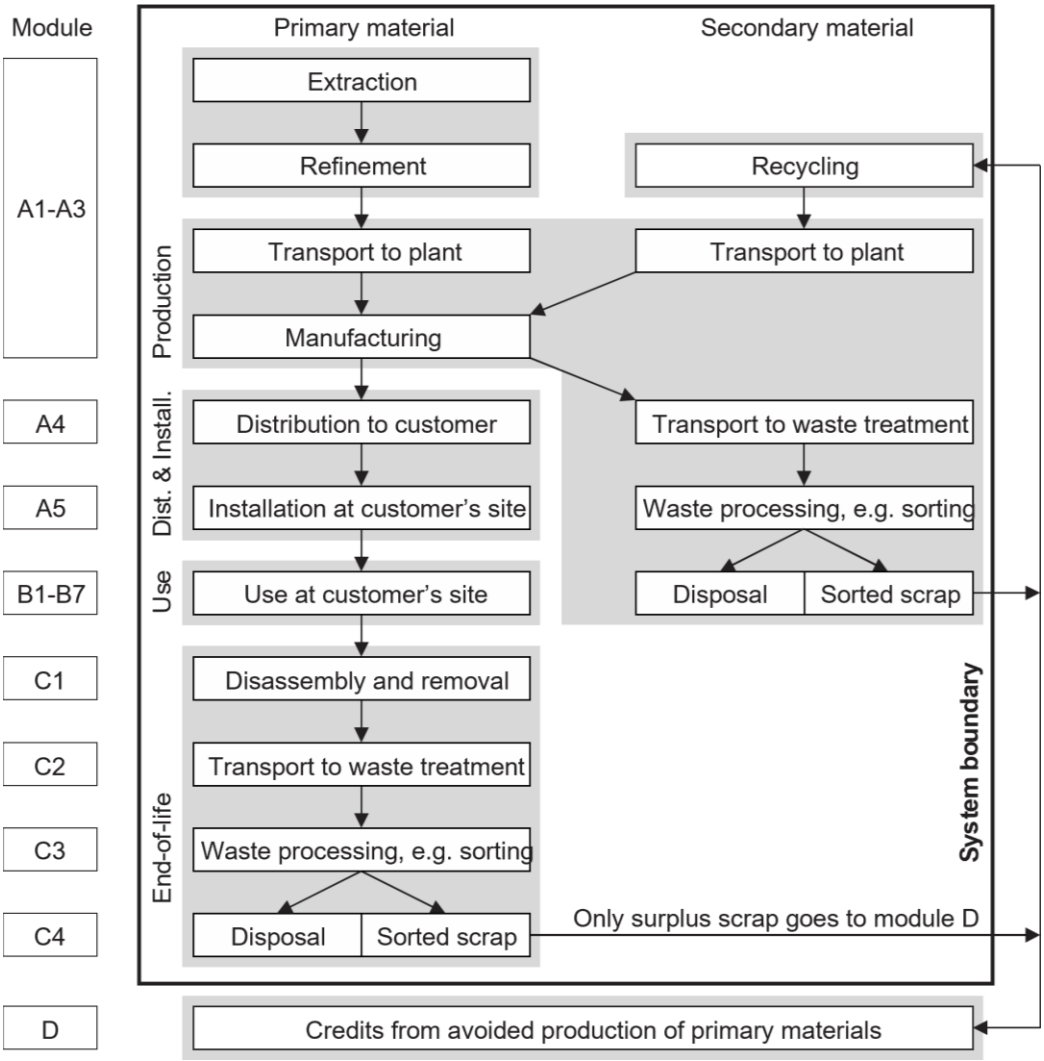

Figure 3: Modular structure used in this EPD (following EN 15804+A2)

Overview of LCA study

Product and packaging manufacture (A1-A3)

Final manufacturing occurs in Silkeborg, Denmark, and the Danfoss QEHS management system is certified to ISO 9001, ISO 14001, and ISO 45001, and in addition, the quality management system is compliant to IATF 16949. Where waste generated on-site is recyclable, it is separated and recycled. For further information, see here. The product is shipped in the packaging described in Table 2 below. All packaging materials can be safely recycled or incinerated if appropriate local facilities are available.

Table 2: Packaging materials

Packaging material	Mass (kg)
Paper and cardboard	0,0162
Polyethylene	0,00115
Total packaging	**0,0174**

Table 3: Biogenic carbon content in product and packaging

	Total (excluding recycling)
Biogenic carbon content in product [kg]	-
Biogenic carbon content in accompanying packaging [kg]	0,00697

Note: 1 kg biogenic carbon is equivalent to 44/12 kg of CO_2.

Shipping and installation (A4-A5)

Distribution is assumed to occur to customers in EU-27 member states. Transportation at 2000 km distance by truck is assumed between the factory and the final customer. This assumption was made following EN 50598-3, section 7.11 on default distance assumptions.

Module A5 includes disposal of packaging materials only, the benefits from e.g., energy recovered after plastic incineration are allocated to module D. The product is assumed to be installed by hand. Energy use in handheld tools during installation is not included as it falls under the cut-off criteria.

Module A5 includes disposal of packaging materials only, the benefits from e.g., energy recovered after plastic incineration are allocated to module D. The product is assumed to be installed by hand. Energy use in handheld tools during installation is not included as it falls under the cut-off criteria.

Use phase (B1-B6)

The Reference Service Life (RSL) applied in this EPD is 10 years. As the radiator thermostat is a mechanical product, it does not require any electricity input to operate the thermostat. The energy used for heating in the radiator system is out of the system boundaries and functional unit of the current product and LCA study.

End-of-life (C1-C4)

The standard end-of-life procedure from EN 50598-3 has been applied:

- Manual dismantling is used to separate recyclable bulk materials, e.g. bulk metals and plastics.

Overview of LCA study

- Shredding is used for the remaining parts, such as printed circuit board assemblies.
- Ferrous metals, non-ferrous metals and bulk plastics are recovered through recycling.
- The remaining materials go to either energy recovery or landfill.

In line with EN 15804+A2, only the 'net scrap' (i.e., the leftover recyclable materials remaining after inputs of recycled content required in the manufacturing phase are first satisfied) is used to calculate the benefits and loads beyond the system boundary (Module D).

Two scenarios are examined for the end-of-life.

1. Recycling scenario with 100% of the product sent to recycling at the end-of-life, excluding fractions that cannot be recycled or incinerated (e.g., glass reinforcing in glass-filled plastics) and are sent to landfill (C3.1, C4.1, D.1)

This scenario illustrates best case performance. It assumes a 100% collection rate and best available recycling technologies. Under this scenario electrical cables, and all metals, flat glass and unreinforced plastics found within the body and chassis of the product are recycled. Printed circuit board assemblies are incinerated, and the copper and precious metals (gold, silver, palladium, and platinum) are recycled.

2. Landfill scenario with 100% of the product sent to landfill (C3.2, C4.2, D.2).

This scenario assumes that the whole product, including its packaging, is landfilled. It is designed to represent a poor end of-life-route where valuable resources are lost.

Benefits and loads beyond the system boundary (D)

Module D considers the net benefit of recycling (including energy recovery) of materials in the product and packaging, taking account of losses in the recycling process and the recycled material used in the production of the product. Module D covers the two end-of-life scenarios, as described above.

Environmental performance

This section presents the environmental performance of the *Aveo room thermostat with remote gas-filled sensor (with RA click socket)* and it is applicable for the whole range of remote gas-filled sensors. Figure 4 presents the environmental impact of the product across a number of environmental impact categories (following EN 15804+A2:2019) per life cycle stage, over its full 10-year life cycle, including Global Warming Potential.

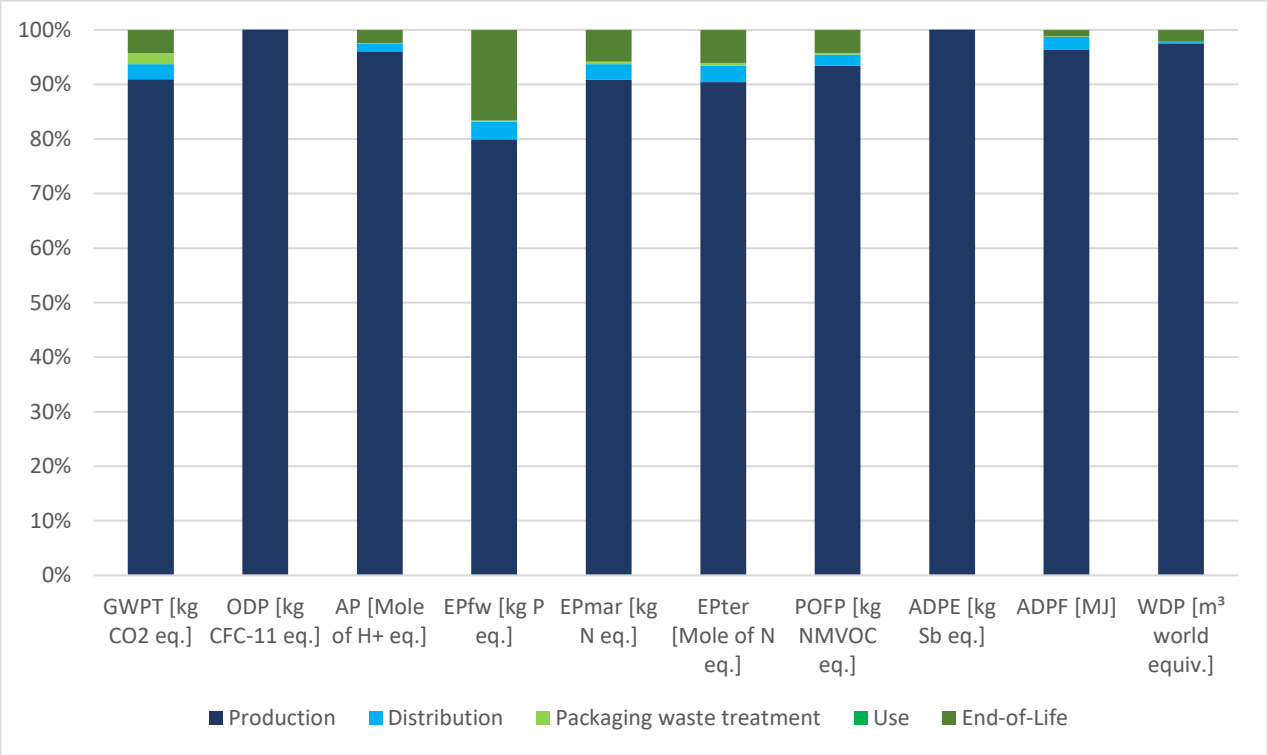

Figure 4: Breakdown of environmental impacts by life cycle stages (see Table 6 for descriptions of environmental impact indicators). Use phase is zero.

Table 5: Environmental impact indicators

	Production	Distribution	Packaging waste treatment	Use	End-of-Life						(not included in Figure 4)	
Life cycle stages based on EN 15804+A2	**A1-A3**	**A4**	**A5**	**B6**	**C1**	**C2**	**C3.1** Recycling	**C3.2** Landfill	**C4.1** Recycling	**C4.2** Landfill	**D.1** Recycling	**D.2** Landfill
Description / **Environmental Impact Indicators**	Manufacture of the product from 'cradle-to-gate'	Transport of the product to the customer	Installation of the product and disposal of used packaging	Use of the product over its lifetime e.g. 10 years	Deinstallation of the product from the site	Transport of the product to waste treatment	Processing waste for recycling		Disposal of waste that cannot be recycled (through landfill and incineration)		Potential benefits and loads beyond the system boundary due to reuse, recycling, and energy recovery	
GWPT [kg CO2 eq.]	1,19E+00	3,59E-02	2,71E-02	0,00E+00	0,00E+00	2,07E-03	1,81E-02	0,00E+00	7,70E-02	1,09E-02	-6,66E-01	-1,98E-01
GWPF [kg CO2 eq.]	1,21E+00	3,57E-02	1,52E-03	0,00E+00	0,00E+00	2,07E-03	1,80E-02	0,00E+00	7,70E-02	1,09E-02	-6,65E-01	-1,98E-01
GWPB [kg CO2 eq.]	-2,55E-02	0,00E+00	2,55E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
GWPLULUC [kg CO2 eq.]	1,39E-03	2,44E-04	1,03E-06	0,00E+00	0,00E+00	4,91E-08	1,22E-04	0,00E+00	1,58E-07	7,02E-06	-9,58E-04	-1,70E-04
ODP [kg CFC-11 eq.]	1,15E-10	3,56E-15	1,14E-16	0,00E+00	0,00E+00	2,37E-19	1,78E-15	0,00E+00	6,16E-15	1,38E-14	-9,36E-11	-3,45E-12
AP [Mole of H+ eq.]	4,66E-03	6,51E-05	8,48E-06	0,00E+00	0,00E+00	3,07E-06	1,10E-04	0,00E+00	7,34E-05	4,65E-05	-2,65E-03	-6,86E-04
EPfw [kg P eq.]	3,24E-06	1,29E-07	9,64E-09	0,00E+00	0,00E+00	4,40E-10	6,48E-08	0,00E+00	1,85E-09	1,28E-06	-8,58E-07	-1,24E-07
EPmar [kg N eq.]	8,39E-04	2,59E-05	4,33E-06	0,00E+00	0,00E+00	1,25E-06	5,36E-05	0,00E+00	3,68E-05	1,42E-05	-4,33E-04	-1,27E-04
EPter [Mole of N eq.]	8,86E-03	2,97E-04	4,74E-05	0,00E+00	0,00E+00	1,38E-05	5,94E-04	0,00E+00	4,13E-04	1,55E-04	-4,59E-03	-1,37E-03
POFP [kg NMVOC eq.]	2,62E-03	5,76E-05	8,03E-06	0,00E+00	0,00E+00	2,91E-06	1,02E-04	0,00E+00	9,35E-05	3,69E-05	-1,42E-03	-4,22E-04
ADPE [kg Sb eq.]	2,37E-04	3,65E-09	4,92E-10	0,00E+00	0,00E+00	7,23E-11	1,83E-09	0,00E+00	1,92E-10	7,49E-10	-1,81E-04	-1,91E-05
ADPF [MJ]	1,97E+01	4,75E-01	1,98E-02	0,00E+00	0,00E+00	2,93E-02	2,38E-01	0,00E+00	2,88E-02	1,52E-01	-1,04E+01	-2,48E+00
WDP [m^3 world equiv.]	1,77E-01	4,05E-04	1,16E-04	0,00E+00	0,00E+00	3,43E-06	2,03E-04	0,00E+00	7,44E-03	1,52E-04	-1,17E-01	-2,28E-02

How to read scientific numbers:

e.g. 2,05E02 = 2,05 x 10^2 = 205

2,04E-01 = 2,04 x 10^{-1} = 0,204

Table 6: Environmental impact indicator descriptions

Acronym	Unit	Indicator
GWPT	kg CO_2 eq.	Carbon footprint (Global Warming Potential) – total
GWPF	kg CO_2 eq.	Carbon footprint (Global Warming Potential) – fossil
GWPB	kg CO_2 eq.	Carbon footprint (Global Warming Potential) – biogenic
GWPLULUC	kg CO_2 eq.	Carbon footprint (Global Warming Potential) – land use and land use change
ODP	kg CFC-11 eq.	Depletion potential of the stratospheric ozone layer
AP	Mole H+ eq.	Acidification potential
EPfw	kg P eq.	Eutrophication potential – aquatic freshwater
EPmar	kg N eq.	Eutrophication potential – aquatic marine
EPter	Mole of N eq.	Eutrophication potential – terrestrial
POFP	kg NMVOC eq.	Summer smog (photochemical ozone formation potential)
ADPE*	kg Sb eq.	Depletion of abiotic resources – minerals and metals
ADPF*	MJ	Depletion of abiotic resources – fossil fuels
WDP*	m^3 world eq.	Water deprivation potential (deprivation-weighted water consumption)

Results for module A1-A3 are specific to the product. All results from module A4 onwards should be considered as scenarios that represent one possible outcome. The true environmental performance of the product will depend on actual use.

The results in this section are relative expressions only and do not predict actual impacts, the exceeding of thresholds, safety margins, or risks. EPDs from others may not be comparable.

Carbon footprint

The total carbon footprint, cradle-to-grave, of the product is **1,30E+00 kgCO2-eq** (A1-C4), based on the average use phase scenario. The carbon footprint of production of this product, cradle-to-gate, is **1,21E+00 kgCO2-eq** (A1-A3).

Table 7: Resource use

	A1-A3	A4	A5	B6	C1	C2	C3.1 Recycling	C3.2 Landfill	C4.1 Recycling	C4.2 Landfill	D.1 Recycling	D.2 Landfill
PERE [MJ]	8,28E00	3,29E-02	8,76E-04			9,66E-05	1,65E-02	0,00E00	3,70E-03	9,35E-03	-9,21E-01	9,83E-02
PERM [MJ]								0,00E00				
PERT [MJ]	8,28E00	3,29E-02	8,76E-04			9,66E-05	1,65E-02	0,00E00	3,70E-03	9,35E-03	-9,21E-01	9,83E-02
PENRE [MJ]	1,64E01	4,77E-01	2,12E-02			2,94E-02	2,39E-01	0,00E00	2,88E-02	1,22E-01	-1,04E01	-1,42E00
PENRM [MJ]	3,39E00							0,00E00				
PENRT [MJ]	1,98E01	4,77E-01	2,12E-02			2,94E-02	2,39E-01	0,00E00	2,88E-02	1,22E-01	-1,04E01	-1,42E00
SM [kg]	1,94E-02							0,00E00				
RSF [MJ]								0,00E00				
NRSF [MJ]								0,00E00				
FW [m3]	5,47E-03	3,81E-05	3,72E-06			1,55E-07	1,91E-05	0,00E00	1,75E-04	5,03E-06	-3,38E-03	-1,27E-04

Table 7: Resource use indicator descriptions

Acronym	Unit	Indicator
PERE	MJ	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	MJ	Use of renewable primary energy resources used as raw materials
PERT	MJ	Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)
PENRE	MJ	Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials
PENRM	MJ	Use of non-renewable primary energy resources used as raw materials
PENRT	MJ	Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)
SM	kg	Use of secondary material
RSF	MJ	Use of renewable secondary fuels
NRSF	MJ	Use of non-renewable secondary fuels
FW	m^3	Net use of fresh water

Table 8: Waste categories and output flows

	A1-A3	A4	A5	B6	C1	C2	C3.1 Recycling	C3.2 Landfill	C4.1 Recycling	C4.2 Landfill	D.1 Recycling	D.2 Landfill
HWD [kg]	8,77E-07	2,52E-12	8,76E-14			2,02E-13	1,27E-12		3,81E-12	1,65E-11	-9,19E-06	-4,77E-06
NHWD [kg]	7,88E-02	7,77E-05	1,97E-06			2,94E-06	3,90E-05		3,77E-04	2,28E-01	-1,11E-02	4,58E-04
RWD [kg]	5,58E-04	8,86E-07	5,03E-08			3,14E-08	4,44E-07		8,32E-07	1,51E-06	-1,66E-04	-5,73E-06
CRU [kg]												
MFR [kg]									1,95E-01			
MER [kg]												
EEE [MJ]	4,47E-03								1,34E-01			
EET [MJ]									2,40E-01			

Table 9: Waste category and output flow descriptions

Acronym	Unit	Indicator
HWD	kg	Hazardous waste disposed
NHWD	kg	Non-hazardous waste disposed
RWD	kg	Radioactive waste disposed
CRU	kg	Components for reuse
MFR	kg	Materials for recycling
MER	kg	Materials for energy recovery
EEE	kg	Exported energy (electrical)
EET	kg	Exported energy (thermal)

Table 10: Additional indicators*

	A1-A3	A4	A5	B6	C1	C2	C3.1 Recycling	C3.2 Landfill	C4.1 Recycling	C4.2 Landfill	D.1 Recycling	D.2 Landfill
PM [Disease incidences]	4,48E-08	4,13E-10	4,90E-11			1,64E-11	6,56E-10	0,00E00	1,93E-10	4,37E-10	-3,14E-08	-1,08E-08
IRP [kBq U235 eq.]	7,61E-02	1,34E-04	4,26E-06			4,45E-06	6,70E-05	0,00E00	1,31E-04	2,12E-04	-1,66E-02	-1,67E-04
ETPfw [CTUe]	9,32E00	3,37E-01	1,60E-02			2,12E-02	1,69E-01	0,00E00	1,05E-02	2,98E-01	-4,89E00	-1,03E00
HTPc [CTUh]	2,10E-08	6,94E-12	2,56E-13			3,95E-13	3,49E-12	0,00E00	5,90E-13	6,87E-12	-1,78E-09	-8,47E-10
HTPnc [CTUh]	3,32E-08	3,87E-10	1,06E-11			1,71E-11	2,14E-10	0,00E00	2,33E-11	6,21E-10	-1,29E-08	-2,06E-09
SQP [Pt]	5,45E00	2,01E-01	4,49E-03			7,50E-05	1,01E-01	0,00E00	4,25E-03	1,24E-02	-1,21E00	-7,39E-02

Table 11: Optional indicator descriptions

Acronym	Unit	Indicator
PM	Disease incidence	Potential incidence of disease due to particulate matter emissions
IRP**	kBq U235 eq.	Potential human exposure efficiency relative to U235
ETPfw*	CTUe	Potential Comparative Toxic Unit for ecosystems (fresh water)
HTPc*	CTUh	Potential Comparative Toxic Unit for humans (cancer)
HTPnc*	CTUh	Potential Comparative Toxic Unit for humans (non-cancer)
SQP*	Dimensionless	Potential soil quality index

**Disclaimer for ADPE, ADPF, WDP, ETPfw, HTPc, HTPnc, SQP:* The results of these environmental impact indicators shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

***Disclaimer for ionizing radiation:* This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Additional environmental information

CEN (2015). *EN 50598-3:2015: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations.* Brussels, Belgium: European Committee for Standardization.

CEN (2019). *EN 15804:2012+A2:2019: Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.* Brussels, Belgium: European Committee for Standardization.

Danfoss (2022). *Danfoss Product Category Rules: Environmental Product Declarations for Danfoss Products.* Nordborg, Denmark: Danfoss A/S.

ISO (2006a). *ISO 14025:2006: Environmental labels and declarations – Type III environmental declarations – Principles and procedures.* Geneva, Switzerland: International Organization for Standardization.

ISO (2006b). *ISO 14040:2006: Environmental management – Life cycle assessment – Principles and framework.* Geneva, Switzerland: International Organization for Standardization.

ISO (2006c). *ISO 14044:2006: Environmental management – Life cycle assessment – Requirements and guidelines.* Geneva, Switzerland: International Organization for Standardization.

Additional environmental information

Annex 1

The sales codes of all products covered in this EPD

015G4042; 015G4092; 015G4182; 015G4292; 015G4542; 015G4552; 015G4562; 015G4592; 015G4682; 015G4692;