



ENGINEERING
TOMORROW



Environmental **Product Declaration**



XL104 Controller

EPD issued	2024-10-12
EPD expires	2029-10-12
EPD author	Danfoss Power Solution
EPD type	Cradle-to-grave
Declared unit	One product over its Reference Service Life
Products included	XL104 (11274445)
Manufacturing Location	Plymouth, MN, USA
Use Location	Japan
Application	Tractor
Mass	0.780 kg without packaging 0.893 kg with packaging
Dimensions (H×W×D)	54 x 204 x 219 mm without packaging
Verification	☐ External ☒ Internal ☐ None
Produced to	Danfoss Product Category Rules (2022-09)
Internal independent verifier	Danfoss Climate Solution

DISCLAIMER

This EPD was prepared to the best of knowledge of Danfoss A/S. The life cycle assessment calculations were performed in accordance with ISO 14040 & 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.

This EPD has been published by Danfoss A/S on Danfoss Product Store and Danfoss Website. For questions, feedback or requests please contact your Danfoss sales representative.



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Product Description

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	MN R	MN R	MN R	MN R	MN R	X	MN R	X	X	X	X	X

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

Product Description

The product covered by this EPD is representative of XL104. The production location is the Danfoss plant in Plymouth, MN, USA. See more information on [Danfoss Product Store](#).

The XL104 is a programmable microprocessor-based controller for use on mobile machines, providing flexible input and output configurations for a range of machine requirements. The XL104 provides input pins with signal conditioning for digital, analog, current, frequency and resistance measurements, and output pins for digital, analog voltage, and analog current modes. These inputs and outputs can be used with a variety of sensors and electrically controlled valves and actuators. Users develop XL Controller applications with PLUS +1® GUIDE. This development environment features a user-friendly, field proven, icon-based graphical programming tool, application downloader, and service/diagnostic tool.

Reference Service Life

For the purpose of this EPD the reference service life (RSL) of the product is considered to be 10 years. However, correct care the lifetime of the product can reach over 15 years.

Intended market

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

Product Description

Table 2: Product composition

Material	Mass (kg)	%
Plastics	0.476	61%
Plastic with no GF	0.476	61%
Electronics	0.304	39%
PCBA	0.304	39%
Product Total	0.780	100%
Paper and cardboard	0.113	99.9%
Polyethylene	0.00014	0.1%
Packaging	0.11314	100%
Total (Product + Packaging)	0.893	

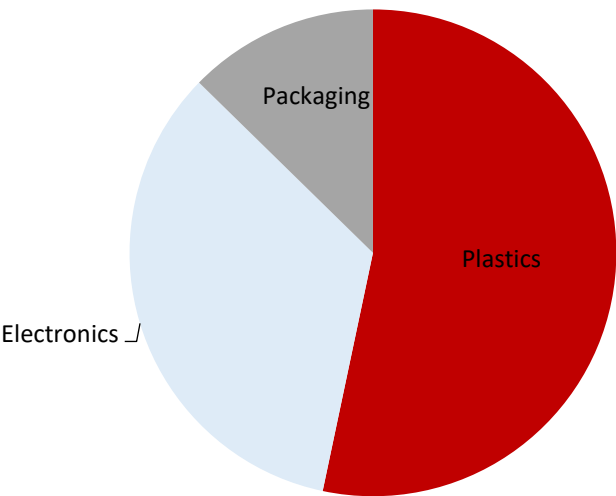


Figure 1: Material Composition Overview

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 *LCA for Experts*© database version 2024.2.

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).

Overview of LCA study

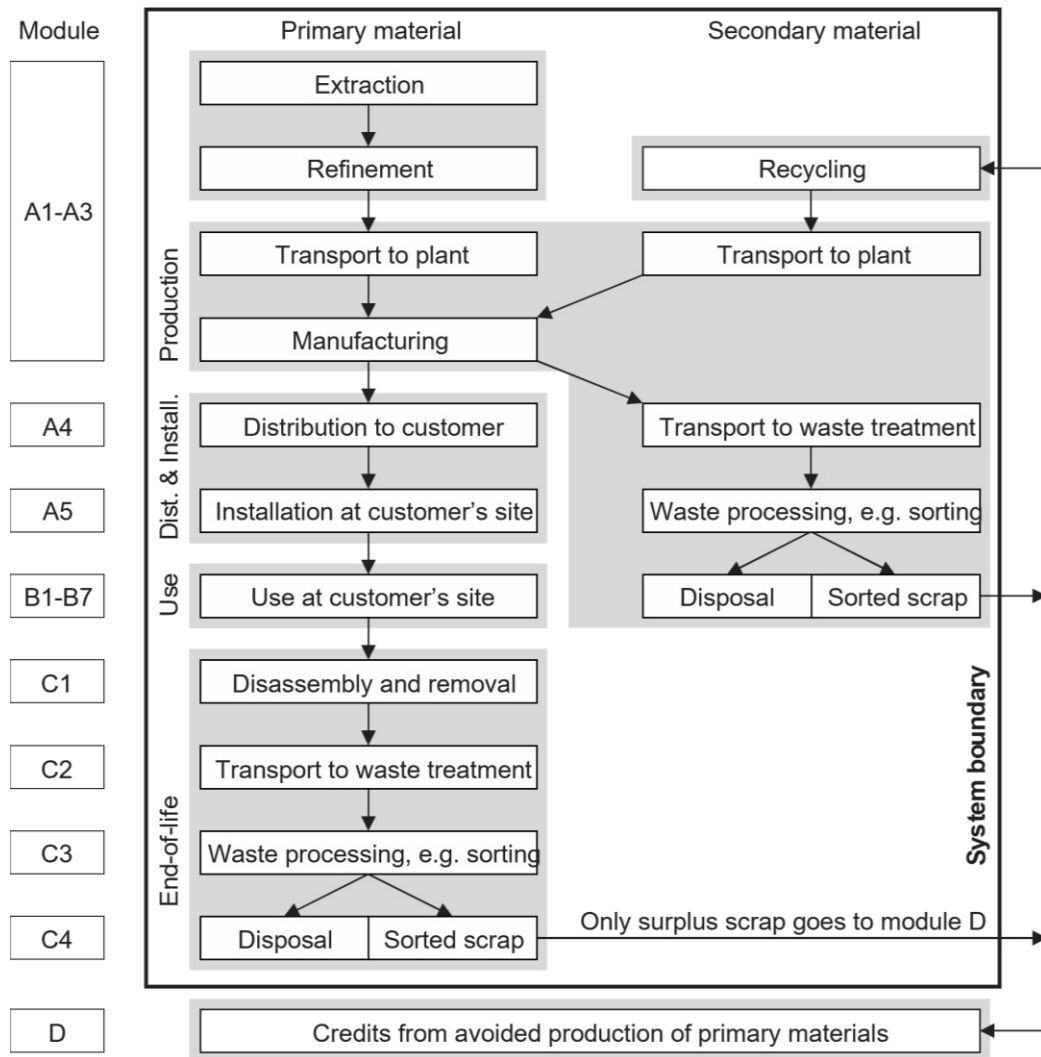


Figure 2: Modular structure used in this EPD (following EN 15804+A2)

Overview of LCA study

Product and packaging manufacture (A1-A3)

Final manufacturing occurs in the Plymouth plant, MN, USA Region. Data collected for this LCA study in the year 2023. The facility is certified according to ISO 14001, ISO 45001, and ISO 9001. Also, the facility hold a Letter of Approval Verification stating that facility has demonstrated to have effective and efficient management systems and processes to be compliant with 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 as described in Table 1. All packaging materials can be safely recycled or incinerated if appropriate local facilities are available.

Table 3: Biogenic carbon content in product and packaging

	Total (excluding recycling)
Biogenic carbon content in product [kg]	0.00
Biogenic carbon content in accompanying packaging [kg]	0.0486

Note: 1 kg biogenic carbon is equivalent to 44/12 kg of CO₂.

Shipping and installation (A4-A5)

Distribution is assumed to occur to customers within Japan. Transportation at 10667 km and at 440 km distance by Air and truck respectively are assumed between the factory and the final customer.

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)

Danfoss has developed a controller unit named XL104 for Tractor application. XL104 Controller with the highest pin count in the PLUS+1® controller family, the XL controller eliminates the need for expansion modules and allows for streamlined, compact machine designs. So, the function of the controller unit XL104 is to provide a solid and powerful background to meet requirements for managing mobile machinery.

The electricity consumption by the controller unit during the use phase (B6) can vary based on application. The use scenario considered here is an average scenario to represent a range of Medium Duty Tractor (25-55 HP) applications, developed according to Danfoss Power Solution Segment global applications experts and internal sales data. The use phase results covered in this EPD are based on a XL104 Controller unit and are therefore only valid for this specific product.

The energy consumption is calculated as per following parameters:

The Reference Service Life (RSL) applied in this EPD is 10 years, 1000 hours/year.

Universal Tractor (GLO) with a typical range of performance is 30kW to 180kW is assumed as a

Overview of LCA study

proxy for Medium Duty Tractor.

Energy chain

Diesel -> Engine -> Alternator -> Electricity -> Controller Unit (XL104)

Engine and Alternator are excluded from this study.

Diesel energy density: 45.5 MJ/KG

Engine Efficiency: 35%

Alternator Efficiency: 100%

Electricity Input: 7 Watt

RSL Diesel energy required: 200 kWh

The scope of this study is targeted for the Japan market; therefore, the product under study is sold and used in Japan. Sales also occur outside of Japan, which is important to note considering the impact the electricity grid mix can have on the emissions in the use phase. However, for the purpose of this assessment, an average Japan CO₂ factor from *LCA for Experts*© database version 2023.1. is applied. This factor will differ, depending on the country and share of renewables and fossil energy sources in the corresponding local electricity grid.

Table 4: CO₂ emissions per use phase location

Location of use	Use phase, kgCO ₂ eq
Japan (Baseline scenario)	56.9

The major limitation of the impact calculations for the use phase is that the electricity grid mix in use is assumed to remain at the same carbon intensity over time. Following the plans for the decarbonization of the grid across EU, the environmental impacts are expected to decrease over time within the course of the next 10 years. However, as decarbonization will occur in the future and as the pace of decarbonization is uncertain, the use of the emission intensity of today's grid should prove to be a "worst-case", conservative assumption.

End-of-life (C1-C4)

The following end-of-life procedure has been applied:

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

Overview of LCA study

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).

For this EPD an average scenario with 50% of the product sent to recycling & 50% of the product sent to landfill (C3, C4, D) was used. This scenario is designed to represent an average end-of-life scenario.

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. It does not cover energy recovery from incineration since the process used in LCA for Experts has an efficiency below 60%. Therefore, the impacts of this process are reported in module C4 and no benefits are claimed in module D.

Environmental performance

This section presents the environmental performance of one XL104. Figure 4 presents the environmental impact of the XL104 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.

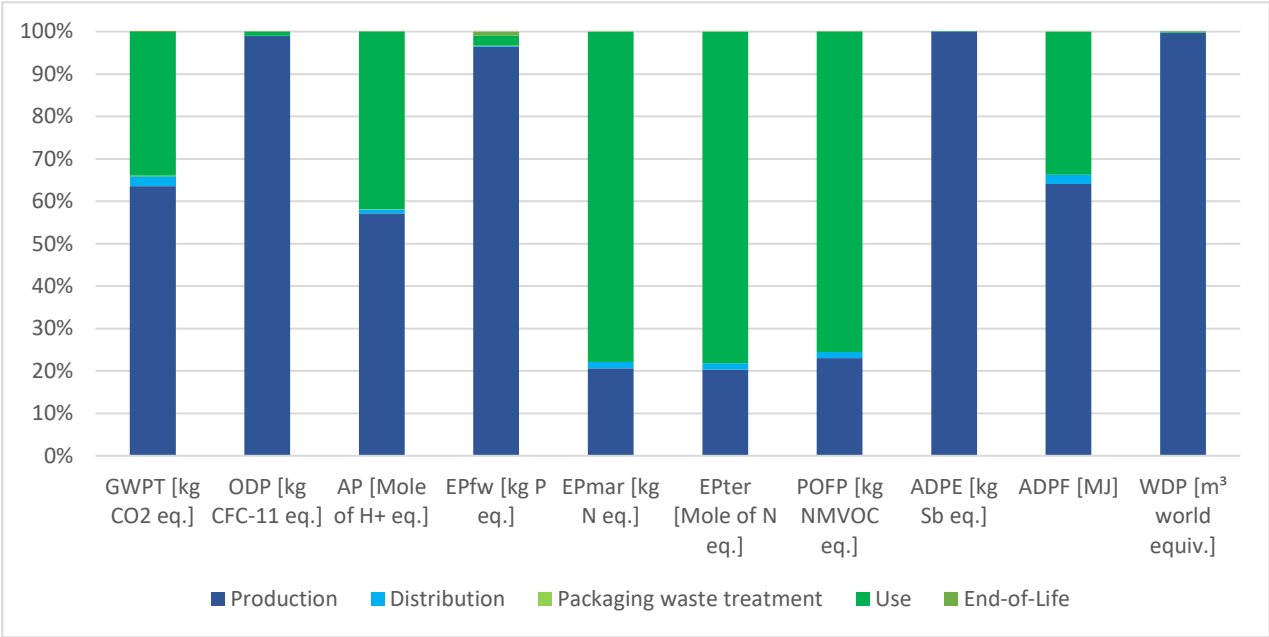


Figure 3: Breakdown of environmental impacts by life cycle stages. See Table 5 and 6 for descriptions of environmental impact indicators.

Environmental performance

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	C4	D
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 CO ₂ eq.]	1.07E+02	3.87E+00	3.67E-01	5.69E+01	0.00E+00	5.05E-03	4.63E-02	1.90E-02	-6.85E+00
GWPF [kg CO ₂ eq.]	1.07E+02	3.87E+00	1.04E-02	5.69E+01	0.00E+00	5.05E-03	4.57E-02	1.90E-02	-6.85E+00
GWPB [kg CO ₂ eq.]	-3.57E-01	0.00E+00	3.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWPLULUC [kg CO ₂ eq.]	8.71E-02	5.23E-04	9.96E-06	9.33E-04	0.00E+00	1.23E-07	5.68E-04	2.84E-05	-3.15E-03
ODP [kg CFC-11 eq.]	7.43E-10	2.39E-13	8.48E-15	7.28E-12	0.00E+00	5.97E-19	1.20E-13	2.77E-14	-4.97E-12
AP [Mole of H ⁺ eq.]	8.78E-01	1.43E-02	5.81E-05	6.44E-01	0.00E+00	7.15E-06	2.44E-04	6.75E-05	-2.59E-01
EPfw [kg P eq.]	4.53E-04	8.30E-07	4.88E-07	1.12E-05	0.00E+00	1.11E-09	1.49E-07	4.02E-06	-2.78E-06
EPmar [kg N eq.]	8.79E-02	6.41E-03	3.12E-05	3.31E-01	0.00E+00	2.78E-06	1.12E-04	2.12E-05	-1.09E-02
EPter [Mole of N eq.]	9.43E-01	7.02E-02	2.84E-04	3.63E+00	0.00E+00	3.13E-05	1.24E-03	2.34E-04	-1.19E-01
POFP [kg NMVOC eq.]	2.84E-01	1.82E-02	7.88E-05	9.32E-01	0.00E+00	6.61E-06	2.25E-04	5.46E-05	-4.39E-02
ADPE [kg Sb eq.]	6.78E-03	9.55E-08	1.05E-09	2.20E-07	0.00E+00	1.82E-10	3.52E-09	5.96E-10	-1.19E-03
ADPF [MJ]	1.50E+03	5.09E+01	1.45E-01	7.87E+02	0.00E+00	7.37E-02	5.79E-01	1.69E-01	-8.70E+01
WDP [m ³ world equiv.]	2.22E+01	6.38E-03	6.87E-04	5.07E-02	0.00E+00	8.63E-06	2.84E-03	2.98E-03	-1.22E+00

How to read scientific numbers: e.g. 2,05E02 = 2,05 x 10² = 205

2,04E-01 = 2,04 x 10⁻¹ = 0,204

Environmental performance

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 **168 kg CO₂-eq (A1-C4)**, based on the baseline use phase scenario. The carbon footprint of production of this product, cradle-to-gate, is **107 kg CO₂-eq (A1-A3)**.

Environmental performance

Table 7: Resource use

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
PERE [MJ]	4.06E+02	2.16E-01	9.73E-03	2.86E+00	0.00E+00	2.43E-04	8.64E-02	2.07E-02	-9.38E+00
PERM [MJ]	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
PERT [MJ]	4.06E+02	2.16E-01	9.73E-03	2.86E+00	0.00E+00	2.43E-04	8.64E-02	2.07E-02	-9.38E+00
PENRE [MJ]	1.48E+03	5.09E+01	1.45E-01	7.87E+02	0.00E+00	7.38E-02	5.79E-01	1.69E-01	-8.70E+01
PENRM [MJ]	1.59E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT [MJ]	1.50E+03	5.09E+01	1.45E-01	7.87E+02	0.00E+00	7.38E-02	5.79E-01	1.69E-01	-8.70E+01
SM [kg]	8.70E-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
RSF [MJ]	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
NRSF [MJ]	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
FW [m3]	7.54E-01	2.78E-04	2.16E-05	2.97E-03	0.00E+00	3.90E-07	1.17E-04	7.61E-05	-3.96E-02

Table 8: 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

Environmental performance

Table 9: Waste categories and output flows

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
HWD [kg]	3.67E-05	1.47E-09	2.20E-11	3.56E-09	0.00E+00	5.07E-13	7.24E-11	3.50E-11	-1.28E-06
NHWD [kg]	5.11E+00	4.82E-03	4.19E-02	1.84E-02	0.00E+00	7.38E-06	2.03E-04	2.53E-01	-1.04E+00
RWD [kg]	7.88E-02	4.50E-05	9.39E-07	1.68E-04	0.00E+00	7.90E-08	4.00E-06	2.08E-06	-9.71E-04
CRU [kg]	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
MFR [kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-01	0.00E+00
MER [kg]	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
EEE [MJ]	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
EET [MJ]	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

Table 10: 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)

Environmental performance

Table 11: Additional indicators*

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
PM [Disease incidences]	8.57E-06	5.84E-08	4.25E-10	1.33E-05	0.00E+00	4.24E-11	1.81E-09	6.35E-10	0.00
IRP [kBq U235 eq.]	8.21E+00	5.83E-03	1.25E-04	2.73E-02	0.00E+00	1.12E-05	4.95E-04	2.89E-04	-0.06
ETPfw [CTUe]	7.27E+02	3.74E+01	1.23E-01	3.73E+02	0.00E+00	5.34E-02	3.51E-01	3.17E-01	-38.20
HTPc [CTUh]	2.68E-08	6.81E-10	2.15E-12	6.27E-09	0.00E+00	9.94E-13	8.41E-12	4.93E-12	0.00
HTPnc [CTUh]	1.18E-06	2.88E-08	1.75E-10	1.19E-07	0.00E+00	4.34E-11	4.64E-10	1.79E-10	0.00
SQP [Pt]	3.01E+02	2.90E-01	2.27E-02	1.71E+00	0.00E+00	1.89E-04	2.42E-01	2.34E-02	-5.30

Table 12: 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 experience 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.



Environmental performance

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.

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