ENGINEERING TOMORROW

Environmental **Product Declaration**

Vacon NXP Inverter Module Liquid Cooled 525-690 Vac, Frame size ch64

EPD issued	2024-01-04
EPD expires	2029-01-04
EPD author	Danfoss Power Electronics & Drives A/S
EPD type	Cradle-to-grave
Declared unit	One product over its Reference Service Life
Product included	NXP17006-A0T0IWG-A1A2000000 (136H9233)
Products covered by EPD	All ch64 in NXP17006 range
Manufacturing Location	Vaasa, Finland
Use Location	Europe
Application	Industrial e.g. F&B, Chemical, HVAC etc.
Mass	182,0 kg without packaging 229,3 kg with packaging
Dimensions (H×W×D)	923 x 746 x 375 mm without packaging
Verification	[ ] External [X] Internal [ ] None
Produced to	Danfoss Product Category Rules (2022-09)
Internal independent verifier	Danfoss Climate Solutions

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.

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

Production 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 reference product used for this EPD is representative of Danfoss Vacon NXP Inverter Module Liquid Cooled 525-690 Vac, Frame size ch64 (Type Code: NXP17006-A0T0IWG-A1A2000000). The EPD covers all products with frame size ch64 in the NXP17006 range, based on the assumption that all drives in range are within +- 10%. This assumption is based on the mass and composition of the smallest and largest products in range. The production location is the Danfoss plant in Vaasa, Finland. See more information on Danfoss Product Store.

The Vacon NXP Inverter Module, ch64 represents a single drive concept that controls the entire range of operations from ordinary to servo-like applications on any machine or production line.

Figure 1: Exploded view of the Vacon NXP Inverter Module Liquid Cooled 525-690 Vac, Frame size ch64.

Reference Service Life

For the purpose of this EPD the reference service life (RSL) of the product is considered to be 10 years. However, with the correct maintenance, the lifetime of the product can reach over 20 years.

Intended market

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

Product Description

Table 2: Product composition

Material	Mass (kg)	%
Metals	**140,4**	**77,1%**
Copper	79,0	43,4%
Aluminium and its alloys	36,3	19,9%
Steel and stainless steel	25,1	13,8%
Plastics	**27,9**	**15,3%**
Polycarbonate	20,9	11,5%
Other plastics	6,98	3,8%
Electrical/electronic	**13,8**	**7,6%**
Product Total	**182,0**	**100%**
Paper (documentation)	0,45	1,0%
Cardboard	13,9	29,4%
Plastic	3,48	7,4%
Wood	29,4	62,3%
Packaging Total	**47,3**	**100%**
Total (Product + Packaging)	**229,3**	

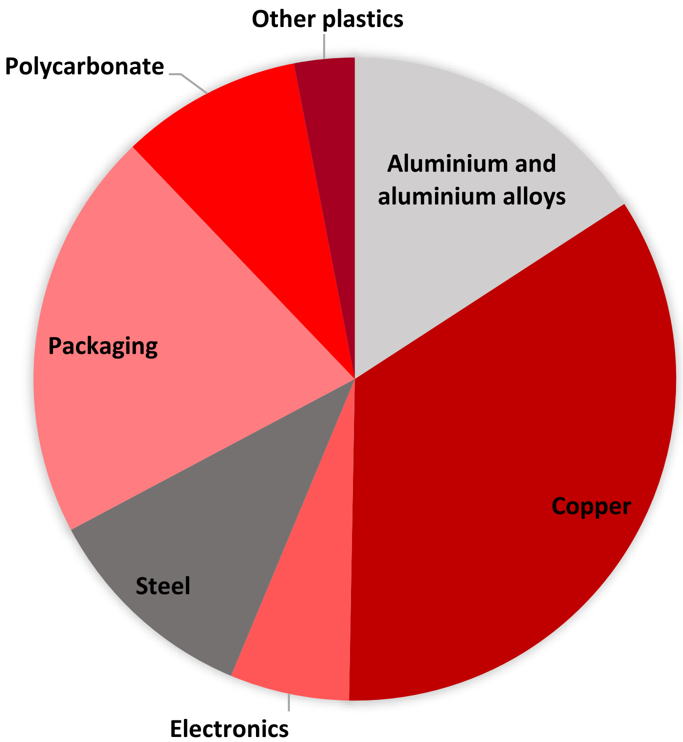

Figure 2: Material Composition Overview

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 LCA for Experts (Sphera) database version 2023.1.

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).

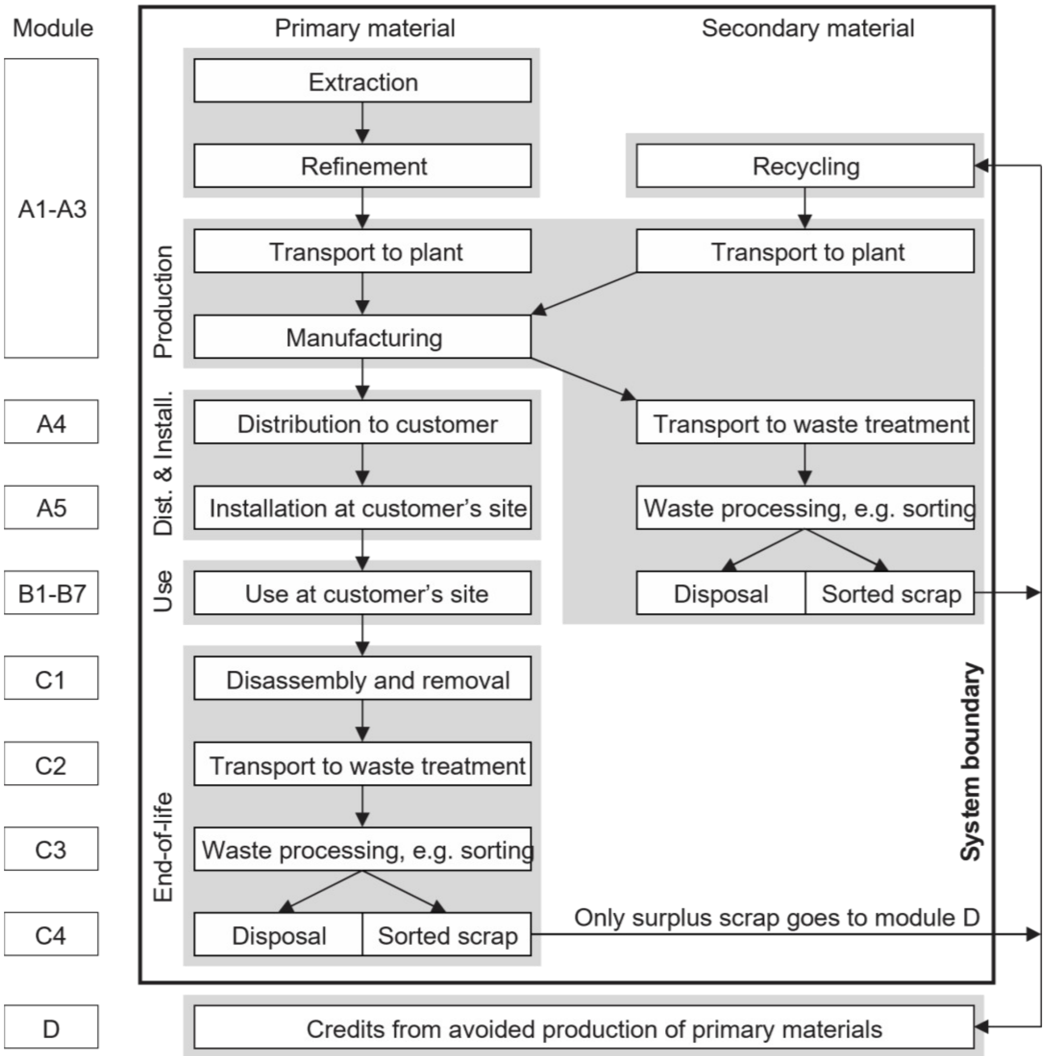

Figure 3: Modular structure used in this EPD (following EN 15804+A2)

Overview of LCA study

Product and packaging manufacture (A1-A3)

Final manufacturing occurs in the Vaasa plant, Finland. The facility is certified according to IATF 16949, ISO 14001, ISO 45001, and ISO 9001. 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 2. All packaging materials can be safely recycled or incinerated if appropriate local facilities are available. The on-site data was gathered for 2022.

Table 3: Biogenic carbon content in product and packaging

	Total (excluding recycling)
Biogenic carbon content in product [kg]	0,205
Biogenic carbon content in accompanying packaging [kg]	12,1

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 within Europe. 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.

Use phase (B1-B6)

The electricity consumption by the drive during the use phase (B6) can vary based on application. The use scenario considered here is an average scenario to represent a range of industrial applications, developed according to Danfoss Drives Segment global applications experts and internal sales data.

The energy consumption is calculated considering an efficiency of 98%. Only the loss from the frequency converter is assigned as energy consumption of the frequency converter. The remaining energy is allocated to the motor and is out of the scope of this EPD. The drive is in active mode on average for 6000 hours/year which results in 60.000 hours over 10 years lifetime or 16,44 hours per day. An average load of 80% is applied. For the remaining hours, the drive is either in standby mode or turned off completely. Standby mode is 2500 hours per year and during the remaining 260 hours the drive is turned off. This therefore results in 25.000 hours over 10 years or 6,85 hours per day, in standby mode.

The scope of this study is targeted for the European market; therefore, the product under study is sold and used in Europe. Sales also occur outside of Europe, 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 EU-27 CO_2 factor from LCA for Experts database (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. For that reason, three scenarios are additionally applied to demonstrate the impact of the results: Norway, Italy and Poland.

Overview of LCA study

Table 4: CO2 emissions per use phase location

Location of use	Use phase, kgCO2eq
Europe, EU-27 (Baseline scenario)	5,02E05
Norway	0,59E05
Italy	5,91E05
Poland	12,9E05

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 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.
- 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).

For this EPD an average scenario has been assumed with 50% of the product being send to recycling and 50% of the product being send to landfill (C3, C4, D).

This scenario is designed to represent an average end-of-life scenario as it is assumed that it represents the majority of cases on average.

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.

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.

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.

Overview of LCA study

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 one-unit Vacon NXP Inverter Module Liquid Cooled 525-690 Vac, Frame size ch64. Figure 4 presents the environmental impact of the Vacon NXP Inverter Module ch64 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.

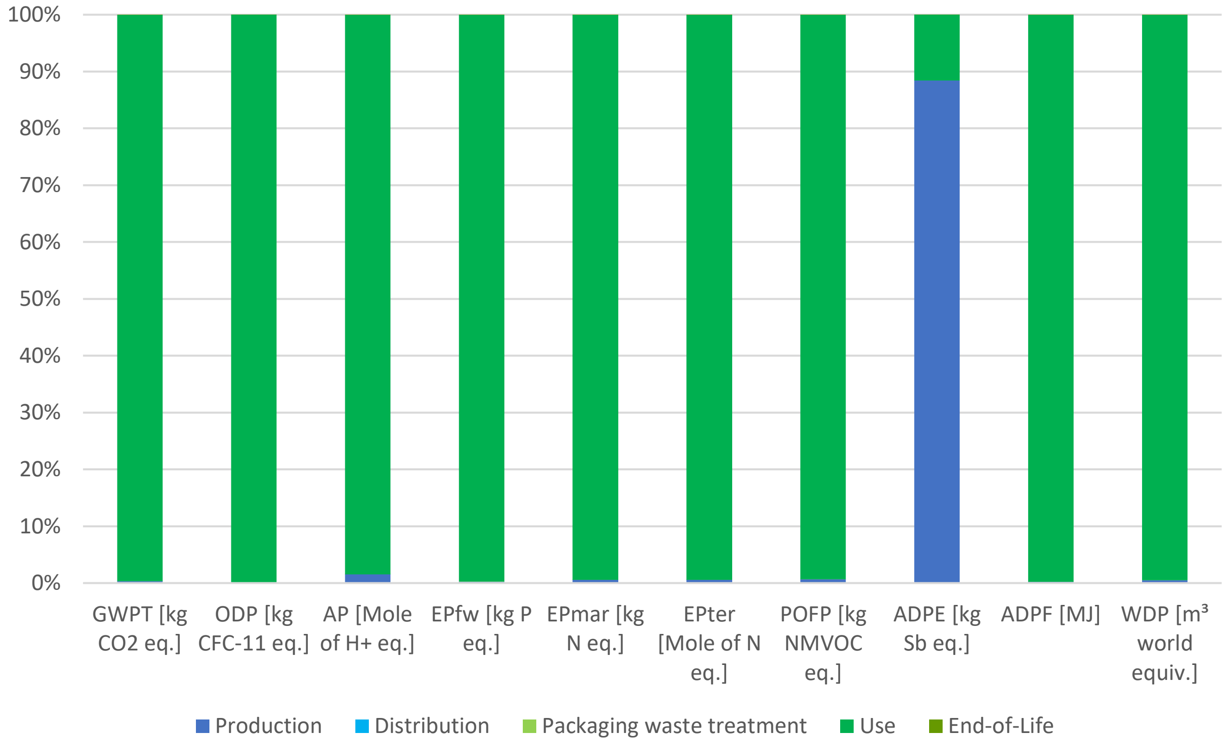

Figure 4: Breakdown of environmental impacts by life cycle stages (see Table 6 for descriptions of environmental impact indicators).

Table 5: Environmental impact indicators results per declared unit

	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 CO2 eq.]	1,61E03	3,66E01	4,94E01	5,02E05	0,00E00	1,81E00	1,03E01	6,49E00	-3,82E02
GWPF [kg CO2 eq.]	1,66E03	3,63E01	5,15E00	4,97E05	0,00E00	1,81E00	1,02E01	6,48E00	-3,82E02
GWPB [kg CO2 eq.]	-4,42E01	0,00E00	4,42E01	4,33E03	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
GWPLULUC [kg CO2 eq.]	3,37E00	3,39E-01	2,68E-03	5,42E01	0,00E00	4,43E-05	9,03E-02	4,41E-03	-6,15E-01
ODP [kg CFC-11 eq.]	5,66E-09	4,76E-12	4,62E-12	9,19E-06	0,00E00	2,14E-16	1,03E-11	5,88E-12	-1,62E-09
AP [Mole of H+ eq.]	1,66E01	6,31E-02	1,45E-02	1,06E03	0,00E00	2,51E-03	6,24E-02	1,97E-02	-3,82E00
EPfw [kg P eq.]	4,08E-03	1,34E-04	8,45E-04	1,86E00	0,00E00	3,97E-07	3,75E-05	1,88E-04	-4,62E-04
EPmar [kg N eq.]	1,46E00	2,49E-02	1,08E-02	2,54E02	0,00E00	9,99E-04	3,02E-02	7,03E-03	-2,78E-01
EPter [Mole of N eq.]	1,55E01	2,86E-01	5,41E-02	2,65E03	0,00E00	1,10E-02	3,35E-01	7,74E-02	-2,95E00
POFP [kg NMVOC eq.]	4,69E00	5,66E-02	2,92E-02	6,77E02	0,00E00	2,38E-03	5,76E-02	1,73E-02	-9,71E-01
ADPE [kg Sb eq.]	5,88E-01	2,42E-06	8,65E-08	7,69E-02	0,00E00	6,52E-08	7,22E-07	1,18E-07	-1,27E-01
ADPF [MJ]	2,22E04	4,98E02	4,37E01	1,04E07	0,00E00	2,64E01	1,43E02	4,78E01	-5,23E03
WDP [m^3 world equiv.]	5,84E02	4,42E-01	1,73E-01	1,09E05	0,00E00	3,09E-03	2,26E-01	8,75E-01	-1,08E02

How to read scientific numbers:

e.g. 2,05E02 = $2{,}05 \times 10^{2}$ = 205

2,04E-01 = $2{,}04 \times 10^{-1}$ = 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 GWPF, cradle-to-grave, of the product is **4,99E05 kg CO2-eq (A1-C4)**, based on the baseline use phase scenario. The GWPF of production of this product, cradle-to-gate, is **1,66E03 kg CO2-eq (A1-A3)**.

Table 7: Resource use results per declared unit

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
PERE [MJ]	7,74E03	3,62E01	3,81E00	6,25E06	0,00E00	8,71E-02	1,58E01	4,58E00	-1,26E03
PERM [MJ]	6,82E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
PERT [MJ]	7,75E03	3,62E01	3,81E00	6,25E06	0,00E00	8,71E-02	1,58E01	4,58E00	-1,26E03
PENRE [MJ]	2,13E04	5,00E02	4,39E01	1,04E07	0,00E00	2,65E01	1,44E02	4,78E01	-5,24E03
PENRM [MJ]	8,56E02	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
PENRT [MJ]	2,22E04	5,00E02	4,39E01	1,04E07	0,00E00	2,65E01	1,44E02	4,78E01	-5,24E03
SM [kg]	1,60E01	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
RSF [MJ]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
NRSF [MJ]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
FW [m3]	1,59E01	3,97E-02	5,45E-03	5,03E03	0,00E00	1,40E-04	1,55E-02	2,19E-02	-3,29E00

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

Table 9: Waste categories and output flows results per declared unit

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
HWD [kg]	6,01E-05	1,55E-09	3,45E-09	-8,17E-04	0,00E00	1,82E-10	-3,94E-10	1,72E-09	-3,90E-04
NHWD [kg]	5,27E02	7,62E-02	3,73E01	7,67E03	0,00E00	2,65E-03	2,79E-02	9,11E01	-9,12E01
RWD [kg]	7,23E-01	9,36E-04	4,91E-04	1,66E03	0,00E00	2,83E-05	1,89E-03	4,98E-04	-1,63E-01
CRU [kg]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
MFR [kg]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	3,76E-01	0,00E00
MER [kg]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
EEE [MJ]	2,14E-01	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00
EET [MJ]	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00	0,00E00

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)

Table 11: Additional indicators* results per declared unit

	A1-A3	A4	A5	B6	C1	C2	C3	C4	D
PM [Disease incidences]	1,47E-04	4,36E-07	1,39E-07	8,92E-03	0,00E00	3,49E-08	4,04E-07	1,93E-07	-3,58E-05
IRP [kBq U235 eq.]	1,12E02	1,40E-01	7,22E-02	2,76E05	0,00E00	4,01E-03	3,09E-01	6,83E-02	-3,29E01
ETPfw [CTUe]	1,36E04	3,57E02	4,55E01	2,90E06	0,00E00	1,94E01	9,80E01	3,62E01	-4,20E03
HTPc [CTUh]	3,90E-06	7,24E-09	2,15E-09	1,54E-04	0,00E00	3,56E-10	2,09E-09	2,33E-09	-3,19E-07
HTPnc [CTUh]	6,05E-05	3,22E-07	2,01E-07	2,45E-03	0,00E00	1,17E-08	8,84E-08	2,06E-07	-1,33E-05
SQP [Pt]	2,84E04	2,08E02	4,21E00	4,12E06	0,00E00	6,76E-02	5,95E01	5,80E00	-1,95E03
GWP-GHG [kg CO2 eq.]	1,66E03	3,66E01	5,15E00	4,97E05	0,00E00	1,81E00	1,03E01	6,49E00	-3,82E02

Table 12: Additional 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
GWP-GHG	kg CO2 eq.	Carbon footprint – greenhouse gases

**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.

References

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