ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	mfh systems GmbH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-MFH-20240487-ICI1-EN
Issue date	04.04.2025
Valid to	03.04.2030

IDEAL / E-NERGY EPS | NEO Heating System

mfh systems GmbH

Institut Bauen und Umwelt e.V.

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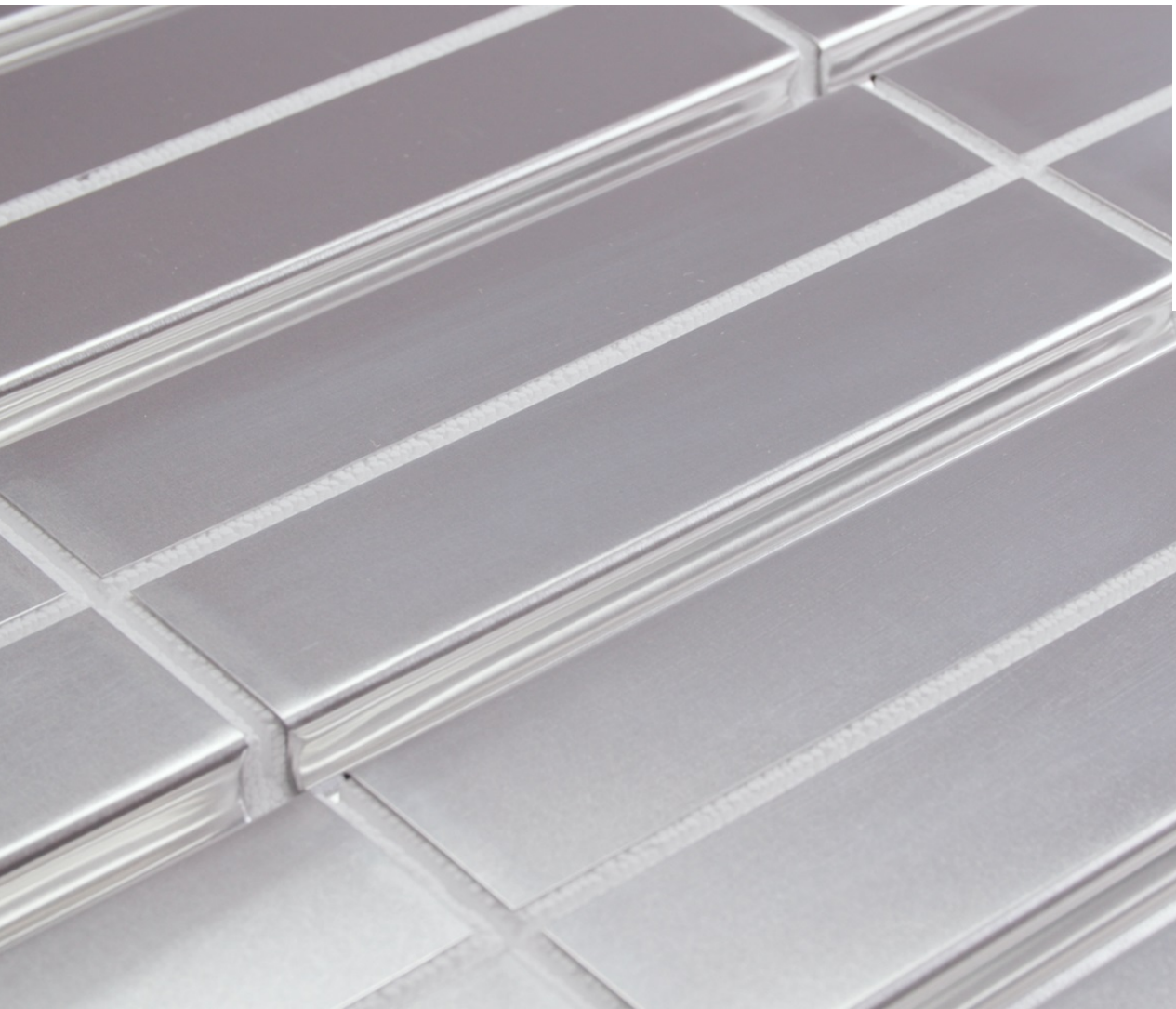


1. General Information

mfh systems GmbH

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-MFH-20240487-ICI1-EN

This declaration is based on the product category rules:

Installation systems for surface heating and cooling with water flow, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

04.04.2025

Valid to

03.04.2030

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

IDEAL / E-NERGY EPS | NEO Heating System

Owner of the declaration

mfh systems GmbH
Hager Feld 8
49191 Belm
Germany

Declared product / declared unit

1m^2 of IDEAL / E-NERGY EPS | NEO heating system and its accompanying packaging.

Scope:

This declaration is a representative EPD. The calculation of the life cycle assessment refers to 1 m² of heating element. This EPD covers the following systems:

- System IDEAL CLASSIC EPS 30 (Representative system)
- System IDEAL BASIC EPS 30
- System IDEAL CLASSIC NEO 20
- System IDEAL TOP EPS 20
- System IDEAL TOP EPS 17
- System IDEAL TOP EPS 15
- System E-NERGY IQ EPS 20

The EPDs are based on the Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report according to EN 15804+A2:2019 from IBU (2021) v1.3 and Part B: Requirements on the EPD for Installation systems for surface heating and cooling with water flow from IBU (2024) v3.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

Dr.-Ing. Nikolay Minkov,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The E-NERGY / IDEAL EPS | NEO system panels are made of rigid foam with aluminium heat distribution plates which are laminated at the factory. The panels are used as surface heating/cooling systems in wet or dry constructions for the installation in floor, wall and ceiling areas.
For the placing on the market of the product in the European Union/European Free Trade Association (EU/EFTA) (with the exception of Switzerland) Regulation (EU) No. 305/2011 (CPR) applies. The product needs a declaration of performance taking into consideration *EN 13163:2017+A2:2016*, Thermal insulation products for buildings - Factory made expanded polystyrene (EPS) products - Specification and the CE-marking.
For the application and use the respective national provisions apply.

2.2 Application

The IDEAL EPS | NEO systems are universal hot water surface heating/cooling systems as dry and wet systems for installation in floor, wall and ceiling areas. By inserting a pipe (surface heating pipe) into the mfh heating elements with different installation distances, it is possible to customise the output. The pipe is fixed and secured by the specially shaped pipe channels (omega shape) of the factory-laminated aluminium heat distribution plates. The systems work with surface temperatures within the thermo-physiologically permissible range and are suitable for accommodating floor coverings with a maximum thermal resistance of 0.15 m²K/W.

2.3 Technical Data

The following (structural) technical data in the delivery state are relevant for the declared product.

Technical data

Name	Value	Unit
Average density	39	kg/m³
Rated value thermal conductivity according to DIN 4108-4	0.035	W/(mK)
Nominal value thermal conductivity according to EN 12667	0.033	W/(mK)
Compressive strength according to EN 826	≥ 0.2	N/mm²
Resistance to bending according to EN 12089	≥ 0.25	N/mm²

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to *EN 13163:2017-02*, Thermal insulation products for buildings - Factory made expanded polystyrene (EPS) products – Specification.

2.4 Delivery status

The E-NERGY / IDEAL EPS | NEO system panels are supplied in the following dimensions: Panel thickness: 15-30 mm & Format: 1000 x 500 mm, 1200 x 750 mm

2.5 Base materials/Ancillary materials

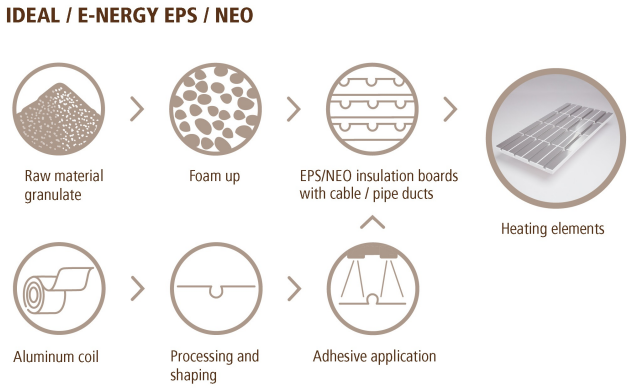
Composition of E-NERGY / IDEAL EPS | NEO system panels

Name	Value	Unit
Expanded polystyrene	46	%
Aluminium	50	%
Adhesive	4	%

This product/article/at least one partial article contains substances on the *ECHA* list of Substances of Very High Concern (SVHC) (27.03.2023 / 18.04.2023 / 17.01.2023) exceeding 0.1 percentage by mass: no
This product/article/at least one partial article contains other carcinogenic, mutagenic, reprotoxic (*CMR*) substances in categories 1A or 1B which are not on *the candidate list*, exceeding 0.1 percentage by mass: no
Biocide products were added to this construction product or it has been treated with biocide products (this then concerns a treated product as defined by the (EU) Ordinance on Biocide Products No. 528/2012): no

2.6 Manufacture

The production of E-NERGY / IDEAL EPS | NEO system panels involves the following process steps:



EPS beads are pre-expanded using water vapour, stabilized with air, and dried in a silo. They are then expanded, moulded, and steamed to form insulation panels. There is no EPS waste as the beads expand within the mould. Aluminium sheets are cut and punched into straight or curved profiles, then trimmed and assembled with glue. Finally, the panels are packed on wooden pallets. The energy required for all these processes is included in the model.
Systems for quality assurance:
CE marking according to *EN 13163*.
FIW external monitoring; identification number 0751 (FIW, 2021).

2.7 Environment and health during manufacturing

Due to the manufacturing conditions, no measures for the protection of the environment or health beyond the legal and other regulations must be taken.

2.8 Product processing/Installation

The IDEAL / E-NERGY EPS | NEO system panels are designed to minimize waste, as precise cutting with a knife ensures efficient material usage. The low weight of the panels reduces transportation-related energy demands and facilitates easy handling on-site. Installation is typically performed as a floating system; however, system-specific requirements may necessitate fixing through glueing or additional mechanical securing. All installation processes follow manufacturer specifications and relevant standards, ensuring proper application and minimal environmental impact during the construction phase. Additional measures to protect the environment are not required.

2.9 Packaging

Polyethylene (PE) film, paper, cardboard and cardboard packaging as well as wood are used for the packaging and delivery of E-NERGY / IDEAL EPS | NEO system panels. All packaging materials are recyclable by type or can be utilised for energy recovery.

2.10 Condition of use

No material changes to the product are to be expected during the utilisation phase if used correctly and as intended.

2.11 Environment and health during use

The E-NERGY / IDEAL EPS | NEO system panels have been in use for over 50 years.
There are no known negative effects on humans, animals or the environment.
According to the Committee for Health-related Evaluation of Building Products (*AgBB* scheme), EPS and Neopor insulation materials are suitable for indoor use.

2.12 Reference service life

If used as intended, no end to the durability of the E-NERGY / IDEAL EPS | NEO system panels is known or to be expected.
The average service life of the product is equivalent to the service life of the building.
Under Central European climatic conditions, a conservatively estimated service life of 50 years can be assumed.
Influences on the ageing of the product when used in accordance with the rules of technology are not known or expected.

2.13 Extraordinary effects

Fire

Specification of the building material class in accordance with EN 13501-1

Fire protection

Name	Value	Unit
Building material class	E	-
Smoke gas development	-	-
Burning droplets	-	-

Water

The E-NERGY / IDEAL EPS | NEO system panels are not water-soluble and do not release any water-soluble substances that could lead to contamination of groundwater, rivers and oceans.

Mechanical destruction

Information on the behaviour of the product, including possible consequences for the environment, in the event of unforeseen mechanical destruction is not relevant.

2.14 Re-use phase

The E-NERGY / IDEAL EPS | NEO system panels can be reused for the same application or can be reused in an alternative location in the same range of applications if they are dismantled without damage after use. If the E-NERGY / IDEAL EPS | NEO system panels are not contaminated, the raw material can be recycled and reused without any problems (e.g. reintroduction into the production process).

2.15 Disposal

Pure insulation residues without impurities (offcuts and deconstruction material) can be recycled in the production process. The waste code according to the *European Waste Catalogue (EWC)* is: 170904.

2.16 Further information

Information about E-NERGY / IDEAL EPS | NEO system panels and other products from mfh Systems GmbH is available at www.mfh-systems.com.

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1m^2 of IDEAL / E-NERGY EPS | NEO heating system and its accompanying packaging. The representative system is IDEAL CLASSIC EPS 30.

Declared unit and mass reference

Name	Value	Unit
Declared unit	1	m^2
Grammage (inkl. packaging)	2.21	kg/m^2
Grammage (without packaging)	2.08	kg/m^2
Layer thickness	0.03	m

Other declared units are allowed if the conversion is shown transparently.

The GWP was calculated for all systems covered by the EPD and compared with the selected representative product. The total GWP, of modules A1-A3 and C1-C3, for all balanced IDEAL / E-NERGY EPS | NEO systems revealed that the IDEAL CLASSIC EPS 30 corresponds to the best-seller system of 2021 as well as being the system with the highest GWP.

3.2 System boundary

The declared unit is 1m^2 OF IDEAL/E-NERGY EPS| NEO heating system and its accompanying packaging. The EPD type is: a) cradle to gate with modules C1–C4 and module D (A1–A3 + C + D)
Modules A1-A3: The system boundaries for A1-A3 include raw material extraction, transportation (materials and energy), and production to the factory gate. Generic datasets are used for raw material extraction and precursor production (A1), including EPS, Aluminium, and Adhesive for IDEAL CLASSIC EPS 30. Transportation (A2) is modeled with generic data, considering upstream fuel processes and emissions from truck transport. The manufacturing phase (A3) uses manufacturer-specific energy consumption data, accounting for 5% waste during aluminium processing and the bonding and pressing of insulating panels. Upstream energy inputs are modelled with generic datasets.
Modules C1-C4: C1 covers the costs of dismantling or demolishing the product at end-of-life, assuming manual removal. In C2, the product is transported by truck for disposal, with the system boundary covering upstream fuel processes and emissions from transport. C3 includes waste treatment, with EPS, and adhesive undergoing thermal recovery and aluminum being recycled. Emissions and waste treatment loads are assigned to C3, with resulting credits allocated to D. C4 covers disposal if recovery or reuse is not possible.
Module D: Module D reports secondary materials/fuels from waste treatment in A3 and C3, which may be used for energy or material input in a downstream system. Emissions from waste incineration are assigned to C3, not D. The net flow, calculated as the difference between input and output flows, reflects the effect in D

3.3 Estimates and assumptions

Proxy datasets were used for the following materials: Expanded Polystyrene (EPS) Foam for Neopor and Hot-melt based on EVA for adhesive. Certain system elements not produced in 2021 were still modelled based on their material composition, energy requirements, and waste outputs. These systems were balanced to a declared unit of 1m² and included in the variability analysis.

At the end of the product life, 95% of the aluminium sheet is assumed to be recycled, with 5% mass losses, and recycling credits are given in Module D. The treatment of the heating system at the end of life was modelled assuming the use of a shredder with an energy requirement of 30 kWh/t, based on secondary data from a disposal company.

3.4 Cut-off criteria

All collected operational data, including material flows with less than one percent mass fraction, were considered, and no production data was excluded. The effort for pallet production was excluded due to their indefinite reuse, but their transport weight is included to account for lifecycle transportation impacts.

3.5 Background data

The LCA model was created using *GaBi* version 10.8 from *Sphera* (Sphera Solutions, 2024). Manufacturer-specific data was used for the entire manufacturing process, while generic background datasets from the *GaBi* database (Service Pack 2023.2) were used for upstream and downstream processes.

3.6 Data quality

Foreground Data: Primary data quality is good, with high accuracy ensuring confidence in LCA results. Data collection was verified for plausibility by Brands and Values GmbH. Time representativeness is medium, with data from the production year 2021. Technical representativeness is very good, with energy requirements measured by the manufacturer and verified by Brands and Values GmbH.
Background Data: Secondary data quality is very good, with high accuracy ensuring confidence in LCA results. Datasets accounting for over 80% of the GWP impact have excellent time representativeness (2022 reference year). All datasets represent similar technologies to those used in manufacturing, ensuring good technical quality. Geographical representativeness is very good, with datasets from Germany and Europe.

3.7 Period under review

The collected material and energy data originate from the period 01.01. - 31.12.2021. The data collection for the investigated products was carried out based on evaluations of internal production and environmental data, the collection of LCA-relevant data within the supplier chain as well as by measuring relevant data for the energy supply.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Europe

3.9 Allocation

The primary data for material and energy inputs was measured for all studied systems products, within the defined system boundaries and considering each processing step. The allocation of electricity, thermal energy and waste to the individual products and participating processing locations was done directly by mfh Systems GmbH, based on primary data of yearly production volumes and energy consumption observed in 2021.
Based on the manufacturer's data, the produced units were scaled to the declared unit (m^2). The production is modelled with specific data for the declared products, there are no co-products and allocation is avoided.
The selection of the representative product was based on a worse-case scenario and the representative products are also the highest produced product. The variability study was analysed, in comparison to the representative product.

3.10 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to *EN 15804* and the building context, respectively the product-specific characteristics of performance, are taken into account. All background data sets used for modelling come from the *LCA for experts (GaBi)* database (Service pack 2023.2).

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

The declared products themselves do not contain biogenic carbon. Module A5 is not within the scope of the LCA study. The biogenic carbon in the packaging is balanced out directly in Modules A1-A3.

Information on describing the biogenic carbon content at factory gate

Name	Value	Unit
Biogenic carbon content in product	-	kg C
Biogenic carbon content in accompanying packaging	-	kg C

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

Installation into the building (A5)

Module A5 is not declared. Amounts of packaging for waste treatment after installation are given as a technical scenario.

Name	Value	Unit
Polyethylene Film	0.02	kg
Wooden pallet	0	kg

If used as intended, no end to the durability of the IDEAL / E-NERGY EPS | NEO system panels is known or to be expected. The average service life of the product is equivalent to the service life of the building. A reference service life according to *ISO 15686* can be declared based on the *BBSR* table, to estimate the service life (BMWSB, 2017). Under Central European climatic conditions, a conservatively estimated service life of 50 years can be assumed. Influences on the ageing of the product when used in accordance with the rules of technology are not known or expected.

Reference service life

Name	Value	Unit
Life Span (according to BBSR)	50	a

End of life (C1-C4)

Name	Value	Unit
Collected separately waste type	1.05	kg
Recycling	1.03	kg

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Name	Value	Unit
Thermal energy recovery	2.95	kWh
Electricity recovery	1.7	kWh
Aluminium sheet cut for recycling	0.98	Kg

5. LCA: Results

The declared unit is 1m^2 of IDEAL /E-NERGY EPS|NEO heating system and its accompanying packaging. The present results in the impact categories refer to the potential environmental impacts in an analysis period of 100 years. Long-term emissions (> 100 years) are not considered in the impact assessment.
Note: Impact assessment results are relative statements only and do not provide information on impact category endpoints, threshold exceedances, margins of safety, or on risks.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2:

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Global Warming Potential total (GWP-total)	kg CO_2 eq	1.24E+01	0	1.57E-02	3.35E+00	0	-9.75E+00
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_2 eq	1.24E+01	0	1.56E-02	3.35E+00	0	-9.75E+00
Global Warming Potential biogenic (GWP-biogenic)	kg CO_2 eq	0	0	0	0	0	0
Global Warming Potential luluc (GWP-luluc)	kg CO_2 eq	4.24E-03	0	8.84E-05	5.16E-06	0	-2.37E-03
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11 eq	1.3E-11	0	2.15E-14	1.62E-13	0	-1.57E-11
Acidification potential of land and water (AP)	mol H^+ eq	4.79E-02	0	2.39E-05	3.38E-04	0	-4.23E-02
Eutrophication potential aquatic freshwater (EP-freshwater)	kg P eq	8.76E-06	0	3.84E-08	4.46E-08	0	-5.7E-06
Eutrophication potential aquatic marine (EP-marine)	kg N eq	8.07E-03	0	9.19E-06	8.36E-05	0	-6.27E-03
Eutrophication potential terrestrial (EP-terrestrial)	mol N eq	8.8E-02	0	1.05E-04	1.58E-03	0	-6.82E-02
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC eq	4.96E-02	0	2.1E-05	2.39E-04	0	-1.9E-02
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb eq	5.87E-07	0	1.22E-09	1.49E-09	0	-4.89E-07
Abiotic depletion potential for fossil resources (ADPF)	MJ	2.17E+02	0	2.21E-01	4.1E-01	0	-1.33E+02
Water use (WDP)	m^3 world eq deprived	1.84E+00	0	2.93E-04	2.77E-01	0	-1.4E+00

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2:

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Renewable primary energy as energy carrier (PERE)	MJ	5.53E+01	0	2.56E-02	1.03E-01	0	-5.61E+01
Renewable primary energy resources as material utilization (PERM)	MJ	0	0	0	0	0	0
Total use of renewable primary energy resources (PERT)	MJ	5.53E+01	0	2.56E-02	1.03E-01	0	-5.61E+01
Non renewable primary energy as energy carrier (PENRE)	MJ	2.17E+02	0	2.21E-01	4.1E-01	0	-1.33E+02
Non renewable primary energy as material utilization (PENRM)	MJ	0	0	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	MJ	2.17E+02	0	2.21E-01	4.1E-01	0	-1.33E+02
Use of secondary material (SM)	kg	5.44E-02	0	0	0	0	9.31E-01
Use of renewable secondary fuels (RSF)	MJ	0	0	0	0	0	0
Use of non renewable secondary fuels (NRSF)	MJ	0	0	0	0	0	0
Use of net fresh water (FW)	m^3	1.42E-01	0	2.18E-05	6.48E-03	0	-1.3E-01

RESULTS OF THE LCA – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2:

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Hazardous waste disposed (HWD)	kg	1.08E-08	0	-1.26E-12	9.91E-12	0	-6.56E-09
Non hazardous waste disposed (NHWD)	kg	2.6E+00	0	4.5E-05	2.64E-02	0	-2.53E+00
Radioactive waste disposed (RWD)	kg	8.11E-03	0	3.51E-06	2.38E-05	0	-8.17E-03
Components for re-use (CRU)	kg	0	0	0	0	0	0
Materials for recycling (MFR)	kg	5.16E-02	0	0	1.03E+00	0	0
Materials for energy recovery (MER)	kg	0	0	0	0	0	0
Exported electrical energy (EEE)	MJ	0	0	0	0	0	5.96E+00
Exported thermal energy (EET)	MJ	0	0	0	0	0	1.06E+01

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional:

Parameter	Unit	A1-A3	C1	C2	C3	C4	D
Incidence of disease due to PM emissions (PM)	Disease incidence	5.09E-07	0	3.19E-10	2.02E-09	0	-4.7E-07
Human exposure efficiency relative to U235 (IR)	kBq U235 eq	1.56E+00	0	5.68E-04	3.83E-03	0	-1.64E+00

Comparative toxic unit for ecosystems (ETP-fw)	CTUe	7.97E+01	0	1.52E-01	1.66E-01	0	-3.26E+01
Comparative toxic unit for humans (carcinogenic) (HTP-c)	CTUh	6.15E-09	0	3.22E-12	2.01E-11	0	-5.16E-09
Comparative toxic unit for humans (noncarcinogenic) (HTP-nc)	CTUh	1.33E-07	0	1.27E-10	3.13E-10	0	-9.77E-08
Soil quality index (SQP)	SQP	1.18E+01	0	7.94E-02	1.27E-01	0	-8.54E+00

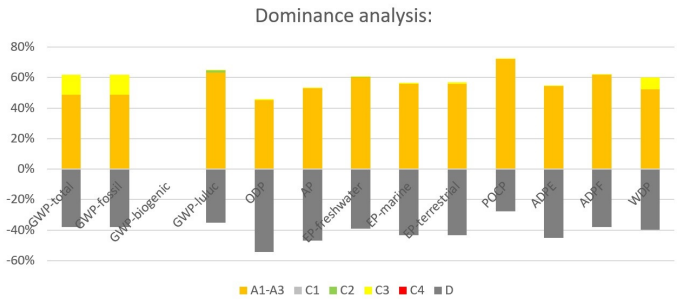
Disclaimer 1 – for the indicator “Potential Human exposure efficiency relative to U235”. This impact category deals mainly with the eventual impact of low-dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure or radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators “abiotic depletion potential for non-fossil resources”, “abiotic depletion potential for fossil resources”, “water (user) deprivation potential, deprivation-weighted water consumption”, “potential comparative toxic unit for ecosystems”, “potential comparative toxic unit for humans – cancerogenic”, “Potential comparative toxic unit for humans - not cancerogenic”, “potential soil quality index”. The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high as there is limited experience with the indicator.

This EPD was created using a software tool.

6. LCA: Interpretation

The following dominance analysis shows the individual impact categories and explores them in depth. The results are shown for a representative product, although they cover the other systems as well.



The environmental impacts were analyzed using the example of global warming potential (GWP total) to identify the responsible sources along the life cycle. Modules A1-A3 are the primary contributors to GWP total, accounting for 79.1% of the impact, followed by C1-C4 with 21.9%. The aluminum ingot mix is responsible for 54% of total GWP, followed by EPS (37.16%). Also, aluminum and EPS together make up 99% of the product composition.
Transportation of raw materials to and between the manufacturing sites (A2) and disposal of production waste in EoL (C2) have minimal relevance in terms of GWP.
In module C1-C4, the incineration of EPS and aluminum is the primary source of GWP. Since A5 is not within the scope of this analysis, the negative contribution to biogenic GWP in A1-A3 is not depicted.

7. Requisite evidence

The following requisite evidence is available:
Formaldehyde
The IDEAL / E-NERGY EPS system panels are producedwithout adhesives containing formaldehyde. The tests were carried out at the Institut für Baubiologie Rosenheim GmbH(3023-1395). VOC emission
The VOC emissions test followed *DIN EN 16516, DIN EN ISO 16000-11, DIN ISO 16000-6,* and *DIN ISO 16000-3 standards*, conducted by Industrie- und Umweltlaboratorium Vorpommern GmbH and IBR Rosenheim GmbH. The sample (IDEAL CLASSIC EPS 30) was tested in a 100L stainless steel chamber under controlled conditions (23°C, 50% RH, 0.5/h air exchange). VOC and aldehyde sampling used Tenax TA and Supelco LpDNPH, analyzed via GC/MSD and HPLC. After 28 days, formaldehyde and acetaldehyde were <2 µg/m³, ethylbenzene 3 µg/m³, styrene 20 µg/m³, and TVOC 28 µg/m³. Detection limits: VOC 1-10 µg/m³, aldehydes 2 µg/m³. The product achieved an A+ rating per French VOC-VO 2011.

8. References

Standards:
DIN 4108-4:2013
Thermal insulation and energy economy in buildings – Part 4: Hygrothermal design values, Deutsches Institut für Normung e.V. (DIN), Berlin, Germany.
DIN EN 1264-1:2021-08
Water-based surface embedded heating and cooling systems – Part 1: Definitions and symbols, German version EN 12644-1:2021, Deutsches Institut für Normung e.V. (DIN), Berlin, Germany.
DIN EN 15804:2012+A2:2019+AC:2021
Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products, Deutsches Institut für Normung e.V. (DIN), Berlin, Germany.
DIN EN 16516:2018
Construction products – Assessment of release of dangerous substances – Determination of emissions into indoor air, Deutsches Institut für Normung e.V. (DIN), Berlin, Germany.
DIN EN ISO 16000-11:2006
Indoor air – Part 11: Determination of the emission of volatile organic compounds from building products and furnishing – Sampling, storage of samples, and preparation of test specimens, International Organization for Standardization (ISO), Geneva, Switzerland.
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