Environmental Product Declaration

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

EnergyHub XL 28kW

from

Ferroamp AB

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-11583
Publication date:	2023-12-07
Valid until:	2028-12-06
Specific product:	EPD of a specific product. The product covered is Ferroamp's EnergyHub XL 28kW

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (PCR)
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product Category Rules (PCR): • PCR 2019:14, version 1.2.5, Construction products (2022-11-01) • c-PCR-024, version 1.0 PV Components: Invertors, battery energy storage systems, combiner boxes, and tracker systems (2023-01-02)
PCR review was conducted by: The Technical Committee of the International EPD® System. See www.environdec.com/about-us/ for a list of members. Review chair: Claudia A. Peña (for PCR 2019:14), and Gorka Benito Alonso (for c-PCR-024). The review panel may be contacted via the Secretariat www.environdec.com/contact-us
Life Cycle Assessment (LCA)
LCA accountability: Axel Cullberg, VästLCA AB
Third-party verification
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☐ EPD verification by individual verifier Third-party verifier: Daniel Böckin, Miljögiraff AB Approved by: The International EPD® System
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD: Ferroamp AB

Contact: Melav Salih (melav.salih@ferroamp.se)

Description of the organisation: Ferroamp is a Swedish Greentech company focused on energy and power optimization of properties. The Ferroamp system maximizes the benefits of solar panels, electric vehicle charging, and battery storage by connecting them to a DC grid, allowing property owners to control and manage their electricity usage and take control of their grid connection.

Society must transition to a sustainable energy supply. Electrification is the key, and with Ferroamp, every property becomes a resource in the grid, contributing to the flexibility needed as the share of renewable electricity production increases.

Name and location of production site(s): Norrtälje, Sweden

Product information

Product name: EnergyHub XL 28kW

Product-related certifications :

Directives[1]

- 2014/35/EU (LVD)
- 2014/30/EU (EMC)

Standards[1]

- EN 62109-1:2010
- EN 62109-2:2012
- EN 61000-6-2:2019
- EN 61000-6-3:2011
- EN 61000-3-11:2011
- EN 50549-1:2019

Product description: The Energyhub XL is a bidirectional inverter that acts as a bridge between the utility AC grid and a local DC nanogrid within the building where solar cells, batteries and loads are connected. The product is used as a power centre for the property, connecting solar panels to the grid, batteries, and electric vehicle charging. The Energyhub XL is part of the Energyhub series, consisting of three different products varying in sizes, and is the model primarily used for larger systems.

Below are physical and electrical properties of the product:

Characteristic	Value
Lifespan	10 years
Weight	26 kg
Rated AC power	28 kVa
Rated AC voltage	230/400 VAC
Nominal grid frequency	50 Hz
DC bus voltage	760 V (nominal)
DC bus voltage range	720 – 800 V
Max efficiency DC to AC	98.5 %
Max efficiency AC to DC	98.0 %

UN CPC code: UN CPC 462, Electricity distribution and control apparatus, and parts thereof

Geographical scope: Europe.

[1] Certificates available on the Ferroamp webpage (Ferroamp AB, 2023)

LCA information

Functional unit / declared unit: The functional unit is the inverting functionality needed to be part of a reference PV system (with a service life of 25 years) that provides 1 kWh of AC energy output converted from DC energy generated from the panels.

Reference service life: The reference service life is set to 25 years in accordance with c-PCR-024 (The International EPD System, 2023)

Time representativeness: January 1st – December 31st 2022

Database(s) and LCA software used: The LCA was modelled in Sphera LCA for Experts v. 10.7.1.28 using the databases Sphera Managed LCA Content version 2023.2 and ecoinvent 3.9.1.

Description of system boundaries:

The declared lifecycle stages are according to a type c) EPD in PCR 2019:14 (Cradle to grave and module D (A + B + C + D), where A1-A2 activities in module A1-A3 are performed in various parts of the world, and A3 occurs in Sweden. Activities in modules A4-A5, C and D take place in Europe.

The system boundary to nature is set to include those processes that provide the material and energy inputs into the system and the following manufacturing, and transport processes up to the factory gate as well as the processing of any waste arising from the processes.
A description of the modules is presented below:

A3 Manufacturing
Module A3 of the Energyhub Wall is based on data collected from Ferroamp's manufacturing partner situated in Sweden, which is an electronic manufacturing services (EMS) supplier that performs electronic component mounting and final assembly.

A4 Transportation

The transportation scenario is based on the transport of the manufactured product from EMS site in Sweden to Ferroamp's warehouse (96 km by truck), as well as the transport from the warehouse to customer (334 km by truck). The total distance modelled was 430 km by Euro 6 class truck, 26-28t from final assembly site in Sweden to the customer.

A5 Installation

The installation scenario for the Energyhub XL at customer location includes a connection cable and electricity to power a screwdriver. PE foam packaging is assumed to be incinerated with energy recovery and cardboard is assumed to be recycled.

B1-B3 Use to repair

There are no direct emissions generated from using the Energyhub XL, nor is there any maintenance, repair, or replacement of subcomponents required during it's service lifetime of 10 years. The full unit is replaced in module B4

B4 Replacement

Since the RSL according to c-PCR-024 (The International EPD System, 2023) is 25 years, and the Energyhub XL has a service lifetime of 10 years, module B4 includes the production and end-of-life for the replacement unit and auxiliaries.

B5 Refurbishment

The Energyhub XL does not require refurbishment during the assessed period

B6 Energy use

In order to model B6, the energy consumption was calculated according to c-PCR-024 (The International EPD System, 2023) to represent the energy loss percentage of the total produced energy by the PV system. The equations used for the calculation as described in the c-PCR-024 is shown below:

$$E1 = S_{rad} * A * y * PR * (1 - \text{deg}) \quad \textit{Eq. 1}$$

$$E2 = E1 * (1 - deg) \quad \textit{Eq. 2}$$

$$ERSL = E1 * (1 + \sum_{n=1}^{RSL-1} (1 - deg)^n) \quad \textit{Eq. 3}$$

The parameter values used in each equation is described according to the following table:

Parameter	Value	Unit	Comment	Source
Srad	1 200	kWh/m^2/year	Solar radiation, varies depending on location and several other factors. Based on the following assumptions: Location: Stockholm System loss: 14% Loss due to angle of incidence: 3.02% Loss due to temperature and low irradiance: 7.89% Slope: 35 degrees Panels are roof added/building integrated	Photovoltaic geographical information system (European Commission, u.d.)
A	40	m^2	Area of PV system, representative area of a typical installation where this product is used	Ferroamp
y	21	%	Efficiency of PV panel, average PV [kWp]	Ferroamp
PR	0.95	Ratio	Performance ratio	Ferroamp
deg	0.07	%	Degradation, c-PCR default value of 0.07% is applied	c-PCR-024
RSL	25	Years	c-PCR-024 standard	c-PCR-024

Based on the equations and the input parameters, the following results were obtained:

- **ERSL** = 237 234 kWh
- **Total without degradation** = 239 400 kWh
- **Energy loss** = 2 166 kWh (0,9%)

B7 Water use

The products do not have any operational water use during their RSL, thus there is no impact from this module.

C1 Deconstruction

No activities are identified in module C1, as the products are expected to be manually deconstructed.

C2 Transport to waste treatment

Transport	Distance	Comment
Road	50 km	Distance assumed to be an average of 50 km based on recommendation from c-PCR-024(The International EPD System, 2023).

C3 Waste pre-processing

The materials are assumed to go to landfilling, incineration, or recycling according to the table below Aluminium and steel are assumed to be recycled to 85%, with the remaining 15% landfilled. Cables assumed to be recycled to 90%, with the remaining 10% incinerated. Remaining components are assumed to be incinerated.

C4 Final disposal

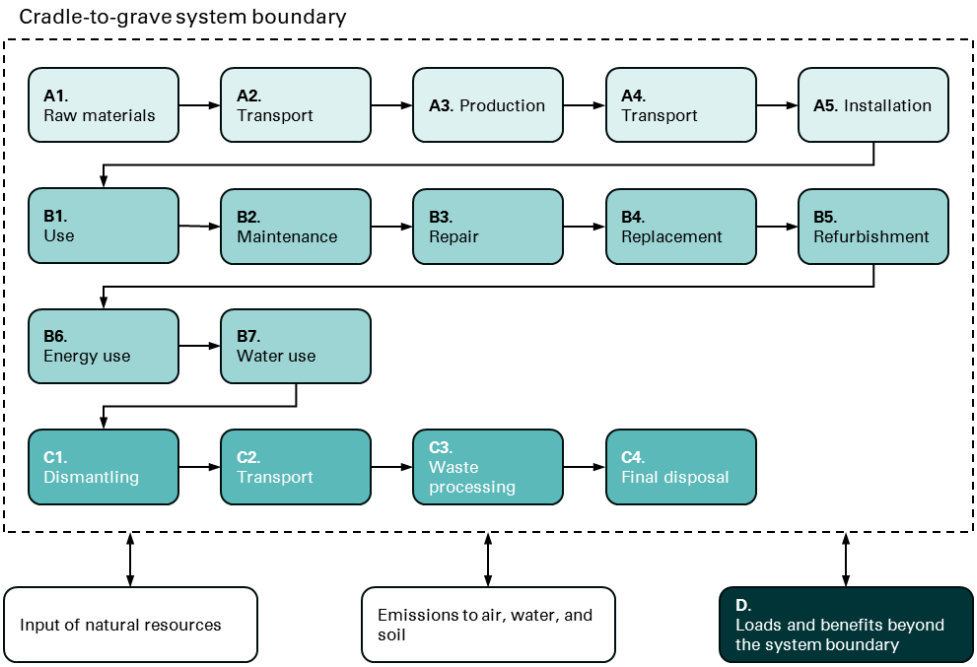
Products are assumed to be recycled according to the recycling rates presented PEF recycling factors “R2”. After the recycling streams are separated, the remaining metals are assumed to go to landfill for inert matter. Datasets used to represent incineration in module C3 include the landfilling of ashes, hence the impact of that activity is part of module C3.

D Potential benefits and loads beyond the product system

The D module is calculated with a formula originally proposed in EN 15804 and adjusted with a factor for material yield (Y) in PCR:2019:14.

Energy generated from incineration in module C3 replaces European electricity and district heating in module D. Recycled materials are processed to functional equivalence before replacing primary material.

System diagram:



Assumptions

- Transports not under Ferroamp ABs control are assumed to be performed by Euro 5 class vehicles in Asia, and Euro 6 Class vehicles in Europe.

Cut-off rules

The cut-off criteria are in accordance with the EN 15804 standard, meaning that max 1% of the renewable and non-renewable primary energy use and max 1% of the total mass input of a specific unit process are allowed to be cut-off (excluded). Particular care should be taken to include material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of EN 15804+A2.

For a full module the summarized cut-off of all unit processes is max 5% of the entire module.

In this study, screws used for installation in module A5 has been cut off

Allocation

Allocation is performed according to the allocation hierarchy in EN 15804 chapter 6.4.3.2, that is:

Step 1 – Avoid allocation by dividing the unit processes into sub-processes or expanding the product system to include additional functions.

Step 2 – Partitioning the inputs and outputs of the system between its different products or functions in a way that reflects the underlying physical relationships between them. Examples of this is mass or energy.

Step 3 – Partitioning the inputs and outputs of the system between its different products or functions in a way that reflects other relationships between them. Examples of this is economic value.

Economic allocation was applied to model the manufacturer activities in module A3.

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geography	GLO	GLO	SE	EU	EU	EU	EU	EU	EU	EU	EU	EU	EU	EU	EU	EU	EU
Specific data used	2%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-	-	-	-	-	-	-	-	-	-	-	-	-	-

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/kg
Steel	**~15**	**0%**	**0%**
Electronics	**~10**	**0%**	**0%**
Plastics	**~0,31**	**0%**	**0%**
Gasket	**~1,0**	**0%**	**0%**
Others	**~0,05**	**0%**	**0%**
TOTAL	**26**	**0%**	**0%**

Packaging materials	Weight, kg	Weight-% (versus the product)	Weight biogenic carbon, kg C
Cardboard	1,3	5%	0,5
Polyethylene foam	0,71	3%	0
TOTAL	2,0	8%	0,5

The product does not contain any substances of very high concern (SVHC).

Results of the environmental performance indicators

The results for A1-A3 should not only be analyzed at face value without considering the impacts represented by modules A4-C.

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

The results of the impact categories abiotic depletion of minerals and metals, land use, human toxicity (cancer), human toxicity, noncancer and ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.

Mandatory impact category indicators according to EN 15804

Results per functional unit

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-fossil	kg CO_2 eq.	3.15E-03	6.51E-06	9.46E-06	0	0	0	4.83E-03	0	8.05E-04	0	0	6.91E-07	5.04E-05	1.39E-07	-9.09E-05
GWP-biogenic	kg CO_2 eq.	1.15E-05	1.50E-08	7.86E-06	0	0	0	2.90E-05	0	3.56E-06	0	0	1.59E-09	2.66E-09	0	2.90E-08
GWP-luluc	kg CO_2 eq.	6.31E-06	6.13E-08	7.88E-10	0	0	0	9.57E-06	0	1.48E-06	0	0	6.50E-09	1.65E-09	4.39E-10	-2.93E-07
GWP-total	kg CO_2 eq.	3.17E-03	6.59E-06	1.73E-05	0	0	0	4.87E-03	0	8.11E-04	0	0	6.99E-07	5.04E-05	1.35E-07	-2.28E-04
ODP	kg CFC 11 eq.	1.09E-10	8.61E-19	1.15E-18	0	0	0	1.64E-10	0	6.48E-11	0	0	9.13E-20	2.26E-17	3.60E-19	-2.10E-12
AP	mol H^+ eq.	2.34E-05	1.03E-08	1.09E-09	0	0	0	3.52E-05	0	5.57E-06	0	0	1.09E-09	2.42E-08	1.00E-09	-1.61E-06
EP-freshwater	kg P eq.	2.93E-06	2.42E-11	5.04E-13	0	0	0	4.40E-06	0	4.43E-07	0	0	2.57E-12	8.58E-12	2.85E-13	-3.56E-08
EP-marine	kg N eq.	4.09E-06	3.81E-09	2.56E-10	0	0	0	6.16E-06	0	1.00E-06	0	0	4.04E-10	1.06E-08	2.59E-10	-1.30E-07
EP-terrestrial	mol N eq.	4.27E-05	4.49E-08	5.06E-09	0	0	0	6.44E-05	0	9.45E-06	0	0	4.76E-09	1.24E-07	2.85E-09	-1.41E-06
POCP	kg NMVOC eq.	1.62E-05	9.06E-09	7.27E-10	0	0	0	2.43E-05	0	3.50E-06	0	0	9.61E-10	2.78E-08	7.82E-10	-6.19E-07
ADP-minerals&metals*	kg Sb eq.	8.06E-07	4.39E-13	1.22E-14	0	0	0	1.21E-06	0	4.14E-08	0	0	4.65E-14	1.16E-13	6.54E-15	-6.60E-08
ADP-fossil*	MJ	4.99E-02	9.01E-05	2.94E-06	0	0	0	7.51E-02	0	1.20E-02	0	0	9.56E-06	4.91E-05	1.88E-06	-1.38E-03
WDP*	m^3	1.17E-03	7.99E-08	8.66E-07	0	0	0	1.77E-03	0	1.32E-03	0	0	8.48E-09	8.44E-06	1.55E-08	-5.52E-05
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption															

** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

Additional mandatory and voluntary impact category indicators

Results per functional unit																
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Particulate matter	Disease inc.	1.74E-10	8.66E-14	6.96E-15	0	0	0	2.62E-10	0	5.38E-11	0	0	9.18E-15	2.96E-13	1.23E-14	-1.59E-11
Ionising radiation***	kBq U-235 eq.	4.01E-04	2.52E-08	2.47E-08	0	0	0	6.02E-04	0	6.81E-05	0	0	2.68E-09	2.65E-07	2.48E-09	-5.19E-06
Ecotoxicity, freshwater**	CTUe	6.35E-02	6.45E-05	1.32E-06	0	0	0	9.54E-02	0	7.19E-03	0	0	6.85E-06	3.59E-05	1.02E-06	-9.31E-04
Human toxicity, cancer**	CTUh	3.85E-12	1.31E-15	8.63E-17	0	0	0	5.78E-12	0	1.02E-12	0	0	1.39E-16	2.45E-15	1.58E-16	-5.74E-13
Human toxicity, non-cancer**	CTUh	1.45E-10	5.83E-14	1.28E-15	0	0	0	2.19E-10	0	3.90E-11	0	0	6.18E-15	1.72E-13	1.67E-14	-2.10E-12
Land use**	Pt	1.78E-02	3.76E-05	1.11E-06	0	0	0	2.69E-02	0	3.22E-03	0	0	3.99E-06	1.25E-05	4.57E-07	-1.45E-03

*** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

**** This impact category deals mainly with the eventual impact of low dose ionising radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure, not due to radioactive waste disposal in underground facilities. Potential ionising radiation from the soil, from radon, and from some construction materials is also not measured by this indicator.*

Results per functional unit																
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-GHG[2]	kg CO_2 eq.	3.17E-03	6.59E-06	9.46E-06	0	0	0	4.86E-03	0	8.10E-04	0	0	6.99E-07	5.04E-05	1.40E-07	-9.12E-05

Resource use indicators

Results per functional unit																
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	MJ	5.50E-03	6.56E-06	7.85E-07	0	0	0	8.27E-03	0	3.68E-02	0	0	6.96E-07	1.22E-05	3.07E-07	-4.89E-04
PERM	MJ	8.05E-05	0	-8.05E-05	0	0	0	0	0	0	0	0	0	0	0	0
PERT	MJ	5.58E-03	6.56E-06	7.85E-07	0	0	0	8.27E-03	0	3.68E-02	0	0	6.96E-07	1.22E-05	3.07E-07	-4.89E-04
PENRE	MJ	5.00E-02	9.04E-05	1.33E-04	0	0	0	7.61E-02	0	1.20E-02	0	0	9.59E-06	5.04E-04	1.88E-06	-1.38E-03
PENRM	MJ	5.85E-04	0	-1.30E-04	0	0	0	0	0	0	0	0	0	-4.55E-04	0	0
PENRT	MJ	5.06E-02	9.04E-05	2.95E-06	0	0	0	7.61E-02	0	1.20E-02	0	0	9.59E-06	4.90E-05	1.88E-06	-1.38E-03
SM	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FW	m^3	2.85E-05	7.18E-09	2.07E-08	0	0	0	4.30E-05	0	3.08E-05	0	0	7.62E-10	2.01E-07	4.76E-10	8.26E-06
Acronyms	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water															

[2] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero. This study use the EN15804 reference package based on EF 3.1, updated February 2023

Waste indicators

Results per functional unit															
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Hazardous waste disposed	kg	7.91E-12	2.80E-16	-3.05E-17	0	0	0	1.19E-11	0	0	0	0	2.97E-17	7.18E-16	4.10E-17	6.87E-12
Non-hazardous waste disposed	kg	5.63E-05	1.38E-08	3.75E-08	0	0	0	1.24E-04	0	0	0	0	1.46E-09	1.67E-05	9.42E-06	3.86E-05
Radioactive waste disposed	kg	5.85E-07	1.69E-10	1.86E-10	0	0	0	8.81E-07	0	0	0	0	1.80E-11	1.89E-09	2.14E-11	-2.32E-08

Output flow indicators

This table presents flows that exit the system boundary that are not waste.

Results per functional unit																
Indicator	**Unit**	**A1-A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Components for re-use	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Material for recycling	kg	3.13E-05	0	5.37E-06	0	0	0	5.50E-05	0	0	0	0	0	0	0	0
Materials for energy recovery	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exported energy, electricity	MJ	5.30E-08	0	1.99E-05	0	0	0	1.32E-04	0	0	0	0	0	6.79E-05	0	0
Exported energy, thermal	MJ	9.94E-08	0	3.55E-05	0	0	0	2.45E-04	0	0	0	0	0	1.28E-04	0	0

References

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