Aluminium Dunkerque

ENVIRONMENTAL PRODUCT DECLARATION

Aluminium ingot

Aluminium Dunkerque

September 2022

Verified by an external independent third-party

Compliant with NF EN 15804+A2

Warning

The information contained in this environmental product declaration (EPD) is provided under the responsibility of Aluminium Dunkerque (owner of the EPD) in accordance with the NF EN 15804+A2 standard.

Any use, total or partial, of the information provided in this EPD must be supported by a reference to the original EPD and to its owner, who will be able to provide a complete copy.

The results of the study are based only on facts, circumstances and assumptions that were submitted during the study. If these facts, circumstances, and assumptions differ, the results may change.

Furthermore, the results of the study should be considered as a whole, in relation to the assumptions made.

Precautions with comparability

EPDs of construction products may not be comparable if they do not comply with the EN 15804+A2 standard.

The NF EN 15804+A2 standard defines in the chapter 5.3 *Comparability of EPD for construction products* the conditions under which products can be compared, based on the information provided by the EPD: "Comparison of the environmental performance of construction products using the EPD information shall be based on the product's use in and its impacts on the building, and shall consider the complete life cycle."

Reading guide

In the following tables 2.53E-06 should be read: 2.53x10-6 (scientific notation).

The units used are specified ahead of each flow and are:

- kilogram « kg »,
- cubic meter « m^3 »,
- kilowatt-hour « kWh »,
- megajoule « MJ ».

Abbreviations:

- LCA: Life cycle assessment
- FU: Functional unit

1. Introduction

Located in the north of France, the Aluminium Dunkerque plant was founded in 1991.

It is the largest primary aluminium smelter in Europe.

It specialises in the manufacture of aluminium sheets and ingots with a purity of over 99% for value-added applications in the transport, automotive, aerospace, packaging, building and construction sectors.

2. General information

Owner of the declaration	Aluminium Dunkerque Route de la ferme Raëvel 59279 Loon-Plage France
EPD scope	From cradle to factory gate with modules C1-C4 and module D
Studied product	Aluminium ingot This product is defined as an average aluminium ingot produced on the Aluminium Dunkerque site.

EN 15804+A2 is used as the basic PCR
This document has been translated from French (original EPD) to English. The external critical review according to EN 15804+A2 has been carried out on the original EPD.
Third-party verifier: Olivia DJIRIGUIAN (LCA & Eco-design consultant – CODDE Department, Bureau Veritas)

3. Product description

Aluminium ingot accounts for 15% of the plant's production (with respect to the total production volume) and is used mainly for remelting in various sectors such as automotive, pharmaceutics or coffee capsules.

Raw material supply

Firstly, alumina is extracted from bauxite using soda ash, at high temperature and under high pressure. The alumina is transported by ship and unloaded on the Aluminium Dunkerque site as the plant is equipped with port facilities.

The raw materials for the electrodes (pitch and coke) are sourced from various geographical areas and delivered either by ship or by truck. The electrodes are produced on site.

Primary aluminium production

Alumina is dissolved in an electrolytic bath and primary aluminium is produced by a reduction reaction. Through this electrolysis process, the positively charged aluminium is deposited on the negative electrode (cathode) and then settles to the bottom of the cell from which it is regularly siphoned off and redirected to the smelter for processing and shaping.

It is in this same foundry that the previously produced aluminium scrap and the various alloying elements are mixed with the primary aluminium to achieve the wanted composition.

Aluminium ingot production

Product overview

At the exit of the smelter section, two different types of ingots are produced, and the compositions are shown below.

Product composition

Product family		Composition (%/100)												
	Sector	ELY	Rebut	Mg	Cr	Mn	Si 553	Fe	Si 3301	Ti	Cu	Si 441	St	Si 1401
IF-ASxx-AB	Automotive	0.9022	0.0144	0.0036	-	0.0012	0.0047	0.0004	0.0268	0.0014	0.0008	0.0297	0.0007	0.0142
IS-Pxxx-RM	Remelting	0.9870	0.0130	-	-	-	-	-	-	-	-	-	-	-

4. Declared unit and scope of the study

▪ Declared unit

The declared unit is 1 kilogram of aluminium alloy as an ingot.

▪ Goal and scope of the study

This EPD assesses the environmental impacts of the production of 1 kg of aluminium alloy ingot from the cradle to the factory gate. Modules C2-C4 and D were also included in this analysis.

▪ System boundaries

This EPD provides information on the production stage of aluminium ingots and their end of life: "from cradle to gate" with modules C2-C4 and module D (A1-A3, C2-C4, D).

Product stage			Construction process stage		Use stage							End of life stage					Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction – installation process	Use	Raw material supply	Transport	Manufacturing	Transport	Construction – installation process	Use	Raw material supply	Transport	Manufacturing	Transport	Construction – installation process	Use
A1	A2	A3	A4	A5	B1	A1	A2	A3	A4	A5	B1	A1	A2	A3	A4	A5	B1
☒	☒	☒	☐	☐	☐	☒	☒	☒	☐	☐	☐	☒	☒	☒	☐	☐	☐

☒ = included in the EPD

☐ = module not declared (ND)

A_{1-3} – From cradle to gate

This module corresponds to the extraction and transformation of raw materials and aluminium scrap, the transport stages to the plant, and the manufacture of aluminium ingot onsite. Aluminium production at the Dunkirk site is subdivided into three sectors:

- Carbon sector (electrode production) ;
- Electrolysis sector (aluminium production) ;
- Smelter sector (ingot production).

A_{4-5} - B_{1-7} – Construction and use

These modules are not declared in this EPD.

C_{1-4} - D – End of life

Regarding the nature of the product and its wide range of applications (aluminium foil, packaging, building material, ...), data for the disassembly step are not available. Module C1 is therefore not declared.

The end of life is modelled according to the EN 15804 standard and includes all relevant processes such as the collection (selective or non-selective collection), sorting, recycling, and disposal processes. The boundaries are located at the point where the waste reaches the "end-of-waste" status, after which it is considered as a secondary material (or a secondary fuel).

▪ Results variability

The average product studied in this report represents a weighted average of the "aluminium ingot" products produced at the Aluminium Dunkerque site. The variability of the results is as follows:

GWP-total – global warming potential total: 14%

ODP – depletion potential of the stratospheric ozone layer: 6%

AP – acidification potential: 15%

EP-freshwater – freshwater eutrophication potential: 33%

EP-marine – marine eutrophication potential: 22%

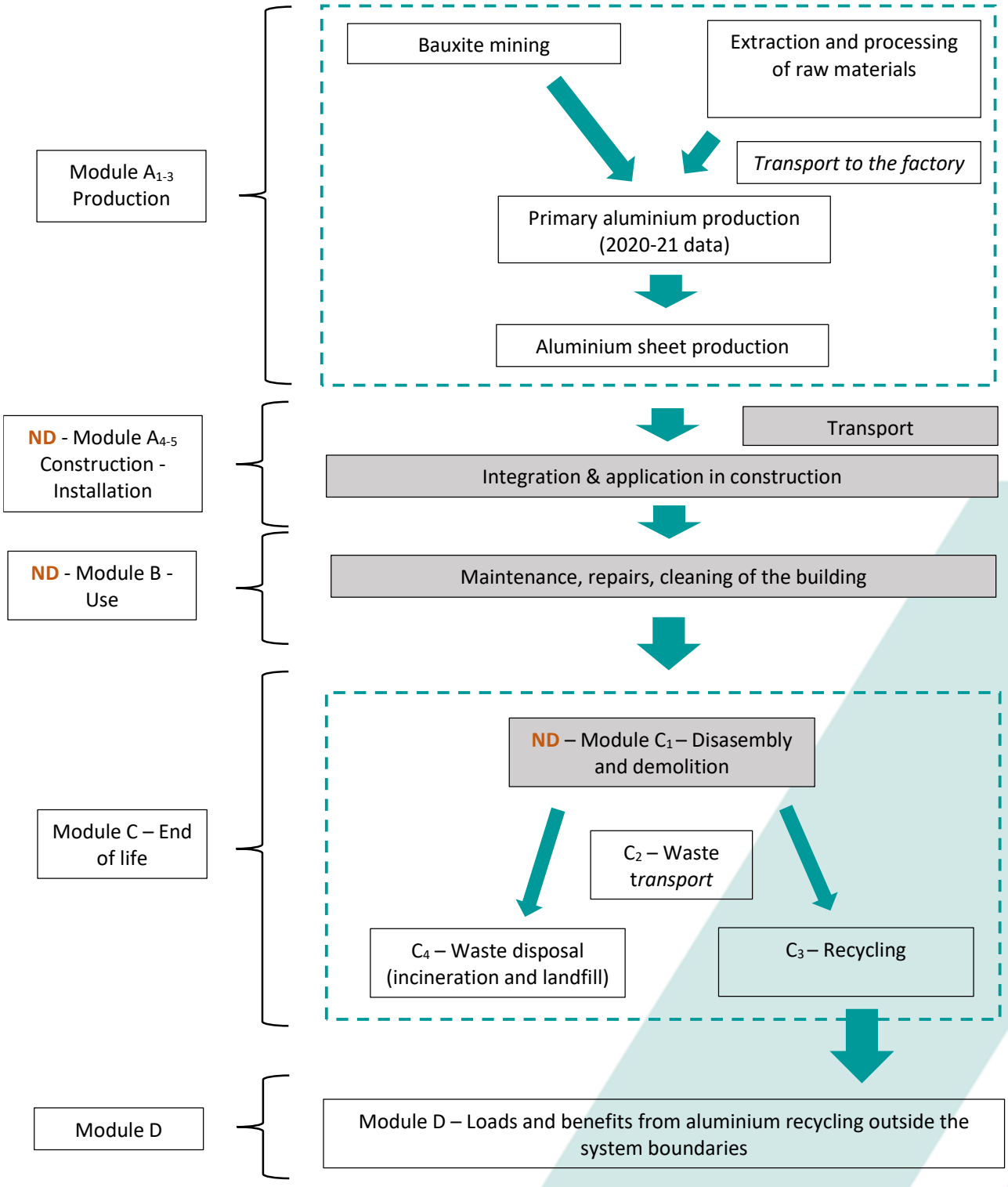
EP-terrestrial – terrestrial eutrophication potential: 23%

POCP – formation potential of tropospheric ozone: 26%

ADP-minerals&metals – abiotic depletion potential for non-fossil resources: 24%

ADP-fossil – abiotic depletion for fossil resources: 6%

WDP – water (user) deprivation potential: 29%



Flow diagram according to EN 15804 framework: modules within greyed-out boxes are not declared (ND) in this EPD.

Temporal representativeness

Data on energy consumption, raw material consumption (carbon and electrolysis sectors), environmental emissions and waste generation have been collected for the year 2020.

In the case of the smelter section, the data on raw material consumption and production volumes by profile type were collected between July 2020 and July 2021.

Database and LCA software

The software used to calculate the result is RangeLCA, developed by RDC Environment.

The database used for this analysis is ecoinvent v3.7.1.

Data quality

In order to achieve a high level of accuracy, representativeness and reliability of the results, the primary data came directly from the Dunkirk plant and was collected through questionnaires and interviews with the technical managers of the various departments.

In parallel, the LCIs (life cycle inventories) have been selected according to their technical and geographical representativeness, with specific data for France for on-site operations, Europe for end-of-life and the world for raw material supply. In the case of raw material supply, the inventories have been adapted to the actual distances to suppliers when applicable.

The inventories were developed to produce a representative model of an average aluminium ingot product.

Allocation

As it was not possible to distinguish energy consumption between the different products of the plant (ingot and sheet), the overall consumption of the plant was allocated according to the mass proportions of sheet and ingot produced on-site.

On the same principle, the boundaries of the system were extended to take into account the re-melting of scrap (internal recycling) and a mass allocation was applied between primary aluminium and scrap. In the case of Aluminium Dunkerque, 19% of the elementary flows were allocated to the scrap production.

Cut-off criteria

All raw materials, packaging and energy consumption related to the manufacturing of the aluminium ingots are included in the analysis. The same applies to waste and emissions of pollutants to the atmosphere during the manufacturing of the ingots.
Modules A4-5 and B1-B7 are excluded due to their dependence on the different specific applications of the ingot product.
Plant construction is not included.

5. Results

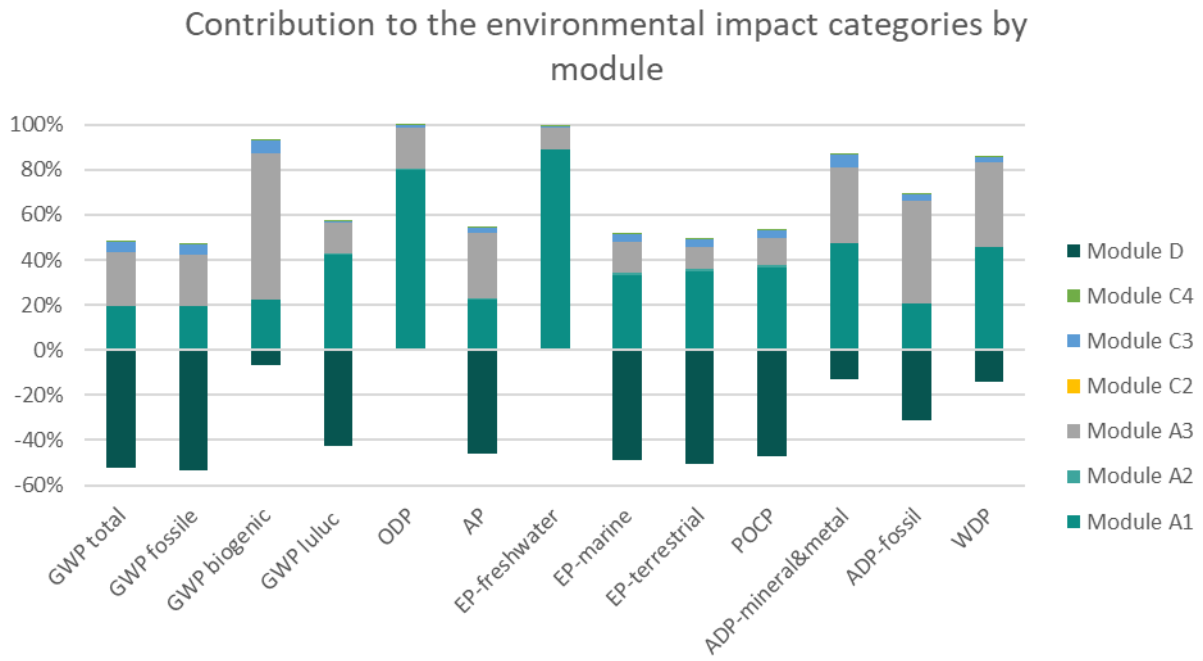
The following tables show the results for the production of an "average" ingot, based on a weighted average of the inputs according to the production volume of the different references presented above.

▪ Core environmental impact indicators

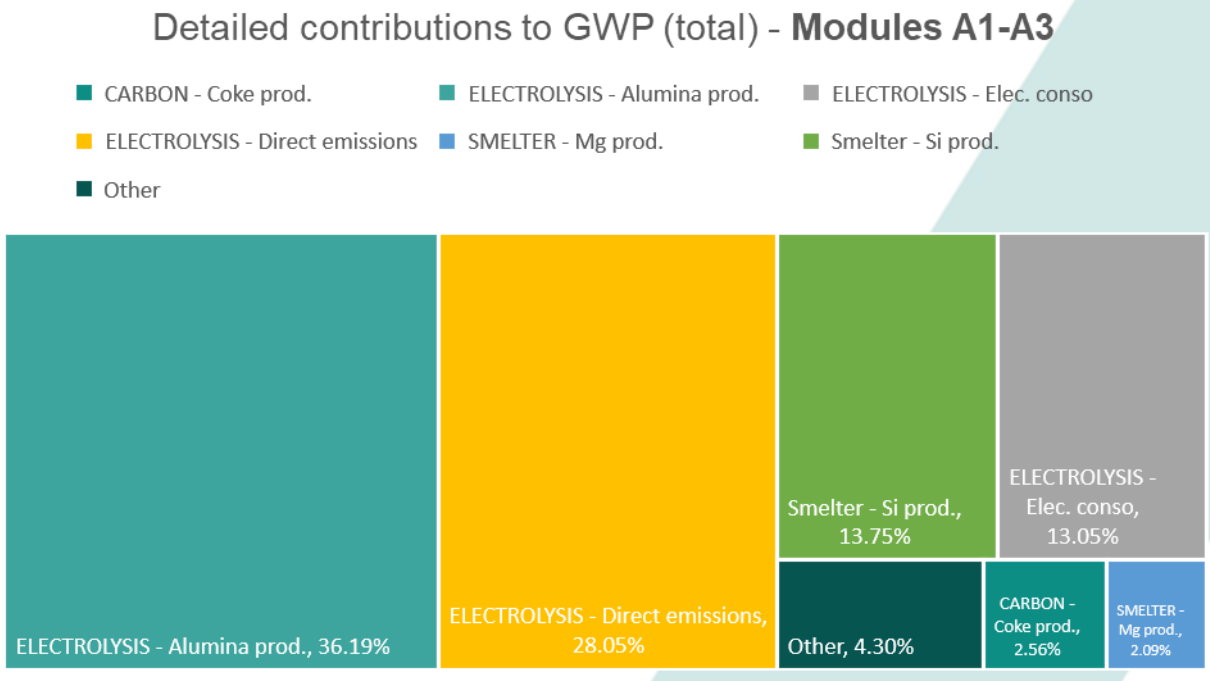
Impact category	Unit	**A1 – A3**	A4-5, B, C1	C2	C3	C4	D
GWP total	kg CO_2 eq./FU	**5.01E+00**	ND	4.07E-03	5.27E-01	1.97E-03	-6.05E+00
GWP fossil	kg CO_2 eq./FU	**4.78E+00**	ND	4.06E-03	5.11E-01	1.91E-03	-6.03E+00
GWP biogenic	kg CO_2 eq./FU	**2.40E-01**	ND	9.48E-06	1.61E-02	5.31E-05	-1.88E-02
GWP luluc	kg CO_2 eq./FU	**1.63E-03**	ND	6.54E-07	1.82E-05	2.04E-06	-1.22E-03
ODP	Kg CFC 11 eq./FU	**8.49E-07**	ND	9.49E-10	6.28E-09	2.12E-10	-1.72E-09
AP	mol H^+ eq./FU	**2.94E-02**	ND	1.75E-05	1.11E-03	1.26E-05	-2.32E-02
EP-freshwater	kg PO_4 eq./FU	**1.13E-03**	ND	1.94E-07	8.25E-06	5.81E-07	-4.88E-06
EP-marine	kg N eq./FU	**3.72E-03**	ND	5.51E-06	2.46E-04	3.15E-06	-3.44E-03
EP-terrestrial	mol N eq./FU	**3.70E-02**	ND	6.05E-05	2.58E-03	3.39E-05	-3.72E-02
POCP	kg NMVOC eq./FU	**1.22E-02**	ND	1.82E-05	7.49E-04	1.00E-05	-1.05E-02
ADP-minerals&metals	kg Sb eq./FU	**1.11E-05**	ND	5.42E-09	7.07E-07	4.27E-09	-1.64E-06
ADP-fossil	MJ, net calorific value/FU	**2.12E+02**	ND	6.21E-02	8.01E+00	3.22E-02	-8.76E+01
WDP	m^3 world eq. deprived/FU	**1.66E+00**	ND	2.20E-04	3.82E-02	8.59E-04	-2.61E-01

Environmental impact indicators – GWP total = global warming potential total (climate change) ; GWP-luluc = global warming potential (climate change) land use and land use change ; ODP = depletion of the stratospheric ozone layer ; AP = acidification potential ; EP = eutrophication potential ; POCP = formation potential of tropospheric ozone ; ADP-minerals&metals = abiotic depletion potential for non-fossil resources [2] ; ADP-fossil = abiotic depletion potential for fossil resources [2] ; WDP = water (user) deprivation potential [2].

Disclaimers to the declaration of core impact indicators: [2] - The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.



Contribution from all the modules to the GWP (total) impact category: 5.01 kg CO_2 eq./UF (CO_2 eq. emissions / cradle-to-gate scope)



Indicators describing resource use

Impact category	Unit	A1 – A3	A4-5, B, C1	C2	C3	C4	D
PERE	MJ/UF	**1.91E+01**	ND	5.66E-04	2.81E-01	1.74E-03	-4.03E+01
PERM	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ/UF	**1.91E+01**	ND	5.66E-04	2.81E-01	1.74E-03	-4.03E+01
PENRE	MJ/UF	**2.12E+02**	ND	6.21E-02	8.01E+00	3.22E-02	-8.76E+01
PENRM	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ/UF	**2.12E+02**	ND	6.21E-02	8.01E+00	3.22E-02	-8.76E+01
SM	Kg/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m^3 eq. water/UF	**1.07E-01**	ND	5.37E-06	8.97E-04	2.08E-05	-6.99E-02

Resource use indicators: 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 resources ; SM = Use of secondary material ; RSF = Use of renewable secondary fuels ; NRSF = Use of non-renewable secondary fuels ; FW = Net use of fresh water

Environmental information describing waste categories

Impact category	Unit	A1 – A3	A4-5, B, C1	C2	C3	C4	D
Hazardous waste disposed	kg/UF	**9.82E-05**	ND	1.53E-07	6.91E-07	2.61E-08	-3.50E-07
Non-hazardous waste disposed	kg/UF	**3.13E+00**	ND	3.88E-03	7.61E-02	5.24E-02	-5.27E-03
Radioactive waste disposed	kg/UF.	**2.08E-03**	ND	4.26E-07	1.78E-06	1.08E-07	-2.68E-06
Components for re-use	kg/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling	kg/UF	**0.00E+00**	ND	0.00E+00	7.30E-01	9.65E-02	0.00E+00
Materials for energy recovery	kg/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	6.68E-02	0.00E+00
Exported energy	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	3.41E-01
Exported energy (heat)	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	2.43E-02
Exported energy (electricity)	MJ/UF	**0.00E+00**	ND	0.00E+00	0.00E+00	0.00E+00	1.07E-01

Additional environmental impact indicators

Impact category	Unit	A1 – A3	A4-5, B, C1	C2	C3	C4	D
PM	Disease incidence	**2.89E-07**	ND	1.25E-10	1.16E-08	1.81E-10	-3.65E-07
IRP	kBq U235 éq./UF	**6.71E+00**	ND	2.96E-04	2.38E-01	1.58E-04	-1.95E+00
ETP	CTUe/UF.	**1.19E+02**	ND	4.06E-02	2.21E+00	3.03E+01	-3.23E+01
HTP-c	CTUh/UF	**1.19E-08**	ND	1.05E-12	8.16E-11	1.82E-12	-1.56E-09
HTP-nc	CTUh/UF	**1.83E-07**	ND	1.97E-11	9.51E-10	4.62E-11	-4.17E-08
Land use impacts	Dimentionless	**2.93E+01**	ND	5.43E-02	9.01E-01	3.49E-02	-2.14E+00

Additional environmental impact indicators: HTP-c = Potential Comparative Toxic Unit for humans, carcinogen effects [2] ; HTP-nc = Potential Comparative Toxic Unit for humans, non-carcinogen effects [2] ; ETP-fw = Potential Comparative Toxic Unit for ecosystems [2] ; PM = Potential incidence of disease due to PM emissions [2] ; IRP = Potential Human exposure efficiency relative to U235 [1].

Disclaimers to the declaration of the additional environmental impact indicators: [1] - 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. [2] - The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator

6. Bibliography

Aluminium Recycling in LCA – European Aluminium Association, 2013.

Ecoinvent Database. http://www.ecoinvent.org/database/.

Environmental Profile Report – European Aluminium Association, 2018.

Suggestions for updating the Product Environmental Footprint (PEF) method – Joint Research Centre, 2019.

Standards and reference documents used in this study:

- ISO 14040:2006: Environmental Management-Life Cycle Assessment-Principles and framework.
- ISO 14044:2006: Environmental Management-Life Cycle Assessment-Requirements and guidelines.
- EN 15804+A2:2019. Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products