Aluminium Dunkerque

LCA RESULTS SYNTHESIS

Aluminium ingot

Aluminium Dunkerque

August 2025

Verified by an external independent third-party

Compliant with ISO 14040-44

Disclaimer

This study has been conducted and externally critically reviewed in accordance with ISO 14040/44. The EN 15804+A2 framework has been considered to ensure continuity with previous studies on this product. In particular, the module structure and system boundaries follow the EN 15804 approach where relevant. However, this study does not claim compliance with EN 15804+A2, nor has it been verified against this standard.

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 LCA	Aluminium Dunkerque Route de la ferme Raëvel 59279 Loon-Plage France
LCA scope	From cradle to factory gate *End-of-life was studied in the complete LCA report but is not reported in this summary, as it depends on the final application and is beyond Aluminium Dunkerque's influence.*
Studied product	Aluminium ingot This product is defined as an average aluminium ingot produced on the Aluminium Dunkerque site.

Reference framework: ISO 14040/44 EN 15804+A2 has been considered to ensure continuity with previous studies on these products. Its methodological recommendations are followed where relevant, but no strict EN 15804 verification or compliance is sought.
External critical review according to ISO 14040/44
Third-party verifier: Bureau Veritas (Damien PRUNEL, damien.prunel@bureauveritas.com)

3. Product description

Aluminium ingot accounts for around 20% 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.

4. Declared unit and scope of the study

▪ Declared unit

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

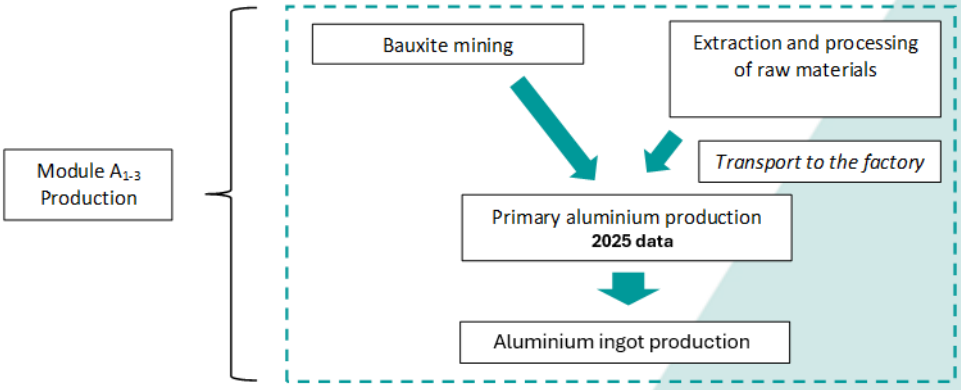
▪ Goal and scope of the study

This LCA assesses the environmental impacts of the production of 1 kg of aluminium alloy ingot from the cradle to the factory gate.

The reported scope includes 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).

The end-of-life stage has also been studied in the full LCA report, but is not reported in this summary, as it depends on the final application and is beyond Aluminium Dunkerque's influence.



Temporal representativeness

Data on energy consumption, raw material consumption, environmental emissions and waste generation have been collected for the full year 2025.

Database and LCA software

The results have been calculated with the Pilario platform (http://pilario.com) and the expert LCA tool RangeLCA (developed by Pilario).

The main database used for this analysis is ecoinvent v3.11. Other sources have been used such as European Aluminium (for aluminium recycling and benefit of recycling), emission factors from Aluminium Dunkerque's alumina supplier, emission factor for electricity (calculated by a third-part carbon footprint expert).

Data quality

A specific Pilario LCA platform has been developed together with Aluminium Dunkerque, enabling automatic collection of monthly site data. To complement this and ensure a high level of accuracy, representativeness, and reliability of the results, the 2025 primary data were also collected through questionnaires and interviews with the technical managers of the different 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. In addition, inventories for alumina (which is the main raw material for aluminium production) have been adapted based on supplier's carbon footprint data.

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

Allocation

As the different aluminium flows cannot be physically distinguished during the common production stages (carbon plant and electrolysis), a mass allocation approach was applied to these shared processes. This approach is considered appropriate as the co-products are of similar nature and correspond to the same aluminium quality produced through the same process.

In contrast, the specific smelter stages (in particular the addition of alloying metals) were directly attributed to the corresponding product, as the associated consumptions are known specifically for each product.

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. Modules C1-C4 and D have been evaluated in the full LCA report but not reported in this summary.
Plant construction is not included.

5. Results

The following tables show the results for the production of an average aluminium ingot.

Global Warming Potential (total)
cradle-to-gate scope

4.05 *$kgCO_2eq$ / kg ingot*

- Core environmental impact indicators

Impact category	Unit	**A1 – A3**	A4-5, B, C1	C2	C3-C4	D
GWP total	kg CO_2 eq./FU	4.05	ND	0.01	0.49	-5.73
GWP fossil	kg CO_2 eq./FU	4.03	ND	0.01	0.49	-5.72
GWP biogenic	kg CO_2 eq./FU	1.55E-02	ND	1.37E-06	3.80E-03	-1.41E-03
GWP luluc	kg CO_2 eq./FU	1.62E-03	ND	3.41E-06	2.09E-05	-1.17E-03
ODP	Kg CFC 11 eq./FU	1.30E-07	ND	1.42E-10	3.71E-09	-3.37E-10
AP	mol H^+ eq./FU	4.41E-03	ND	1.73E-05	1.10E-03	-2.22E-02
EP-freshwater	kg PO_4 eq./FU	9.33E-04	ND	4.76E-07	7.96E-06	-5.30E-06
EP-marine	kg N eq./FU	3.75E-03	ND	4.84E-06	2.59E-04	-3.28E-03
EP-terrestrial	mol N eq./FU	3.65E-02	ND	5.27E-05	2.59E-03	-3.55E-02
POCP	kg NMVOC eq./FU	1.44E-02	ND	2.60E-05	7.68E-04	-1.01E-02
ADP-minerals&metals	kg Sb eq./FU	1.02E-05	ND	2.41E-08	3.99E-07	-1.57E-06
ADP-fossil	MJ, net calorific value/FU	203.6	ND	0.1	7.8	-83.7
WDP	m^3 world eq. deprived/FU	1.78E+00	ND	4.76E-04	2.61E-02	-2.51E-01

Environmental impacts – *GWP-total = Global Warming Potential (climate change); GWP-luluc = Global Warming Potential (climate change) related to land use and land use change; ODP = Ozone Depletion Potential; AP = Acidification Potential for soil and water; EP = Eutrophication Potential; POCP = Photochemical Ozone Creation Potential; ADPE = Abiotic Depletion Potential for non-fossil resources; ADPF = Abiotic Depletion Potential for fossil resources (fossil fuels); WDP = Water Use (user deprivation potential, deprivation-weighted water consumption).*

- Additional environmental impact indicators

Impact category	Unit	A1 – A3	A4-5, B, C1	C2	C3-C4	D
PM	Disease incidence	0.00	ND	0.00	0.00	0.00
IRP	kBq U235 éq./UF	6.77	ND	0.00	0.23	-1.86
ETP	CTUe/UF.	9.13	ND	0.01	9.30	-18.60
HTP-c	CTUh/UF	2.49E-09	ND	1.07E-12	5.52E-11	-1.49E-09
HTP-nc	CTUh/UF	6.47E-08	ND	3.15E-11	7.70E-10	-3.15E-08
Land use impacts	Dimentionless	10.48	ND	0.06	0.90	-2.04

Additional environmental impacts – *HTP-c = Human toxicity – carcinogenic effects; HTP-nc = Human toxicity – non-carcinogenic effects; ETP = Ecotoxicity – freshwater (comparative toxic unit for ecosystems); PM = Particulate matter (potential incidence of disease due to particulate matter emissions); IRP = Ionizing radiation – human health effects (human exposure efficiency relative to U235).*

6. Bibliography

This document summarizes the results of the LCA report, Analyse du cycle de vie des produits du site Aluminium Dunkerque (version 1.2 – 06/08/2026), prepared by RDC Environment for Aluminium Dunkerque.

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