ENVIRONMENTAL PROFILE REPORT FOR THE ALUMINIUM REFINING INDUSTRY

Life Cycle Inventory data (2017-2019) for the production of cast alloys ingot from scrap and waste

November 2021

EXECUTIVE SUMMARY

EUROPEAN ALUMINIUM

THE ALUMINIUM EFFECT

95+ members across the aluminium value chain
600 plants in 30 European countries
40 billion euros annual turnover

1 million+ direct and indirect jobs

75% of all aluminium ever produced is still in use

Recycling saves 95% of the energy needed for primary production

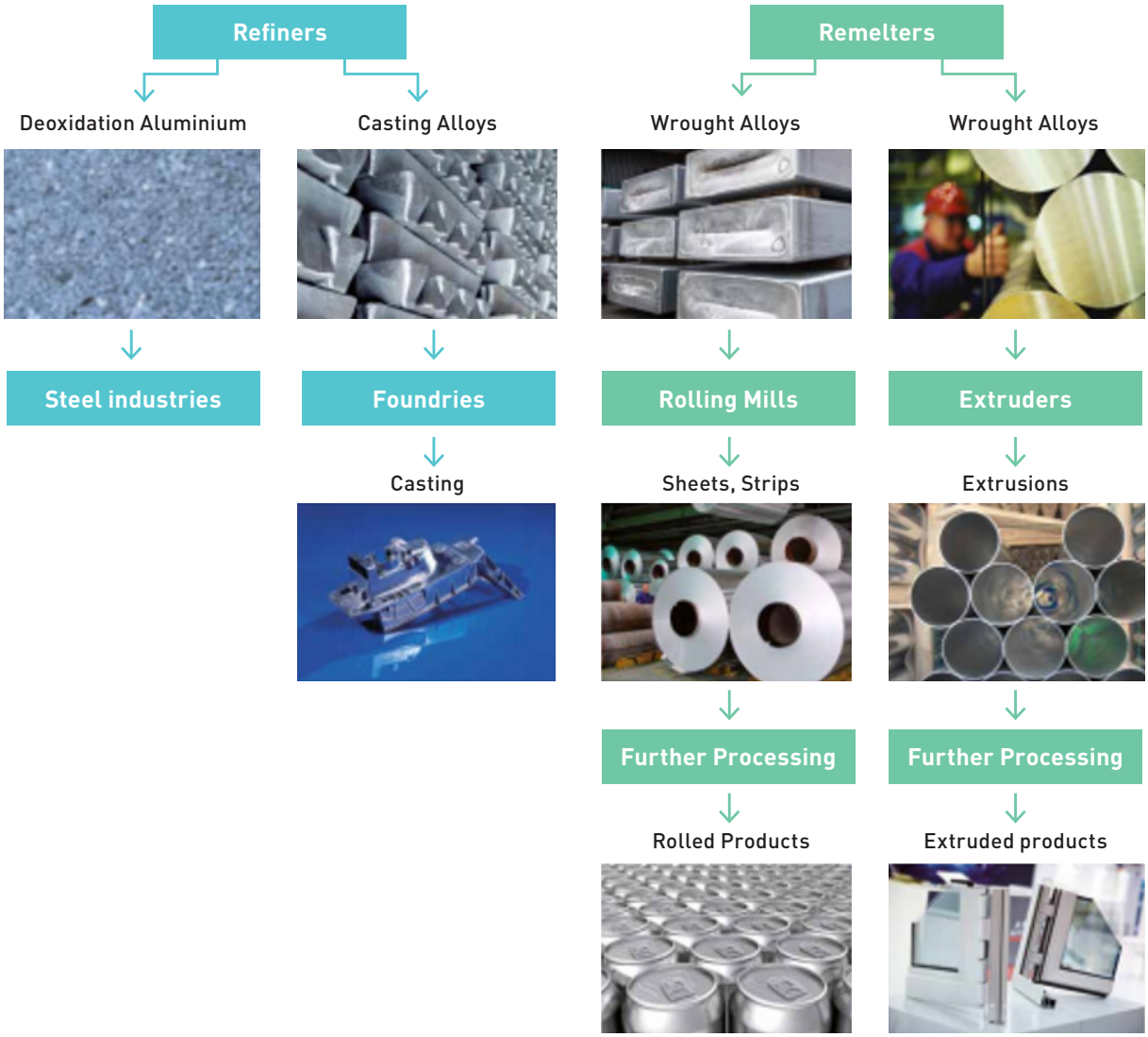
Aluminium has one-third of the density of steel. This means lighter vehicles, lower energy consumption and reduced emissions.

Introduction

As part of our commitment to the Circular Economy, European Aluminium proactively contributes to lifecycle thinking by supporting the development of Life Cycle Inventory (LCI) datasets. We have been monitoring the industry's environmental performance for more than 20 years. Progress is monitored through regular data collection and public reporting.
By providing transparent and robust data that reflects the true impact processes and related products have on the environment, we aim to help aluminium customers and consumers make informed decisions on what to buy and use.

The latest LCI datasets for the European aluminium industry were published in European Aluminium's Environmental Profile Report in February 2018.

Typical Products: Aluminium Refiners and Remelters



This new report complements the 2018 Environmental Profile Report with recycling datasets related to the refining process used to produce cast alloy ingots from scrap and waste. Because of the aluminium refining industry's specificities, a dedicated data collection process and in-depth analysis have been carried out for this report.

To assess the full environmental impacts of aluminium products, one must consider the product's full life cycle, including the use and end-of-life recycling stages. These stages are essential to fully reflect aluminum products' unique properties, such as their lightweight and endless recyclability.

As highlighted in the ISO standards 14040 and 14044 , the environmental performance of a product system or a service can only be assessed in a scientifically sound manner when one adopts a life cycle perspective, namely from cradle to grave or from cradle to recycling.

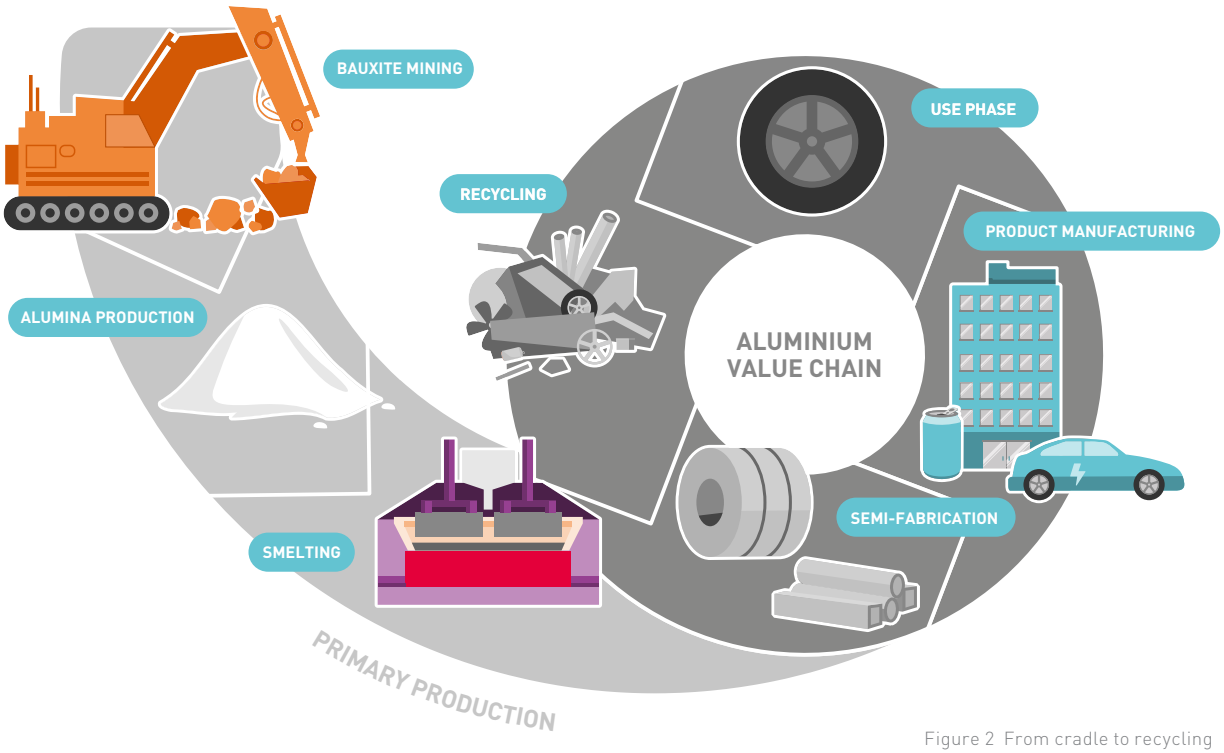


Figure 2 From cradle to recycling

Benefits: Resource efficiency and GHG savings

For the LCA modelling of the aluminium refining process, it is also recommended to include the salt slag recycling process, whether or not it is done on-site, in the scope to capture the full environmental impacts and benefits of the aluminium refining industry.

Compared to the previously existing data, the updated data demonstrate a great improvement in the refining industry's environmental performance in Europe. For instance, the refining datasets show the Green House Gas (GHG) emissions of the refining process decreased by 14% between 2010 and 2018.

Furthermore, the aluminium refining industry (including the salt slag recycling process) allows for the production of three main value-added products: Recycled aluminium, fluxing salt and aluminium oxide. These products are mostly generated from materials generally considered waste; Aluminium scrap (mostly post-consumer); Salt slag and dross.

Thus, the aluminium refining industry generates raw materials and energy savings which can benefit various industrial processes within the aluminium value chain - and beyond. For example, the fluxing salt regenerated via the salt slag recycling process is reused by the aluminium industry in the melting and dross recycling furnaces. Furthermore, the aluminium oxide recovered during the salt slag recycling process can be used in other industries such as refractories, ceramics, or cement, substituting other sources of aluminium oxides.

By considering the substitution benefits (i.e. by system expansion) related to the recovery of the aluminium oxide from the salt slag recycling process in the modelling, the Global Warming Potential (GWP) of the refining process can potentially be decreased by 11% in comparison with a system where the aluminium oxide from the salt slag recycling process is not valorised.

Why aluminium is the perfect material for the circular economy

Aluminium is the perfect material for the circular economy. It is fully and infinitely recyclable, maintaining its original properties no matter how many times it is processed and used. The aluminium recycling process requires only 5 percent of the energy needed to produce the primary metal, resulting in greenhouse gas emissions below 0.5 tonne CO_2 eq/tonne recycled aluminium (gate to gate).

The Circular Aluminium Action Plan is the sector's strategy for achieving aluminium's full potential for a circular economy by 2030. It builds on the aluminium industry's Vision 2050, with a focus on recycling and provides policy recommendations for EU policymakers for the new Circular Economy Action Plan and the EU's objectives to reduce its CO_2 emissions.

Objectives

This report aims to:

- Update the **environmental data** (e.g. energy consumption) related to aluminium cast ingot (or deox) production from aluminium scrap and waste in Europe.
- Provide accurate and reliable generic industry **Life-Cycle Inventory (LCI) datasets** for the key process steps essential for calculating the environmental impact of cast ingot from aluminium scrap and waste in Europe.

These new datasets, based mainly on data from 2018, update previous versions. The report is aimed at LCA practitioners, researchers and environmental managers interested in the aluminium recycling industry, particularly experts in aluminium companies, their customers (such as in transport, building and construction and packaging), consultancies (e.g., LCA databases suppliers), research centres (e.g., university, R&D centres) or administrations (e.g., EU institutions).

Scope of the report

This report provides the environmental dataset for the aluminium refining process in Europe:

- Production of cast alloys aluminium ingot from (pre- and post-consumer) scrap without the benefits related to the valorisation of the aluminium oxide (Scope A: gate to gate):

  This dataset includes the environmental impact of the transformation of the aluminium (pre- or post-consumer) scrap into a cast alloys aluminium ingot ready for delivery to the user. This dataset includes the scrap preparation done on-site, in melting, purifying, and casting operations. It also includes the salt slag recycling process. This dataset is based mainly on 2018 data and 2019 data when available.

  Moreover, this report illustrates the environmental benefits of the aluminium refining process in Europe when the aluminium oxide generated from the salt slag recycling process substitutes aluminium oxide generated out of bauxite as raw materials in other industries such as ceramics and cement. This dataset should be considered as one example of substitution but does not intend to reflect all possible substitution routes available on the market.

- Production of aluminium cast alloys aluminium and ingot from (pre- and post-consumer) scrap with the benefits related to the valorisation of the aluminium oxide (Scope B: gate to gate + system expansion):

  In addition to the dataset presented above, this specific dataset also includes the environmental benefits related to the recovery of aluminium oxide via the salt slag recycling process. This approach uses the system expansion methodology as defined by the ISO standards ISO 14040 and 14044.

  The aluminium oxide generated out of the salt slag recycling process can be used in other industries (e.g., refractories, ceramics, cement) in substitution of the aluminium oxide from bauxite primary raw material. This dataset is based mainly on 2018 data and 2019 data when available.

This report provides the environmental dataset for following scopes:

- Emissions reporting scope
  These two LCI datasets include the direct emissions related to aluminium processes (Scope 1), the indirect emissions (e.g., from electricity) related to energy consumption (Scope 2) and all other indirect emissions (Scope 3) from other ancillary materials.
  A simplified definition of the project scope is provided below.
- Geographical scope
  The geographical area covered by European Aluminium's dataset is composed of the 27 EU Member States, United Kingdom and EFTA countries (Norway, Switzerland, and Iceland).

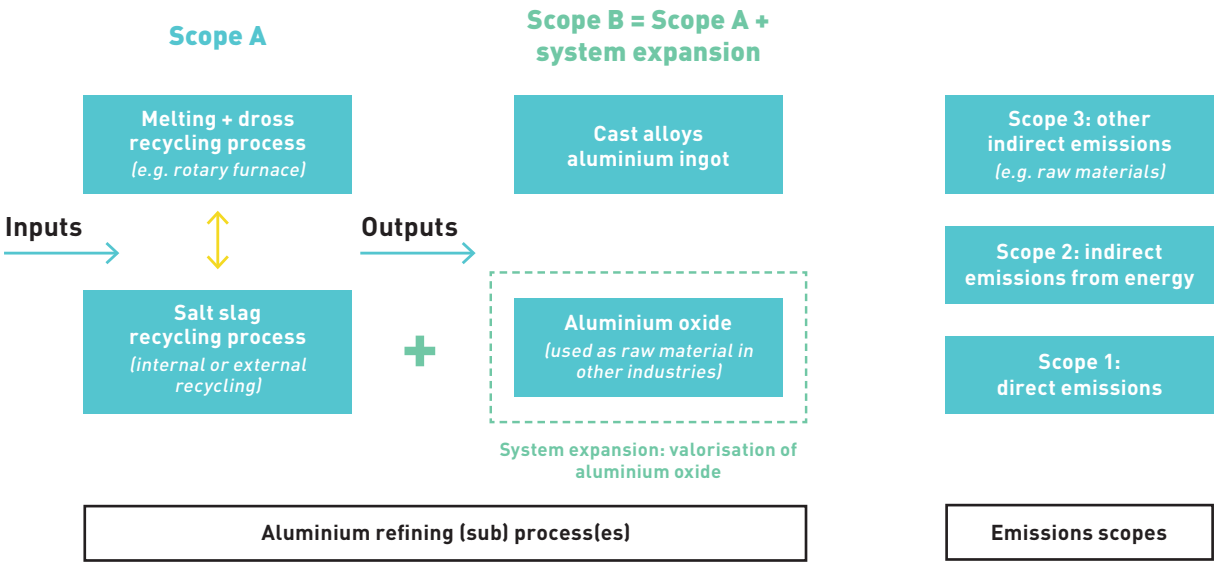


Figure 3: Scopes of the report

Methodology

This report, and the associated LCI data, have been **developed in full compliance with the two relevant ISO standards ISO 14040 and 14044**. The environmental data have been collected and developed by the aluminium industry based on members' input. The completeness of the data is considered representative of the aluminium industry by industry experts. For example, for the melting and dross recycling process, the industry data collected covers around 60 per cent of the European production. For the salt slag recycling process, the coverage is about 80 per cent of the existing treatment capacity in Europe.

Following consolidation, the data collected have been integrated in LCA software (i.e. Gabi) to generate the full environmental impact assessment of aluminium processes (i.e. reporting scopes 1, 2 and 3).

The data, methods and analysis included in this study have been subject to ongoing review and validation by various internal experts acting at different stages of the project (i.e. data collection/ analysis, LCA modelling and reviewing the LCI report). These experts come from the aluminium industry (i.e. via a Task Force on the Environmental Profile Report for Refiners) and Sphera, which acted as an external consultant.

Finally, the experiences learned from the previous external reviews from Prof. Dr. Matthias Finkbeiner and Prof. Dr. Walter Klöpffer for the 2018 Environmental Profile Report have been taken into account. However, this complementary report focuses only on the refining industry and was not submitted to an external reviewer prior to publication. European Aluminium aims to continue to seek external critical review by independent experts as part of the regular update of its Environmental Profile Reports.

How to use these aluminium LCI datasets

The European aluminium industry develops environmental datasets for various aluminium process steps *(metal supply, transformation steps and recycling).* To determine the life-cycle profile of the respective products, these datasets need to be combined in a modular way.

For instance, the specific LCI datasets related to the refining industry are "gate to gate" datasets and do not include the environmental impacts of the aluminium flows (e.g., scrap) and additional alloying elements entering the process. The environmental impacts of the inputs' material can vary depending on the scrap origin (e.g., pre-, and post-consumer) or on the percentage (or type) of alloying elements into the raw material (e.g., ingot, scrap).

Therefore, for specific case studies requiring a cradle to gate scope, the environmental impacts of these input materials must be included when relevant.

In addition, when assessing the full environmental impact assessment of aluminium products, one must also consider the product's full life cycle, including its use phase and its end-of-life phase (e.g., recycling).

These steps are essential to fully reflect the intrinsic and unique properties of aluminium products (e.g., lightweighting, endless recyclability) when assessing their environmental impact. As highlighted in ISO 14040 and 14044, only the environmental aspects of a product system or a service from a life-cycle perspective, i.e. from cradle to grave or from cradle to recycling, are scientifically sound for comparative purposes.

Highlights from the report

The updated data for the refining process demonstrate a strong improvement of the refining industry's environmental performance in Europe for most environmental indicators compared with 2010 data (Scope A). For instance, the Green House Gas (GHG) emissions of the refining process decreased by 14 per cent to 438 g CO_2 equivalent (CO_2e) per kg of aluminium ingot between 2010 and 2018.
When including the benefits (i.e. system expansion) related to the recovery of the aluminium oxide from the salt slag recycling process, the environmental impacts of the refining process can be potentially reduced further by 10 to almost 30 per cent (Scope B). For instance, the GHG emissions of the refining process can be decreased further by 11 per cent to reach 390g CO_2 equivalent (CO_2e) per kg of aluminium ingot.

As an example of the environmental indicators in this report, the Global Warming Potential (i.e. Green House Gas emissions expressed in CO_2 equivalent - 'CO_2e') is summarised below.

European Aluminium datasets (2018)	Value (in g CO_2e per kg of production)
Production of cast alloys aluminium ingot from scrap without the benefits related to the valorisation of the aluminium oxide (gate to gate) – Scope A	438
Production of cast alloys aluminium ingot from scrap including the benefits related to the valorisation of the aluminium oxide (gate to gate + system expansion) – Scope B	390

Finally, the aluminium refining process (including the salt slag recycling process) allows for the recovery and generation of three value added products. This includes recycled aluminum and the recovery of fluxing salt and aluminium oxide from what is generally considered waste, aluminium scrap (mostly post-consumer), salt slag and dross.

In conclusion, the aluminium refining industry, especially when including the salt slag recycling process, generates raw materials and energy savings that can benefit various industries (e.g., aluminium, ceramic, cement, refractories). It is an excellent illustration of an efficient circular economy business model for the aluminium value chain but also other industries, mainly thanks to the salt slag recycling process.

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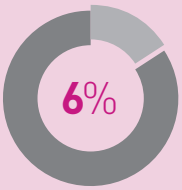
The full report is available upon request.

ANNUAL TURNOVER

~40 Billion €

1 million direct and indirect jobs



of the world's annual primary aluminium production is made in Europe

TONNES RECYCLED

4.3 million in 2020

of the European aluminium industry's output comes from recycled sources

~600

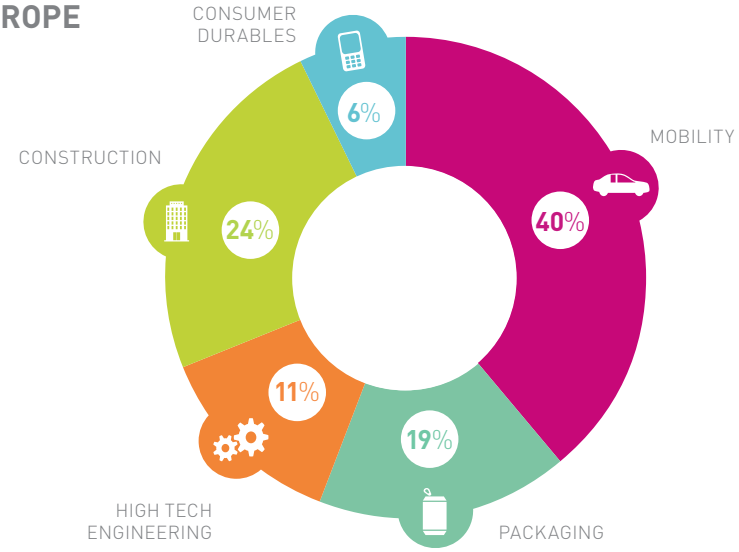
plants in 30 European countries (EU27, UK, EFTA and Turkey)

95%

recycling saves 95% of the energy needed for the primary production

source: European Aluminium 2020 (estimates)

MAIN END-USES FOR ALUMINIUM PRODUCTS IN EUROPE IN 2020



ALUMINIUM - TRULY SUSTAINABLE

8g 
the reduction in CO_2 emissions per km obtained by cutting 100Kg from a car's mass

61% 
the amount of aluminium alloys in the structure of an Airbus A380

50% 
the potential energy saving from buildings with intelligent façades incorporating aluminium systems.

76.1% 
the recycling rate for used aluminium beverage cans in Europe in 2018

34% 
the average reduction of foil thicknesses in the last 30 years without jeopardising the quality of the contents the foil protects

TRULY SUSTAINABLE

~75% **of the aluminium ever produced is still in use**

ABOUT EUROPEAN ALUMINIUM

European Aluminium, founded in 1981 and based in Brussels, is the voice of the aluminium industry in Europe. We actively engage with decision makers and the wider stakeholder community to promote the outstanding properties of aluminium, secure growth and optimise the contribution our metal can make to meeting Europe's sustainability challenges. Through environmental and technical expertise, economic and statistical analysis, scientific research, education and sharing of best practices, public affairs and communication activities, European Aluminium promotes the use of aluminium as a material with permanent properties that is part of the solution to achieving sustainable goals, while maintaining and improving the image of the industry, of the material and of its applications among their stakeholders. Our 95+ members include primary aluminium producers; downstream manufacturers of extruded, rolled and cast aluminium; producers of recycled aluminium and national aluminium associations are representing more than 600 plants in 30 European countries. Aluminium products are used in a wide range of markets, including automotive, transport, high-tech engineering, building, construction and packaging.

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