

ENVIRONMENTAL PROFILE REPORT

Life-Cycle inventory data for aluminium
production and transformation processes in Europe

February 2018



EXECUTIVE SUMMARY



EUROPEAN ALUMINIUM

THE ALUMINIUM EFFECT



80+ members across the aluminium value chain
600 plants in 30 European countries
39.5 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



Compared to steel, 200kg of aluminium in a car can save up to 16g of CO₂ per km

Executive summary

Introduction

This European Aluminium Environmental Profile Report covers the environmental impact of the entire aluminium value chain in Europe, from metal supply - primary and recycling - to semi-fabrication - rolling, foil and extrusion. **It provides accurate and reliable data on aluminium industry's environmental performance in Europe.**

The **2015 data demonstrate strong improvement by the industry.** First, the environmental impact of the primary production has decreased significantly (by 21 per cent for Global Warming Potential) while the environmental performance of the primary aluminium consumed in Europe has remained stable. For the semi-fabrication (rolling and extrusion) and the recycling industry there has been a strong improvement in the environmental performance of those processes in Europe.

The European aluminium industry has been a leader in improving environmental performance for many years. Since 1990, the industry has reduced the carbon intensity of its primary production by more than half. This has led to Europe being able to boast one of the lowest primary production carbon footprints in the world; less than half the global average and almost one-third that of China.

This is important, not simply from an environmental perspective but also from that of meeting growing public interest and concern. Stakeholders rightly want to know the impact of the products they use and consume to inform their behaviour.

However, when assessing the full environmental impact of aluminium products, it is vital to consider the full life-cycle of the product, including the use and recycling phases. These steps are essential to fully reflect the intrinsic properties of aluminium products such as light weighting and recyclability).

As highlighted in ISO 14040 and 14044, only the environmental aspects of a product system or a service in a life-cycle perspective, i.e. from cradle to grave or from cradle to recycling, are scientifically sound.

This European Aluminium Environmental Profile Report has been reviewed by two renowned Life Cycle Assessment experts, Prof Dr Matthias Finkbeiner and Prof Dr. Walter Klöpffer. An essential overview, it recognises the ongoing efforts by the aluminium industry on LCA as stressed in the following statement: **“To sum up, this project is an excellent example for generic data acquisition, consolidation and presentation. It contributes to the Life Cycle Assessment development by providing reliable data for one important material and continues a tradition of one and a half decade in an exemplary way”.**

Highlights from the report

Primary aluminium

European Aluminium is providing two environmental datasets for primary aluminium: one for domestic production in Europe (representing the European production mix) and the other for aluminium consumed in Europe (representing the European consumption mix), i.e. including net imports. In fact, Europe (EU28+EFTA) imports around half of its supply of primary, mainly from Russia, Africa and the Middle East.

- o Primary aluminium production in Europe

In comparison with the previous LCI data collection exercise in 2010, four smelters located in EU have been closed. EFTA countries (i.e. Iceland and Norway) represent around 50 per cent of

European production in 2015, up from around 40 per cent five years ago. As a result, the electricity mix of European smelters has shifted from approximately **50 per cent renewable energy** (e.g. hydro and geothermal) **in 2010 to around 70 per cent in 2015**.

In addition, European smelters continue to improve their environmental performance. For example, PerFluoroCarbon (PFC) emissions (CF₄ has dropped by 50 per cent and C₂F₆ by 52 per cent compared to 2010), have dropped significantly. Total PFC emissions have now fallen by 97 per cent compared with 1990.

In alumina production in Europe, there has also been a significant reduction in thermal energy consumption (down 13 per cent compared to 2010). **This reflects a switch from heavy fuel to natural gas calciner technology within alumina refineries**. This has made a significant improvement to air emissions quality. For example, sulphur dioxide (SO₂) particulates emissions decreased by more than 90 per cent and nitrogen dioxide (NO_x) by around 74 per cent in compared with 2010.

Ultimately, all environmental indicators for primary production in Europe have significantly improved. For example, the Global Warming Potential (GWP) i.e. the **Green House Gas (GHG) emissions decreased by 21 per cent to 6.7 kgCO₂e equivalent (CO₂e) per kg of primary aluminium**.

For illustration, this saving of 7.6 million tonne CO₂e is equivalent, on an annual basis, to around one-third of the GHG emissions of Croatia¹.

- o Primary aluminium consumption in Europe

This dataset is based on the European production of primary aluminium (see above), plus net imports.

Europe is increasingly dependent on imports of primary aluminium. In 2015, imports of primary metal represented around 49 per cent of European consumption up from 44 per cent in 2010.

In addition, the sources of primary metal have slightly changed. Russia remains the main exporter of primary metal to Europe with 39 per cent of total imports, follows by Africa with 23 per cent. However, the Middle East now provides around 21 per cent of European imports up from only 11 per cent in 2010. Meanwhile, the share of imports from North America decreased significantly from 11 to 6 per cent in 2015.

This situation explains the decrease of the imports derived from hydroelectricity (67 per cent in 2015 vs. 79 in 2010) and an increase of the imports derived from natural gas (22 per cent in 2015 vs. 12 in 2010).

This has slightly increased all environmental indicators relating to European imports of primary aluminium. For example, the carbon intensity of the electricity mix of European imports increased from 203g CO₂e/kWh in 2010 to 267g CO₂e/kWh electricity in 2015.

In terms of total consumption, the overall environmental impact of the primary aluminium used in Europe remains relatively stable at 8.6kg CO₂e per kg of primary aluminium. This is explained by the strong decrease in the environmental impact of domestic production (down 21 per cent) being balanced by an equivalent increase in the environmental impact of imports.

Semi fabrication

The aluminium industry is providing three environmental datasets for semi fabrication (i.e. production mix) in Europe: one for rolling production, one for extrusion production and one for foil

¹ In 2015, Croatia emitted approximately 24 million tonnes CO₂-equivalent (Source: European Environmental Agency)

production (via EAFA²). For these datasets, imports of semis have not been considered due to the absence of other regional datasets and the limited trading flow of semis entering Europe, i.e. on average around 10 per cent of the domestic production.

- o Rolling

The environmental impact of rolling mill processes fell significantly in comparison with 2010. For example, the total energy consumption decreased by 9 per cent. The same trend is seen in other inputs materials used in the process, such as ancillary products or packaging.

The processes showed a strong decrease in the outputs of most air emissions and in the volume of hazardous waste generated.

As a result, the environmental impact of the aluminium rolling mill process has decreased for most indicators. For example, the Global Warming Potential (GWP) decreased by around 25 per cent while total energy consumption fell by 16 per cent. Other indicators such as acidification (related to SO₂ emissions) and eutrophication (related to NO_x emissions) have also decreased, by 52 per cent and 25 per cent respectively.

- o Extrusion

The environmental impact of extrusion processes improved significantly compared with 2010. For example, total energy consumption fell by 8 per cent. Consumption of ancillary materials has remained stable in the same period even if there seems to have been a slight increase in the consumption of materials for packaging.

Regarding the outputs from the process, the main air emissions (i.e. NO_x and SO₂) have decreased. The total volume of waste generated increased, however, most of this increase is directed for recycling and not for landfill.

As a result, the overall environmental impact of the aluminium extrusion process decreased for most indicators. For example, the Global Warming Potential (GWP) fell by 11 per cent. In addition, indicators such as acidification (i.e. related to SO₂ emissions) also decreased significantly, falling 37 per cent.

- o Foil

The LCI dataset relating to foil production was developed by EAFA (the European Aluminium Foil Association) and covers the entire process, i.e. production of foil stock (both hot-rolling and continuous-casting routes), foil rolling plus recycling of process scraps. Compared with 2010 data, the hot-rolling process, which generates the foil stock for the hot-rolling route was directly include in the LCI dataset. For this reason, there is no direct comparison with 2010 in this report.

Recycling

European Aluminium is providing two environmental datasets for recycling in Europe: one for remelting production (i.e. for wrought alloy ingots) and one for refining production (i.e. for casting alloys ingots).

- o Remelting

The overall environmental impact of remelting improved significantly compared to 2010. For example, total energy consumption decreased by 12 per cent. Otherwise, ancillary materials consumption is stable. There was a significant fall in outputs from the process, with a strong decrease of most air emissions (e.g. down 15 per cent for NO_x and 19 per cent for SO₂) and volume of

² European Aluminium Foil Association (EAFA)

waste generated.

As a result, the overall environmental impact of remelting has decreased for most environmental indicators. Global Warming Potential (GWP) decreased by 9 per cent and total energy consumption by 4 per cent. In addition, indicators such as acidification (related to SO₂ emissions) also fell by 19 per cent.

- o Refining

Recycling efficiency and recycling routes are heavily dependent on scrap origin and quality. Therefore, for specific aluminium applications or products, the recycling scenario(s) and the recycling routes should be closely analysed in order to develop better-adapted models and associated LCI datasets. This European model for recycling is being refined by European Aluminium members. Hence, this report relies on 2010 results. The updated LCI results will be part of a future publication.

Focus on Global Warming Potential (GWP) results

As an example of the environmental indicators in this report, the Global Warming Potential (i.e. Greenhouse Gas emissions expressed in CO₂ equivalent - 'CO₂e') is reported below for the various datasets.

European Aluminium datasets	Value (in kg CO ₂ e per kg of production)
Primary aluminium produced in Europe (cradle to gate)	6,7
Primary aluminium used in Europe (cradle to gate)	8,6
Sheet production (gate to gate)	0,4
Extrusion production (gate to gate)	0,7
Foil production (gate to gate)	1,3
Remelting production (gate to gate)	0,3
Refining production (gate to gate)	0,5

Background

Society is increasingly sustainability conscious and aware. Growing numbers of stakeholders seek information and data on the environmental impact of the products they use and consume.

To meet this demand, companies are increasingly turning to Life-Cycle Assessments³ (LCAs) as a communication tool. Policy makers also use LCA concepts in certain environmental legislations. For example, at European level, legislation on eco-design and environmental products policies (e.g. MEErP⁴, PEF⁵) are based on LCA concepts. This is also the case for the Environmental Products Declarations (EPDs) commonly used in the building sector.

Aluminium offers numerous 'intrinsic properties' (e.g. lightness, strength, recyclability) that match the growing demand for more sustainable products in several applications such as transport, building and packaging. Through its use and promotion of life-cycle thinking for more than 20 years, European Aluminium supports customers in assessing the environmental impact of products using aluminium. This has highlighted the clear need for robust and reliable data to make these assessments.

3 Life-cycle assessment (LCA) is a technique to assess the environmental aspects and potential impacts associated with all the stages of a product's, process or services life.

4 Methodology for the Eco-design of Energy related Products (MEErP)

5 Product Environmental Footprint (PEF)

Scope of the report

This report aims to:

- o Update the **environmental data** (e.g. energy consumption) on the various processes of aluminium production in Europe.
- o Provide accurate and reliable generic industry **Life-Cycle Inventory (LCI) datasets** for the key process steps essential for calculating the environmental impact of products using aluminium.

These new datasets, based on 2015 production data, update the 2010 versions. The report is aimed at LCA practitioners, researchers and environmental managers working in, and interested in, the aluminium value chain, particularly those experts that are part of 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).

This report **provides seven environmental datasets** covering the **entire aluminium value chain production** in Europe:

1. Primary aluminium produced in Europe (cradle to gate ⁶): this dataset includes the environmental impact of producing a primary aluminium ingot in Europe ready for delivery to the user as well as the impact of sourcing the raw materials from the smelters (i.e. alumina and bauxite mining). The data uses 2015 figures.
2. Primary aluminium consumed in Europe (cradle to gate): this dataset includes the environmental impact of the consumption (i.e. production and net imports) of a primary aluminium ingot in Europe ready for delivery to the user. It also captures the impact of sourcing the raw materials from the smelters (i.e. alumina and bauxite mining). The data uses 2015 figures.
3. Rolling mill process in Europe (gate to gate): this dataset includes the environmental impact of the aluminium rolling mill process, from ingot (i.e. slab) to aluminium sheet (i.e. flat-rolled products) ready for delivery to the user. The data uses 2015 figures.
4. Foil process in Europe (gate to gate): this dataset includes the environmental impact of the aluminium foil process in Europe, i.e. from the strip-casting process and from the cold-rolling process to the aluminium foil ready for delivery to the user. The data uses 2014 figures. These datasets are prepared in collaboration with the European Aluminium Foil Association (EAFA).
5. Extrusion process in Europe (gate to gate): this dataset includes the environmental impact of the aluminium extrusion process, from the ingot (i.e. billet) to the aluminium profile ready for delivery to the user. The data uses 2015 figures.
6. Remelting process in Europe (gate to gate): this dataset includes the environmental impact of the aluminium remelting process, from pre-or post-consumer scrap to the wrought alloy ingot ready for delivery to the user. The data uses 2015 figures.
7. Refining process (gate to gate): this dataset includes the environmental impact of the aluminium refining process from pre-or post-consumer scrap to casting alloy ingot ready for delivery to the user. The data uses 2010 figures. An update to these datasets is under

6 Mining to primary ingot casting

development, as they require deeper analysis as explained below. These new data will be published separately at a later date.

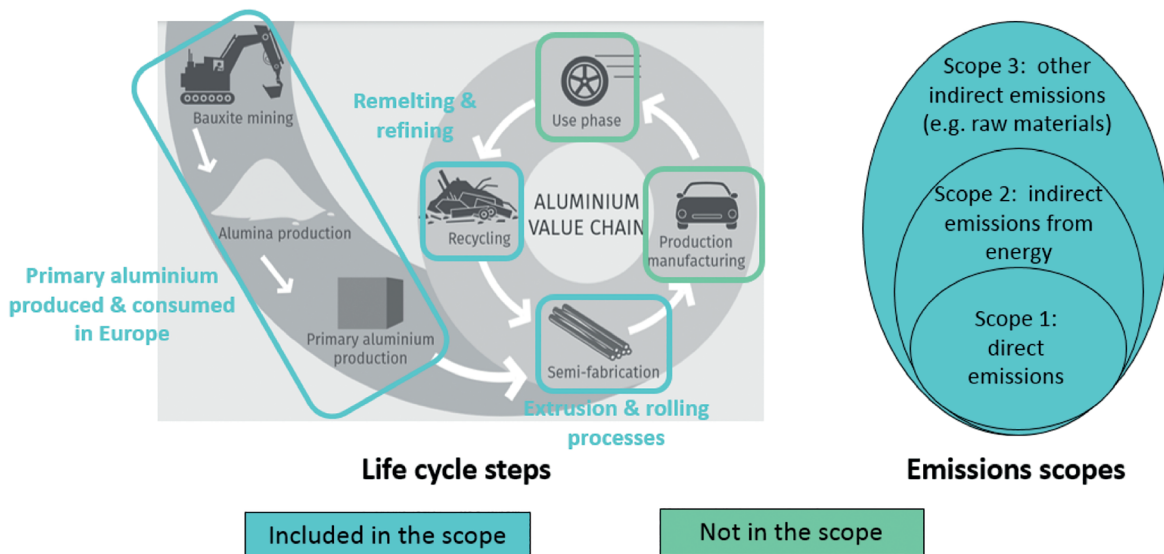
Production manufacturing of final products (e.g. motor vehicles, aluminium cans, etc.) and the use phase of the products are not included in this assessment, as these datasets are more specific to aluminium customers. However, these shall be included when assessing the full life-cycle assessment of final products containing aluminium, as emphasised below.

- o Emissions reporting scope

These seven LCI data include the **direct emissions** relating 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.

- o Geographical scope

The geographical area covered by European Aluminium’s dataset is composed of the 28 EU Member States and the EFTA countries (Norway, Switzerland and Iceland) unless otherwise stated (e.g. Turkey for rolling).



Methodology

This report, and the associated LCI data have been **developed in full compliance with the two relevant ISO standards ISO 14040 and 14044** [8-9]. The 2015 environmental data have been collected and developed by the aluminium industry based on inputs provided by its members.

The completeness of the data is considered excellent for most segments and representative of the aluminium industry.

For example, for the electrolysis step, which contributes significantly to the environmental impact of the value chain, the industry data collected covers around 85 per cent of European production.

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). For primary aluminium industry, which is electricity intensive, **a specific model has been developed reflecting real energy sourcing of the primary aluminium produced and used in Europe.**

Finally, this **report has been reviewed** by two renowned LCA experts, Prof. Matthias Finkbeiner (Technische Universität Berlin, Chair of Sustainable Engineering, Managing Director of the Department of Environmental Technology) and Prof. Dr. Walter Klöpffer (Editor-in-chief, International Journal of Life-Cycle Assessment). Reviewers acted as independent experts and not as representatives of their organisations.

How to use these aluminium LCI datasets

The aluminium industry develops environmental datasets for various aluminium process steps (primary, recycling, rolling, foil and extrusion). To determine the life-cycle profile of the respective products, these datasets need to be combined in a modular way. For example, the LCI of an aluminium sheet made from primary aluminium needs to combine the cradle to gate LCI of the primary step (production or consumption) and the gate to gate LCI of the rolling mill process.

However, when assessing the full environmental impact assessment of aluminium products, **one must also consider the full life cycle of the product, by including, for example, the benefits or burdens the product provides during its use phase and at its end of life (e.g. recycling).** In addition, the European aluminium industry recommends crediting the environmental benefits from recycling using the so-called **'substitution' methodology**. This approach is explained in detail in the technical paper 'aluminium recycling in LCA', which can be downloaded from our [website](#).

These steps are essential to be able to fully reflect the intrinsic properties of aluminium products (e.g. lightweighting, 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.**

INDUSTRY OVERVIEW

ANNUAL TURNOVER

~39.5 Billion €

1 million direct and indirect jobs

TONNES RECYCLED

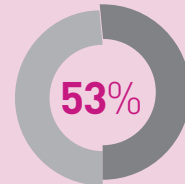
4.9 million in 2017

~600 plants in 30 European countries (EU28 + EFTA and Turkey)

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



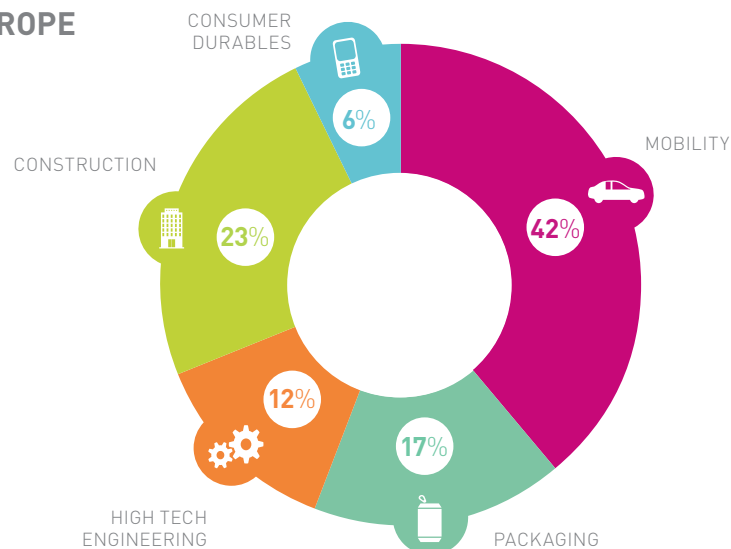
of the world's annual primary aluminium production is made in Europe

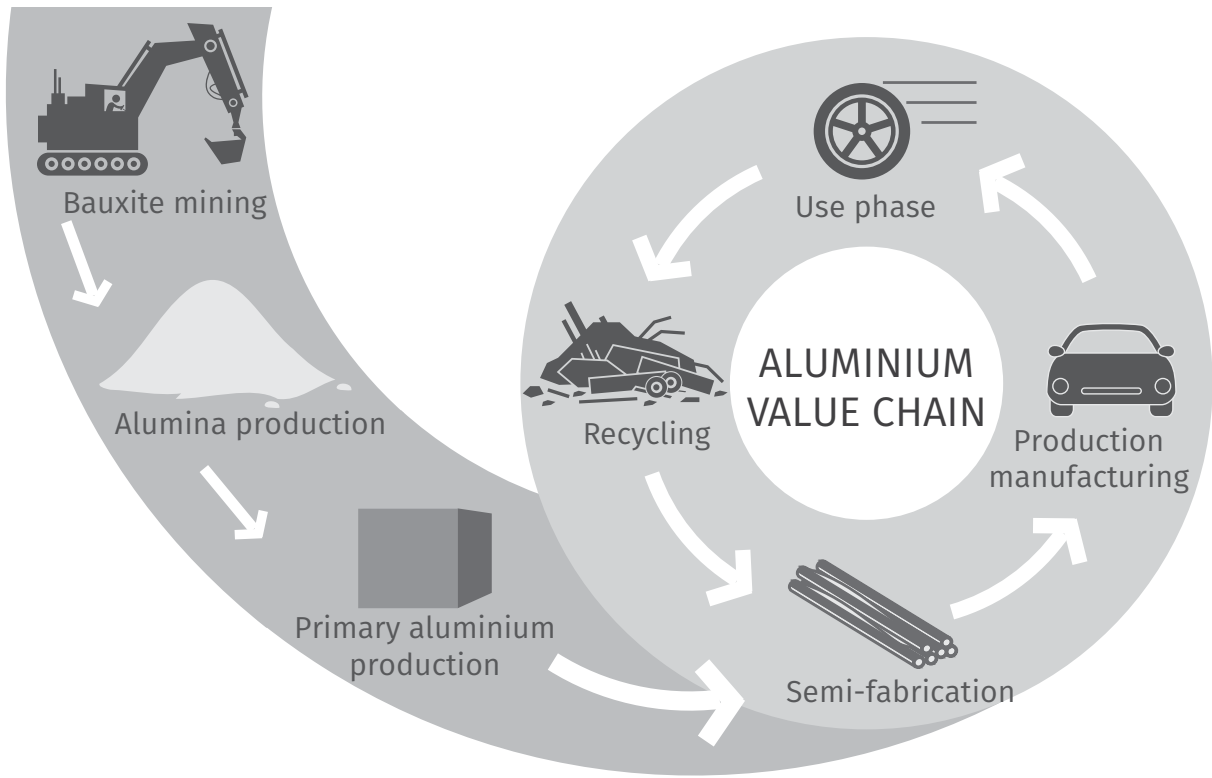


of the European aluminium industry's output comes from recycled sources

source: European Aluminium 2017 (estimates)

MAIN END-USES FOR ALUMINIUM PRODUCTS IN EUROPE IN 2017





8g



the reduction in CO₂ 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.

73%



the recycling rate for used aluminium beverage cans in Europe in 2014

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 80+ 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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