Life Cycle Assessment of Greenhouse Gas Emissions Report

of Aluminium Profiles of Sanlev Callibre Hellas S.A.

In accordance with ISO 14040 and 14044

ATHENS

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1. Introduction

This specific LCA Report has been developed by **Sanlev S.A.** aiming at the life cycle assessment (LCA) for greenhouse gas emissions (GHG) of aluminium profiles of Sanlev S.A., manufactured in their production site located in Aspropyrgos, Attiki, Greece.

The Life Cycle Assessment methodology (LCA) is used to determine which impacts a product or a service has on the environment. LCA provides the framework for assessing the potential environmental impacts of products. However, an LCA is a study of the environmental impacts from the processes inside the system boundaries, defined in the goal and scope of the study. Therefore, it must be mentioned that not all the environmental impacts, from a product or service, can be taken into account.

The framework for LCA includes:

- Definition of goal and scope. The system boundaries must be clearly stated, since they have a direct impact on the result of the study.
- Life Cycle Inventory Analysis: At this stage, the data regarding all processes inside the system boundaries are gathered and the inputs and outputs of the product system are presented.
- Life Cycle Impact Assessment: The data from the inventory analysis is further processed in the impact assessment stage, where pollutant emissions are sorted into different categories depending on what environmental impact they contribute to. These categories include global warming, acidification and eutrophication, etc. Through the impact assessment the total environmental impact of the studied system can be evaluated.
- Life Cycle Interpretation - Sensitivity Analysis: The results will be interpreted by investigating how the variation in the output of a numerical model can be attributed to variations of its input factors.

The above-mentioned information is presented in the following chapters.

The report was developed according to the requirements of ISO 14040, ISO 14044 and ISO 14067.

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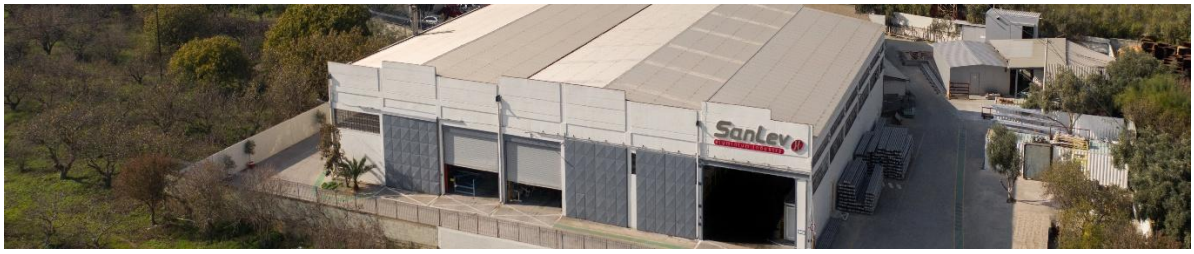
Practitioner	**Terra Neutral PC** Kaisareias 39, 11527, Athens +30 210 7472814 email: information@terraneutral.gr
Standards	ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification ISO 14040:2006 Environmental management — Life cycle assessment — Principles and framework ISO 14044:2006 Environmental management — Life cycle assessment — Requirements and guidelines

1.1 Company information

Sanlev S.A. has been designing and producing specialized extruded aluminium profiles since 1971. The privately owned facilities of Sanlev S.A. are located in the industrial zone at Aspropyrgos, Attiki, Greece.

The company is active in Greece as well as in other European countries. With the assistance of an experienced design department Sanlev S.A. provides services for tailor-made aluminium profiles. Special investment has also been targeted on equipment for different kinds of fabrication such as microperforation, punching types, cutting at different angles & lengths, bending of profiles etc. The powder coating plant, uses the latest available technology and has a full range of glossy, mat, special shades and a variety of colors ensuring a superior quality product.

Sanlev S.A. has developed and implemented an Integrated Quality Management System, Production Control, Environment and Occupational Health and Safety according to standards ISO 9001:2015, ISO 14001: 2015, ISO 45001: 2018 respectively, following national, European and international legal and regulatory requirements, as well as all other compliance requirements governing its operation, with full respect for man, society and the environment. Also, owns the quality sign of the latest SEASIDE CLASS of Qualicoat, which is the highest quality mark for the protection of powder coated profiles in seaside environments.



2. Goal and Scope of the study

Goal

The main goal of this Life Cycle Assessment (LCA) is to calculate the potential contribution of **extruded and powder coated aluminium profiles** manufactured by **Sanlev S.A**. to global warming, expressed as CO_2 equivalent. This LCA was performed aiming at the development of the carbon footprint of specific products. The intended use of this report aims to inform construction companies, fabricators, architectural industry, and designers.

Life Cycle Analysis preparation follows the ISO 14044:2006 "Environmental management – Life cycle assessment – Requirements and guidelines" and ISO 14040:2006 "Environmental management – Life cycle assessment – Principles and framework" standards. LCA Study was performed also based on the requirements of the following standards: ISO 14067:2018 "Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification".

Scope of the study

The scope of the product system under investigation includes all the steps involved in the production of **extruded and powder coated aluminium profiles.** The LCA was carried out under a cradle-to-gate.

Aluminium profiles comply with the general requirements of EN 15088:2005 "Aluminium and aluminium alloys - Structural products for construction works - Technical conditions for inspection and delivery" and the painting method is certified with a quality sign of the latest Qualicoat which is the highest quality mark for the protection of powder coated profiles in seaside environments.

For more information about aluminium profiles please visit https://www.sanlev.gr/modular.html where all specifications of the products are available.

2.1 LCA information

Declared unit	The declared unit is 1 kg of aluminium profile
Time representativeness	All primary data used in this study is for the reporting year 2024
Databases used	The database used was EN15804 add-on to ecoinvent v3.9.1. The impact assessment method used was EN15804+A2 (EF 3.1 method)
Geographical Scope	Worldwide
System boundaries	The approach followed is "Cradle to gate". The following life cycle stages were considered: • Raw material production, • Transportation of raw materials to the industrial unit, • Manufacturing process of the product.
Cut-off rules and exceptions	All inputs and outputs were included in the calculation of the carbon footprint of the products. Specifically, wooden pallets are either reused or sent for fixing before reused again, therefore it was not added in the calculations of the emissions. The materials that were <1% for the total mass and that were excluded were specific packaging material, fuel for forklifts and minor materials. The following activities and processes have been exempted from the LCA report: the manufacturing processes of the capital goods or spare parts, infrastructures for general management, office and headquarters operations as well as people activities (common activities, travel to work etc.), maintenance and wastes regarding machinery and office buildings, transport of finished products to installation, application of product, use stage, end of life stage.
Data Quality	All the data used to model the manufacturing process for the specific products is specific data, and there are no data gaps. Data for raw material supply and transport to the manufacturing plant and production are based on specific consumption data for the specific production process taking place at the production site in Aspropyrgos for the reference year 2024. Generic datasets were used for the upstream processes (production of raw material and transportation). For this reason, the European life cycle inventory database EN 15804 add-on for ecoinvent 3.9.1 has been used, as this database contains the most extensive and updated information and its scope coincides with the geographical, technological and temporal area of the project. All the datasets used for calculations cover the area of Europe for the materials produced in Europe or globally. Technological coverage is specific or average. The LCA was modelled with OpenLCA 2.1.0.
Assumptions	The following assumptions have been made:

	• It does not include the manufacturing processes of capital goods or spare parts. • It does not include equipment maintenance. • The environmental impact of infrastructure for general management, office and headquarters operations is not included. • The impact caused by people (wastes, common activities, travel for work) was not considered. • The environmental impact of raw material transport has been calculated using lorries, 16 – 32 metric tons, EURO 5. These lorries have been selected to reflect the most realistic scenario possible. • Yavuz Metals has not issued a certificate regarding the recycled content of its aluminium billets. Therefore, it was assumed that the recycled content is the same as Alfa Metals, as both suppliers operate in the same country and are expected to follow similar production practices. • In assessing the impact of using European versus Turkish aluminium billets, it is assumed that, in each scenario, all billets are supplied exclusively from the respective country. • The scenarios included are currently in use and are representative for one of the most probable alternatives.
Allocations	Taking into account that all the products are produced implementing the same production procedure, there is no need for allocation in different production subsystems (sub - processes). There are no co-products produced during the production process of each product. Regarding the input of raw materials as well as packaging materials, it was based on the total materials that were bought. The material losses from manufacturing were lower than 1%. Electricity, LPG, water, coating powder, chemicals, lubricants and packaging were calculated based on the division of total consumptions, indicated in invoices, by the mass of final products. Also, waste has been divided by the total quantity of products. Therefore, no allocation method was used (economic or physical) for raw materials. Economic allocation was not used in any case.

3. Life Cycle Inventory Analysis (LCI)

3.1 Product information

Aluminium profiles are manufactured in plenty of shapes, sizes, textures, and colors depending on the use focusing on the quality of the final product, the flawless powder coated surface of the profiles, strong adhesion and durability.

Some of the uses are for architectural profiles, special profiles, standard profiles, roller shutters, ladders, solar panels, ventilation, furniture, automotive, marine applications, solar collectors, lighting, blinds, bicycles and more.

The following products were assessed for their Greenhouse Gas Emissions (GHG):

1. **Extruded Aluminium Profiles**
2. **Powder Coated Aluminium Profiles**

UN CPC code: 41532 Bars, rods, and profiles of aluminium
HS code 7604 Bars, rods and profiles, of aluminium, n.e.s.
For more information about aluminium profiles, please visit https://www.sanlev.gr/modular.html where all specifications of the products are available.

Content information

The main components of the products are presented in Table 3.1.

Table 3.1. Content of aluminium profiles covered by this report

Components	Extruded Aluminium Profile	Powder Coated Aluminium Profile
Aluminium billets	**100%**	**>94%**
Al	**>98%**	**>98%**
Mg	**<0.6%**	**<0.6%**
Si	**<0.8%**	**<0.8%**
Fe	**<0.3%**	**<0.3%**
Others	**<0.2%**	**<0.2%**
Powder Coating	**-**	**<6%**

Aluminium billets consist of a minimum of 25% and a maximum of 90.5% recycled aluminium, depending on the supplier, as presented in Table 3.2. All packaging used is recyclable. The products are 100%

recyclable. Aluminium billets that are supplied outside Europe are transported to the manufacturing site by truck and ship, and those supplied inside Europe are transported by truck. The other raw materials are transported by trucks. The final products are wrapped with stretch film and crepe paper and sent to the clients by trucks.

Table 3.2 Content of primary and recycled aluminium billets in percentage per supplier

	Primary ingot aluminium (%)	Pre-consumer aluminium scrap (%)	Post-consumer aluminium scrap (%)
EPALME	9.5	56.6	33.9
ALFA METALS	75	25	0
YAVUZ	75	25	0

3.2 Description of the manufacturing process

The manufacturing process starts with the aluminium billets heated and then pushed by a hydraulic cylinder through a die with the required cross-section. The aluminium profile extruded is then cool down, stretched and cut to the desired length. This is followed by aging with heat treatment in order to improve the mechanical properties of the products. The products continue either for packaging and storage or for coating. The extruded aluminum profiles to be painted by powder coating are cleaned with soap and chemical baths in order to passivate the surface and then powder coated electrostatically.

Final products are packaged with stretch film and crepe paper. The manufacturing process is shown in the next diagram (Figure 1).

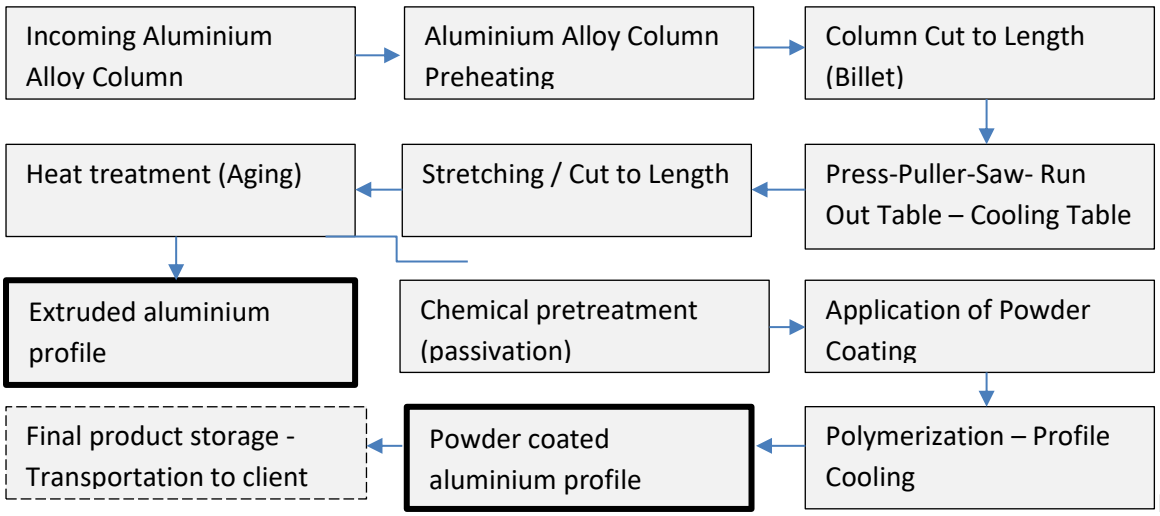


Figure 1: Manufacturing process of the products.

3.3 Specific data sources, allocation and dataset sources

The development of the LCI in the LCA Software tool was based on entering input and output data for each unit process. A unit process according to ISO 14040 is the smallest element in the life cycle inventory analysis for which input, and output data are quantified. Also, a unit process represents a part of the life cycle analysis.

- **Production of raw materials**

Each material has been combined with a dataset containing LCI-data, selected from the database EN 15804 add-on for ecoinvent 3.9.1. In the production of raw materials included data sets for aluminium billets, lubricants for the hydraulic press, chemicals for pretreatment (coated powder product), powder coat (coated powder product) and water indicated in invoices for the reference year. All data sets were from representative geographical areas. For aluminium billets, emission factors from specific data were used, such as the CO_2 eq emissions from suppliers' declarations.

- **Production of packaging material**

Specific data for the reference year were used for packaging material based on quantity of plastic packaging and crepe paper for packaging indicated in invoices. All packaging materials are recyclable.

The production of polyethylene packaging film polyethylene and kraft paper production has been combined with a dataset containing LCI-data, selected from the database EN 15804 add-on for ecoinvent 3.9.1.

- **Energy Production**

Specific data for the reference year was used for electricity. Data was taken from invoices for the reference year. Sanlev S.A. has installed photovoltaic system to reduce the electricity consumption from the grid.

Electricity has been combined with a dataset containing LCI-data, selected from the database EN 15804 add-on for ecoinvent 3.9.1. for Greece. A data set was modified according to Greece's energy residual mix 2023, provided by DAPEEP.

- **Transportation of raw materials from other industrial units to the industrial unit in Aspropyrgos**

The transportation of raw materials is performed by land and sea transport. Raw materials are coming from Greece and Turkey. The dataset used for Land Transport represents the service of 1tkm freight transport in a lorry of the size class 16-32 metric tons gross vehicle weight (GVW) and EURO 5 emissions class.

The dataset used for Sea Transport represents the transport of one ton of freight by a container ship over one kilometer. The DWT (load capacity) of the container ship is 43,000 tonnes, and it is estimated to transport an average of 7,200 million tonne.km per year for 25 years (the average DWT and annual kilometers are weighted averages over the size class from data in IMO (2015)). The dataset represents the entire transport life cycle including the production and maintenance of the container ship, the transportation of freight, and the construction of the port.

The material production is modeled using datasets from the database EN 15804 add-on for ecoinvent 3.9.1. and specific data from the transportation distances of raw materials from other units.

- **Production of final products in the industrial unit in Aspropyrgos and waste management**

Specific data for the reference year was used for waste taken from the Waste Registry for the reference year. Also, specific data used for LPG used for heating in the production of the products included in this product unit.

The data used as Input in the unit process includes all the components to produce the product expressed as kg/kg of product. The components (raw materials) for each product are calculated based on the materials used for the manufacture (material composition for each product).

3.4 Impact Assessment methodologies and characterization factors

The scope of this project as mentioned above, is to calculate the climate change impact of aluminum profiles of Sanlev S.A., expressed in CO_2 eq emissions. For this purpose, the impact indicators according to ISO 14067 that are declared in this report are:

- Global warming potential - biogenic (GWPB)
- Global warming potential - fossil (GWPF)
- Global warming potential - land use (GWPL)
- Global warming potential - total (GWPT)
- Global warming potential - (GWP - GHG)

The indicator Global warming potential - total (GWPT) includes all the other indicators (biogenic, fossil, land use). The GWP – GHG indicator includes only the emissions of fossil-based greenhouse gases and excludes biogenic or land-use related emissions.

The impact assessment method used was EN 15804 (Version: EF 3.1, February 2023). According to Open LCA database EN 15804 add-on for ecoinvent 3.9.1 characterization factors aligned with Environmental impact characterization factors are implemented by the ecoinvent Association, based on the original EN15804 impact method version 3.1 from the European Commission. The characterization factors are presented in the following table.

Name	Description	Reference unit
Global warming potential (biogenic) | GWPB	Method EF3.1 EN15804. Indicator: global warming potential (GWP100)	kg CO_2 eq
Global warming potential (fossil) | GWPF	Method EF3.1 EN15804. Indicator: global warming potential (GWP100).	kg CO_2 eq
Global warming potential (land use) | GWPL	Method EF3.1 EN15804. Indicator: global warming potential (GWP100).	kg CO_2 eq
Global warming potential (total) | GWPT	Method EF3.1 EN15804. Indicator: global warming potential (GWP100).	kg CO_2 eq
Global warming potential | GWP – GHG	Method EF3.1 EN15804. Indicator: global warming potential (GWP100).	kg CO_2 eq

This report does not include avoided emissions, mitigation actions or any social or economic aspects or other related impacts arising from the life cycle of a product. Also, it should be mentioned that there are no emissions during the use of the products.

4. Emissions of Greenhouse Gases

The GHG emissions regarding the production of aluminium profiles are presented in the following Table 4.1. The GHG emissions from the production of aluminium billets are presented in Table 4.3.

4.1 Carbon footprint of aluminium profiles

In the table 4.1 is presented the carbon footprint of the two products, the Extuded Aluminium Profiles and the Powder Coated Aluminium Profiles.

Table 4.1 Results of GHG emissions per product (kg CO_2eq/ kg of aluminium profile)

	Extruded Aluminium Profile	Powder Coated Aluminium Profile
GWPT – Total (kg CO_2eq/ kg aluminium profile)	**7.44**	**7.72**
GWP – GHG (kg CO_2eq/ kg aluminium profile)	7.46	7.74
GWPB – Biogenic (kg CO_2eq/kg aluminium profile)	-0.02	-0.02

The following table 4.2 presents the carbon footprint from products by country of origin, specifically Greece and Turkey. These results are based on calculations that take into account the quantity of billets supplied by each supplier. Emissions from EPALME's billets were calculated using the emission factor provided in EPALME's 2024 carbon footprint report.

Table 4.2 Results of CO_2 eq emissions of aluminium profiles per supplier (kg CO_2eq/ kg of aluminium profile)

	EPALME S.A. (Greece)		Alfa Metals & Yavuz (Turkey)	
	Extruded Aluminium Profile	Powder Coated Aluminium Profile	Extruded Aluminium Profile	Powder Coated Aluminium Profile
GWPT – Total (kg CO_{2eq}/ kg aluminium profile)	**3.35**	**3.82**	**18.76**	**18.46**
GWP – GHG (kg CO_2eq/ kg aluminium profile)	3.45	3.92	18.82	18.52
GWPB – Biogenic (kg CO_2eq/kg aluminium profile)	-0.01	-0.01	-0.06	-0.06

As shown in table 4.2, there is a significant difference in the production of aluminium profiles when using billets from Greece compared to billets from Turkey. This difference is due to the variation in the recycled content of the billets from each country, as presented in Table 3.2. The use of primary aluminium ingots in the billets contributes significantly to the overall emissions.

4.2 Carbon footprint of aluminium billets

The following Table 4.3 presents the emission factors associated with aluminium billet production from suppliers in Greece and Turkey, which Sanlev has been supplied. The total emissions per kilogram of aluminium billet production have been calculated based on the proportion of post-consumer scrap, pre-consumer scrap, and primary aluminium ingot used by each supplier (Table 3.2). For Greece, the emissions from EPALME's billets are calculated using the emission factor reported in EPALME's 2024 carbon footprint report (marked as *), while the emissions for Turkish suppliers reflect a higher reliance on primary aluminium, resulting in significantly higher total GHG emissions per kilogram of billet.

Table 4.3 Emission factors of aluminium billets production per supplier's country

	Greece	Turkey
Total kg $CO_{2\ eq}$/kg aluminium billet	**1***	**16.4**
Post-consumer aluminium scrap (kg $CO_{2\ eq}$/ kg aluminium billet)	0.30	0.32
Pre-consumer aluminium scrap (kg $CO_{2\ eq}$/ kg aluminium billet)	0.54	0.56
Primary ingot aluminium (kg $CO_{2\ eq}$/ kg aluminium billet)	7.21	21.69

** Specific CO_2 emissions from EPALME's carbon footprint report for 2023.*

Table 4.4 below shows the percentage distribution of billet supplies by each supplier during 2024.

Table 4.4 Aluminium billets supply from each supplier

Supplier	Supply percentage during 2024
EPALME S.A.	80%
Alfa Metal	19%
Yavuz Aluminium	1%

Based on the emission factors of recycled and primary aluminium as well as the supplied billets from different suppliers, the CO_2 equivalent emissions per kg of aluminium billets have been calculated **4.1 kg CO_2 eq/kg.**

4.3 Interpretation

The greenhouse gas (GHG) emissions associated with the production of aluminium profiles and their raw material inputs (billets) have been carefully quantified for the needs of the company. The main results are:

- The total carbon footprint values (GWPT) are 7.44 kg CO_2eq/kg for extruded profiles and 7.72 kg CO_2eq/kg for powder-coated profiles.
- Aluminium profiles produced from billets supplied by Turkish companies exhibit significantly higher emissions - around 18.5-18.8 kg CO_2eq/kg - compared to those from Greece, which are in the range of 3.35–3.82 kg CO_2eq/kg. This difference is primarily attributed to the sourcing and production practices of the billets.
- The sourcing and production practices are reflected in Table 4.3 by the emission factors for aluminium billet production by country. Billets from Greece have a much lower carbon footprint (1 kg CO2eq/kg billet) compared to Turkish billets (16.4 kg CO_2eq/kg billet). This stark contrast stems from the higher use of recycled aluminium scrap in Greece, versus a higher reliance on primary aluminium ingot in Turkey, which has a substantially higher emission factor (21.69 kg CO_2eq/kg billet) compared to recycled scrap (0.3–0.56 kg CO_2eq/kg billet).
- By weighting the emission factors of each supplier's billet production according to the supply shares, the overall emission factor for aluminium billets used in 2024 is calculated at approximately 4.1 kg CO_2eq per kilogram of billet.

The analysis highlights that the choice of billet supplier and their production methods significantly influence the overall carbon footprint of aluminium profiles. Higher shares of recycled aluminium scrap substantially reduce emissions, as exemplified by the Greek supplier EPALME S.A. This information is critical for targeting supplier strategies and material sourcing decisions aimed at lowering the environmental impact of aluminium products.

4.4 Sensitivity analysis

A Sensitivity Analysis has been performed in order to investigate the parameters that influence the outcomes of the study. Based on the Sensitivity Analysis, a significant parameter that influence GHG emissions is the origin of the raw materials. More specifically the higher influence is by the primary ingot production of billets. This is shown by the table 4.2 as well as in table 4.3. Therefore, if the raw materials used are produced in Europe comparison to the rest of the world, the emissions would be less since the carbon footprint of the raw material and the transportation is lower, as it shown below for aluminium billets that is the main raw material for the aluminium profiles:

- GWP – GHG emission for aluminium billet:
    1. 1.1 kg CO2eq/kg in Europe
    2. 16.4 kg CO2eq/kg billet in Turkey

In order for SALVEL S.A. to reduce its product carbon footprint, it is recommended to prioritize suppliers with a higher share of recycled aluminium content (e.g., EPALME). In addition, the company should request updated and accurate data from all suppliers regarding the recycled content of their aluminium billets to improve transparency and data reliability in future assessments.

Disclaimer: This report represents the Life Cycle Analysis of the greenhouse gas emissions of aluminium profile products of SANLEV S.A. While care has been taken, uncertainties exist due to data limitations, assumptions and system boundaries. The owner has the sole ownership, liability and responsibility for the data. GHG emissions within the same product category but from different programmes may not be comparable.

5. References

1. ISO 14040:2006 Environmental management Life cycle assessment. Principles and framework.
2. ISO 14044:2006 Environmental management. Life cycle assessment. Requirements and guidelines.
3. ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification.+
4. Ecoinvent database v3.9.1, system model: cut-off by classification. www.ecoinvent.org.
5. Residual Energy Mix 2023 from Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP SA).
6. "Certificate of recycled content by Eurocert S.A.", EPALME, 2025.
7. "Statement of Carbon Footprint of Secondary Aluminium Billets produced by EPALME", 2024.
8. ALFA Metals declaration, "Recycled content rates", 2024.