DECARBONISATION ROADMAP FOR BEVERAGE CANS PRODUCTION IN EUROPE

Metal Packaging Europe

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DECARBONISATION ROADMAP FOR METAL PACKAGING EUROPE

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Abbreviations

CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
EA	European Aluminium
EU	European Union
GHG	Greenhouse Gas
GWP	Global Warming Potential
IAI	International Aluminium Institute
IPCC	Intergovernmental Panel on Climate Change
LCA	Life-Cycle Assessment

Glossary

Carbon dioxide equivalent (CO2e)	Unit of measurement that represents the amount of GHG emissions released into the atmosphere in terms of their equivalent warming potential to carbon dioxide (CO_2) over a specified time period, usually 100 years. It is used to compare and aggregate the impact of different GHGs, each with its own global warming potential (GWP), on climate change
Decarbonisation roadmap	Trajectory outlining steps and measures to progressively reduce GHG emissions from a particular sector, industry, or region in order to achieve climate goals and transition to a low-carbon future.
GHG Protocol	Framework for measuring, managing and reporting GHG emissions, established by the World Resources Institute and World Business Council for Sustainable Development.
Life-cycle assessment	The systematic analysis of the environmental impacts of a product, process, or service throughout its entire lifecycle, from raw material extraction to disposal.
Primary aluminium	New aluminium metal produced from raw materials through the electrolytic process, also referred to as the aluminium smelting process.
Scope 1, 2 and 3 emissions	Common classification of GHG emissions established by the GHG Protocol. Scope 1 includes direct emissions from a company's own activities, mainly on-site fuel combustion and other process-related emissions. Scope 2 covers indirect emissions from purchased electricity or heat. Scope 3 encompasses all other indirect emissions, including for example, emissions from material extraction and production in the value chain, employee commuting, and the transport of products.
Secondary aluminium	Recycled aluminium derived from pre- or post-consumer scrap, which is reprocessed to create new aluminium products. In this report, secondary and recycled aluminium are used interchangeably

EXECUTIVE SUMMARY

This report outlines a roadmap for the European aluminium beverage can industry to achieve net-zero greenhouse gas (GHG) emissions by 2050, aligning with EU climate targets and enhancing strategic resilience by reducing reliance on energy imports. Firstly, this report analyses the industry's current carbon footprint and identifies key decarbonization levers across the value chain, namely (i) focusing on aluminium sourcing, (ii) manufacturing, (iii) transport, and (iv) recycling. Based on these four levers, the report provides a roadmap to implement a set of actions towards decarbonisation and concludes by providing a set of policy recommendations to accelerate the decarbonisation potential of the aluminium can industry.

Aluminium beverage cans require a relatively low energy input for their production and benefit from a high recycling rate. In comparison to other beverage packaging materials, such as glass or PET, aluminium provides the same functions and may generate only a fourth of the CO_2 emissions. These characteristics make aluminium cans one of the beverage packaging formats with the greatest potential to decarbonise the drinks packaging sector and to contribute to a climate-neutral economy.

This report recommends deploying new production technologies that use non-fossil energy, purchasing renewable electricity, and developing advanced techniques to manufacture cans as efficiently as possible though innovative lightweight design. However, the highest potential lies in the adoption of more circular practices, maximising the use of recycled aluminium and developing standardised alloys to further facilitate the recycling of aluminium cans.

This report concludes with a set of policy recommendations to support the decarbonisation efforts of the European aluminium beverage can industry. These recommendations focus on strengthening the collection and recycling of post-consumer scrap through the comprehensive implementation of mandatory Deposit Return Systems (DRS) within EU Member States, supporting measures to increase the availability of affordable and reliable renewable electricity, including necessary grid developments, and boosting innovation to speed up the development of low-carbon technologies across the aluminium beverage can value chain.

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1. INTRODUCTION

1.1 Climate context and policy background

There is a pressing **need for global decarbonisation** to mitigate the effects of **climate change** and reduce **fuel dependence**. According to the Intergovernmental Panel on Climate Change (IPCC) report (2023, p.12), reducing the greenhouse gas (GHG) emissions rapidly and sustainably towards net-zero would lead to a discernible slowdown in global warming within around two decades[1]. To mitigate climate change requires decisive and rapid actions from all actors in society, including the industrial sector, to decarbonise its operations. Among the industrial sectors, the global aluminium industry is responsible for about 2% of global anthropogenic emissions, generating more than 1.1 $GtCO_2$ e of emissions annually[2]. Additionally, the EU's external dependence on energy imports, especially on fossil fuels, represents a source of vulnerability in front of international crises, a vulnerability that especially affects energy-intensive activities such as aluminium production[3].

Such needs are also reflected within the **EU policy objectives and legislation**. Namely the European Union has defined a specific timeline to become climate-neutral by 2050[4]. This timeline firstly sets the objective to reduce net greenhouse gas emissions by at least 55% by 2030 (compared to 1990 levels)[5], and to reduce emissions by 90% in 2040[6] through a set of climate, energy, transport and taxation policies. Additionally, the European Commission published its REPowerEU plan[7], to drastically reduce the EU energy dependence on fossil fuels and to accelerate the European Green Deal[8]. Finally, other policies such as the Clean Industrial Deal[9], and the Action Plan for Affordable Energy[10] aim to specifically support the decarbonisation of energy-intensive industries by accelerating the production of renewable energy, and to ensure an affordable access to renewable energy by these industries, while the CBAM (Carbon Border Adjustment Mechanism) and ETS (Emissions Trading System) aim to create a carbon market to further incentivise the EU decarbonisation.

Such **policies will impact the European industry** in general, and the aluminium beverage packaging in particular, as they will require the rapid decarbonisation of the industrial processes associated with the manufacturing of aluminium beverage cans. This context, shaped by climate change and fuel dependence, requires the European beverage can industry to reduce its consumption of fossil fuels through solutions that foster energy efficiency and substitute fossil fuels for renewable sources of energy across its value chain. In this regard, the global aluminium industry

[1] IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001

[2] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

[3] European Economic and Social Committee. & CEPS. (2023). What ways and means for a real strategic autonomy of the EU in the economic field? Publications Office. https://data.europa.eu/doi/10.2864/552201

[4] European Commission. Energy, Climate and Environment (2024). 2050 long-term strategy. https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en

[5] European Commission. Energy, Climate and Environment (2024). 2030 climate targets. https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-targets_en

[6] European Commission. Energy, Climate and Environment (2024). 2040 climate target. Reducing net emissions by 90% by 2040. https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2040-climate-target_en

[7] COM/2022/108 final

[8] European Commission (2022). In focus: Reducing the EU's dependence on imported fossil fuels. https://commission.europa.eu/news/focus-reducing-eus-dependence-imported-fossil-fuels-2022-04-20_en

[9] Clean Industrial Deal - European Commission

[10] Affordable energy

can be seen as part of the challenge, being responsible for some 2% of global GHG emissions and considered as one of the "hard to abate" industrial sectors. Yet, aluminium's technical properties make it also an essential part of the transition to a circular and low-carbon society.

The aluminium beverage can industry has the potential to be an **essential contributor towards decarbonisation and towards strategic resilience in the beverage sector**. The specific advantages of aluminium include its recyclability, its lower energy needs for its recycling compared to other materials, its low weight, and its strength and durability. Such conditions make aluminium a key material for a more energy and material-efficient packaging sector, and for realising decarbonisation efforts of the EU industry. In this sense, the European aluminium manufacturers are already frontrunners in lowering their carbon footprint. Although aluminium beverage can industry still has to increase its decarbonization efforts[11] to align itself with a 1.5 °C scenario, the aluminium beverage can industry can be considered a frontrunner among all the aluminium product categories and has a strong potential to decarbonise its activities in the coming decade.

1.2 Aim of this report

The aim of this **decarbonisation roadmap** is to support the aluminium beverage can industry to provide a long-term plan to reduce its GHG emissions, hence, contributing to transform the industry in an enabler of Europe's transition to a net-zero and to contribute to improve Europe's resilience by reducing its external energy dependence. For this purpose, this report lays out a pathway towards a **net-zero GHG emissions roadmap for the aluminium beverage can supply chain**, by identifying the most efficient approaches and levers to decarbonise the value chain of aluminium beverage cans in Europe in line with the latest scientific literature and industry knowledge. As a result, this pathway provides guidance for beverage can producers towards decarbonisation in accordance with the decarbonisation pathway for the European aluminium industry[12].

1.3 Overview of this report

The report is organised as follows: First, in section 3, the aluminium beverage can sector is introduced. The different phases that compose the aluminium beverage can value chain are analysed, along with its embedded carbon footprints.

Next, a decarbonisation roadmap is proposed (section 4). This roadmap proposes four different decarbonisation levers based on the different segments of the aluminium beverage can value chain. The report also proposes a set of activities relevant to each of the levers, and their decarbonisation potential. Finally, to build a high-level pathway towards 2050, this report describes the different actions, and compares their decarbonisation potential and commercial availability to establish what actions can be prioritised by the actors across the aluminium beverage can value chain.

Finally, this report concludes with a set of policy recommendations to identify what public action can further enable the decarbonisation of the aluminium beverage can industry (section 5). These policy recommendations are based on the decarbonisation levers outlined in section 4 and identify the responsibilities that are out of reach for the can manufacturing industry or the actions that can accelerate these decarbonisation efforts.

[11] The Eunomia and ZWE report estimates that the carbon overshoot of the aluminium beverage can industry is a 50%, whereas the glass and PET packaging manufacturers overshoot their carbon budget by a +200% and +150% respectively.

[12] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. 23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

2. APPROACH

This report aims to develop a decarbonisation roadmap towards a net-zero European aluminium beverage can industry. This was done in three steps and included workshops with members of Metal Packaging Europe (MPE) as well as expert interviews to gather input data, validate assumptions, and ensure that the findings are in line with industry best practice.

First, GHG emissions throughout the aluminium beverage can value chain were analysed using LCA data from MPE[13]. This analysis identified current emission hotspots in the value chain, highlighting key phases to target when considering decarbonisation efforts. This report reviews the entire value chain of aluminium beverage cans, except the filling, distribution and use phases (see Figure 1). It captures the climate impact from both the can manufacturing process (Scopes 1 and 2 emissions) and from input materials, transportation, and end-of-life treatment of aluminium scrap (Scope 3 emissions).

Box 1. Understanding emission scopes in the GHG Protocol

The GHG Protocol categorises emissions into three scopes to help organisations or entire industries measure and manage their GHG emissions:

- **Scope 1 (direct emissions)**: These are direct emissions from sources that are owned or controlled by the company, such as emissions from on-site fuel combustion, company vehicles, and industrial processes.
- **Scope 2 (indirect emissions from energy)**: These emissions come from the generation of purchased electricity, steam, heating, and cooling consumed by the organisation.
- **Scope 3 (other indirect emissions)**: These include all other indirect emissions in the value chain, both upstream and downstream. *Upstream Scope 3 emissions* cover emissions from purchased goods and services, transportation, waste generated, and other activities required for production, and *downstream Scope 3* emissions include emissions from the distribution and use of products, end-of-life treatment, and other post-sale activities.

Second, current and future decarbonisation measures were identified and mapped to provide an overview of the most relevant emission reduction options across the value chain. The assessment focuses on the decarbonisation potential, considering the existing carbon footprint of the European aluminium beverage can value chain activities (section 3), and the year of commercial availability of each measure, together with a review of existing initiatives and actions already implemented by aluminium can industry actors.

In the third step, a high-level pathway to 2050 was developed, identifying the most promising measures for rapid sectoral decarbonisation and outlining an implementation timeline for the different measures. To facilitate the transition, a set of policy recommendations was also specified, offering guidance for policymakers to provide the aluminium beverage can industry with the essential tools and support needed to achieve net-zero.

While this report focuses on the GHG emissions from the aluminium beverage can value chain, the production of cans involves other environmental impacts, including consumption of water, the management of chemicals associated with coatings and inks, or other land impacts associated with raw material extraction for aluminium production directly, or indirectly for the generation of renewable electricity. Such other environmental impacts are outside of the scope of this report.

[13] Every three to five years, MPE compiles comprehensive and robust industry data, including life-cycle assessments (LCAs) for European aluminium beverage cans.

3. THE EUROPEAN ALUMINIUM BEVERAGE CAN SECTOR

This section reviews the state of the aluminium beverage can industry in Europe, describing the aluminium beverage can value chain – from aluminium production and can manufacturing to end-of-use collection and recycling – and explores the GHG emissions footprint from each stage.

3.1 The European aluminium beverage can industry in figures

Over **87 billion** beverage cans are produced annually in Europe

54 production facilities across Europe, employing **15,000 people**

90% of added value from beverage can placed on European market is generated in Europe

In 2023, the European aluminium beverage can industry reached an impressive production volume of over 87 billion cans[14], a testament to the region's strong demand and robust manufacturing capabilities. This production is distributed across 54 facilities, which together employ more than 15,000 people[15]. These facilities not only contribute significantly to local economies but also ensure that close to all beverage cans on the European market are produced domestically[16], minimizing the need for imports. This regional production capacity illustrates the important role of existing manufacturers in supplying the European market with aluminium beverage cans. Further, a remarkable 90% of the added value of an aluminium beverage can placed on the European market is generated in Europe[17].

3.2 The aluminium beverage can value chain

The production of aluminium beverage cans involves a complex value chain with a broader set of activities, from the extraction of raw materials to production of primary or secondary aluminium, can manufacturing, transportation, and recycling of used cans (see Figure 1).

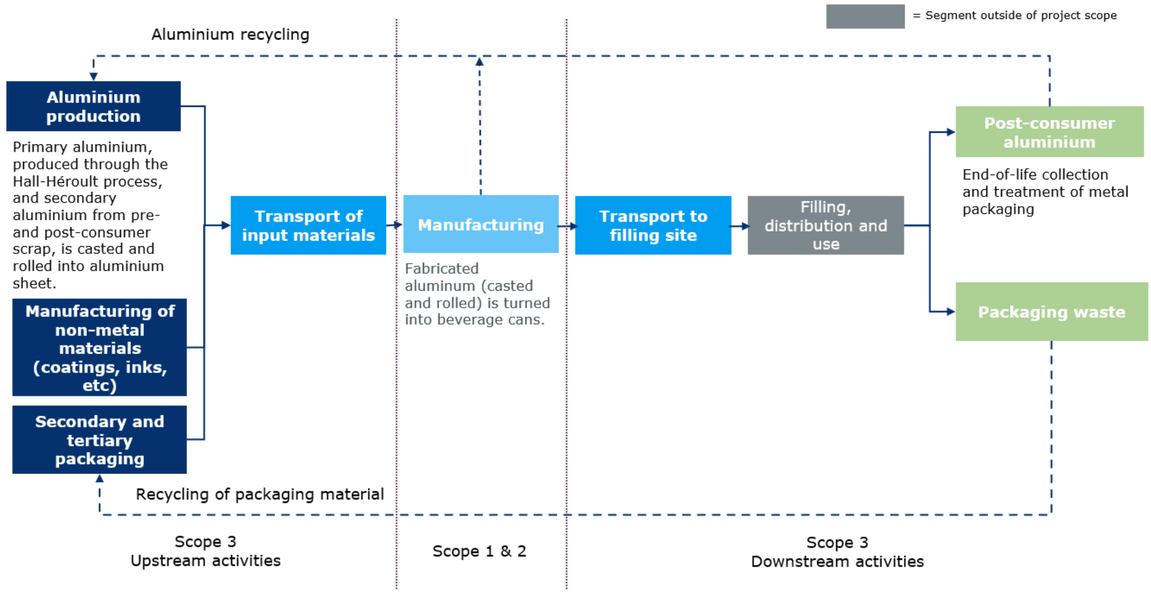
[14] MPE Filling Stats data

[15] MPE data

[16] IAI & Eunomia (2022). Journey of a European Aluminium Beverage Can. https://international-aluminium.org/resource/european-aluminium-can-cycle/

[17] IAI & Eunomia (2022). Journey of a European Aluminium Beverage Can. https://international-aluminium.org/resource/european-aluminium-can-cycle/

Figure 1. The aluminium beverage can value chain



Source: Ramboll

Aluminium production

The first phase in the aluminium beverage can value chain is the production of aluminium, which can be split into primary or secondary aluminium production.

The production of **primary aluminium** implies the extraction of bauxite ore, the bauxite ore is refined (through the so-called Bayer process) to produce alumina (aluminium oxide), and finally, alumina is turned into aluminium through a smelting process (also known as the Hall-Héroult process). The refining process requires washing, crushing and grounding the bauxite into a fine powder that is dissolved with caustic soda at high temperatures (digestion). The resulting product is washed, filtered, and calcinated to remove impurities. Then, the smelting process requires an electrolysis phase where aluminium oxide is subjected to a high electric current on a molten bath of cryolite at 960°C. Liquid aluminium oxide is deposited at the cathode, while oxygen combines with carbon from the carbon anode to form CO_2 and generate purified aluminium. The liquid aluminium is finally refined to remove remaining impurities, and it is cast into ingots that can be repurposed at the rolling mills[18]. This process has a high climate impact, with the highest emissions resulting from the alumina smelting process followed by alumina refining. Other emissions stem from the heating and melting phases to cast aluminium from ingots into coils or sheets that are sold to can manufacturers.

Secondary aluminium is produced by collecting and sorting aluminium scrap, melting and casting the melted metal into new ingots or billets, and finally its rolling into can sheets[19]. These steps require a furnace at temperatures around 660-700°C[18]. Sources of secondary aluminium are either pre-consumer scrap (from manufacturers and rolling mills) or post-consumer scrap (including aluminium beverage cans recovered after use and other compatible scraps). Pre-consumer aluminium scrap usually requires little treatment before being remelted and refined into aluminium

[18] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

[19] European aluminium (2024). Recycling. https://european-aluminium.eu/projets/recycling/

ingots, making it a very efficient process. For post-consumer scrap, the recycling process includes collecting, sorting, and cleaning the aluminium before remelting. Additionally, aluminium recycling requires sorting disposed aluminium, shredding, cleaning, melting, removal of byproducts, creation of alloy and pouring out the final material and forming it into ingots for its use. It is important to consider that during the recycling process, a small proportion of aluminium may be lost during the shredding of bales and as a result of oxidation in the furnace. However, the extent of aluminium loss can vary depending on the specific process employed and the quality or origin of the scrap material. In short, producing secondary aluminium has a far smaller climate footprint compared to primary aluminium production, requiring about 95% less energy and limiting the need for raw materials[20], and it is the most effective action to reduce the GHG footprint of beverage cans.

Can manufacturing

Next is manufacturing of cans, which are produced using aluminium as well as a small amount of ink and coatings. The process of turning aluminium coils into beverage cans involves several steps, including cupping, body-making, trimming, cleaning, inking, drying, coating, neck-forming, quality control and palletising (see Table 1), and making can ends, including their shaping, tab production and riveting (see Table 2). Besides these steps, the seaming process is done after the can filling by the customer.

Table 1: Steps in the beverage can manufacturing process

Step	Description	Tool/machine	Energy required
Cupping	Stamping aluminium blanks or discs into cups.	Cupper	Electricity
Body making	Shaping aluminium sheets into a can-shape.	Bodymaker and coolant filtration system	Electricity
Trimming	Cutting edges of shaped sheets.	Trimmer	Electricity
Can washing and drying	Clean cans to eliminate residues and applying heat to dry cans.	Boiler, can washer and dryer	Electricity and fossil gas
Coating, decoration and oven	Application of inks of beverage brands, a protective varnish, and drying and curing in a pin oven.	Basecoater, decorator and pin oven, embosser and profiler	Electricity and fossil gas
Internal spray and curing	Application of coatings to protect the can from its contents.	Inside spray, internal bake oven	Electricity and fossil gas
Necking flanging	Shaping bottom and the neck of the can to seal it.	Necker and flanger	Electricity
Quality control	Testing the presence of possible leaks in cans.	In-line quality inspection	Electricity

[20] International Aluminium (2023). Call to Accelerate Aluminium Beverage Can Circularity. https://international-aluminium.org/wp-content/uploads/2024/04/Can-Recycling-Call-to-Action.pdf

Step	Description	Tool/machine	Energy required
Palletisation	Packing cans into secondary and tertiary packaging (pallets, layerpads and topframes).	-	Electricity
Other activities	Auxiliary actions (compressor to move cans on the lines with compressed air and other conveying systems), maintenance of working spaces (including heating, ventilation, and air conditioning, illumination), or office-related activities	-	Electricity and fossil gas

Table 2: Steps in manufacturing beverage can ends

Step	Description	Tool/machine	Energy required
Shell forming	Shells with curls are formed by pressing the coil.	Shell press	Electricity
Lining application	Lining compounds are applied inside of the curl to facilitate the seaming process.	Unlined shell line balancer and compound end liners	Electricity
Indexing	Indexing of one side of the lined shells to form the end.	Conversion press	Electricity
Tab production and riveting	Tabs are produced by shaping an aluminium strip and riveted to the end of shells.	Tooling stations	Electricity
In-line quality inspection	Testing the presence of possible leaks in can ends.	In-line inspection	Electricity
Bagging and palletisation	Packing can ends into secondary and tertiary packaging.	Autobagger	Electricity

The processes described above require mechanical pressers and trimmers as well as bake ovens, air compressors, ovens, and washers, which require energy sourced either from electricity or the combustion of fossil gas. The total energy consumption for manufacturing aluminium cans is quite evenly split between electricity and fossil fuel consumption, with electricity accounting for about 55% of the energy used (see Table 3). By demonstrating the specific energy sources and their respective shares, the division between electricity and fossil fuel consumption supports the identification of suitable decarbonization measures.

Table 3: Total energy consumption for each type of aluminium beverage can across its whole life cycle[21]

Can size	Electricity consumption (kWh/1000 cans)	Fossil fuel consumption (kWh/1000 cans)	Total (kWh/1000 cans)	Electricity share
250 ml	15.1	11.1	26.2	58%
330 ml	17.9	13.3	31.2	57%
500 ml	22.6	16.9	39.5	57%

Production of ancillary materials and secondary and tertiary packaging

Besides aluminium, the can manufacturers use non-metal materials in the form of inks and coatings (ancillary materials), and secondary and tertiary packaging.

Inks and coatings are essential in the production of aluminium beverage cans, serving both aesthetic and functional purposes. Inks add colour, branding, and information to the can, making it visually appealing and recognizable. They are produced by blending pigments with resins, solvents, and various additives. Coatings protect the metal, ensuring product safety, durability, and preventing the can from reacting with its contents. The coatings are made by combining predominantly water with resins, hardeners, and solvents to form protective exterior and interior layers.

Secondary and tertiary packaging materials for aluminium beverage cans are used to protect and ship cans efficiently and safely to can fillers. This type of packaging can include reusable plastic or wooden pallets, topframes, straps, layer pads (plastic or cardboard) and occasionally shrink foil. Both secondary and tertiary packaging materials are designed for durability, and they are generally reusable, and these often incorporate recycled materials to reduce environmental impact.

Transport

The transport phases include both the transport of input materials (aluminium coils, ancillary materials) and secondary and tertiary packaging material to the can manufacturing facilities, as well as the transport of manufactured cans to beverage filling facilities. After transport, brand owners fill the cans with beverages and distribute them to retailers.

End of use

Once used, the aluminium beverage cans ideally should be collected and recycled into new aluminium beverage cans, marking a highly circular production process. Aluminium is a permanent material[22], meaning its inherent qualities do not change during use and despite repeated recycling into new products and it can be changed into its initial state. This is the case when materials such as aluminium beverage cans consist of basic components, which are either chemical elements or robust chemical compounds, making repeated use and recycling possible without change of inherent material properties. Hence, the potential of aluminium to be used, collected, and recycled continuously means that deploying a recycling system around aluminium cans can significantly reduce the demand for primary aluminium energy at a ratio of almost 1:1. However, despite the high recyclability of cans, a relatively large share of cans put on the market are currently lost due

[21] Ramboll analysis based on MPE LCA 2022

[22] Carbotech (2014). Permanent materials. [235 01PeM Report Carbotechfinal v3.docx]

to insufficient collection practices. More specifically, the recycling rate for cans is estimated to be around 75%[23]. This indicates that there is a broad potential to improve recycling rates.

3.3 The carbon footprint of aluminium beverage cans

Understanding the carbon footprint of aluminium beverage cans requires analysing the impact of each value chain phase, including input materials, energy consumption in manufacturing facilities, transportation, and end-of-life treatment. In this regard, life-cycle assessments (LCAs) can be used to evaluate and better understand the climate impacts of producing aluminium beverage cans. The GHG emissions of beverage cans differ significantly depending on the can size; the 500 ml can has a 51% higher impact than the 250 ml can (see Table 4). This is a result of the different material needs and transportation emissions associated with each type of beverage can.

Table 4. Climate impacts of European aluminium beverage cans per type of can (GWP100)[24][25]

Type of can	GHG emissions per 1000 cans
250 ml	53 kg CO_2e
330 ml	62 kg CO_2e
500 ml	80 kg CO_2e

Besides information on the total carbon footprint, LCA results are also useful for identifying key emissions hotspots across the aluminium beverage can life cycle (Figure 2). Aluminium production is by far the largest contributor to the climate impact of aluminium beverage cans, representing about 65% of total GHG emissions. It is important to note that this data already accounts for the existing use of secondary aluminium material (end-of-life phase) to produce beverage cans.

The second-highest emitting process of the aluminium can life cycle is manufacturing, accounting for 16% of total emissions, followed by the transport of beverage cans to filling sites (ca. 13%). Together, these three activities represent the lion’s share of value chain climate impacts. By focusing measures on these high-impact areas, the sector can make substantial progress towards cutting its overall GHG emissions footprint.

Although the manufacturing phase currently represents only 16% of the total life cycle GHG emissions, the can makers must collaborate with and influence value chain partners to accelerate decarbonisation of scope 3 emissions, both ‘upstream’ in the form of purchased input materials and ‘downstream’ in the way the cans are transported to filling facilities and treated and recycled at end of use. In this regard, can makers have advanced towards reducing their carbon footprint. Between 2006 and 2016, the carbon footprint of the most common aluminium beverage cans (330 ml) was reduced by 31% on average, and by further 3% between 2018 and 2023 (excluding the aluminium production), confirming the industry’s commitment to reduce carbon emissions and to decouple production growth from its environmental footprint throughout the value chain[26]. This is due to

[23] European Aluminium and Metal Packaging Europe (2024). Aluminium beverage can recycling in 2021 at a new record level of 76%. https://european-aluminium.eu/wp-content/uploads/2024/02/EA-MPE_BevCan-2021-Recycling-Results_Press-Release_23-February-2024final.pdf

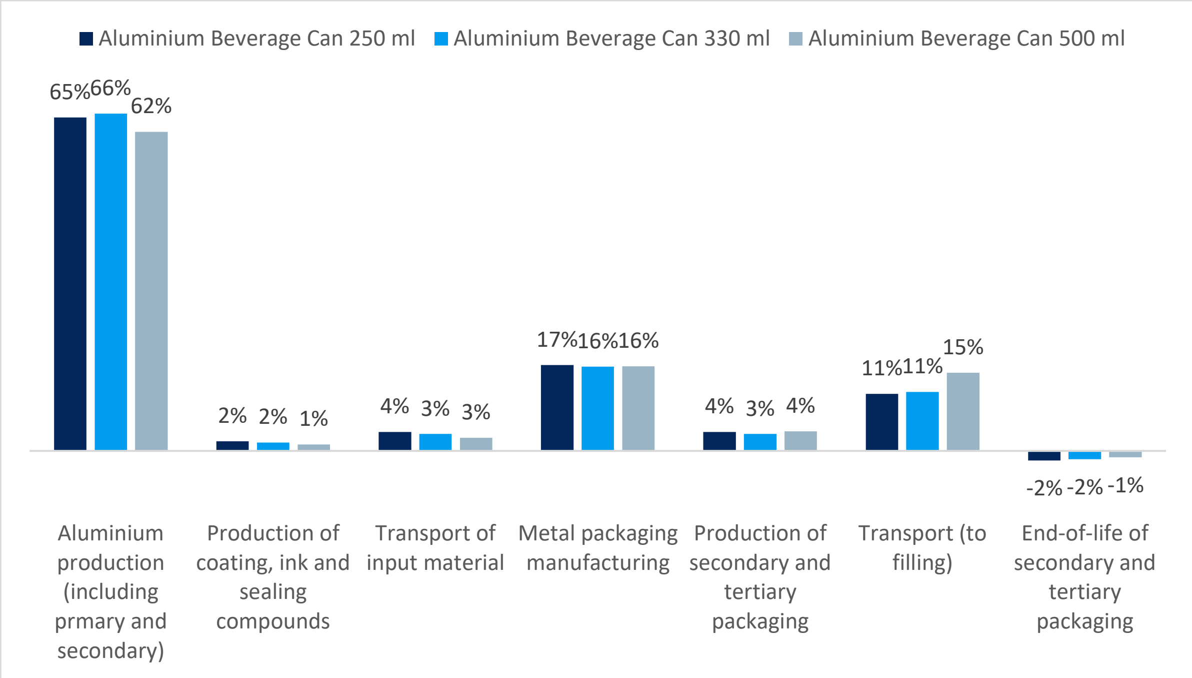
[24] Excludes the climate impact from filling, distribution and use phases

[25] This data from the LCA is based on an assumption of a closed loop between recycled aluminium and the use of recycled content in cans, based on a recycled estimated content of a 76% in aluminium beverage cans.

[26] This is based in the industry report of Life Cycle Assessment (LCA) of aluminium beverage cans (25, 33 and 50 cl volumes) published by MPE in 2016 (https://metalpackagingeurope.org/article/new-life-cycle-assessment-aluminium-beverage-cans-shows-significant-carbon-emissions).

challenges and interventions at all points of the value chain, such as the reduction of material use and an increased energy efficiency in the can making process, as well as a higher use of recycled aluminium as input material and the increased recycling rates.

Figure 2: Share of climate impacts across the aluminium beverage can value chain[27]



Source: Ramboll analysis based on MPE LCA 2025

The carbon footprint of can manufacturing is associated with the use of energy. The use of fossil gas, which is primarily driven by the use of boilers and ovens in can manufacturing plants, involves a direct carbon footprint, while the other activities rely largely on electricity. Hence, the energy mix when purchasing electricity and the types of ovens largely determine the carbon footprint associated to can manufacturing.

[27] Assumes closed loop-system, i.e., all recycled cans are used for manufacturing of new cans, and a post-consumer recycling rate of 76.5% (= recycled content). This is higher than current industry average levels for recycled content. End-of-life for packaging waste is estimated to have no impact.

4. DECARBONISATION ROADMAP

The annual GHG emissions from the EU aluminium beverage can industry are estimated to be approximately 4 million metric tons (Mt)[28]. European can makers have set ambitious goals to significantly reduce these emissions and contribute to meeting the EU's climate targets. This requires decarbonisation measures across the value chain, including processes directly related to can manufacturing as well as upstream and downstream activities. This section presents a roadmap for achieving such emission reductions, highlighting key opportunities that can accelerate progress toward a low-carbon aluminium beverage can industry in Europe.

This section develops an overview of decarbonisation opportunities and their expected impact by looking at all the phases of the value chain. Additionally, this report provides a broad scope of the aluminium beverage can value chain, and therefore, it provides advice on a wide array of measures towards decarbonising the aluminium beverage can industry beyond can manufacturing (i.e. sections of the value chain such as transportation, post-consumer scrap management, and aluminium production).

For each of the proposed measures, a general assessment of the carbon reduction potential is provided. This assessment is based on a three-grade system for the carbon reduction potential, varying between low [+], medium [++] or high [+++].

4.1 Levers to achieve a net-zero aluminium beverage can value chain

Four levers have been identified to foster the decarbonisation of aluminium beverage cans, including (1) the sourcing of low-carbon aluminium, (2) measures for manufacturing, (3) measures for transport, and (4) recycling. Within each of these levers, this section discusses the potential measures that can be adopted to further foster decarbonisation, their feasibility, availability, and efficiency.

Figure 3. Decarbonisation levers for the aluminium beverage can industry

Levers	**Low-carbon aluminium sourcing**	**Manufacturing**	**Transport contracting**	**Recycling**
Decarbonisation measures	• Purchasing low-carbon primary aluminium. • Prioritising higher recycled aluminium content.	• Decarbonising manufacturing processes requiring heat • Shifting to renewable electricity • Improving efficiency measures • Lightweighting • Reducing pre-consumer scrap	• Using electric or alternative fuel-power vehicles • Improving logistics	• Optimising alloy designs for enabling the use of secondary aluminium
Scope of GHG emissions	Scope 3	Scope 1 & 2	Scope 3	Scope 3

[28] Eunomia and Zero Waste Europe (2023). Single Use Beverage Packaging. Investigating 1.5°C aligned carbon budgets for aluminium, PET and glass beverage containers in the EU. https://eunomia.eco/reports/single-use-beverage-packaging/.

4.1.1 Low-carbon aluminium sourcing

Table 5. Measures for Lever 1 – Low-carbon aluminium sourcing

Measures		CO_2 reduction potential
Lever 1 – Low-carbon aluminium sourcing	Purchasing low-carbon primary aluminium	[+++]
	Prioritising higher recycled aluminium content	[+++]

Input aluminium material is the most carbon-intensive segment of the aluminium beverage cans value chain, as it weighs between 62% to 66% of all the CO_2 emissions associated with the aluminium beverage can value chain (see Figure 2). Hence, can makers may significantly reduce their carbon footprint by **sourcing** aluminium from suppliers that adopt low-carbon production techniques and offer high levels of recycled aluminium. In this sense, Can makers do not directly participate in the aluminium production process as they purchase coils of aluminium can sheets. However, they have the potential to capitalise their position in the supply chain to influence the behaviour of aluminium manufacturers through **responsible purchasing,** in coherence with the European Aluminium decarbonisation plan. This purchasing policy can further encourage aluminium producers to adopt methods, techniques and decisions towards decarbonisation. Therefore, beverage can makers should continue to implement the principles outlined in the European Aluminium Decarbonisation Roadmap, prioritising the sourcing of aluminium from producers that employ **low-carbon production techniques.**

Box 2 provides a description of the measures that aluminium suppliers can adopt to reduce the GHG footprint of aluminium used by can makers.

Can makers do not directly participate in the aluminium production process as they purchase coils of aluminium can sheets. However, they have the potential to capitalise their position in the supply chain to influence the behaviour of aluminium manufacturers through **responsible purchasing,** in coherence with the European Aluminium decarbonisation plan[29]. This purchasing policy can further encourage aluminium producers to adopt methods, techniques and decisions towards decarbonisation. Therefore, beverage can makers should continue to implement the principles outlined in the European Aluminium Decarbonisation Roadmap, prioritising the sourcing of aluminium from producers that employ **low-carbon production techniques.**

Box 2: Overview of actions for decarbonising primary aluminium production

The process of alumina **refining (digestion and calcination)** can be decarbonised through the incorporation of **alternative digestion boilers** that use either electricity, hydrogen, Concentrated Solar Thermal (CST) energy, or Mechanical Vapor Recompression (MVR) to generate steam. Also, the **calcination** process can be decarbonised through the incorporation of **electric or hydrogen-based baking ovens**.

[29] European Aluminium (2025). An Action Plan for European Aluminium

However, these technologies are not expected to be commercially available until 2027 for the case of non-fuel-based digestion boilers and between 2030 and 2035 for electrical and hydrogen baking ovens[30].

For aluminium **smelting, carbon anodes can be substituted by inert anodes** (to extract aluminium from aluminium oxide, producers use carbon anodes that produce aluminium and CO_2, whereas inert anodes allow to extract aluminium without producing CO_2). Although some of these elements are not commercially ready yet, there are significant developments in the market to develop inert anodes, such as the case the Elysis[31] project, which is a joint venture with Rio Tinto and Alcoa[32].

Finally, the **primary cast-house segment** of aluminium production relies on the use of baking ovens that, as in the calcination process, will require the switch to **electric or hydrogen-based baking ovens** that are not expected to be commercially available until 2030 and 2035.

Aluminium producers should seek to source electricity from renewable sources. However, the sourcing of renewable electricity can be challenging depending on the context, as other industries with a lower energy demand can pay a higher price for renewable electricity. Therefore, the adoption of new techniques may still require investment in innovation and technology development. Also, this electrification can be especially costly given the elevated energy demand associated to aluminium production, which may hamper its electrification and transition to renewable sources[33].

In addition, aluminium producers expect in the future to use carbon capture and storage (CCS) as an intermediary option to minimise their carbon emissions. This option can be used while transitioning towards carbon free technological options[34] to mitigate emissions. However, it is important to note that CCS has not been developed yet at the scale needed for its commercial availability and there are uncertainties on its future costs and availability[35]. In addition, the option to use CCS is not expected to be available before 2030.

The second possibility to lower the climate impact of input materials in aluminium beverage can manufacturing lies in increased use of **secondary aluminium**. Currently, the overall average share of recycled content in European aluminium cans manufacturing is estimated to be around 54%[36]. The production of recycled aluminium has a significantly smaller footprint in comparison with primary aluminium due to its lower energy requirements, making these measures one of the most influential for industry decarbonisation. To exemplify the importance of this action, a previous MPE study has shown that for every 5% increase in recycled aluminium beverage can contributed to reduce an average of 6% reduction in GHG emissions[37].

To take advantage of the decarbonisation potential of secondary aluminium, **aluminium beverage can makers should source their input aluminium from smelters and reprocessors with a recycled content share as high as possible.** To minimise GHG emissions from recycled

[30] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

[31] Elysis (2022). Elysis moves toward commercialisation of inert anodes. https://elysis.com/sites/default/files/newsfiles/lmaelysisfeb2022.pdf

[32] Rio Tinto (2021) Start of construction of commercial-scale inert anode cells. https://www.riotinto.com/news/releases/2021/ELYSIS-Start-of-construction-of-commercial-scale-inert-anode-cells-

[33] National Bank of Belgium (2024). Obstacles to the greening of energy-intensive industries https://www.nbb.be/en/blog/obstacles-greening-energy-intensive-industries

[34] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

[35] IISD (2023). Unpacking Carbon Capture and Storage: The technology behind the promise. https://www.iisd.org/articles/insight/unpacking-carbon-capture-storage-technology

[36] IAI (2022). The journey of a European aluminium beverage can. https://international-aluminium.org/wp-content/uploads/2022/09/European-Cans-Factsheet-2022.pdf

[37] https://metalpackagingeurope.org/article/new-life-cycle-assessment-aluminium-beverage-cans-shows-significant-carbon-emissions

aluminium, the use of electric or hydrogen baking ovens for remelting and refining processes can be promoted. One of the most pressing challenges throughout the aluminium beverage can value chain is the transitioning of the entire remelting capacity to run on green energy, which requires substantial investments due to its high energy requirement, and time to amortise their existing assets and to deplete their value.

Box 3: Decarbonising secondary aluminium production

Although aluminium recycling is an essential contributor to decarbonisation, the recycling of aluminium still requires **remelting and refining** the collected aluminium (through an extrusion process) using a high temperature furnace to heat secondary aluminium to more than 600 °C. This process can be fully decarbonised through adopting electric or hydrogen-based baking ovens, although these are not expected to be commercially available until 2030 or 2035[38]. In addition, the next few years hold significant promise for scaling plasma torch technologies (if backed by strong government support) while hydrogen remains technically viable, though its economic feasibility is still uncertain.

4.1.2 Manufacturing

Table 6. Measures for Lever 2 – Manufacturing

Measures		CO_2 reduction potential
Lever 2 – Manufacturing	Decarbonising of manufacturing processes requiring heat	[++]
	Shifting to renewable electricity	[++]
	Improving efficiency measures	[+]
	Lightweighting	[++]
	Reducing pre-consumer scrap	[=]

The CO_2 impact of aluminium beverage cans manufacturing is derived from the use of fossil gas and electricity derived from fossil fuels. To decarbonise this process, can makers are advised to switch to **non-fossil-fuelled production equipment**, and to transition to **renewable electricity sources** with power purchase agreements to ensure that the existing electricity consumption is decarbonised.

The first measure that manufacturers can adopt is the switch to production equipment that does not require the direct use of fossil fuels. Currently, can manufacturers require the direct use of fossil gas for (1) can washing and drying, (2) decoration and oven, (3) internal spray and curing, and for (4) other secondary activities not directly related to can manufacturing (for example, the heating of working spaces). These activities require the use of different types of ovens (boiler, drying ovens,

[38] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

pin oven, internal bake oven, and heating in the manufacturing facilities) that need to be **decarbonised** through switching to **new energy sources**.

For the existing electricity consumption in the can manufacturing, and in the case of further electrification, this process would need to be complemented with the **sourcing of renewable electricity** to ensure that this electrification does not involve the use of fossil gas.

The **electrification of aluminium can production offers the most advantages** towards decarbonisation due to its higher efficiency compared to other alternatives, the already present electricity distribution infrastructure, and the existing efforts in developing renewable electricity generation plants. The simultaneous electrification efforts and shift to renewable electricity sources are the steps that can reduce more significantly the carbon footprint of the can production processes, and the electrification of can manufacturing is an option that can be promising in a short or medium term, depending on the development of technologies to electrify all its manufacturing processes. However, there are additional alternatives to decarbonise manufacturing. For instance, **hydrogen** is an alternative that can be used in cases where it is more difficult to get the necessary supply of renewable energy due to a lack of infrastructure. However, the round-trip efficiency of hydrogen is notably low. When accounting for the energy lost during hydrogen production (i.e. electrolysis), approximately 75% of the original energy is lost. This results in a round-trip efficiency of around 25%, highlighting the significant energy penalties associated with hydrogen as an energy carrier. In addition, there are uncertainties on the use of hydrogen, namely its availability, pricing, and extension of the hydrogen infrastructure. Finally, **biogas or biomethane** can also offer the possibility to adapt existing ovens and infrastructure, and in combination with CCS it can be considered a carbon negative emissions option.

However, the adoption of these alternatives still requires additional improvements in their access. Namely, the electricity grid needs to be updated to provide a sufficient predicted additional load for the decarbonisation of all industrial activities that may switch to the use of electricity. The uncertainties over the future availability and the price of new energy sources, such as biogas, hydrogen, or CCS, are also an obstacle to their adoption. In the case of CCS in Europe, this option is constrained by both economic and infrastructural limitations. Firstly, the pricing of CCS is still uncertain as the costs associated remain variable and difficult to predict. Additionally, the limited geographical availability of CCS infrastructure across Europe may pose a significant barrier, as the CCS transport networks may only be available in very few limited locations, making this option unpractical or even unfeasible for most cases.

Box 4: Options to reduce fossil fuel use in can manufacturing

Electrification	• Electric baking ovens and other types of electric ovens are expected to be commercially available from 2030 and to reach full market coverage until 2040. • The round-trip efficiency of electric ovens is expected to reach 95%. • The costs of electricity are significantly higher than existing ovens as electricity is between 3 to 4 times more expensive than gas per unit of energy.
Hydrogen	• The hydrogen market in Europe is still under development. • Hydrogen combustion has a great potential to support energy-intense activities. • Hydrogen baking ovens and other types of hydrogen-based ovens are expected to be commercially available from 2035. • The round-trip efficiency of hydrogen ovens is expected to reach 25%. • There is still uncertainty on the costs of hydrogen for the EU industry.

Biogas or biomethane with CCS	• The development of biomethane and biogas would still require the development of a production and transport infrastructure[39]. • If combined with CCS, biomethane can be considered a source with negative emissions. • CCS in Europe is expected to be commercially available from 2030, although this availability may be limited to certain geographical areas.	

A second set of measures to enable decarbonisation in aluminium beverage can manufacturing is through **increasing efficiency**, reducing both energy and material needs. These improvements can be achieved by pursuing energy efficiency through **continuous process optimisation**[40], or by innovating to produce new models of **more lightweight cans**[41] that require less aluminium and less energy to be produced. Efficiency measures proved to be effective in the past to reduce carbon emissions in can manufacturing, for instance, the adoption of efficiency measures in can making process has led to a 36% reduction in electricity and 15% in heat consumption, resulting in a 2% reduction of carbon emissions between 2018 and 2023[42].

The last possible action to accelerate decarbonisation is to **keep maximising the recycling of pre-consumer scrap** through recycling and reincorporating this aluminium into production. Such action maximises the use of aluminium and minimises material needs. However, since aluminium beverage can makers already recycle close to all scrap, this measure is not expected to contribute to significant emission reductions, although it is important to maintain the effort to keep pre-consumer scraps as reduced as possible.

4.1.3 Transport contracting

Table 7. Measures for lever 3 - Transport

Measures		CO_2 reduction potential
Lever 3 – Transport contracting	Using electric or alternative fuel-power vehicles	[++]
	Improving logistics	[+]

The transport phase includes the transportation of aluminium coils and auxiliary materials to can manufacturers and the transport of cans from can makers to filling sites, and hence, the decarbonisation of transport activities is aligned with scope 3 (as indicated in Box 1). Given the lightweight combined with its stuffing efficiency, the aluminium beverage can already outperforms other beverage packaging systems. To further lower the carbon emissions associated with transport,

[39] Eyl-Mazzega, M. A., & Mathieu, C. (2019). Biogas and biomethane in Europe. Lessons from Denmark, Germany and Italy. The energy centre for the French institute of international relations (IFRI).

[40] The CanPack group is implementing some pilot projects to use energy and aluminium more efficiently, including an optimised waste heat recovery system in Orzesze (Poland), a heat exchanger in Hämeenlinna (Finland).

[41] Existing projects, such as the design of lightweight cans by Ball Corporation, led to the reduction of weight by between 3% and 8%, further lowering the carbon footprint of can manufacturing. Such reduction has the potential to save approximately 30,000 metric tons of metal each year for Ball Corporation, or the equivalent to nearly 200,000 metric tons of GHG emissions.

[42] Metal Packaging Europe LCA. https://www.metalpackagingeurope.org/sustainability/life-cycle-assessment-lca/

can makers need to **select their transport contractors prioritising low-carbon options** and ensuring that transport companies either fully decarbonise their direct operations or at least minimise their CO_2 emissions.

Using **electric or alternative fuel-power vehicles**, such as hydrogen, is the main measure for decarbonising transportation[43]. Some aluminium beverage can producers have already started working closely with third-party transport providers to increase efficiency and lower the emissions of the transportation phase[44].

The associated emissions of the transportation section in the aluminium beverage can value chain represent between 3 and 4% for the transport of coating, ink and sealing, and between 11 and 15% for the transport of filling (see Figure 2) of the total value chain emissions. Hence, such electrification would represent a positive contribution to reducing the overall carbon emissions of aluminium beverage cans. However, this transition requires significant work in the electric charging infrastructure and may affect its costs and require readapting its logistics, although the cost of electrified trucks is expected to significantly decrease over the coming decade and to even reach parity with combustion engine[45]. Also, the evolution of the BEV battery sector provides promising expectations on their future cost and range, although there is still a need to expand the charging infrastructure across the EU.

Finally, transport companies can also seek to explore how to **improve their logistics**, maximising capacities in their vehicles or optimising routes to reduce the energy costs associated to transport, although transport companies already operate by optimising their logistics, hence, we expect the CO_2 reduction potential of this measure to be low.

4.1.4 Aluminium recycling

Table 8. Measures for lever 4 – Improve recycling

Measures		CO_2 reduction potential
Lever 4 – Improved recycling	Optimising alloy designs for enabling the use of secondary aluminium	[+++]

Recycling is a major driver for material efficiency because it reduces the need for primary aluminium, and therefore, it contributes to reducing the energy demand associated with aluminium production[46]. However, increasing the recycled aluminium content in beverage cans requires further improving current collection and recycling rates and facilitating the recycling and its recovery for the beverage can production as much as possible. The global use of aluminium beverage cans is

[43] Mission Possible Partnership (2022). Making Zero-Emissions Trucking Possible. An industry-backed, 1.5°C-aligned transition strategy. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Zero-Emissions-Trucking-Possible.pdf

[44] As reported in the CanPack sustainability report.

[45] Mission Possible Partnership (2022). Making zero-emissions Trucking Possible. https://3stepsolutions.s3-accelerate.amazonaws.com/assets/custom/010856/downloads/Making-Zero-Emissions-Trucking-Possible.pdf

[46] European Aluminium (2016). Aluminium beverage can recycling at new record high. https://www.nvc.nl/userfiles/files/European%20Aluminium%20Press%20Release%20-%20AluBevCanRecycling_.pdf

set to increase to 630 billion units by 2030 (from 420 billion units in 2020), hence, recycling the total of the 630 billion aluminium beverage cans that are expected to be produced globally in 2030 would save 60 million tonnes of greenhouse gas emissions per year[47]. Hence, the improvement of recycling is expected to significantly contribute to the aluminium beverage can makers' ambitions to minimise their carbon footprint.

The aluminium beverage can industry is already seeking ways to further contribute to can recyclability. In this sense, the **optimisation of alloy design** can contribute to the upscale of aluminium recycling. This is because alloys can be designed to promote recycling by seeking mixtures that can be more easily remelted from used cans for their reuse. Also, the development of homogenised alloys reduces the processes needed for treating recycled aluminium beverage cans. Finally, the promotion of used beverage can recycling within a can-to-can loop[48] provides a pathway to further lower GHG emissions and improved energy efficiencies. The Can-to-Can recycling process is a closed-loop system specifically designed for aluminium beverage cans, where used cans are collected, processed, and remelted directly back into new cans. This approach maintains the material’s quality and performance reducing degradation and it reduces the energy consumption in recycling.

Box 5: Best practice case of innovation in aluminium alloy design to increase can recyclability

European aluminium p**roducers are** developing new standardised aluminium alloys that would be more recycling-friendly. These alloys are designed to perform well in high-quality, value-added products, and to further contribute to reducing the need for processing recycled aluminium. For example, the European Aluminium Packaging Group (EAPG) members are collaborating to develop standardised alloys that are more recycling-friendly for can ends. The use of new standardised alloys enable**s** maximising the recycled content levels of aluminium beverage cans, reducing the processes needed for recycling, and boosting their recyclability[49].

4.2 High-level pathway towards 2050

The nature of climate impact and the urgency of GHG emissions reductions require accelerated decarbonisation efforts across the aluminium beverage can industry. To meet their climate targets, aluminium beverage can makers will need to adopt decarbonisation measures directly relating to their manufacturing processes while also promoting emission reduction across the value chain. This section reviews the proposed measures and compares their contribution to decarbonise the carbon footprint of aluminium beverage cans, and their commercial availability to build a set of priorities that guide the decarbonisation roadmap.

[47] International Aluminium (2023). Call to Accelerate Aluminium Beverage Can Circularity. https://international-aluminium.org/wp-content/uploads/2023/12/Can-Recycling-Call-to-Action.pdf

[48] Innoval (2025). Can-to-can recycling: Metallurgy, processing and circularity PowerPoint Presentation

[49] European Aluminium (2024). European Aluminium Producers to Boost the Circularity of Beverage Cans. https://european-aluminium.eu/wp-content/uploads/2024/04/2024-04-18_Press-Release-European-Aluminium-Producers-to-Boost-the-Circularity-of-Beverage-Cans-1.pdf

Table 9: Levers and measures classified by impact, price, and decarbonisation contribution.

Lever	Measures	Estimated commercial availability	Decarbonisation potential
Low-carbon aluminium sourcing	Purchasing low-carbon primary aluminium	2030 to 2040	High
	Prioritising higher recycled aluminium content	Now	High
Manufacturing	Decarbonising of manufacturing processes requiring heat	2030	Medium
	Shifting to renewable electricity	Now	Medium
	Improving efficiency measures	Now	Low
	Lightweighting	Now	Medium
	Reducing pre-consumer scrap	None	None
Transport	Using electric or alternative fuel-power vehicles	Now	Medium
	Improving logistics	Now	Low
Improved recycling	Optimising alloy designs for enabling the use of secondary aluminium	Now	High

Based on this assessment, the first priority for the aluminium value chain in general, including the non-beverage aluminium sector, would be to improve circularity and tighten the aluminium material loop, minimising the need for primary aluminium. This is justified by the fact that primary aluminium production is the most carbon-intensive activity of the aluminium beverage can value chain. Additionally, the shift towards renewable electricity sources and the switch from fossil-fuelled equipment to equipment based on alternative power sources can significantly contribute towards the decarbonisation of the aluminium beverage can value chain. In this sense, several companies have already published their pledges to accelerate the purchase of decarbonised electricity.

Secondly, measures related to improving the efficiency of materials can be implemented to reduce the energy demand of can manufacturing. This includes to develop new alloys and methods to lightweight existing cans, as well as implementing actions to improve energy efficiency, such as reusing residual heat from baking ovens to heat manufacturing facilities and to optimise operational logistics. Also, the switch to a decarbonised transportation can reduce emissions, as between 12 to 15% of emissions were associated to transportation.

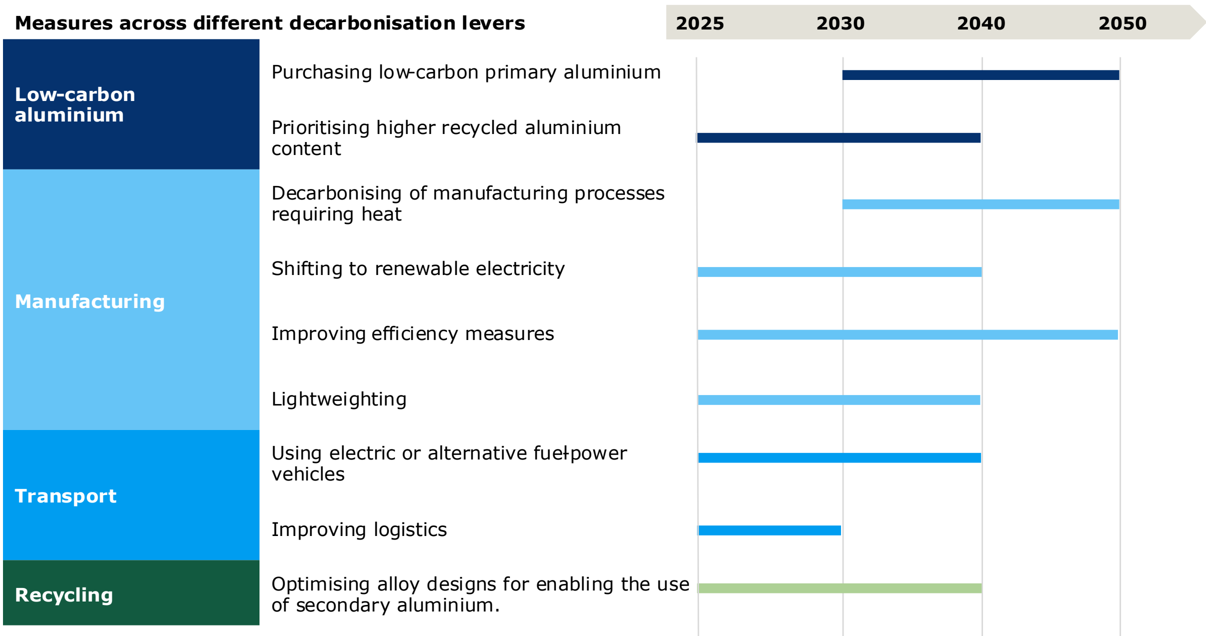
Lastly, the decarbonisation of manufacturing and aluminium production processes that use heat require the adoption of technologies that need to be implemented at a later stage, as the technologies are not yet commercially available, such as the case of electric baking ovens. In this sense, such electrification can be feasible by 2035[50]. To mitigate the impact of these activities, aluminium producers can explore solutions such as carbon capture and storage (CCS), as this would allow to avoid GHG emissions to the atmosphere until all the activities of the value chain can be decarbonised. However, CCS is expected to be commercially available around 2030[51], and there are high uncertainties on its price, geographical distribution, and its availability for aluminium

[50] Fraunhofer ISI (2024): Direct electrification of industrial process heat. An assessment of technologies, potentials and future prospects for the EU. https://www.agora-industry.org/fileadmin/Projects/2023/2023-20_IND_Electrification_Industrial_Heat/A-IND_329_04_Electrification_Industrial_Heat_WEB.pdf

[51] European Aluminium (2023). Net-Zero by 2050: Science-Based Decarbonisation Pathways for the European Aluminium Industry. https://european-aluminium.eu/wp-content/uploads/2023/11/23-11-14-Net-Zero-by-2050-Science-based-Decarbonisation-Pathways-for-the-European-Aluminium-Industry_FULL-REPORT.pdf

producers. Hence, despite the expectations that CCS can be an option for aluminium producers to mitigate emissions until a decarbonised technological option is ready, in practice, it is unclear if CCS will play a role in decarbonising aluminium production and it may be an unpractical option to mitigate the associated emissions of can manufacturing.

Figure 4: Roadmap of measures to decarbonise the aluminium beverage can value chain



5. POLICY RECOMMENDATIONS

This section builds a concrete set of recommendations to policy makers to support the sector's path to net-zero through developing the means that the aluminium beverage can industry needs towards decarbonisation:

- **Establishing an ambitious recycling agenda**
- **Supporting the decarbonisation of power generation**
- **Facilitating the uptake of low-carbon production technologies and transport**

Together, the three areas will enable actors across the beverage can value chain to shift from current emission-intensive activities, allowing beverage can makers to reduce emissions in line with sector climate goals, and enable a reduction in emissions that aligns with industry climate goals. The necessary policy actions within each area are outlined below.

5.1 Establishing an ambitious recycling agenda

The transition towards a circular economy does not only provide new avenues **for maximising the use of resources** but it also significantly **reduces energy demand** and speeds up decarbonisation efforts. Notably, the aluminium recycling process requires only 5% of the energy needed to produce primary metal, leading to significant CO_2 savings[52]. This is specifically relevant in the case of aluminium given its ability to be continuously recycled without losing its original properties and only with a minor material loss in its recycling process. Hence, decision-makers must seek to maximise the role of aluminium as the go-to material to foster a more circular economy.

In this sense, MPE has proposed the EU to **formally recognise permanent materials**, namely those retaining their properties through repeated recycling, such as steel and aluminium, and integrating a clear definition of permanent materials into EU legislation. This should prioritise materials that remain in circulation indefinitely, and incentivise eco-modulation for high-performing materials. In addition, harmonising End-of-Waste (EoW) criteria for aluminium and steel across EU Member States could also provide a consistent recognition of secondary materials across the EU. This would facilitate intra-EU movement, create a level playing field, and maintain material quality. However, EoW recognition for aluminium should be limited to materials processed within the EU to prevent scrap leakage.

The **recycling of post-consumer scrap** is essential to enable the decarbonisation of aluminium. In this sense, the collection and recycling rates have improved in general across Europe (see Figure 5). In 2021, 76% of all used aluminium beverage cans in Europe were recycled[53] thanks to well-performing collection and sorting schemes and the active participation of consumers[54], although this data shows that there is a remaining 24% of aluminium that can be recycled and reincorporated in the supply chain. In addition, while the number of cans recycled has increased in absolute terms, the EU recycling rate has evened out over the last few years as a result of an increase in cans put on the market for final consumption. Hence, there is a significant potential to further improve the recycling of aluminium.

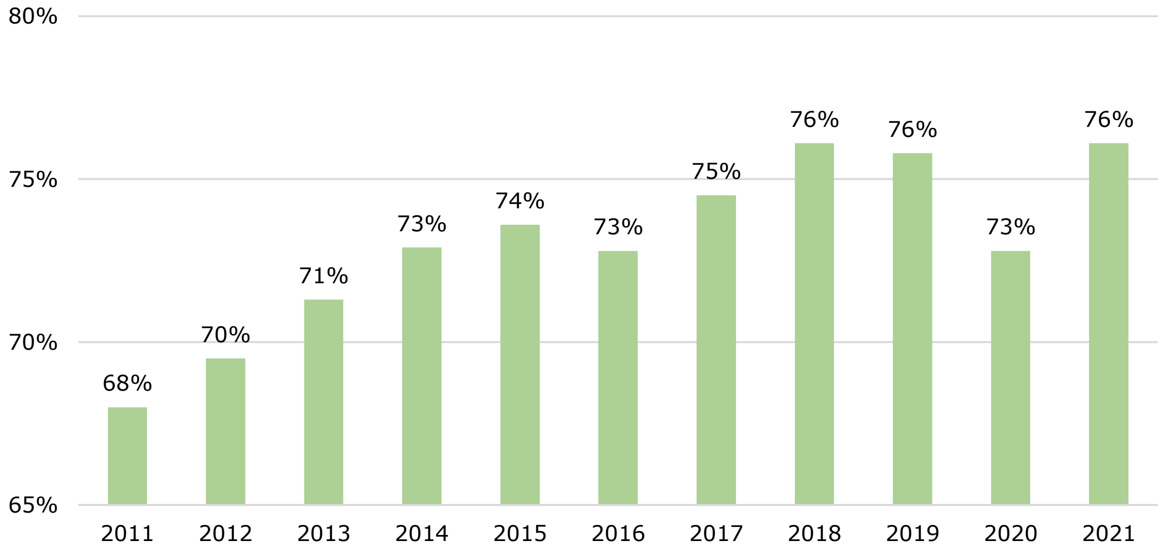
[52] European Aluminium. 2024. Enabling the circular economy with aluminium. https://european-aluminium.eu/blog/enabling-the-circular-economy-with-aluminium/

[53] European Aluminium and Metal Packaging Europe (2024). Aluminium beverage can recycling in 2021 at a new record level of 76%. https://european-aluminium.eu/wp-content/uploads/2024/02/EA-MPE_BevCan-2021-Recycling-Results_Press-Release_23-February-2024final.pdf

[54] Metal Packaging Europe (2016). New Life Cycle Assessment of aluminium beverage cans shows significant carbon emissions reduction. https://metalpackagingeurope.org/article/new-life-cycle-assessment-aluminium-beverage-cans-shows-significant-carbon-emissions

As such, there is potential to further **improve the recycling rates** of aluminium cans in Europe, although this requires implementing ambitious circularity policies, as waste management is a governmental responsibility. The approved EU proposal for a regulation on packaging and packaging waste (PPWR) (COM/2022/677 final)[55] demonstrates a clear step in the right direction. The future PPWR will include provisions to harmonise the labelling of products and waste receptacles to facilitate consumers' sorting, which are expected to enter into force in June 2028. Additionally, the PPWR will require the set-up of mandatory Deposit Return Systems (DRS) for single-use plastic beverage bottles and single-use metal beverage containers with a capacity of up to three litres, to increase collection and recycling[56]. The DRS proposal has a strong potential to rapidly upscale aluminium recycling, increasing the supply of secondary aluminium and contributing to reduced climate impact from input material used in can manufacturing. In addition, MPE proposed a stricter enforcement of the Landfill Directive to prevent recyclable metals from being landfilled or incinerated. This enforcement can involve higher disposal costs for recyclable materials, mandatory separate metal collection, and investment in sorting and recycling infrastructure. Going forward, it is important to ensure the timely and proper implementation of well-designed DRS across Europe. Here, the EU can play a key role supporting Member States in DRS implementation by providing good practices, enforcing deadlines to prevent delays, establishing minimum requirements, and by providing an accurate and reliable reporting on separate collection and recycling activity to enable a proper fulfilment of the PPWR.

Figure 5: European recycling rate for beverage cans, 2011-2021.



Source: Ramboll based on MPE and EA data

In terms of existing policies, **MPE opposes mandatory recycled content targets for steel and aluminium**, which already achieve high recycling rates. Instead, it advocates for targets only where the uptake of recycled materials is low. Recycled content data should use mass balance methodology, including both pre- and post-consumer scrap. The focus should remain on optimising recycling systems to maximise carbon savings. In addition, MPE supports a **revision of harmonised Extended Producer Responsibility (EPR) minimum requirements** to improve

[55] Proposal for a regulation of the European Parliament and of the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC. COM/2022/677 final.

[56] There are some exemptions such as those Member States with a rate of separate collection exceeding 90% by 2026 and 2027, as states in Art 44.3 of the COM(2022) 677 final.

transparency and fairness. Key proposals include maintaining industry-led Producer Responsibility Organisations (PROs) with independent oversight, ensuring full territorial coverage, and separating governance for industrial/commercial and household packaging. Costs should be transparently allocated per material, avoiding cross-subsidisation, while eco-modulation fees should reward recyclability without distorting competition.

Finally, MPE calls for export controls and traceability mechanisms to **prevent the export of high-quality aluminium scrap outside of Europe**. Europe exports over one million tonnes of aluminium scrap annually. Hence, retaining scrap within the EU would strengthen its strategic autonomy while upholding environmental standards and reducing reliance on virgin materials.

5.2 Supporting the decarbonisation of power generation

While beverage can makers and aluminium producers can look for alternative sources of energy to avoid fossil fuels, such as electrifying their production systems, they are dependent on the composition of the energy grid mix and the availability of renewable electricity in the mix to provide energy for such increased demands of electricity, or the creation of hydrogen hubs for those activities where hydrogen becomes a more adequate alternative. In this sense, many companies have made significant investments to ensure a reliable supply of renewable energy. For instance, Novelis has signed a Power Purchase Agreement (PPA) that will cover an extensive part of up to 40% of the electricity used at two manufacturing plants in Nachterstedt (Germany), which corresponds to around 16% of the company's total German electricity consumption[57]. Additionally, Speira has invested 1.9 million euros in a new large-scale battery storage system[58]. To further support these investments, governments can establish financial guarantees for long-term power purchase agreements (PPAs) of renewable power to support the purchase of renewable electricity for energy-intensive sectors.

Additionally, it is important to **review the electricity pricing system** and fees within the different EU Member States to ensure that energy-intensive activities are incentivised to switch to electricity. Namely, many EU Member States have a price setting for electricity that penalises high electricity consumption to incentivise energy efficiency. However, such settings can be harmful for energy-intensive sectors such as aluminium beverage can manufacturing, as the high costs of electricity disincentivise them from electrifying their production methods. To address that issue, EU Member States should review the pricing system for electricity to facilitate the decarbonisation of energy-intensive industries and the other existing measures that affect electricity costs, such as subsidies or measures to carbon pricing. For example, Germany plans to modify its electricity fees to incentivise flexible industrial electricity consumption, which may especially benefit energy-intensive industries[59].

Finally, governments can provide direct **subsidies to support the integration of renewables to energy-intense activities** such as aluminium smelting and alumina refining. For example, governments can promote the deployment of on-site or near-site renewable power generation, including solar PV and onshore and offshore wind. This must be combined with policies promoting the implementation of energy storage solutions.

In addition to technological advancements, the **necessary infrastructure to support these innovations must also be developed**. This includes installing batteries or other systems for energy storage, expanding the electricity grid and improving grid connections, improving the

[57] Novelis signs 100% Renewable Energy Contract for Its German Rolling and Recycling Plants :: Novelis Inc.

[58] Store, relieve, and economise

[59] Clean Energy wire. 2024. German grid agency to modify fees to incentivise flexible industrial electricity consumption. https://www.cleanenergywire.org/news/german-grid-agency-modify-fees-incentivise-flexible-industrial-electricity-consumption

interconnection in the electricity grid between Member States to enable more flexible use of electricity to mitigate production peaks[60], adapting the electricity grid to new generation and consumption patterns[61], or developing a hydrogen and carbon capture and storage infrastructure. The development of these infrastructures is necessary to make decarbonisation through electrification or hydrogen use, along with carbon dioxide capture, feasible options for can makers.

5.3 Facilitating the uptake of low-carbon production technologies and transport

The promotion of energy efficiency measures and the shift from gas-powered to electric manufacturing technologies, supported by targeted funding schemes and knowledge-sharing initiatives, can accelerate the phase-out of fossil fuels in the aluminium beverage can industry.

Despite the existing potential for electrification, many **decarbonisation measures and technologies are not yet commercially ready** for widespread implementation within the aluminium beverage can value chain. To address this, the EU and national governments should prioritize **investments in research and development of manufacturing technologies** (e.g., inert anodes for smelting and electric calcination for alumina refining) to accelerate their commercial readiness and implementation.

Also, the uptake of low-carbon transport alternatives requires further **support to decarbonise transportation**. This includes promoting the investment in developing new types of trucks, such as electric trucks, in the charging infrastructure, and updating the electricity grid. This infrastructure development needs to take into consideration the different geographical realities, such as rural areas, enabling electrification. These actions should be aimed at making electrification feasible for transport contractors and to further advance towards decarbonisation.

[60] European Environment Agency. 2023. Rapid growth in renewables calls for greater cooperation among Member States to double flexibility in the EU power system. https://www.eea.europa.eu/en/newsroom/news/rapid-growth-in-renewables-calls

[61] European Environment Agency. 2024. Renewable energy. https://www.eea.europa.eu/en/topics/in-depth/renewable-energy.