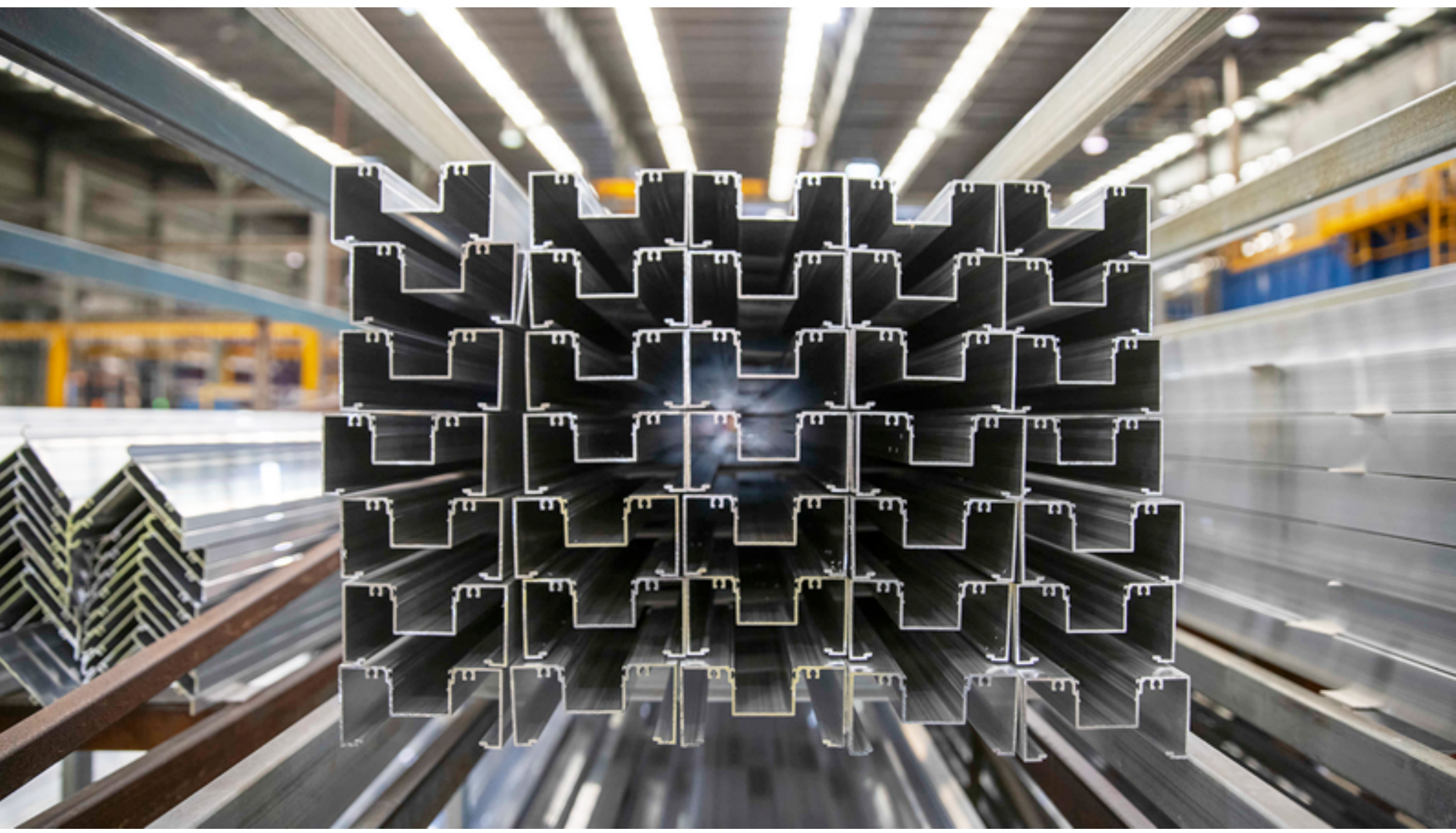

Market Sounding Report
Domestic Utilisation of Australian Scrap Aluminium

Prepared for

AUSTRALIAN ALUMINIUM COUNCIL LTD

November 2024

AEAS Australian Economic Advisory Services

REPORT PREPARATION

This report has been prepared by AEAS for the Australian Aluminium Council.

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Executive Summary

Australian Economic Advisory Services (AEAS) was engaged by Australian Aluminium Council (AAC) to provide insight through a market sounding exercise on the composition of scrap aluminium exports and the extent of Industry opportunity for the domestic utilisation of recycled scrap aluminium.

Market sounding has indicated that the market is now starting to look for lower carbon aluminium and Australian extrusion industry sees it as an important opportunity to meet customer needs and make more responsible procurement decisions when they source extruded aluminium. This can include low carbon primary aluminium and recycled metal. Due to aluminium's significant ability to be recycled, thereby saving 95 per cent of the energy it would take to make primary aluminium, pathways to increase scrap collection rates will reduce global CO_2 emissions and energy emissions.

Despite having a fully vertically integrated primary aluminium sector, the closure of Australia's car industry a decade ago was accompanied by a closure of the two aluminium rolling mills which also provided aluminium remelt capabilities. According to the market sounding, Australia has essentially lost its aluminium recycling/manufacturing capability.

There are examples of recent recycling pilots or trials, but these are limited and market sounding indicated that it is challenging for primary producers to ensure scrap re-processing is commercially viable due to limitations in existing processes and plant, high cost supply chain/logistics costs within Australia, contamination/quality issues with the scrap supply as well as reduced production rates when remelting.

The International Aluminium Institute currently estimates the global Recycling Efficiency Rate (RER) of aluminium is currently 76%. Market sounding indicated that Australian collection rates are expected to be higher than this, with for example all Australian states and territories having in place container deposit schemes. Currently most scrap aluminium due to its value (see figure 8) is recycled but virtually all (~95 per cent) aluminium scrap metal collected in Australia is exported. Based on the above, for the purposes of this report the volume of scrap aluminium exported can also be used as a reliable guide to the volume of aluminium scrap generation in Australia. AEAS statistical analysis indicates:

- The volume of exported scrap aluminium has steadily risen over the past two decades with the last three years seeing annual volumes well over 400,000 tonnes per annum (figure 6). In 2023 the amount of scrap exported was 467,664 tonnes;
- Commensurately the value of exported scrap aluminium has also steadily risen and is now valued in excess of $1.1 billion (figure 7). That is, aluminium scrap export is a billion dollar industry which is expected to grow with increase generation rates from aluminium derived from end of life solar panels etc;
- Scrap aluminium is a valuable commodity and in 2023 had an average value of $2,401 per tonne (figure 8);
- Australian's major scrap aluminium export markets include India, China, Korea, Thailand and Indonesia; however
- Publicly available data does not give significant insights into the composition or sources of the scrap which is exported. Improved public data quality could help support analysis of future commercial opportunities in Australia.

Scrap aluminium is traded as a global commodity on an export parity basis and what is currently missing in Australia is local processing capability and to some extent local demand for end users of pre- and post-consumer aluminium scrap materials which is why much of it is exported offshore. It is critical that any development of more local onshore remelt capacity recognises the economics is based on the globally competitive nature of the entire value chain and that Australia does not have a sizeable aluminium downstream processing industry.

Based on market sounding, AEAS has provided an estimate range for the amount of available pre-consumer aluminium scrap. The amount of annual pre-consumer scrap aluminium generated is estimated to range between 40 – 47 k tonnes per annum. The mid-range estimate is 43,279 tonnes of pre-consumer aluminium scrap.

Table: Estimate Range of Pre-consumer Scrap Aluminium Exported 2023-24 (tonnes)

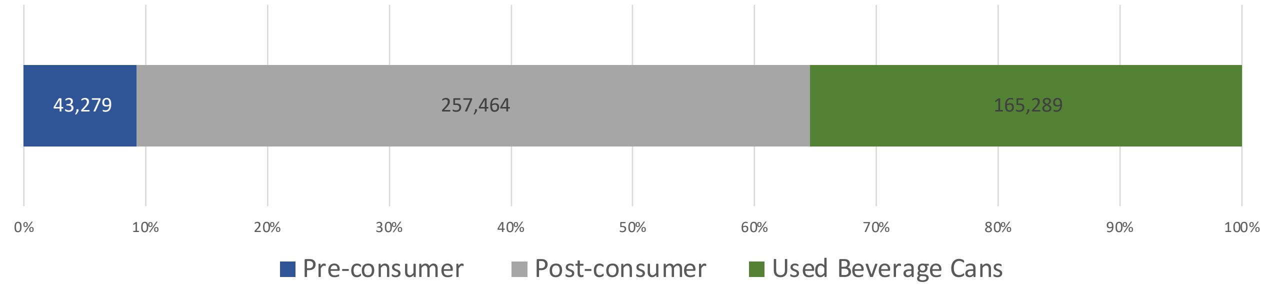
	K Tonnes
Lower range	40
Mid-range	43
Upper range	47

Source: AEAS 2024

Accordingly, the market sounding exercise confirms that the Australian aluminium industry particularly in respect to extruders make up only a small percentage (9.3 per cent) of scrap aluminium exports but also scrap aluminium generation. The Industry's chain of responsibility for scrap predominantly occurs through end of life scrap aluminium (see figure next page).

By State, Victoria generates and exports the largest volume (92,942 tonnes) of scrap aluminium followed by Queensland (59,541 tonnes) and NSW (52,226 tonnes).

Figure: 2022-23 Scrap Aluminium Generation and Export Volumes (tonnes) by Scrap Type



Source: AAC, ABS and AEAS 2024

Market sounding indicated there are significant environmental and commercial benefits to recycling aluminium including:

Economic	Environmental
▪ Energy savings and operational cost reductions; ▪ Increased Revenue Streams for Companies; ▪ Reduction of Import Dependency; ▪ Improved rating of company thereby attracting investors and influencing stock prices; ▪ Improved ESG reputation generating stickiness and pull from customers; ▪ Increased employee engagement and attraction and retains the best talent improving employee productivity with millennials and Gen Z wanting employers to share their values; ▪ Improved reputation with end users and communities in which the smelters operate; ▪ Helps meet carbon abatement targets and justification of industry assistance from Government; and ▪ Increasingly provides access to finance or cheaper finance leading to better financial returns.	▪ Recycling aluminium is produced with lesser energy compared to primary aluminium from raw materials (bauxite ore). By conserving energy, it reduces carbon emissions and helping mitigate climate change. ▪ Preservation of Natural Resources ▪ Reduction of Waste in Landfills ▪ Lower Environmental Impact of Manufacturing (eg non-natural residuals) ▪ Recycling aluminium is a cornerstone of the circular economy, which emphasizes keeping materials in use for as long as possible. Aluminium can be recycled indefinitely without losing its properties, making it a sustainable resource that reduces the need for new raw materials and minimizes environmental harm.

As awareness of climate change and the necessity of climate action grows amongst the community, decarbonisation and sustainability according to the market sounding is resulting in opportunities for the Industry to grow further and enhance existing revenue lines through proven sustainability credentials. As a result of these economic and environmental benefits, global demand for recycled aluminium and low emissions primary aluminium is growing rapidly, with demand for recycled aluminium estimated to be growing more than two times faster than primary product supported by favourable regulation, enhanced scrap collection and recovery and corporate demand for lower carbon products.

However, significant barriers prevent its widespread adoption and optimisation in Australia. These barriers can be categorised into technical, economic, and societal challenges, but a key limitation is the lack of downstream manufacturing, outside of the extrusion industry:

- Contamination of Scrap Material
- Collection and Sorting Infrastructure
- Economic, Cost and Finance Barriers
- Downcycling
- Energy Use in Recycling Facilities
- Design for Recycling
- Consumer Behaviour and Perception
- Technological Limitations

- Regional Disparities in Recycling Rates & Infrastructure
- Market structure – limited aluminium downstream processing industry other than extrusion
- Geography and freight costs

Furthermore, Australian smelters, which are primarily focused on transforming alumina into aluminium, indicated that due to their existing technology and process they are restricted in recycling scrap at scale. This can also impact the range of scrap which could be re-melted without impacting metal quality. In addition, costs incurred would need to be absorbed or passed onto customers with reservations expressed that the increase is affordable.

Despite these significant challenges, the market sounding indicated that the Industry is actively looking for pathways to move to using more recycled aluminium to meet its needs as it moves to decarbonise manufacturing processes as key challenges are addressed. To overcome these challenges, improvements in collection and sorting infrastructure and investments, public awareness and policy incentives are needed.

As part of the market sounding four pathways forward have been identified:

1. No change to Australian recycling – Rely on imports of recycled Aluminium and continue to export aluminium scrap; or
2. No change to Australian recycling – Rely on adoption of renewable energy to reduce the footprint of primary aluminium supply; and/or
3. Remelt scrap in existing manufacturing process; and/or
4. Investment in new recycling capability (pre and post-consumer) and downstream processing industry to create demand; reduce imports of secondary aluminium semis

No change to Australian recycling – Rely on Imports of Recycled Aluminium and continue to export aluminium scrap

Without domestic manufacturing utilisation of recycled scrap metal as a feedstock, Australia's extruders might have to rely on imports of recycled aluminium billet in combination with low carbon footprint primary billets to meet the needs of particular customers. They will continue exporting scrap. This represents a missed opportunity for the environment but also commercially. The risk is if domestic smelters do not embrace recycling, then Australian extruders and end consumers will source from overseas with lower emissions per tonne metrics. Market sounding indicated that demand erosion has been forecasted at between 15-30 per cent up to 2030 under a do-nothing approach for Australian aluminium manufacturers. However, over this same time period, Australian smelters will increasingly be able to supply lower carbon primary aluminium, produced with increased penetration of renewable energy.

No change to Australian recycling – Rely on Adoption of Renewable Energy to reduce the footprint of primary aluminium supply

In manufacturing low carbon aluminium, both renewable energy and recycling of scrap aluminium play significant roles, but their environmental impacts differ in scope. Shifting from fossil fuels to renewable energy can lower the carbon footprint of primary aluminium production by up to 85 per cent. Australian aluminium smelters are working hard to reduce the energy intensity of their process and utilise renewable energy sources.

Recycling in existing manufacturing process

Market sounding indicated widespread international examples of aluminium smelters using pre and post-consumer scrap remelted in their existing cast houses. Recent trials in utilising pre-consumer scrap demonstrated significant advantages when recycling scrap of known composition and quality.. The recycling of aluminium needs only a fraction of the energy required to produce primary aluminium. However, discussion with smelters indicated limited capacity for remelting citing limitations of existing processes and plant; need for post-consumer scrap to be free of contaminants, of known alloy, available at sufficient quantities and at a price that was affordable.

Investment in new recycling capability (pre and post-consumer)

In the longer term, it is anticipated that companies might invest in dedicated remelt facilities. Recycling pre consumer scrap offers an entry point for the industry to start producing recycled product. However based on market sounding it is unlikely sufficient pre-consumer scrap is available for a dedicated remelt facility given the transport distances and costs involved and the limited amount of pre-consumer scrap available. It is most likely that a dedicated remelt facility will have to utilise both pre and post consumer scrap sorted and processed to a sufficient standard to be used as feedstock at the required input level. Market sounding indicated that across Queensland, NSW and Victoria there exists sufficient high-quality scrap to potentially support a dedicated remelt facility. Feedback indicated that dedicated recycling facilities would require between 50 – 60kt of scrap feedstock. According to figure 13 these volumes are available.

Overall Finding – Predicted Future

The key to a sustainable operation is seen in the development of upstream recycling capability. Feedback indicated that there would however need to be parity in price between exporting the scrap and its purchase price. The difference between transport costs of shipping verses road transport will need to be addressed, possibly through Government support. At present domestic road and rail transport economics favours the movement of scrap to nearby ports as opposed to the transportation further distances to Australia's eastern smelters. This is both a scrap price and transport cost and distance issue. The willingness for consumer to pay and perception that recycled aluminium would achieve cost savings could also be an issue.

In the medium term, government transport support and infrastructure funding would allow for dedicated remelt facilities at smelters and accordingly should be prioritised as part of industry policy, that can also help create demand for closed-loop aluminium products that are "Made in Australia" ,as part of ensuring a future for a sustainable Australian aluminium industry.

1.0 Introduction and Overview

It is important that the Australian aluminium industry focuses on recycling of scrap as part of a broad effort to enhance the standing of the industry in Australia and to enhance the recognition of how aluminium can reduce impacts on the environment. Aluminium is particularly well suited to as it is infinitely recyclable and recycling saves up to 95 per cent of the energy needed to produce the primary product thereby reducing the environmental impacts.[1]

Australian Economic Advocacy Solutions (AEAS) was engaged by Australian Aluminium Council (AAC) to provide insight through a market sounding exercise on the composition of scrap aluminium exports and in turn the extent of Industry chain of responsibility for the sustainable and domestic recycling of Australian scrap aluminium.

AEAS through this report provides a detailed indication on the current amount of aluminium material exported out of Australia, its potential usages and export material source points. The market sounding, that was conducted as part of this project, represented a core element in gaining a clearer picture on what is a relatively unknown feedstock in the domestic market.

2.0 Background

Australia (prior to this study) was estimated to export around 440kt of aluminium scrap including approximately 40kt of pre consumer extrusion scrap. Most of the scrap being exported was believed to be end of life products that in their new state were imported into Australia (i.e. not manufactured domestically).

In relation to the 440 kt of scrap export, there was little visibility on what it actually was (i.e. sources and alloys) and where it was generated (i.e. states and regions). The AAC has indicated that a clearer understanding of these materials would assist the Industry with addressing potential challenges relating to developing domestic remelt capacity.

It is expected that scrap metal, despite its current exemption under Australia's waste export ban, is anticipated over time to come under closer scrutiny as to its product fate. As a society we have a responsibility towards maximising recycling where economically, technically and environmentally feasible to do so. he AEAS report seeks to fill the gap through a detailed market sounding exercise on exported scrap aluminium.

3.0 Scope of the Report

AEAS in collaboration with the AAC conducted a market sounding exercise and material flow analysis to establish:

- What is the volume, locations and alloys mix for both pre and post-consumer export scrap aluminium;
- What is the potential for downstream manufacturing in Australia (i.e. potential re-use options) including and the feasibility of establishing recycling alternatives;
- What are the commercial and policy barriers (eg transport and logistics) to commercially sound and sustainable recycling and reuse solutions in Australia.

The outcome of the market sounding and material flow analysis provides key information and data relating to:

- Whether the theorised export figure is accurate and what is it made up of;
- How much of the theorised export figure has potential for any re-use option in Australia and what are the barriers to this;
- How much of the theorised export figure has no re-use option in Australia and why; and
- What is the likely growth rate of scrap and how will this impact commercial opportunities.

In better understanding the above, key information will be established for aluminium scrap exports in terms what it is and where it comes from. Additionally, the question will be answered whether there are better usages domestically for this material.

Limitations of analysis included in this report are that it significantly focuses on extrusion scrap. The intent was to include all scrap but there is insufficient data to enable analysis at a detailed level except on extrusion. Accordingly, a key recommendation is liaison with the Australian Bureau of Statistics to provide greater clarity on aluminium scrap materials exported.

[1] *https://international-aluminium.org/landing/environmental-claims/*

4.0 Methodology

The AEAS report was developed in close consultation with the AAC in order to establish the amount, origin and destination of aluminium scrap exports as well as challenges that are needed to be addressed for greater domestic utilisation of recycled materials to be realised. AEAS methodology included:

- An inception workshop was held with AAC;
- Comprehensive literature and statistical review of available information and previous reports;
- Development of an internal market sounding plan including establishment of proposed organizations, contact person interview list and questions for discussion; and
- A series of qualitative interviews with AAC and NWRIC members on exported aluminium materials in order to develop a more accurate understanding of the material flow of aluminium scrap exports.

The market sounding exercise sought to provide tangible and accurate data including the ability to understand and address market practices, material flows and other related issues. AEAS wishes to express its appreciation to the following organisations who participated in the market sounding exercise:

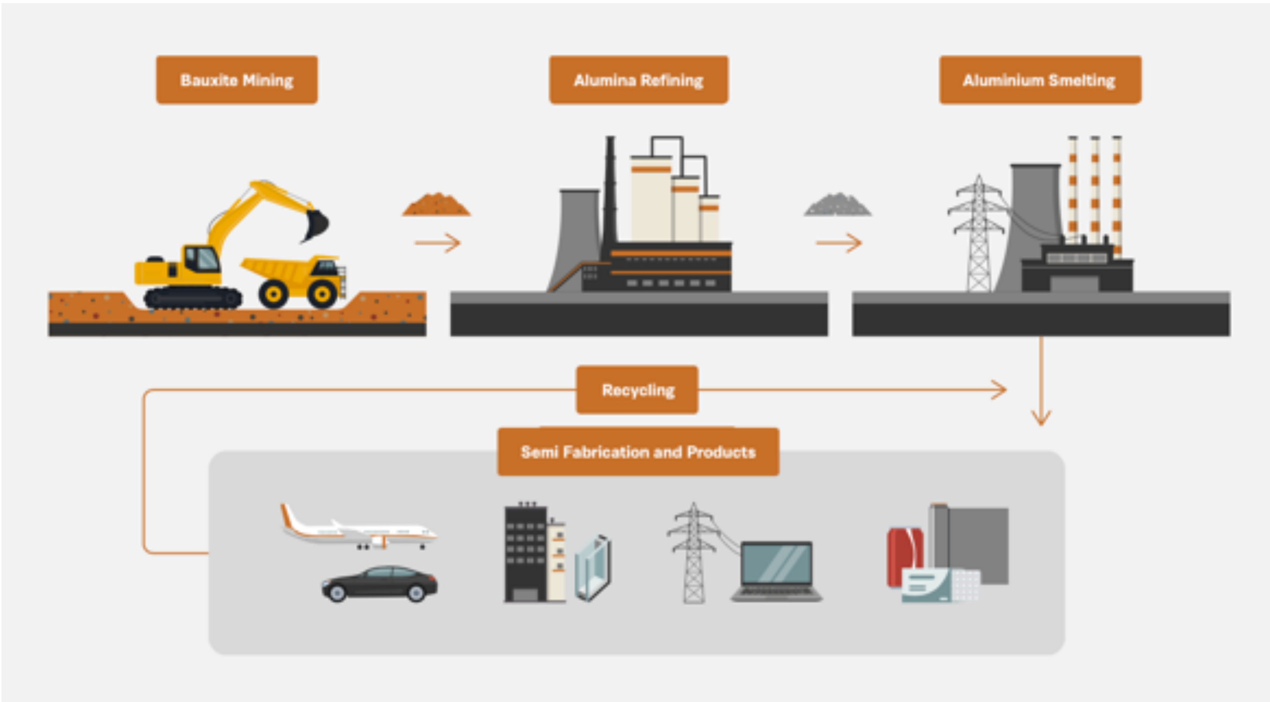
- Alspec
- Alumina Limited *(interview conducted pre 1/8/24)*
- Alushapes
- BlueScope Distribution
- Capral Limited
- Extrusions Australia
- G James Aluminium Products
- Inex – Independent Extrusions Ltd
- Infrabuild
- Rio Tinto
- Sims Metals
- Tomago Aluminium Company
- Vulcan Ullrich Aluminium

5.0 The Australian Aluminium Industry

5.1 Australian Aluminium Production

Aluminium is the most abundant metal in the earth's crust. It is strong, durable, flexible, impermeable, lightweight, corrosion resistant and infinitely recyclable. It is a critical enabler in a carbon-constrained future and supports the development of innovative technologies and solutions in various industry sectors including transport, marine, renewable energy, electrical and construction.

Figure 1: Aluminium Production Process



Source: Australian Aluminium Council 2024

The mineral bauxite is mined in Australia from open-cut mines in Queensland and Western Australia and transported to local refineries where it is converted into alumina (Al_2O_3), a fine white powder. The alumina is then smelted into pure Aluminium ingots and/or alloyed and cast into extrusion, sheet or foundry ingots. It takes 4-6 kilograms of bauxite (depending on the grade) to make approximately 2 kilograms of alumina, which then makes 1 kilogram of aluminium.

Aluminium smelters use an electrolytic process to extract aluminium metal from alumina which requires significant consumption of energy as electricity. Production of aluminium is an energy intensive process, with the underlying chemistry of electrolysis producing greenhouse gas emissions. Aluminium can be formed into various products by extruding, rolling or casting.

5.2 Australian aluminium industry Statistics

Australian aluminium industry has been operating in Australia since 1955, and over the decades has been a significant contributor to the Australian economy. The industry currently consists of 5 Bauxite mines (> 10 Mt); 5 Alumina refineries and 4 Aluminium smelters.

Figure 2: Map of Australian aluminium industry

Source: Australian Aluminium Council 2024

5.3 What is lower carbon aluminium

Aluminium is a "sustainable metal" that can be recycled time and again, however, there are significant variations in the carbon emissions generated by smelters during the production of primary aluminium.

The main contribution to the carbon emissions of aluminium comes from the electrolysis process used in aluminium smelting. Around 60 per cent of the Australian aluminium sector's carbon emissions are from the production of electricity consumed during the aluminium smelting process. The four Aluminium smelters producing primary aluminium within Australia are estimated to consume more than 10 per cent of the national electricity grid.

The carbon emissions in primary aluminium production range from under 2kg CO2e/kg Al to over 20kg CO2e/kg Al, largely dependent upon the energy sources used. According to market sounding and AAC the current global average carbon emission for primary aluminium is approximately 12.46kg CO2e/kg Al. The Australian average for 2023 is 11.74 kg CO_2-e / t Al.[2]

In response to the Paris Agreement, the global aluminium sector is working through pathways to reduce carbon emissions from over a billion tonnes of CO_2-e to around 50 million tonnes under a 1.5-degree scenario by 2050. This is less than one-twentieth of current emissions. The industry tracks its progress towards this via the International Aluminium Institute (https://international-aluminium.org/).

There is no agreed threshold or standard in the aluminium industry that defines low carbon aluminium. Different companies market material with their own brands and thresholds. For example in Australia Capral markets aluminium under their LocAl brand and describes the product as "Lower-carbon aluminium: using this term to describe primary aluminium with low carbon emissions of 8kg CO2e/kg Al or lower and secondary aluminium produced with large amounts of end-of-life scrap. Different companies may use other thresholds. Lower-carbon aluminium has the same technical properties as primary aluminium produced using traditional energy sources; it simply has lower embodied emissions.

Several Australian extruders have committed to reaching net zero emissions by 2050 through step change and innovation throughout their businesses, most notably within procurement and operations. Market sounding indicated that at present Australian extruders are now offering lower carbon aluminium options with carbon emissions of 8kg CO2e/kg Al to as low as 4kg CO2e/kg Al amongst the lowest carbon aluminium available globally.

As an example, according to Capral's website, 22 per cent of the primary aluminium billet Capral uses in its eight local extrusion presses has a carbon content lower than 8 kilograms CO2e per kilogram of aluminium. G. James and Alspec also market low carbon aluminium on their websites.

Market sounding has indicated that the market is now starting to look for low carbon products and Australian manufacturers see it as an important opportunity to make more responsible procurement decisions when they source extruded aluminium.

6.0 Recycling Australian Aluminium

6.1 The Waste Hierarchy and Aluminium

Aluminium will be one of the commodities most widely used in the global transition to a clean energy future. As Australia moves towards its net zero target, processes adopted by aluminium industry companies are reflecting or at least wanting to reflect the waste hierarchy, driving a circular economy and directly contributing to the economic growth and sustainability. This has resulted in recycling increasingly seen as a vitally important sector manufacturing input for value add in the economy.

The recovery of resources and the efficient operation of aluminium recycling in Australia results not only in a variety of tangible environmental benefits, including the reduced use of raw materials, energy and water savings and the avoidance of greenhouse gas emissions, but also considerable economic and employment benefits.

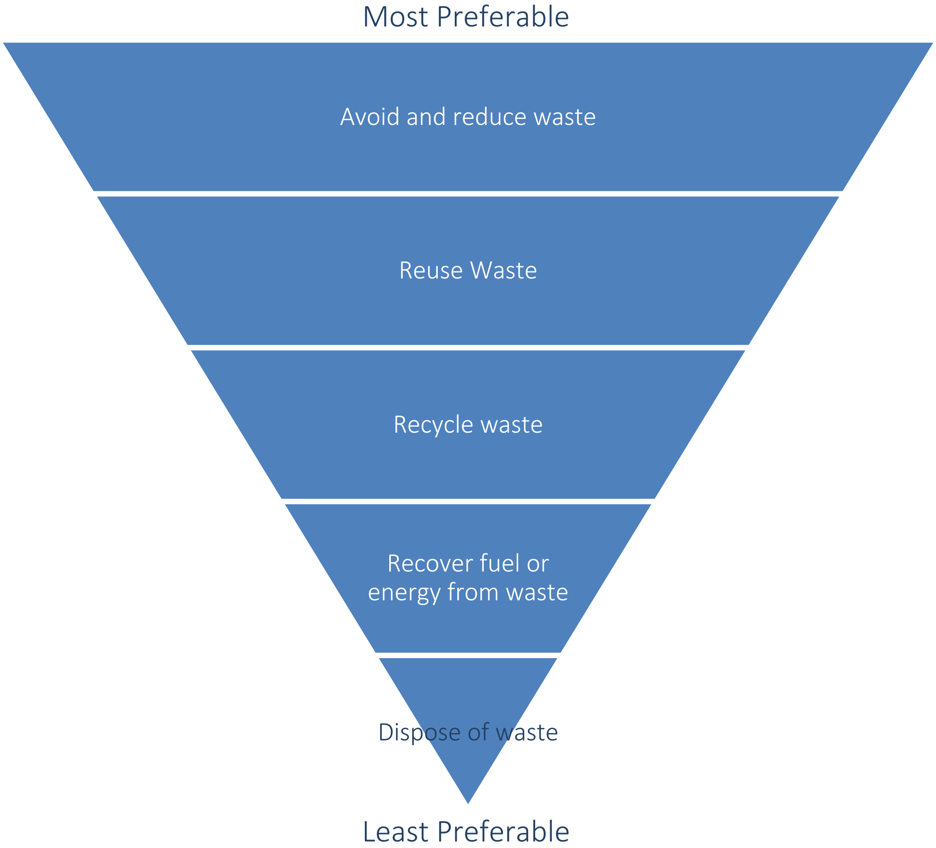
Specifically for aluminium, scrap can be recycled and is one of the most commonly recycled materials due to its sustainability and cost-effectiveness. Approximately 76 per cent of the aluminium ever produced is still in use today as it can be recycled again and again, almost infinitely, without compromising any of its unique properties or qualities, making it an incredibly sustainable material.*

Market sounding indicated that whilst aluminium scrap is a valuable commodity, the most economically sound business case relates to the minimisation of residuals from manufacturing and extrusion processes – that is the avoidance and reduction in scrap identified in figure 3.

**The global Recycling Efficiency Rate (RER) of aluminium is currently 76%. The RER defines how efficiently aluminium is recycled throughout the value chain. It is an indicator used to estimate the amount of recycled aluminium produced annually from scrap, as a percentage of the total amount of available scrap sources. This rate includes collection, processing and melting losses, but internal scrap is not included.*

[2] https://aluminium.org.au/sustainability-main/sustainability/

Figure 3: The Australian aluminium industry Waste Management Hierarchy



Source: AEAS 2024

6.2 Types of Aluminium Recycled

Most products of aluminium can be recycled, and nearly all aluminium products can be reprocessed into new material. Aluminium scrap is sourced from a wide range of consumer, commercial and industrial sources. There are generally considered to be three categories of aluminium scrap:

- Pre-consumer scrap is surplus material that arises during the manufacture and fabrication of aluminium products, up to the point where they are post-consumer to the final consumer. For example, offcuts of aluminium sheet or extrusions are considered pre-consumer scrap. This pre-consumer scrap has the potential to be safely recycled by aluminium smelters as its composition is known (albeit this practice is relatively limited in Australia).

Figure 4A: Types of Pre-Consumer Scrap (Industrial scrap)

Source: Rio Tinto 2024

- Post-Consumer scrap is material that has been used by the consumer and subsequently discarded. For example, used beverage cans, window frames, electrical cabling and car cylinder heads are all considered post-consumer scrap. Aluminium smelters have some restrictions on the ability to process some forms of scrap, these restrictions may be based on undesirable compositions, heavily contaminated scrap, and scrap types that have a higher safety risk (see section 6.3). Figure 4B: Post-Consumer scrap


6061 extrusion


Painted Sidings


Mixed

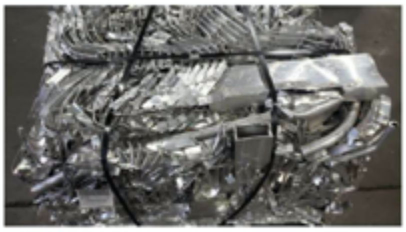

Old Cast

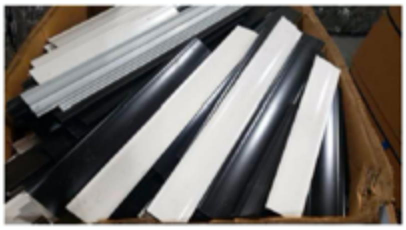

6061 Truck wheels


Twitch


1010 Extrusion


1010 Extrusion


6061-6063


6063 painted


3003 painted

Source: Rio Tinto 2024

- Internal Scrap is scrap which is pre consumer and is remelted in the same company where it was generated.

Table 1: Summary of Aluminium Materials Recycled

Scrap from Manufacturing	Industrial aluminium scrap, generated during the manufacturing process (cuttings, shavings, leftover material), is collected and recycled back into new aluminium products, reducing waste in production.
Foil	Clean aluminium foil used for cooking, wrapping, or food storage can be recycled. However, if the foil is heavily soiled with food waste, it should be cleaned before recycling to ensure proper processing. Recycled in dedicated facilities due to the very high surface area to volume ratio - giving potential high yield loss (low yield/high dross generation)
Packaging	Aluminium used in packaging, such as food trays, bottle caps, and takeout containers, can be recycled as long as they are free from contamination like food residue or oils. recycled in dedicated facilities due to the very high surface area to volume ratio - giving potential high yield loss (low yield/high dross generation)

Automotive Parts	Parts from vehicles, including engine components, wheels, and body panels, contain aluminium that is recyclable.
Construction	Architectural aluminium used in building construction, such as window frames, door frames, and curtain walls, is often recycled during renovations or demolitions. Aluminium in construction materials is highly recyclable and valuable.
Extrusions	Extruded aluminium products, such as those used in structural components, furniture, railings, and industrial applications, can be melted down and reused. Aluminium extrusions are widely used due to their lightweight and durable properties.
Appliances and Electronics	Many appliances (refrigerators, washing machines) and electronics (laptops, phones) contain aluminium components that can be recycled. These items are typically processed through special recycling centres to extract the aluminium and other valuable materials.
Wires and Cables	Electrical wires and cables made of aluminium can also be recycled. This material is common in power transmission and is valuable in scrap recycling.
Furniture	Outdoor furniture, chairs, and other products made from aluminium are fully recyclable, helping to keep this durable material in use for longer periods.
Used Beverage Cans	Beverage cans (soft drinks, beer, energy drinks) are the most commonly recycled aluminium products. They are easily collected, cleaned, and melted down to create new cans or other aluminium products.
Utensils and Tools	Kitchen utensils, tools, and other household items made from aluminium can be recycled, although they should be cleaned or decontaminated before processing.

Source: AEAS 2024

6.3 Recycling Process

The potential risk of explosion when recycling or remelting aluminium is the most important consideration. Any scrap type that could or may contain entrapped moisture (for example in baled or compacted scrap), pressurized vessels, chemical oxidisers, nitrates, sulphates, fertilizer should be avoided and treated separately and specifically for these risks. Other considerations for the recycling aluminium include:

- Cleanliness: Aluminium must be clean and free from contaminants (such as Oil/grease, any coatings or anodic films, wood or other metals).
- Mixed components: Some aluminium products, may be combined with plastic or other materials, making them harder to recycle unless separated eg windows with thermal breaks and cross contamination with other metals.

Accordingly, the recycling process should reflect these considerations and can roughly be summarised a having six steps. Recycling aluminium has five steps:

Table 2: Summary of Recycling Process

Step 1: Collecting Scrap	Scrap aluminium is also collected from the community – from households, scrap merchants, local and regional authorities, etc.
Step 2: Sorting Scrap	The scrap is then sorted – grouping scrap qualities together (criteria for sorting can include enclosed/pinched scrap (explosion risk criteria), level of contamination (explosion risk criteria and yield criteria), and surface area to volume ratio (yield criteria). Extraneous items such as paper, plastic and other non-aluminium should be removed. At this point some scrap types can be directly recycled. Other types require further processing.
Step 3: Shredding	If required scrap can be shredded into smaller pieces and processed to remove contaminants like iron, paint, plastics, and dirt.
Step 4: Crushing	If required sorted aluminium may be compacted into bales – this is typically used to reduce the volume thereby reducing freight, storage and handling costs. Care should be taken when

	remelting or recycling compacted scrap as it may contain contaminates or entrapped moisture that can be an explosion risk.
Step 5: De-coating and Remelting	Uncoated scrap can be loaded directly into re-melting/melting furnaces. If the scrap aluminium is coated, it is typically processed through a gas fired rotary furnace to remove any coating and then transferred to the remelter. Note, this is the process for a dedicated remelter, rather than a smelter.
Step 6: Melting and Casting	The molten aluminium is cast at a temperature of just over 700°C to form ingots. The casting (and melting) process may be somewhat altered for recycling. For the melting process, metal charging routines may need to be adapted for recycling and metal cleanliness routines and equipment of various types are used.

Source: AEAS 2024

Market sounding indicated that in practice after ("rough") sorting into fractions based on format (using criteria such as surface area to volume ratio, enclosed/closed scrap and Level of contamination), scrap may be further processed (noting that a portion of post-consumer scrap is already ready to be recycled at this point - wheels for example are typically send straight to recycling without more handling).

Ideally scrap should be sorted at the collection point (for example can collection). Although not widely used in Australia, internationally much scrap is already rough sorted at the collection point (format and potentially alloys). Shredded scrap is typically the lowest quality – and will require further processing. Painted scrap also requires further processing.

Shredded scrap is then typically processed on site at the recycler. A typically processing is "fine" sorting with both magnets (to remove steel), and online scrap sorting technologies. Heavily contaminated scrap (like painted) will also go through a delacquering/decoating process. It is like a tree process with acceptable fractions of scrap taken off at each step and lower quality scrap continuing on for further processing. The sorting normally (and should) follows a process based on explosion risk of the scrap type, level of contaminated and yield on remelt.

6.4 Australia's Current Aluminium Recycling Capability

Whilst scrap aluminium has long been collected for recycling within Australia, Australian aluminium smelters have had limited capacity for remelting and an estimated 95 per cent of Australia's scrap aluminium is exported for recycling. A full statistical summary is provided in section 7.0.

Despite having an integrated primary aluminium sector, the closure of Australia's car industry a decade ago was accompanied by a closure in the two aluminium rolling mills which also provided aluminium remelt capabilities. According to the market sounding, Australia has essentially lost its downstream recycling/manufacturing capability.

There are however limited examples of recent remelt pilots or trials including:

- In 2022, Capral Aluminium and Tomago Aluminium, publicly announced a partnership to remelt 550 tonnes of pre-consumer scrap annually. This pilot was not continued.

- In 2024, Capral Aluminium and Rio Tinto's Boyne Smelter Limited completed a closed loop recycling trial to deliver locally produced primary aluminium billet containing a minimum of 20 per cent recycled content sourced directly from extruder's manufacturing sites.

In the main, the market sounding indicated that it is challenging for primary producers to ensure scrap re-processing is commercially viable due to supply chain/logistics costs, contamination/quality as well as reduced production rates when remelting and economics have yet to be validated. These are discussed more extensively in section 10.

7.0 Policy Drivers Underpinning Australian Aluminium Recycling

Australia's recycling industry is operating during a period of evolving government policy with the implementation of the Australian Government's response to climate change, the National Waste Policy and the implementation of an export ban on waste materials that can be recycled.

7.1 The Paris Agreement

Australian industry is undergoing a major transformation. One of the major drivers for this transformation is the COP21 Paris agreement. The UN Paris Agreement, signed by 196 countries in 2016, committed the world to limit global warming to 1.5 to 2.0 degrees Celsius above pre-industrial levels. This agreement seeks to reach global peak emissions as soon as possible and achieve net-zero emissions in the second half of this century.

To achieve a 1.5-degree pathway, all sectors of the global economy including the Aluminium Industry require dramatic emissions reductions over the next ten years. For this to happen, low-carbon technologies are needed to grow quickly, coupled with waste reduction, reuse and recycling, resulting in diversion from landfill reducing emissions and reducing the need for virgin materials and, in turn, their manufacturing emissions. The climate conferences in Glasgow (2021) and Bali 2022 (COP26) continue to show global support for environmental change.

The Australian Government has signed up to the Paris Agreement and set a target of net-zero emissions by 2050 – in line with the Agreement. All Australian states and territories have committed to achieving net zero targets within varying levels of ambition between 2030 and 2050.

7.2 National Waste Policy

The National Waste Policy and Action Plan provides a national framework for action by governments, the business sector, the waste and resource recovery industries, and communities to achieve sustainable waste management and recycling in Australia until 2030.

The policy responds to the challenges facing waste management and resource recovery in Australia, and the China Sword Policy, and reflects the global shift towards a circular economy – including the need for better resource-efficient systems, products and services to avoid waste, to conserve resources and maximise the value of all materials used. It also acknowledges the need to improve our capacity to better design, reuse, repair and recycle goods used.

The following are targets of the National Waste Policy:

1. Ban the export of waste plastic, paper, glass and tyres, commencing in the second half of 2020;
2. Reduce total waste generated in Australia by 10 per cent per person by 2030;
3. 80 per cent average resource recovery rate from all waste streams following the waste hierarchy by 2030;
4. Significantly increase the use of recycled content by governments and industry; and
5. Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions

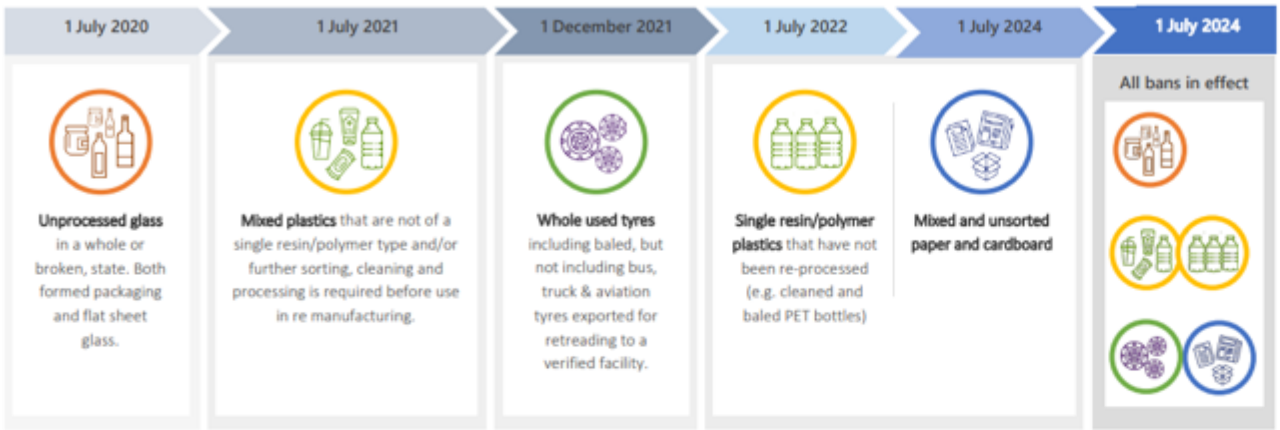
7.3 Export Ban on Recycled Materials

In August 2019, a decision was made by the Council of Australian Governments (COAG) to establish a timetable to ban the export of waste plastic, paper, glass and tyres, while building Australia's capacity to generate high-value recycled commodities.

Transforming waste material into high-value materials is hoped to create jobs, build a more sophisticated industry, and provide positive outcomes for the environment and community wellbeing. The Commonwealth, State and Territory governments and the Australian Local Government Association agreed to a response strategy at the 13 March 2020 COAG meeting.

All unprocessed glass, mixed plastics, whole used tyres, single resin/polymer plastics and mixed and unsorted paper and carboard will be banned for export by July 2024. Metals including aluminium are currently excluded under the ban.

Figure 5: Australian Waste Export Ban Timetable



Source: COAG Waste Response Strategy

Under the ban, action by all levels of government is required in the following key areas: driving demand for recycled content; public education to reduce contamination at its source; investment in recycling and waste infrastructure; improving access to, and quality of, waste tracking data; improving product design and fostering innovation and commercialisation of new technology; and accelerated development of standards for use of recycled material in civil works.

7.4 Implication for Australia's Recycling Industry

It is widely accepted that the Australian aluminium industry has a social license in respect to the management, processing and recycling of waste that aligns with the policy directives of Australia's tiers of Government and community expectations. With strong government and industry investment and overwhelming public support for resource recovery, recycling, and local remanufacturing, there is significant opportunity for activating the full potential of Australia's recycling sector through key policy measures.

It is anticipated that the aluminium industry companies' commercial and community importance will be future proofed with greater domestic utilisation of recycled scrap for aluminium production in tandem with usage of renewable energy. This however will require greater focus on developing local remelt capacity and resilient nearby supply chains for recycled scrap aluminium.

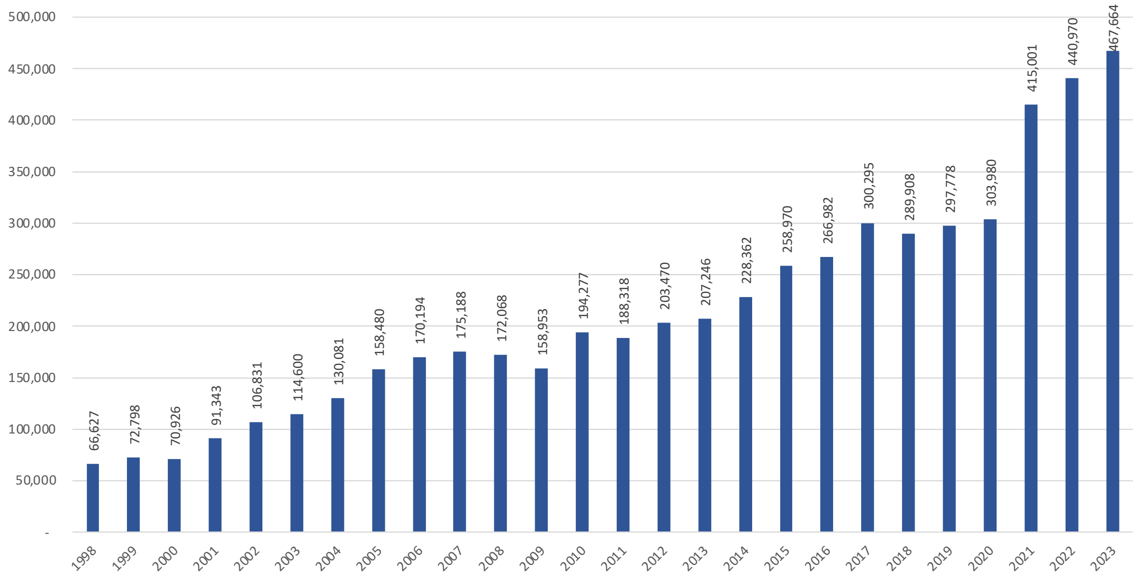
8.0 Australian Scrap Industry Statistical Anlaysis

8.1 Domestic Utilisation of Aluminium Scrap and Aluminium Scrap Generation

The International Aluminium Institute currently estimates the global Recycling Efficiency Rate (RER) of aluminium is currently 76%. Market sounding indicated that Australian collection rates are expected to be higher than this, with for example all Australian states and territories having in place container deposit schemes. Market sounding indicates that currently most scrap aluminium due to its value (see figure 8) is recycled but virtually all (~95 per cent) aluminium scrap metal is exported. None of the largest scrap companies supply any local remelting capability (given its absence), rather they send their scrap offshore to end users. Based on the above and market sounding, the volume of scrap aluminium exported may also be used as a reliable guide to the volume of aluminium scrap generation in Australia. Figures 6, 7 and 8 indicate:

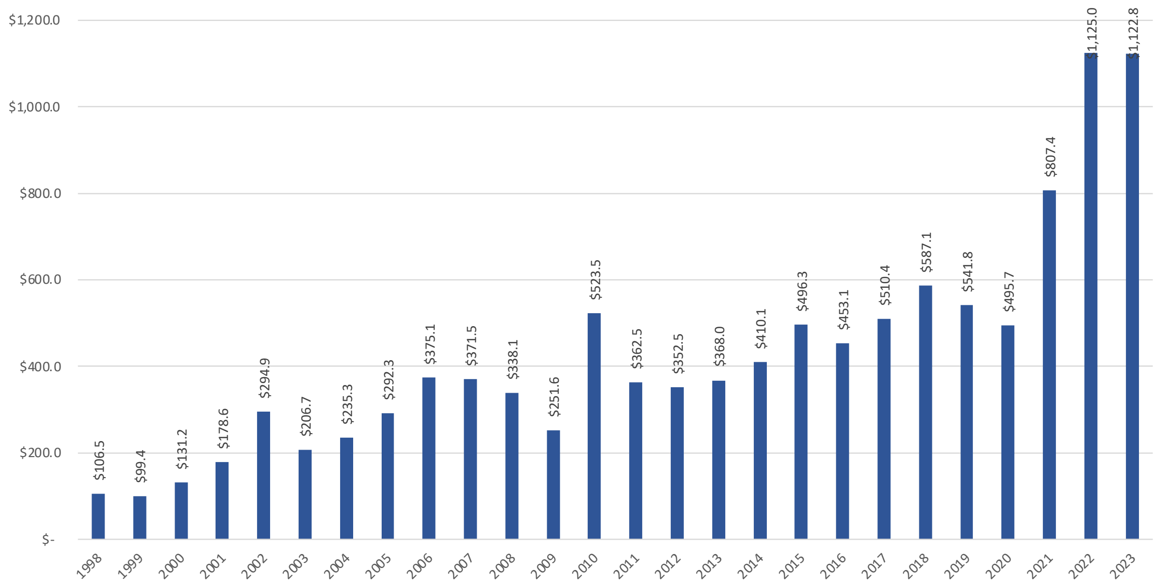
- The volume of exported scrap aluminium has steadily risen over the past two decades with the last three years seeing annual volumes well over 400,000 tonnes per annum (figure 6). In 2023 the amount of scrap exported was 467,664 tonnes. There was no reason established as to why volumes are up in the last three years;
- Commensurately the value of exported scrap aluminium has also steadily risen and is now valued in excess of $1.1 billion (figure 7). That is aluminium scrap export is a billion dollar industry; and
- Scrap aluminium is a valuable commodity and in 2023 had an average value of $2,401 per tonne (figure 8)

Figure 6: Annual Scrap Aluminium Export Volumes (tonnes)



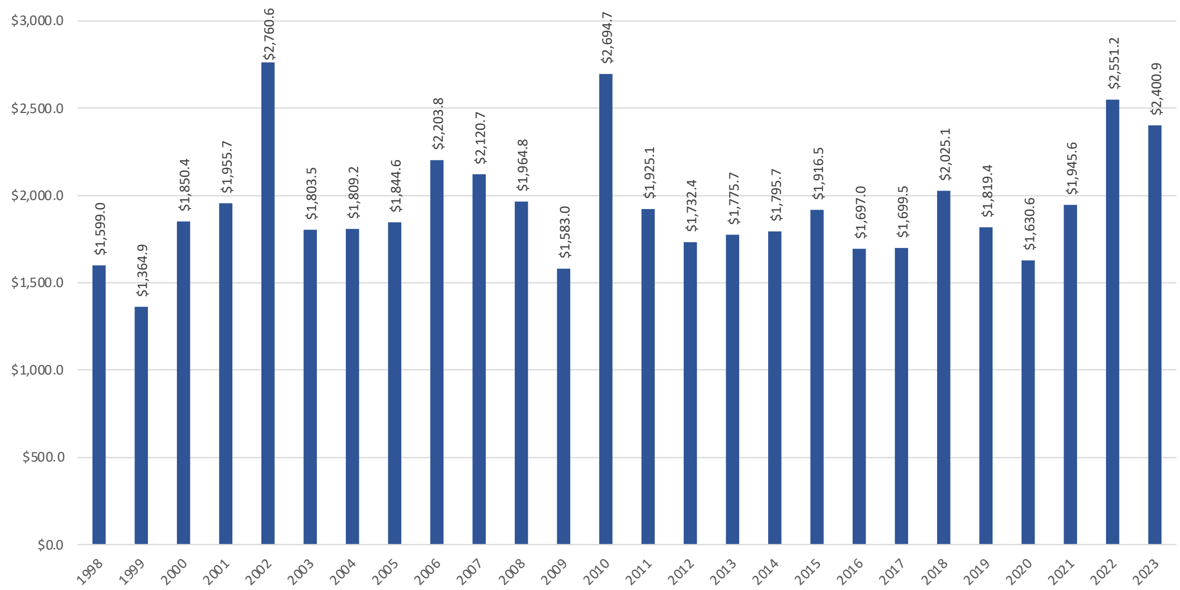
Source: AAC, ABS and AEAS 2024

Figure 7: Value of Scrap Aluminium Export Volumes ($ millions)



Source: AAC, ABS and AEAS 2024

Figure 8: Average Annualised Export Value Per Tonne of Aluminium Scrap ($)



Source: AAC, ABS and AEAS 2024

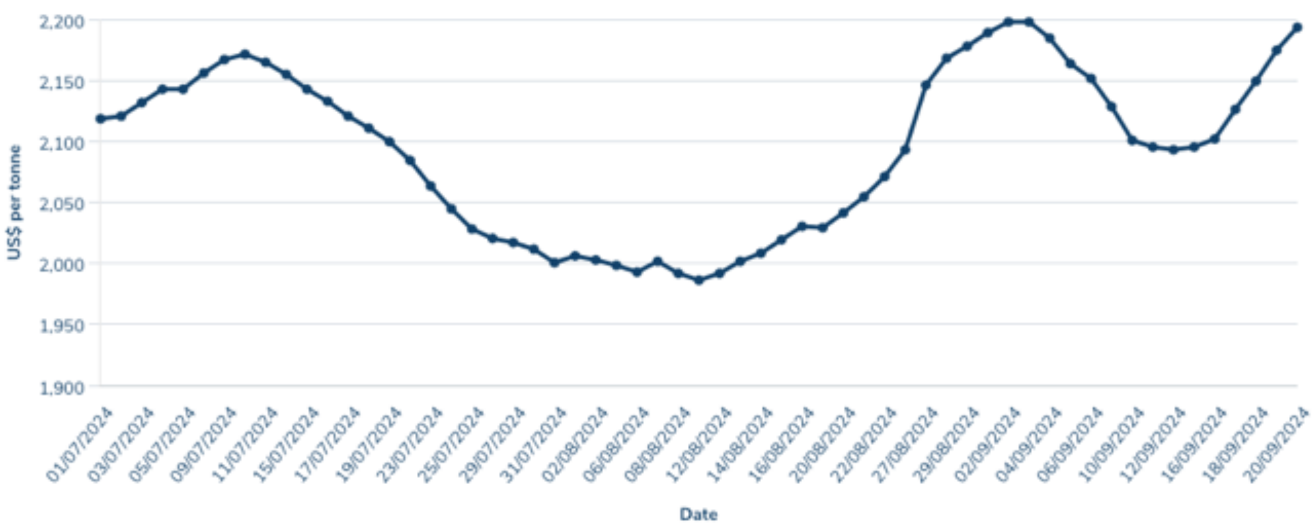
8.2 Determinants of the availability of aluminium scrap generation and export volumes

Based on market sounding the largest determinant of the availability of domestic aluminium scrap metal is the end of life of existing aluminium products and its recovery rate. This can be seen from figure 12 where in 2023 the absolute majority of aluminium scrap (90.7 per cent) was post-consumer scrap. Market sounding indicated Australia doesn't manufacture most of this and it is largely from imports (that is, it is not a product stewardship issue for smelters but instead one for importers). However, it is instead potentially a source of future resource for lower carbon aluminium and a potential source of "recycled content" for their output if treatable and if there is a local downstream processing industry to convert it into semis, which Australia is currently importing.

Following the actual availability of recovered aluminium scrap metal, competition for scrap (and therefore whether the metal is theoretically available for domestic remelt) is determined by the “buy price” offered to the scrap generator. The price of scrap aluminium is priced as a percentage of the London Metals Exchange in USD (converted to AUD) and reflects specifications regarding quality, lot size and shape. More specifically, the buy price for aluminium is influenced by a combination of factors including:

- The global scrap aluminium price (global demand and supply);
- The expected yield from the scrap is also determining to a large extent the price;
- Scrap is a % of LME. Accordingly, a lot of the increase in price of scrap is actually just because LME is going up
- Global shipping rates;
- Exchange rates;
- The expected shredder floc / dross content of the scrap and the cost of disposal in the buyer’s jurisdiction. Additionally, dross generated from recycling is often difficult to dispose of (in most western countries), by exporting scrap we are also exporting a waste issue.
- Local processing and logistics costs.
- Availability of shipping containers;
- Trade barriers and effects (eg, Article 232 of China’s ‘National Sword Policy’); and
- Other duties and taxes of foreign jurisdictions.

Figure 9: LME Aluminium UBC Scrap US (Argus) Closing Prices graph



Source: LME, AEAS 2024

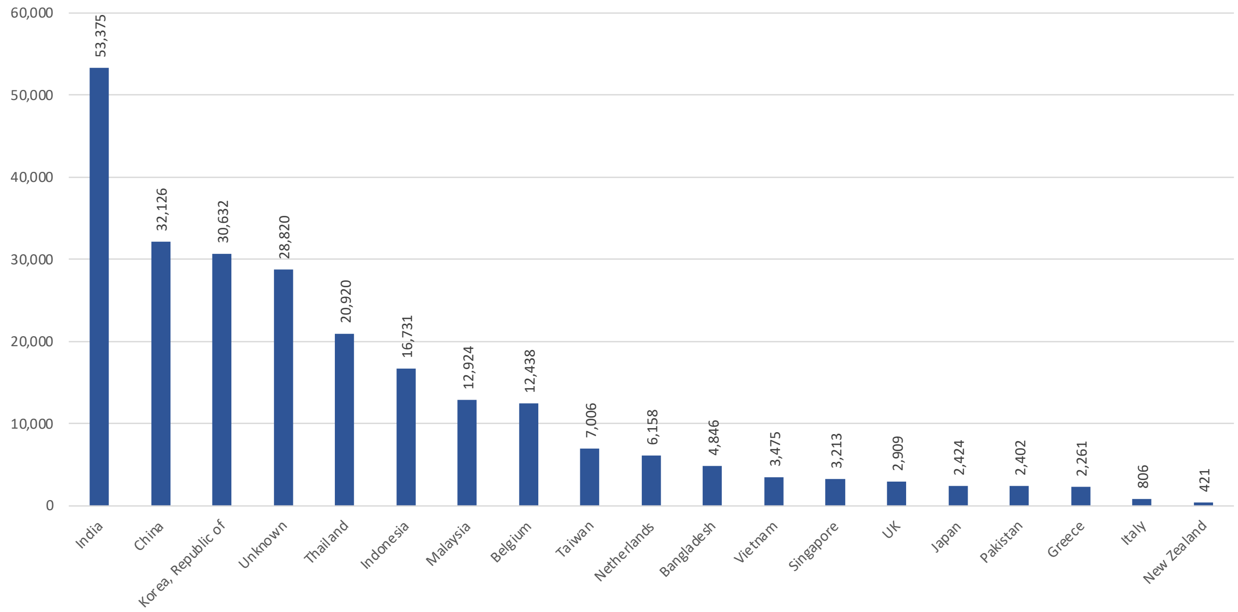
Feedback indicated above data is only over 3 months and ideally it would be preferrable to be able to compare over a longer period to see whether price is a driver of recycling levels.

Scrap aluminium is traded as a global commodity on an export parity basis and what is currently missing in Australia is local reprocessing capability as well as demand from end users (including manufacturing) of pre- and post-consumer aluminium scrap materials which is why much of it is exported offshore. It is critical that any development of more local onshore remelt capacity is based on the globally competitive nature of the entire value chain.

8.3 Australian Scrap Aluminium Scrap Export Markets

Australian's major scrap aluminium export markets include India, China, Korea, Thailand and Indonesia.

Figure 10: 2022-23 Scrap Aluminium Export Volumes By Destination (tonnes)

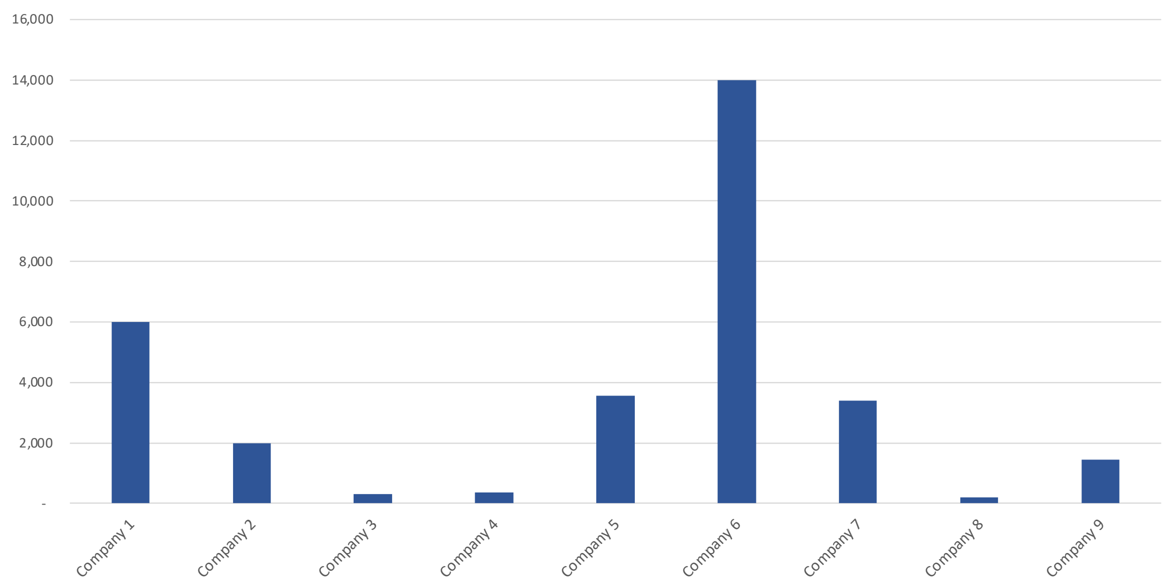


Source: AAC, ABS and AEAS 2024

8.4 Estimates of Pre-Consumer Scrap Aluminium

Through the detailed market sounding process, AEAS has confirmed amount of pre-consumer aluminium extrusion scrap in 2023-24. Through the market sounding process, AEAS was able to account for 31 k tonnes of pre-consumer extrusion scrap.

Figure 11: Company Estimates of the Amount of 2023-24 Pre-Consumer Scrap Aluminium Generation



Source: AEAS 2024

Based on market sounding, AEAS has provided an estimate range for the total amount of pre-consumer aluminium scrap. The amount of annual pre-consumer scrap aluminium generated is estimated to range between 40 to 47 k tonnes per annum. The mid-range estimate is 43 k tonnes of pre-consumer aluminium scrap and is believed to have the highest confidence in its accuracy.

Table: 3 Estimate Range of Pre-consumer Scrap Aluminium Exported 2023-24 (tonnes)

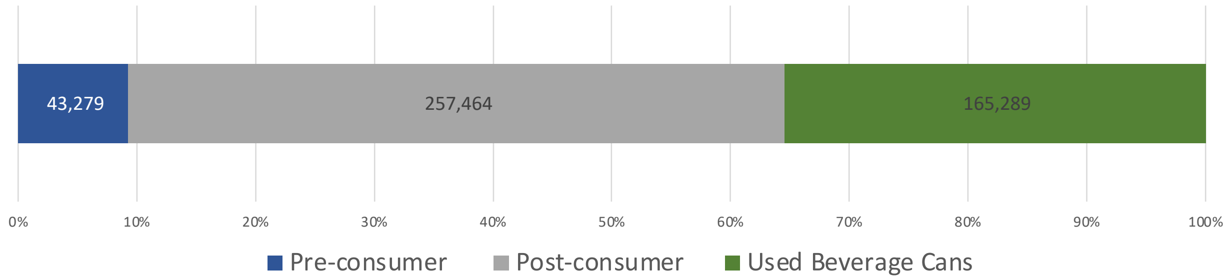
	K Tonnes
Lower range	40
Mid-range	43
Upper range	47

Source: AEAS 2024

Accordingly, the market sounding exercise confirms that the Australian aluminium industry particularly in respect to extruders make up only a small percentage (9.3%) of scrap aluminium exports but also scrap aluminium generation. The Industry's responsibility for end-of-life scrap aluminium is minimal (see figure 12) and instead arises predominantly from overseas manufactured products.

There could be merit in better collection of data on the composition of the post-consumer scrap in Australia's exports, for example by the Australian Bureau of Statistics. The market sounding indicated that regardless of source or composition it represents a significant resource and can be manufactured.

Figure 12: 2022-23 Scrap Aluminium Generation and Export Volumes (tonnes) by Scrap Type



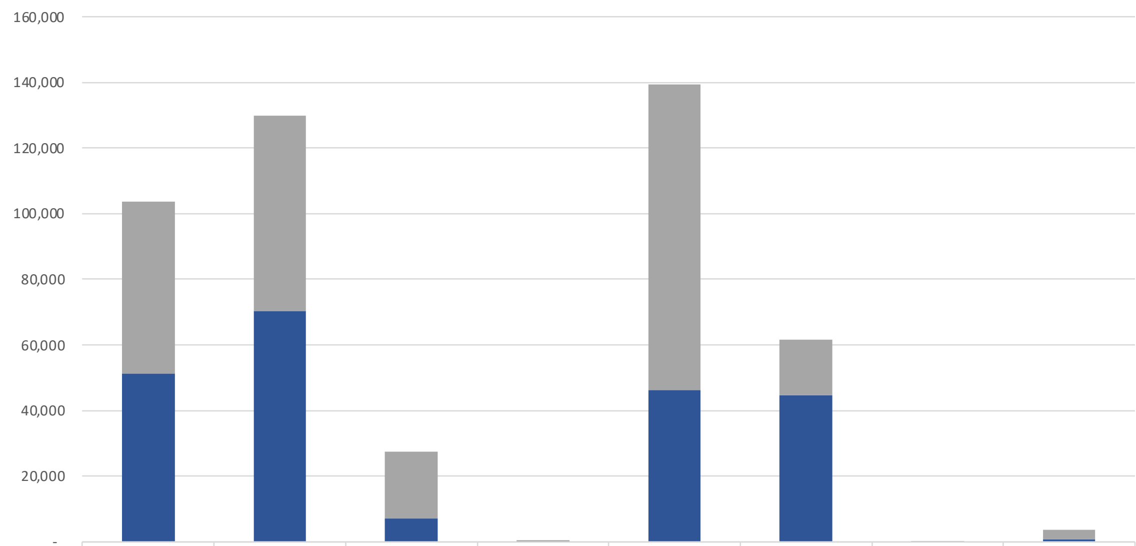
Source: AAC, ABS and AEAS 2024

Additionally, feedback indicated that the estimated tonnes for used beverage cans was too high. Feedback indicated that India uses different trade codes, and all materials imported show as 'used beverage cans' but aren't (this had been estimated at 55,634 tonnes). Accordingly, the above graph has been adjusted to add 55,634 tonnes to post consumer scrap and the volume deducted from used beverage cans.

8.5 Aluminium scrap generation and export volumes by State

By State, Victoria generates and exports the largest volume (92,942 tonnes) of scrap aluminium followed by Queensland (59,541 tonnes) and NSW (52,226 tonnes).

Figure 13: 2022-23 Scrap Aluminium Generation and Export Volumes By State (tonnes)



	NSW	QLD	SA	TAS	VIC	WA	NT	Re-export
Scrap	52,226	59,541	20,286	332	92,942	17,038	24	2,720
used beverage cans	51,341	70,388	7,130	160	46,307	44,692	20	885

Source: AAC, ABS and AEAS 2024

8.6 Key finding

Market sounding indicated that the Industry relies heavily on scrap companies and ultimately their economic case favoured the scrap being exported as the transport costs of international shipping was considerably lower than the option of road transport to Australian smelter (see section 10.1 for more detail).

9.0 Benefits of recycling aluminium

9.1 Economic Benefits

Recycling aluminium provides significant economic benefits due to its efficiency, energy savings, and the value it adds to Industry. Key economic benefits are provided in the below table:

Table 4: Economic Benefits of Recycled Scrap Aluminium

Energy Savings	Recycling aluminium uses only 5 per cent of the energy required to produce new aluminium from raw materials (bauxite ore).
Job Creation	The recycling industry, including aluminium, creates a wide range of jobs, from collection and sorting to processing and manufacturing. In Australia recycling contributes to thousands of jobs, boosting local economies.
Reduces Landfill Costs	Aluminium scrap diverted from landfills reduces the volume of waste, lowering the costs that municipalities or governments face for waste management. Recycling aluminium helps extend the lifespan of existing landfill sites, leading to reduced waste disposal costs.
High Recycling Value	Aluminium is valuable in scrap form. It retains a significant portion of its value even after use, making it highly desirable for recycling businesses. This demand for scrap creates opportunities for businesses and individuals to profit by collecting and selling aluminium scrap. It was highlighted that there will be higher dross levels from recycled aluminium which must be disposed of.
Increased Revenue Streams for Companies	Companies that use or generate aluminium waste can sell their scrap to recyclers, turning waste into a profitable resource. This helps companies reduce their operational costs and increase revenue streams.
Supports Circular Economy	Recycling aluminium aligns with the principles of a circular economy, where materials are reused and recycled, leading to long-term economic sustainability. It helps industries optimize resources, reducing the need for raw materials and minimizing environmental costs.

Source: AEAS 2024

Market sounding indicated there are other significant financial and commercial benefits to sustainable business practices such as recycling including:

- Improves rating of company thereby attracting investors and influencing stock prices;
- Improves ESG reputation generating stickiness and pull from customers;
- Increases employee engagement and attracts and retains the best talent improving employee productivity with millennials and Gen Z wanting employers to share their values;
- Improves reputation with end users and communities in which the smelters operate;
- Helps meet carbon abatement targets and justification of industry assistance form Government; and
- Increasingly provides access to financial or cheaper capital leading to better financial returns.

As awareness of climate change and the necessity of climate action grows amongst our population, decarbonisation and sustainability according to the market sounding is resulting in opportunities for the Industry to grow further and enhance existing revenue lines through proven sustainability credentials.

In summary, aluminium recycling provides energy and cost savings, job creation, waste reduction, and additional revenue opportunities, all contributing to strong economic benefits to aluminium industry companies.

9.2 Environment Benefits

Recycling aluminium also offers numerous environmental benefits, making it a key component of sustainable practices. Key environmental benefits are provided in the below table:

Table 5: Environmental Benefits of Recycled Scrap Aluminium

Energy Conservation	Recycling aluminium uses only 5 per cent of the energy needed to produce new aluminium from raw materials (bauxite ore). By conserving energy, it lowers carbon emissions and helping mitigate climate change.
Preservation of Natural Resources	Recycling reduces the need for mining bauxite, the raw material from which aluminium is made.
Reduction of Waste in Landfills	Aluminium is highly durable and does not break down in landfills. Recycling aluminium prevents it from ending up in landfills, reducing landfill waste, and extending the lifespan of existing landfill sites.
Lower Environmental Impact of Manufacturing	Recycled aluminium requires fewer processes than new aluminium production, reducing the need for inputs and decreasing the overall environmental footprint of manufacturing processes.
Sustainability and Circular Economy	Recycling aluminium is a cornerstone of the circular economy, which emphasizes keeping materials in use for as long as possible. Aluminium can be recycled indefinitely without losing its properties, making it a sustainable resource that reduces the need for new raw materials and minimizes environmental harm.

Source: AEAS 2024

Market sounding was unclear whether the carbon footprint of exporting scrap metal to an overseas recycling facility was higher or lower than the transfer of scrap metal to an Australian aluminium smelter with the answer ultimately depending on the road transport distances from collection/processing to the Australian smelter.

In summary, recycling aluminium conserves energy, reduces greenhouse gas emissions, minimizes environmental pollution, and preserves natural resources, making it a highly beneficial process for the environment. For all of these economic and environmental benefits global demand for recycled aluminium is growing more than two times faster than primary product supported by favourable regulation and corporate demand for lower carbon products

10.0 Barriers to the recycling of aluminium

10.1 Barriers and Challenges

Recycling aluminium is highly beneficial but based on market sounding significant barriers prevent its widespread adoption in Australia. These barriers can be categorized into technical, economic, and societal challenges:

Table 6: Barriers and Challenges to Recycling Scrap Aluminium

Contamination of Scrap Material	Aluminium products often contain other materials (e.g., coatings, paints, plastics, or adhesives), making it harder to recycle. Aluminium comes in different alloys for specific applications (e.g., used beverage cans, automotive parts), and mixing alloys during recycling can affect the quality of the recycled aluminium, limiting its reuse in high-quality applications. Effective separation of aluminium from other metals and materials is crucial but not always achieved, especially in products where aluminium is bonded with other substances.
Collection and Sorting Infrastructure	In many regions, aluminium recycling systems are underdeveloped or inconsistent, leading to low collection rates. Consumers may not properly sort or recycle aluminium, especially in regions (regional Australia) with weak recycling infrastructure or low public awareness of recycling benefits. Investment in sorting technologies is needed to properly separate aluminium from mixed waste streams, but these are not universally available, especially in regional Australia. The ability to collect scrap over the geographically large area and the transportation costs are reported to be a significant barrier. It is noted that these issues are not confined to regional Australia.

Economic Barriers	The cost of collecting, sorting, and processing scrap aluminium can be high, particularly if the scrap is contaminated or mixed with other materials. This may make recycling less economically viable. The market value of scrap aluminium can fluctuate, sometimes making it less economically attractive for recycling facilities to collect and process aluminium compared to other materials. The lack of strong government policies, subsidies, or incentives to promote aluminium recycling discourages investment in recycling infrastructure. Australia coastal bulk shipping costs and vessel availability are prohibitive.
Global Disparities in Recycling Rates	Limited access to the infrastructure needed for effective aluminium recycling, leading to low recycling rates as is the case in Australia. Accordingly aluminium scrap is exported rather than recycled locally, which can reduce the availability of high-quality recycled aluminium for domestic use.
Design for Recycling	Many aluminium-containing products are not designed with recycling in mind. Products that are difficult to disassemble or contain mixed materials (e.g., aluminium with plastic or composite materials) make recycling more challenging and less efficient.
Consumer Behaviour and Perception	Consumers may not recycle aluminium consistently due to a lack of awareness about the benefits of recycling or the perception that it's inconvenient. In some areas, recycling programs are underutilized because of inadequate consumer engagement, leading to lower collection rates for recyclable materials. Recyclers and authorities and the Aluminium industry need to also promote recycling (sorting) of aluminium. There is also a perception that because "scrap/waste" is used, that it should be cheaper, and it is nascent at this stage whether customers are willing to pay a premium for lower carbon/recycled product.
Technological Limitations	Items such as electronics, cars, and appliances contain multiple metals, plastics, and other materials, complicating the recycling process and lowering the efficiency of aluminium recovery from these products.
Other	The market value follows rather closely the LME and transport costs. The demand for scrap is highly linked to the demand for Aluminium. Local scrap processing and remelting capabilities are limited. Some Australian smelters may be constrained in terms of the capacity in their cast houses. This may mean undertaking recycling of any scrap (pre or post-consumer) would mean needing to reduce the amount of hot metal able to be cast Even where smelters have capacity it may only be to some product lines within the cast house. This can also impact the range of scrap which could be re-melted without impacting the quality (i.e. customers are sensitive to silicon, iron, copper, manganese, magnesium, chromium, zinc levels)

Source: AEAS 2024

Feedback indicated these lead to a lack of investment in infrastructure and low recycling rates. In addition, there are some limits to the potential role that scrap metal can play in supplying inputs to Australian smelters. These include:

- An increase in the percentage of floc (waste contamination) content;
- Cost of removing and disposing of contamination; and
- Price increases from government fees and regulation (most of which is made up of landfill levies) and the inability of local processors to recover these costs in the 'sell price'.

Market sounding indicated that an Australian smelter closed their associated rolling mill which included remelting options 10 years ago not because of a lack of available aluminium scrap to recycle but because of the high costs of sorting and collection along with the closure of the associated smelter. Energy, labour, environmental and other compliance costs associated with operations were also influential, but feedback indicated the most significant cost, and impediment was the logistic management and cost associated to the collection and sourcing of enough material to meet production requirements. While that plant (50-60kt) could use a wide range of material and alloy types in their production, the scrap had to be sourced across multiple states.

Having to source product from outside of a particular region meant paying the additional transport over and above what it would cost to export. For example, estimates based on the market sounding found that while road transport from Brisbane to Sydney could be around $225 per metric tonne, sea transport from Brisbane to South East Asia could be comparatively around a quarter of this cost at only $50 per metric tonne. Costs of road transport from regional areas may be substantially higher.

Furthermore, smelters indicated that due to their existing technology and process they are restricted in remelting recycled scrap. In addition, costs incurred would need to be absorbed or passed onto customers with reservations expressed that the increase is affordable.

To overcome these challenges, improvements in collection and sorting infrastructure and investments, public awareness and policy incentives are needed.

10.2 Addressing Key Barriers:

Through the market sounding, Industry indicated that it would like to move to using recycled aluminium to meet its needs as it moves to decarbonise manufacturing processes however key challenges referenced in 10.1 will need to be addressed. More specifically examples of solutions being deployed by Industry include:

10.2.1 Financial Viability

As part of a literature review for this report, Deloitte[3] indicated that international leaders in aluminium recycling are taking three consistent measures to ensure they can provide quality and reliable recycled products. These include:

- Securing high quality scrap feedstock supplies. For example, by employing new leasing business models to collect and recycle products such as aluminium window frames employed by Norsk Hydro, or acquisitions of specialist metal recyclers such as Alux which CBA Brazil recently completed for USD $21 million.
- Securing offtake agreements with large manufactures for recycled products. For example, Novelis North America is developing closed loop agreements with automotive clients.
- Embracing modular capacity to co-locate recycling capability with supply of scrap. Demonstrated by Norsk's $51m investment in their Eastern Pennsylvania plant and Rio Tinto's $29 million expansion of its Arvida Smelter to add new aluminium scrap recycling capacity.

These examples are all taking from countries with very large domestic markets which support significant in-country scrap recycling.

10.2.2 Contamination

A major challenge in the recycling of post-consumer scrap (PCS) is to ensure that the quality of the metal is preserved in the recycling process, and to identify the alloys and properties of the metal being purchased. The metal must be collected and properly sorted, before being recycled back to high-quality products. Market sounding indicated that smelters must have a clear understanding on the quality and composition of the scrap feedstock. Typically, the more the scrap is sorted and processed the better it is for the smelter and creates value. Scrap merchants also indicated that technology is enabling this to occur. For example, new technology in scrap shredding and sorting, is under development making it possible to produce high-quality products from post-consumer. This uses laser induced breakdown spectroscopy (LIBS) that enables the recovery of specific aluminium alloys. The technology was developed in and currently being used in Europe.

10.2.3 Lost productivity

When recycling PCS there is metal loss when the pieces are too small or thin which can lead to dross. To address this issue, companies have developed a 'screw extruder' to handle thin gauge scrap such as chips, swarf or shredded material. The screw will compact the scrap and the larger metal pieces which will reduce dross generation in the recycling process.

Scrap with high surface area to volume ratios and/or higher levels of contamination can lead to higher levels of dross generation and yield loss when meting and casting recycled aluminium. Baling, briquetting, and compacting scrap (although extreme caution must be taken to avoid enclosed scrap) can give some improvements in yield. Other productivity losses can include longer dedrossing operations, the need for additional metal cleanliness steps, lower furnace charging rates (increased charging time due to lower density scrap) and lower melting rates (particularly if using burners designed for smelters). With proper routines and certain equipment and operational design some/all of these losses can be negated

[3] Cast Anew: Opportunities to bring aluminium to life through manufacturing & recycling A discussion paper for the Australian Aluminium Council September 2022

10.2.4 Production Costs

Market sounding indicated that recycling at present is more expensive option than manufacturing of raw materials. However new technologies are lowering the net cost to recycle aluminium. For example, x-ray transmission enables alloy-based sorting based on spectroscopy; dismantling robots are making significant efficiency gains, now eight times faster than manual labour. Utilisation of artificial intelligence (AI) imagery, data analytics and advanced sensors to produce aluminium packages from shredded automobiles is now occurring.

10.2.5 Transport and Logistics

Transport and logistics to smelters in Australia are a major constraint with further work to discover solutions needing to be deployed to address this issue. This is the area where there is one of the strongest opportunities for policy support.

11.0 Key Findings and Discussion

11.1 Options Going Forward

Based on the market sounding the aluminium industry companies believe that despite many challenges they are looking for pathways to move to utilise scrap aluminium. However, it is anticipated that this transition will take time. Announcements are being made by companies at an international level about their recycling initiatives but to the domestic context including market size and transport constraints impact on the case for investment and operations in Australia.

Recycling contributes to a circular economy by keeping aluminium in use. With a lack of domestic recycling capacity Australia is missing out on a valuable opportunity to utilise this feedstock domestically to help decarbonise aluminium supply chains to produce lower emissions ‘Made in Australia’ material..

A coordinated approach is needed to address the disconnect between supply and demand, a shift which could be enabled by industry action supported by focused industry and government policy. As part of the market sounding four pathways forward have been identified:

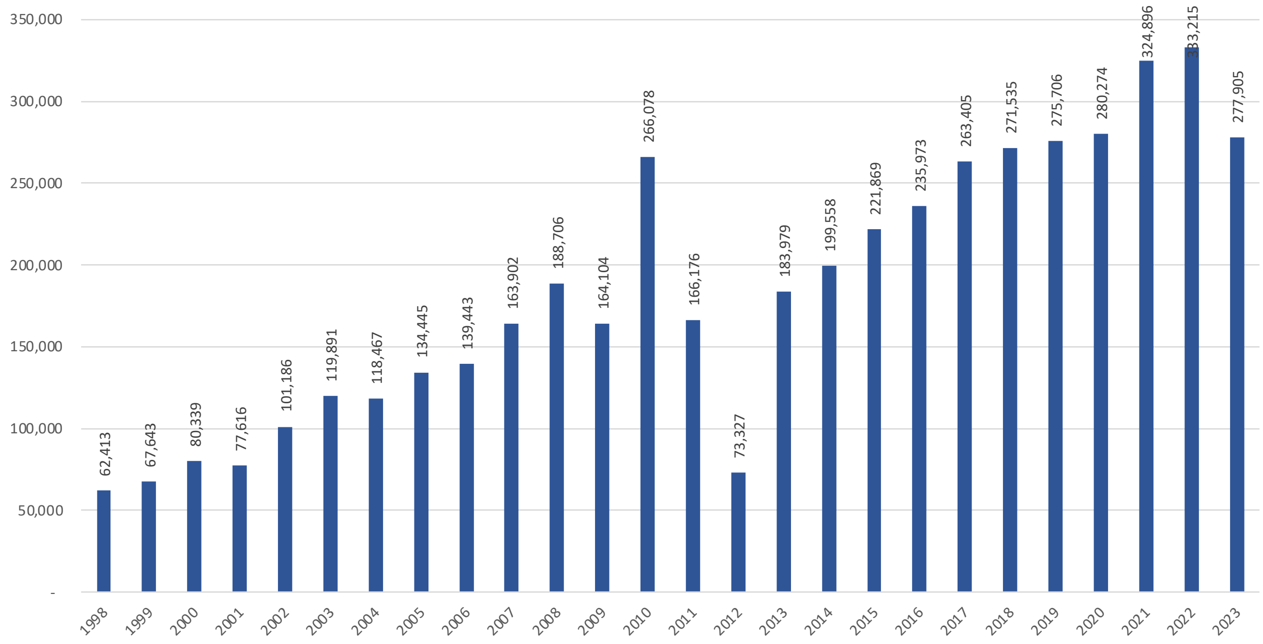
- No change to Australian recycling – Rely on imports of secondary aluminium semis and continue to export aluminium scrap; or
- No change to Australian recycling – Rely on adoption of renewable energy to reduce the footprint of primary aluminium supply; and/or
- Remelt scrap in existing manufacturing process; and/or
- Investment in new recycling capability (pre and post-consumer) and downstream processing industry to create demand; reduce imports of secondary aluminium semis

11.2 No change to Australian recycling – Rely on imports of secondary aluminium semis and continue to export aluminium scrap

Without domestic manufacturing of recycled scrap metal, Australia’s smelters will continue to produce primary metal from the vertically integrated Australian supply chain. This represents a missed opportunity for positioning the industry with environmentally conscious consumers. The risk is if local smelters do not embrace recycling, then Australian extruders may source more of their requirements from overseas with lower emissions per tonne metrics (excluding emissions associated with shipping).

The alternative would be to move away from domestic Australian aluminium suppliers with substitution to overseas smelters for specific products that require recycled content, which is already occurring albeit it at very low levels (trial stage).

Figure 14 : Total Semifabs Imports (tonnes)



Source: AAC, ABS and AEAS 2024

Market sounding indicated that demand erosion has been forecasted at between 15-30per cent up to 2030 under a do nothing approach for Australian aluminium manufacturers. There is an opportunity for this metal to be produced in Australia, meeting a consumer demand for more sustainable produced aluminium that are 'Made in Australia'.

11.3 No change to Australian recycling – Rely on adoption of renewable energy to reduce the footprint of primary aluminium supply

Market sounding indicated that in manufacturing lower carbon aluminium, both renewable energy usage and recycling of scrap aluminium play significant roles, but their environmental impacts differ in scope. In short, the recycling of scrap aluminium results in only about 5 per cent of the energy used to produce primary aluminium from bauxite. This significant reduction in energy use makes recycling highly sustainable.

The alternative or in tandem is the adoption of renewable energy. As stated, aluminium production is incredibly energy-intensive, with electricity accounting for about 30-40 per cent of production costs. Using renewable energy (e.g., hydropower, solar, wind) in the smelting process will drastically reduce carbon emissions. Shifting from fossil fuels to renewable energy can lower the carbon footprint of primary aluminium production by up to 85 per cent. Australian aluminium smelters are working hard to reduce the energy intensity of their process and utilise clean energy sources.

The properties of final products mean that combinations of both recycled material and primary metal need to be used to produce aluminium with the right properties for extrusion – accordingly, reducing emissions from both primary metal and the use of recycled material can together deliver a product with all of a consumers desired properties.

11.4 Remelt in existing manufacturing process

In aluminium remelt furnaces, aluminium is remelted and recycled into new products. Market sounding indicated widespread international examples of aluminium smelters using pre and post-consumer scrap remelted in their existing processes.

For example, Hydro in Europe remelts scrap from its own production and recycles pre and post-consumer scrap from the market. Aluminium recycling is one of the main pathways of Hydro's decarbonisation strategy. Hydro has pioneered the green aluminium transition, powered by renewable energy and by investments in new recycling capacities. The company remelts process scrap from its own downstream business and from other companies and recycles post-consumer scrap from the market.

- As an example, Hydro has invested EUR8.6m in recycling technology at the Årdal primary aluminium plant in Norway. The Årdal cast house now has a capacity to process 25,000 t per annum of post-consumer scrap. The upgraded casting line in Årdal will mix primary aluminium with up to 30% PCS. This is resulting in a record low-carbon footprint that helps some of the most advanced customers in Europe cut the embedded climate gas emissions of their products. Hydro Årdal is now able to deliver Reduxa 3.0 aluminium with a carbon footprint of below 3.0 kg CO2/kg aluminium. This is around 80% lower than the world average, according to Hydro.

As set out in their public announcements at the time Capral Aluminium previously signed an agreement with Tomago Aluminium to supply approximately 550 tonnes of production scrap annually for remelting. Under the arrangement, production scrap from Capral's Penrith extrusion plant was baled and sent to Tomago to be remelted and added to new aluminium products – including billet.

The key point to this trial was that the scrap provided was generated during the extrusion process which meant the alloy of the scrap was known which was critical for the remelt process.

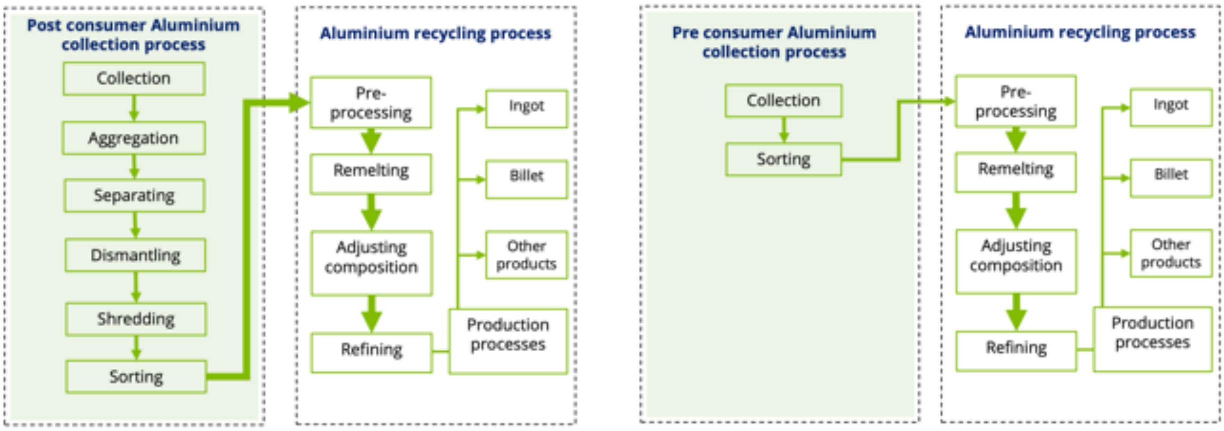
However, discussion with the smelter indicated limited capacity for remelting citing limitations of existing processes and plant; need for pre and post-consumer scrap to be quality free of contaminants, of known alloy, available at sufficient quantities and at a price that was affordable. This trial and its discontinuation highlight some of the challenges for the Australian industry.

11.5 Investment in new recycling capability (pre and post-consumer)

In the medium term it is anticipated that the aluminium industry companies will invest in dedicated remelting and recycling facilities. Recycling pre consumer scrap offers an entry point for the industry to start producing recycled product.

- Pre consumer scrap provides a source of feedstock that can often be directly recirculated into smelters and remelters to then be reused to produce recycled billets and improve efficiency.
- As pre consumer scrap comes directly from fabricator the quality and alloy is often known and very little pre-processing is required.
- It is also least complex in terms of sourcing as feedstock. See figure 15. Pre consumer scrap offers a simpler, more cost-efficient feedstock for recycled billet product. The production process of aluminium and its alloys creates high quality pre-consumer scrap that can be more easily recycled.

Figure 15: Pre and Post-consumer aluminium collection and aluminium recycling process



Source: Deloitte 2022

However based on market sounding it unlikely sufficient pre-consumer scrap is available for a dedicated remelt facility given the transport distances involved and the actual limited amount of pre-consumer scrap available (see section 8.0).

It is most likely that a dedicated remelt facility would have utilise both pre and post consumer scrap sorted, prepared and treated to sufficient standard to be used as feedstock at the required input level. Metal recycling companies as part of the market sounding indicated that sorting and preparing of post consunmer scrap to meet required specificaiton is already available.

Feedback indicated that there would however need to be par between exporting the scrap and its purchase price. The difference between transport costs of shipping verses road transport would also need to be addressed -possibly through Government support. At present transport economics favours the movement of scrap to nearby ports as opposed to the transportation further distances to Australia's eastern smelters. This is both a scrap price and transport cost and distance issue. The willingness for consumer to pay and perception that recycled aluminium would achieve cost savings could also be an issue.

Market sounding indicated that across Queensland, NSW and Victoria there exists sufficient high-quality scrap to support dedicated remelt facilities. Feedback indicated that smelters would require between 50 – 60kt of scrap feedstock. According to figure 13 these volumes are available.

11.6 Overall Finding – The Future

Part of a long-term sustainable Australian aluminium industry is the development of upstream recycling capability. In the short term, Australia's aluminium smelting will most likely move to increase remelt of pre-consumer scrap in their existing manufacturing processes in small volumes. This practice is already highly prevalent overseas with above cases studies provided.

In the medium term, government transport support and infrastructure funding has the potential to underpin dedicated remelt facilities and accordingly should prioritised as part of industry policy. Such an investment in infrastructure will support a sustainable and environmentally conscious future for the Australian aluminium industry.

AEAS Business Information

Australian Economic Advisory Services delivers services in economic analysis, research and advocacy in Australia and was set up by Nick Behrens following two decades of experience applying these skills in the real world for Australia's business community. More specifically AEAS provides:

- Economic Contribution and Valuation Analysis;
- Data Analysis, Market research and Economic Modelling;
- Stakeholder Consultation; and
- Government Relations and Submissions.

AEAS delivers services nationally to exemplary organisations including ACOR, AORA, Australian Industry Group, Australian Gas Industry Trust, Australian Steel Institute, BASF, Brisbane Airport Corporation, CCIQ, Canegrowers, Cairns Airport, Dexus, IOR Petroleum, LifeFlight, Mackay Airport, Master Builders Australia, Natroads, NWRIC, Port of Brisbane, Property Council of Australia, Queensland Resources Council, RACQ, Remondis, Suncorp, VTA, Victorian Waste Management Association, unions, local government authorities, the Commonwealth and State Governments and many others.

We can be engaged for either a special project (for the entire project or just the parts our clients need help with) or on an ongoing basis. We will take the time to understand your unique challenge and create a partnership with you to tailor a solution specific to your budget. We engage with confidentiality and integrity. Choose AEAS for our expertise, professionalism and ability to work with our valued clients to achieve exceptional results.

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Professional Bio: Nick Behrens

Across his professional career Nick has realised many outstanding outcomes to complex challenges for the business community. He possesses significant experience in gathering and presenting information, and leveraging that information to achieve results across a range of areas including economic, taxation, regulatory environment, workers compensation, employment legislation, population, infrastructure and planning issues. As Director of Australian Economic Advisory Services (AEAS), Nick provides:

1. Exceptional understanding of social, political and economic issues impacting on business and the economy;
2. Considerable real-world application of project, business and economic research and analysis;
3. Significant expertise in advocacy, including government and stakeholder relations;
4. In-depth and firsthand knowledge of the workings of Government;
5. Extensive networks in political, government, business and community sectors;
6. Previous appointments on a number of high level Government committees; and
7. Media commentator and public speaker.

Nick's representations are based on extensive research and his preferred approach to economic analysis, research and advocacy is to achieve results by working with stakeholders behind the scenes to secure positive and lasting outcomes. He places much emphasis on having a thorough and convincing evidence that is readily understood and in turn leads to real world application and solutions.

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