Global Cooperation on Key Challenges for the Aluminium Industry

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Abstract

This paper reviews six key challenges for the global aluminium industry. The challenges are:

1. Producing enough (primary) aluminium – given that China has now capped primary aluminium production capacity.
2. Improved recycling – requiring not just higher scrap collection rates but also improved sorting, segregation and closed-loop recycling.
3. Decarbonising the industry – addressing challenges of technology development and, more critically, investment.
4. Demonstrating sustainability – across a range of issues with greater consistency of metrics.
5. Managing bauxite residue – which is the most significant waste stream from the aluminium supply chain.
6. Delivering product to customers – where existing global supply chains are under pressure from trade policy.

There is a role for global cooperation among participants of the aluminium industry on all these issues, with cooperation of greatest importance on the issues of: improved recycling, demonstrating sustainability, and decarbonising the industry.

Keywords: Sustainability, Decarbonisation, Bauxite Residue, Global aluminium industry.

1. Introduction

This paper examines the major challenges currently faced by the aluminium industry and the role of collaboration within the global industry in addressing those challenges.

1.1 Opportunity

Opportunity for the aluminium industry comes from key trends at a macro level, such as:

- The transition to renewable energy sources of electricity.
- Increased market share for electric vehicles in the automotive market.
- Consumer pushback on impacts of packaging waste, particularly from single-use plastics.

The aluminium industry will benefit from these trends because aluminium products can deliver key benefits due to the innate properties of the metal. Some properties qualify aluminium for use in certain applications – aluminium's conductive properties qualify it for use in electrical application; aluminium's protective properties qualify it for use in food, drink and medicine packaging.

Some qualities make aluminium particularly efficient – formability and lightweight make aluminium an efficient material in vehicle design; these properties and durability make aluminium an efficient material in building and construction.
In all applications, aluminium's high recyclability increases the appeal of the material.

1.2 Market Growth

The result is a positive market outlook for aluminium with good demand growth for this decade, projected in four key markets [1]:

- Electrical
- Transport
- Packaging
- Construction

In the electrical market, the International Energy Agency (IEA) forecasts strong demand for both copper and aluminium [2].

In the transport market electric vehicles are expected to use greater levels of aluminium than internal combustion engine vehicles [3].

And in food & drink packaging, aluminium can address concerns about waste and single-use plastics [4].

So, there is a positive outlook for aluminium and a healthy growth in demand to be met, if the industry can meet expectations associated with production. Those expectations form the basis of the six key challenges that this paper examines:

1. Producing enough (primary) aluminium
2. Improved recycling
3. Decarbonising the industry
4. Demonstrating sustainability
5. Managing bauxite residue
6. Delivering products to customers

2. Global Challenges

2.1 Producing Enough (Primary) Aluminium

The first challenge will be to produce sufficient primary aluminium (recycling is challenge #2) to meet growing demand. Specifically, what will be the basis for the construction of additional green-field primary aluminium capacity?

This has not been a challenge for the global industry for more than two decades. Approximately 90 % of the growth in primary aluminium production capacity over that period has occurred in China, driven by strategic objectives of the Chinese Government. The bulk of the remainder of new capacity has been installed in the Middle East.

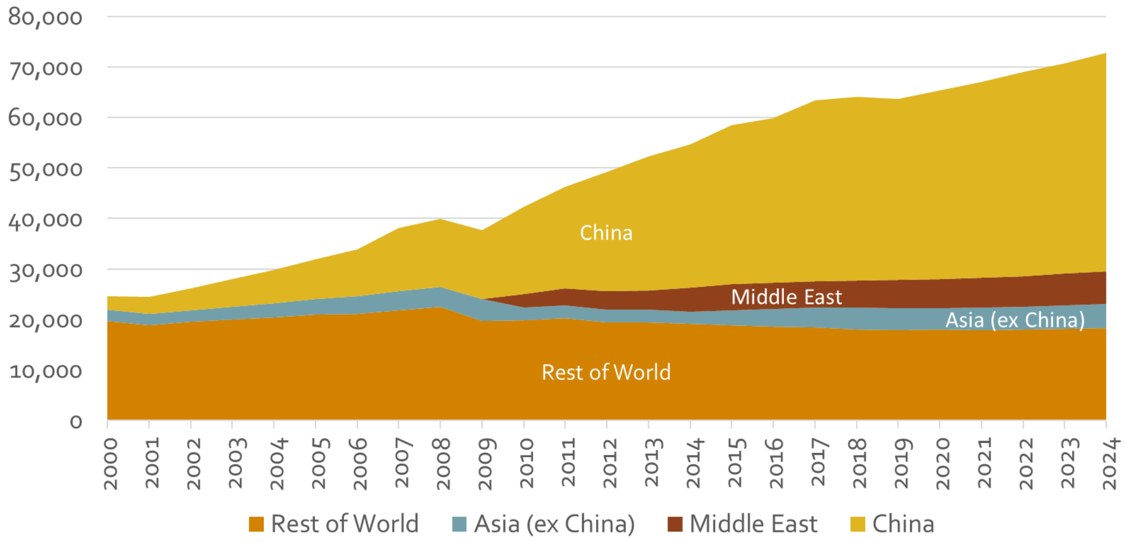

Figure 1. Aluminium Production by Region 2000-2024 (kt) [5].

But the Chinese Government has now capped primary aluminium production capacity at 45 million tonnes per year, and this cap has virtually been reached. And while there is some room for additional capacity in the Middle East, it is clear that future capacity additions will need to occur elsewhere.

New primary aluminium production capacity will require three key components: bauxite supply, electricity supply, and capital investment.

Significant global sources of bauxite such as Guinea, Australia and Brazil will continue to be a prominent part of supply. However, a combination of limited scope for expansion, and strategic interest in diversifying sources, is likely to lead to new sources, particularly from Africa and Southeast Asia, along with growth where feasible in locations such as India. That said, with exception of India, the bauxite from these sources is likely to be exported as ore or as alumina, for aluminium production elsewhere.

Electricity supply for aluminium production must be reliable and continuous for operational reasons; low-cost for competitiveness reasons; and, ideally, low- or zero-carbon to limit greenhouse gas emissions. Unsurprisingly there are few options where these criteria are simultaneously met. Recently, the construction of data centres has become a competitor for similar characteristics of electricity supply, with a greater ability to pay.

And construction of primary aluminium production capacity will require hundreds of millions of dollars of capital from willing investors expecting a return.

Considering these factors, the next capacity additions will likely be in Southeast Asia, particularly in Indonesia, based on local bauxite supply, using capital and technology from China. There is some possibility of capacity additions in the United States if sufficiently supported by domestic policy – which would require imported bauxite with capital and technology perhaps from the Middle East. India may also see capacity additions with bauxite, technology and capital all local.

It should be noted that in some of these scenarios – Indonesia and India most notably – the electricity supply is unlikely to be low- or zero-carbon despite the obvious preference. The combination of reliable, competitive and low-carbon is increasingly difficult to achieve.

Looking further ahead, new bauxite sources in Africa could underpin additional capacity; Chinese capital and technology could also be available for further expansions; with sources of competitive and reliable electricity, the greatest uncertainty or limiting factor.

2.2 Improved Recycling

Aluminium already has high recycling rates compared to competing materials, creating a marketing advantage. This is particularly true in the food and drinks packaging market where consumer facing brands express a strong preference for recycled input, and short product lifetimes mean material is available again soon after each sale.

Recycling (pre- and post-consumer) represents one-third of the current aluminium supply and is expected to grow to half of the supply by 2050 as increasing amounts of scrap become available. Much post-consumer scrap that is currently collected is mixed and subsequently used in products that have lower purity constraints. However, these markets – such as automotive engine blocks – are expected to decline in importance.

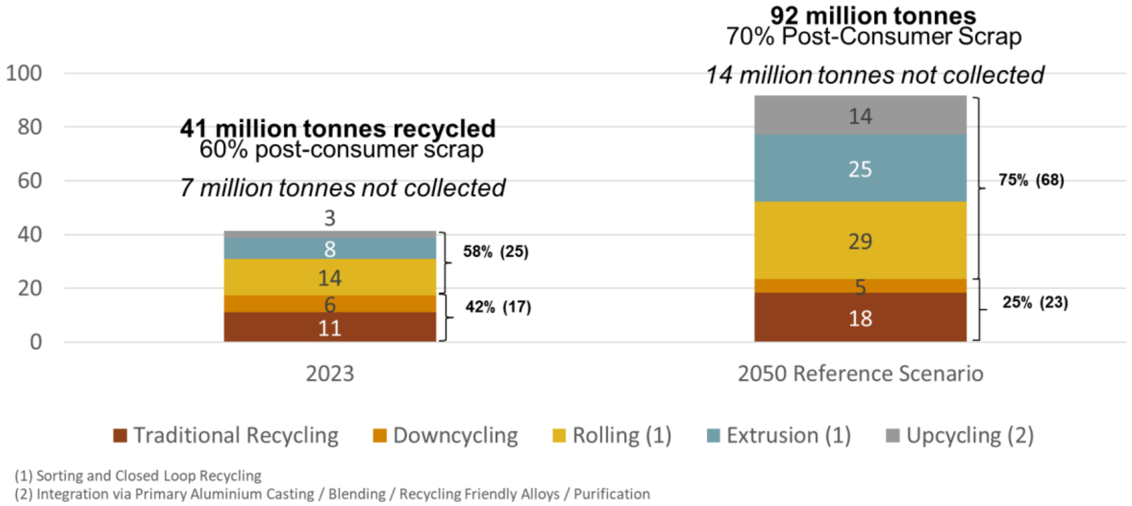

Figure 2. Recycling by type: 2023 vs 2050 Reference Case (Mt).

To process and find markets for the increasing future supply of scrap will require practices that enable it to be used in higher value markets. In addition to the capacity to collect and utilise increased quantities of scrap, we will also need practices that identify and maintain the value of the scrap or develop alloys and products that can utilise higher levels of recycled content.

The following techniques will be needed to enable greater future utilisation of recycled material:

- Improved collection & segregation – to ensure different alloy types are kept separate and can be recycled in a way that maintains the value of that alloy type.
- Closed loop recycling – so that scrap can be utilised in products where it is of greatest value.
- Better sorting – so that mixed scrap sources can be divided to produce material streams of higher value.
- Purification – to enable removal of minor elements that would otherwise be impurities.
- Recycling-friendly alloys – that can tolerate a greater mix of alloying elements or impurities.
- Product design – that uses a narrower range of alloys; alloys with lower tolerances for impurities; and/or assist segregation of scrap at end of life.

2.3 Decarbonising the Industry

A significant proportion of the expected growth in aluminium demand will come in applications where aluminium helps to reduce the carbon footprint of the activity – such as in motor vehicle design, and generation and transmission of renewable electricity.
However, this increases the parallel expectation that aluminium production will decarbonise to maintain and grow share in these markets.

In 2020, the International Aluminium Institute (IAI) released analysis, which identified the three main technology pathways needed to reach net-zero emissions from aluminium production:

- Decarbonisation of electricity.
- Reduction of direct emissions.
- Increased recycling and improved resource efficiency.

And mapped the emission reduction trajectories that the industry would need to follow to contribute to global climate4 change targets.

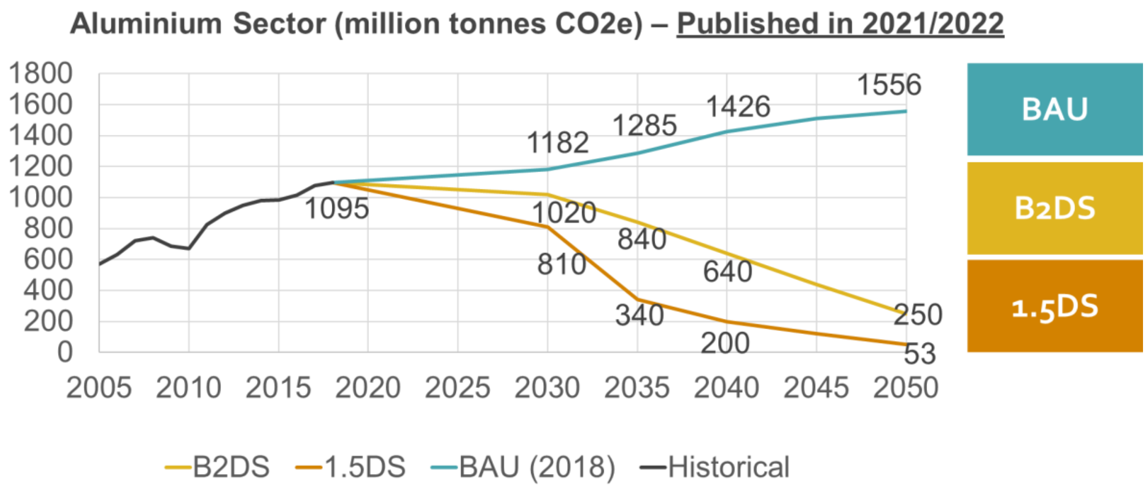

Figure 3. Greenhouse gas emission trajectories to meet climate targets [6].

Key implications of those trajectories are:

- Emissions will need to reduce in the short-term even as production increases. This will require delinking the historical trend in emissions from the historical trend in production – both of which have been increasing.
- Overall reductions in emissions-intensity of more than 90 % will be needed by 2050.
- The rate of emissions reductions should accelerate after 2030 – based on implementation of technology that is assumed to be developed by then.

It has been estimated by the Mission Possible Partnership that more than 500 billion USD in investment will be needed to decarbonise the industry to the extent outlined [7].

It is now possible to assess the industry's early progress in decarbonisation. The IAI publishes annual estimates of total greenhouse gas emissions for aluminium production (full value chain to semi-finished products, primary and recycling).

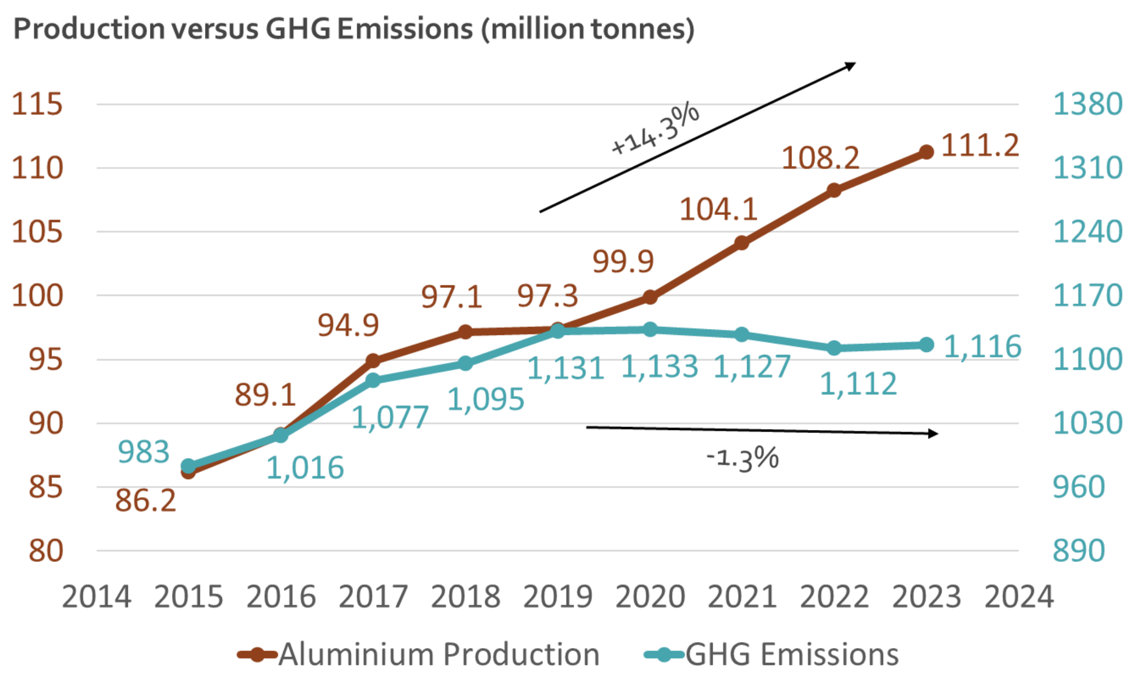

Figure 4. Greenhouse gas emissions from aluminium production [8].

These data reveal several noteworthy features.

- There has been a levelling of annual greenhouse gas emissions since 2019, despite continued growth in production. This suggests that the previous link between production and emissions is being broken.
- It is possible that greenhouse gas emissions from aluminium production may have peaked (in 2020), though this is dependent on investments in the next few years.

Underlying these changes have been two trends – a reduction in the emissions intensity of primary aluminium production; and an increase in the proportion of aluminium production that comes from recycling. These have offset the impacts of overall increased aluminium production.

This is the result, in turn, of investments by participants in the aluminium industry in developing and implementing the technology needed for decarbonisation – in all regions where the industry operates, and in all the technologies needed for decarbonisation.

These are positive signs for the aluminium industry – particularly in comparison to other industries facing similar challenges – however, it should be noted that the industry is still not 'on track' to contribute to global climate change targets, and the scale of action needed in the near future is many times larger than what has occurred this far.

2.4 Demonstrating Sustainability

Decarbonisation is perhaps the most important element of sustainability, but the industry must continue to deliver and demonstrate progress on the full range of relevant sustainability issues.

In previous work the IAI has identified six areas of greatest impact in delivering on the UN Sustainable Development Goals [9].

These six areas are:

- Climate change
- Emissions & waste
- People
- Biodiversity
- Water
- Circularity

All these issues are important, but they should not be treated as equal, nor should we expect progress to occur at the same rate.

Based on feedback, stakeholders and customers expect quantitative metrics (and associated improvement) on two key issues – carbon footprint (under *climate change*) and recycled content (under *circularity*).

On other issues, the expectation could be described as 'competent management, improvement, and absence of controversial failure'. However, for a variety of reasons – e.g., social licence, regulatory constraints, corporate reputation, environmental benefits – the industry should continue to prioritise progress on all sustainability issues.

In work that is yet to be released, the IAI has reviewed the sustainability performance of a cross-section of the industry – based on publicly available information.

The review reveals that the aluminium industry is demonstrating progress against all the important elements of sustainability, with instances of best practice. However, outside the two central issues of carbon footprint and recycled content, there is a lack of consistency in how companies report on issues, making it difficult to compare suppliers and aggregate data to report at a whole-of-industry level.

The IAI will work with member companies to improve performance and specifically to increase consistency in how sustainability is reported on a range of issues.

2.5 Managing Bauxite Residue

The aluminium production process generates a range of waste material, some of which, such as spent pot lining, requires significant action to address impacts. However, the management of bauxite residue warrants identification as a challenge in its own right based on the scale of waste generated.

The aluminium industry currently generates approximately 180-220 million tonnes per year of bauxite residue and is estimated to have generated 4 billion tonnes cumulatively so far, much of which has been stored.

In addition to the scale of waste generated, bauxite residue is challenging due to the high moisture content and high pH prior to any treatment.

Facilitating collaboration in the global industry on addressing bauxite residue has long been a priority of the International Aluminium Institute. The work in this area is covered in another keynote being presented at the conference by Sebastien Fortin from Rio Tinto.

2.6 Delivering Product to Customers

The final global challenge to be profiled in this paper is delivering aluminium products to customers, when national Governments are implementing policies that restrict, or increase costs of, trade.

The IAI maintains a material flow analysis model that tracks the aluminium production supply chain, use of aluminium, collection and recycling [10].

Using the data within this model, it can be estimated that more than 70 % of aluminium products currently delivered to consumers have been traded across national borders at least once in the production process.

The location of bauxite is dictated by geology. The location of processing stages such as alumina refining and aluminium smelting – while partially impacted by the location of input materials – are heavily influenced by the availability of competitive energy supplies.

The location of all these processing stages is only mildly influenced by the location of the market for the final product – areas of high population, and high GDP: Europe, North America, Southeast Asia. Given the location of these processing stages, it is unsurprising that most supply chains that transform bauxite into products for final consumers involve trade across national borders.

Policies that restrict or increase the costs of trade may benefit the local competitiveness of one stage of the aluminium production process but are likely to increase the cost of the final product to the consumer.

If these policies have a heavier impact on aluminium supply chains – through policy design, or because aluminium supply chains involve more trade – the competitiveness of aluminium compared to competing materials will be reduced, negatively impacting the overall aluminium industry.

The aluminium industry will continue to need to trade across national borders to efficiently supply competitive products to consumers.

3. Conclusions on Global Cooperation

Global cooperation has a role to play in addressing all the challenges identified in this paper. Cooperation can take the form of company-to-company interaction, either informally or through structures such as joint-ventures; and can also be managed through organisations created for the purpose of facilitating cooperation, such as the International Aluminium Institute (IAI).

The possible role for global cooperation in addressing each of the challenges is outlined below:

Producing enough (primary) aluminium
Individual company investment will play a significant role in producing sufficient primary aluminium, however there is also a role for joint venture investments and development of supply chains across companies and regions to minimise costs.

Improved recycling
Cooperation has a significant role to play in improving recycling practices given that it requires actions from participants at different stages of the supply chain – alloy choice, product design, collection, segregation, etc. Collaboration will need to occur within formal and informal mechanisms and may also require Government support.

Decarbonising the industry

Decarbonising the industry will require the development and rapid widespread implementation of new technologies. This will happen faster and more efficiently with higher levels of cooperation. There are roles for many different forms of cooperation from information sharing at pre-commercial stages, to formal joint ventures to develop and implement new technology.

Demonstrating sustainability

While individual companies are doing a good job of demonstrating sustainability, the ability to compare suppliers and to aggregate data to demonstrate whole-of-industry performance will be enhanced through greater levels of cooperation. The technology and techniques needed to improve sustainability performance may also be best developed through collaborative means.

Managing bauxite residue

Cooperation between companies to develop technology and management approaches for bauxite residue has already been significant and this will need to continue if the industry is to meet expectations of communities, stakeholders and customers.

Delivering products to customers

The development of supply chains to deliver products to customers inherently includes cooperation. It is in the interest of the aluminium industry to allow cooperation and trade of this type to continue.

4. Acknowledgements

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