Can the Aluminium Industry Meet Global Climate Change Targets?

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Abstract

There is increasing expectation and scrutiny from the public, customers and stakeholders on the aluminium industry's progress in meeting global climate change targets. The International Aluminium Institute (IAI) has previously outlined the trajectories and technology pathways that the industry would need to follow to be consistent with global *Beyond 2 Degrees (B2DS)* or *1.5 Degree (1.5DS)* scenarios. These trajectories took 2018 as the base year and the most recent comprehensive global data – for 2022 – shows that the aluminium industry has reduced emissions below *Business-as-Usual (BAU)* but is not yet aligned with either the B2DS or 1.5DS scenarios. However, the data also reveals that, for the first time, global aluminium industry greenhouse gas emissions did not increase in 2021 and 2022, despite production increasing. This can be attributed to the significant number of projects in the industry that are developing and implementing the decarbonisation technologies needed. To meet global climate change targets, the challenge for the industry is to speed up and scale up this technology development and investment.

Keywords: Sustainability, Climate Change, Decarbonisation, Aluminium Industry.

1. Introduction

1.1 Sustainability

Over recent decades, sustainability of production is of increasing importance in procurement decisions within supply chains and purchasing choices by final customers. The same issues are also becoming prominent in regulation (particularly in Europe) and investment decisions.

Sustainability issues are usually interpreted to include environmental (including emissions to air, land and water, wastes, consumption of resources, and biodiversity), social (including workforce, communities and the public) and governance components.

While the broad scope of sustainability issues and the integrated nature of sustainability remain important, public, consumer and user attitudes clearly prioritise climate change as the most important sustainability issue for most industries – including the aluminium industry.

1.2 Greenhouse Gas Emissions and the Aluminium Industry

The aluminium industry – considered here as the value chain from bauxite mining to semi-finished products and including recycling – is a significant contributor to global greenhouse gas (GHG) emissions; usually estimated to contribute approximately 2 % of global emissions. This warrants specific attention to reduce emissions. However, for context, it is less than sectors such as steel, cement and plastics and chemicals.

The aluminium industry is also commonly classified alongside these industries as "hard to abate" on the basis of the long-life of assets, significant energy use and need to develop new technologies to decarbonise some aspects of production.

At a global level, the majority of greenhouse gas emissions in the aluminium sector are from the generation of the significant quantities of electricity required for electrolysis (Table 1). However, the importance of this specific source varies at plant level depending on the type of electricity – near zero for hydro power, highest for coal-fired power.

The next most significant sources of emissions are from burning fuels for the thermal energy required in alumina refining (and elsewhere in the production process) and direct process emissions from the consumption of the carbon anode in electrolysis. The emissions of perfluorocarbons in the smelting process have been greatly reduced in the industry since the 1990s. but still remain a noticeable source of emissions.

Table 1. Greenhouse Gas Emissions Intensity - Primary Aluminium, 2022 [1].
(tonnes CO_2e/tonne aluminium)

	Electricity -Indirect	**Perfluorocarbon (PFC) - Direct**	**Process (CO2) -Direct**	**Ancillary Materials -Indirect**	**Thermal Energy -Direct/Indirect**	**Transport -Indirect**	**Total -Cradle to Gate**
Mining	<0.0			<0.0	0.04		**0.04**
Refining	0.3			0.4	1.7	0.2	**2.6**
Anode Production	<0.0		0.1	0.6	0.1		**0.9**
Electrolysis	8.9	0.8	1.5	0.1		0.2	**11.4**
Casting	<0.0			<0.0	0.1		**0.1**
Primary Aluminium	**9.3**	**0.8**	**1.6**	**1.2**	**1.8**	**0.4**	**15.1**

2. Climate Change Targets

2.1 General

The development of climate change targets – at a national, industry sector or corporate level – is usually focussed on alignment with one of the global temperature change objectives of the Paris Agreement (well below 2 degrees, or limited to 1.5 degrees, above pre-industrial levels) or to net zero emissions by a deadline year (often 2050).

Structurally, climate change strategies usually involve targets that align with one or more of these objectives, some level of plan or strategy developed on how it could be met – or at least the initial steps, given the need to develop new technology – and then progress toward the target tracked and reported.

In recent years there has been significant activity, at many levels, in setting climate change objectives and developing strategies. Given the short timeframe available to meet the objectives, external attention necessarily shifts to assessment of early progress toward meeting the targets.

2.2 Aluminium Industry Climate Change Targets

Through the International Aluminium Institute, the industry has detailed global trajectories that would need to be followed to contribute to meeting beyond 2 degrees (B2DS) and 1.5 degrees (1.5DS). [2]. The 1.5DS can also act as a surrogate for a 'net zero by 2050' scenario.

A Business-As-Usual (BAU) trajectory was also included based on existing technology, energy mix, recycling rates, and expected increases in production driven by aluminium demand.

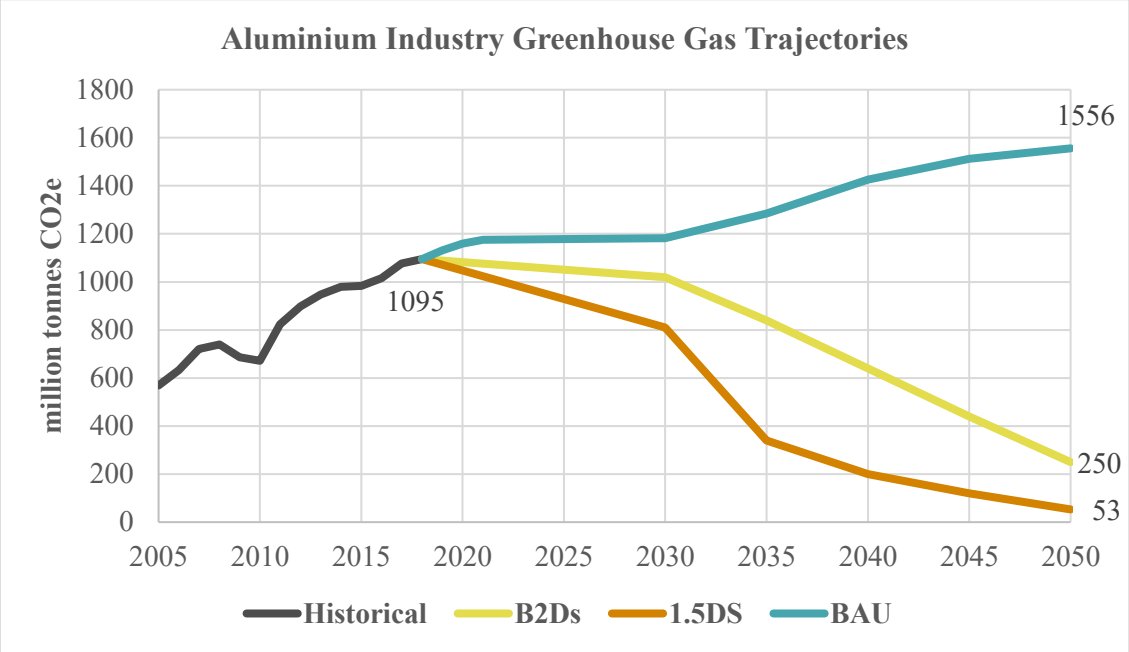

Figure 1. Aluminium Industry Greenhouse Gas Trajectories.

The two decarbonisation trajectories (B2DS and 1.5DS) are based on analysis from the International Energy Agency (IEA) aligned to the two climate objectives. Therefore, the overall emission budget and trajectories are not 'self-determined' by the aluminium industry, but are the result of global economy-wide analysis from an independent agency.

These trajectories describe what the industry would need to do to play its part in meeting the climate change targets. It is not a commitment from the industry nor a forecast of the likely future trajectory.

IAI's work also outlines the likely technology needed to deliver the required emissions reductions. Reflecting the composition of industry emissions, the technologies are grouped under three pathways:

1. Electricity Decarbonisation
2. Direct Emissions
3. Recycling and Resource Efficiency

All three pathways will need to be pursued to meet the climate change targets. The work identifies technology options under each pathway rather than predicting successful technologies.

3. The Aluminium Industry's Progress in Decarbonisation

3.1 Total Greenhouse Gas Emissions

Given the time elapsed since the base year for the emissions trajectories (2018) and launch of the pathways (2021), there is now interest in how the industry is tracking relative to business-as-usual and the two decarbonisation trajectories.

The IAI has collected plant level data needed to calculate the greenhouse gas emissions from the industry since 1998. Data collection inputs to the estimation of industry greenhouse gas emissions include: energy mix (annual collection) perfluorocarbon emissions (every two years) and full life cycle inventory (every five years), along with monthly collection of production data.

The most recent estimates of greenhouse gas emissions from the aluminium industry are based on energy mix data for 2022. Total greenhouse gas emissions for the aluminium industry were estimated to be 1.112 billion tonnes CO_2e, compared to a baseline estimate in 2018 of 1.095 billion tonnes CO_2e (a 1.55 % increase) [3]. Over the same period, production of aluminium semi-finished products grew to 108.2 million tonnes from 97.1 million tonnes (an 11.4 % increase).

While it is very early to plot performance against decarbonisation trajectories that extend from 2018 to 2050, this data suggests that the industry has reduced emissions below the BAU trajectory but not to the extent needed to reach the B2DS trajectory (nor the 1.5DS).

3.2 Trends in Greenhouse Gas Emissions

The 2022 data and estimates also confirmed two notable outcomes:

For the first time over the period for which data is available, total greenhouse gas emissions from the industry did not grow, even as aluminium production grew.

A clear separation in trend is occurring between aluminium production – which grew as it has for many years and is expected to continue for many more – and greenhouse gas emissions which have stabilised and then fallen slightly.

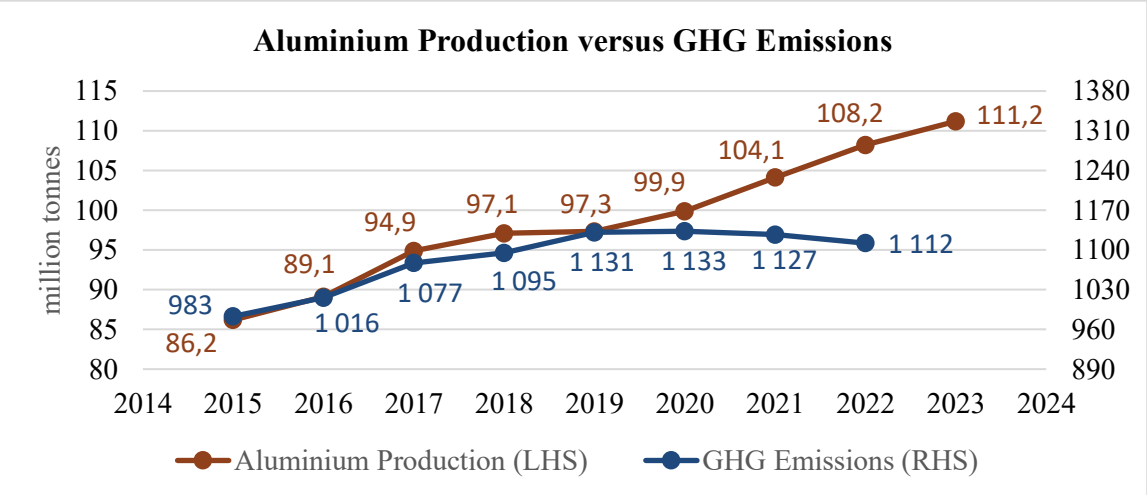

Figure 2. Aluminium Production versus GHG Emissions.

These outcomes were first apparent in 2021 but could only reasonably be acknowledged once they continued in 2022.

It is possible that 2020 will subsequently be shown to be the year that greenhouse gas emissions from aluminium production peaked globally. However, this will require a continuation of key trends such as reduced emissions-intensity of electricity input, increased recycling rates and sustained investment in key technologies (see next section).

3.3 Emissions Reductions Projects

As well as estimating and reporting industry greenhouse gas emissions the IAI, since 2018, has also tracked projects within the industry that develop or implement the technologies needed to decarbonise the industry.

In 2020, 16 projects were identified, by 2022, it was 50 projects, and in 2024 it has reached 90 projects. Of the 90 projects, 35 % are directed to the decarbonisation of electricity supply, 42 % to reducing direct emissions, and 23 % to increased recycling and resource efficiency. Geographically, projects are being implemented in all regions where the industry operates.

The IAI now publicly tracks these projects through an interactive map [4].

3.4 Updated Business-as-Usual

In addition to driving the reduction in emissions now apparent in the data, these projects also change what can be seen as 'business-as-usual'. The implementation of the projects, along with incremental changes in factors such as recycling rates and energy mix means that 'business-as-usual' in 2022 is different to what was considered 'business-as-usual' in 2018 (Figure 3).

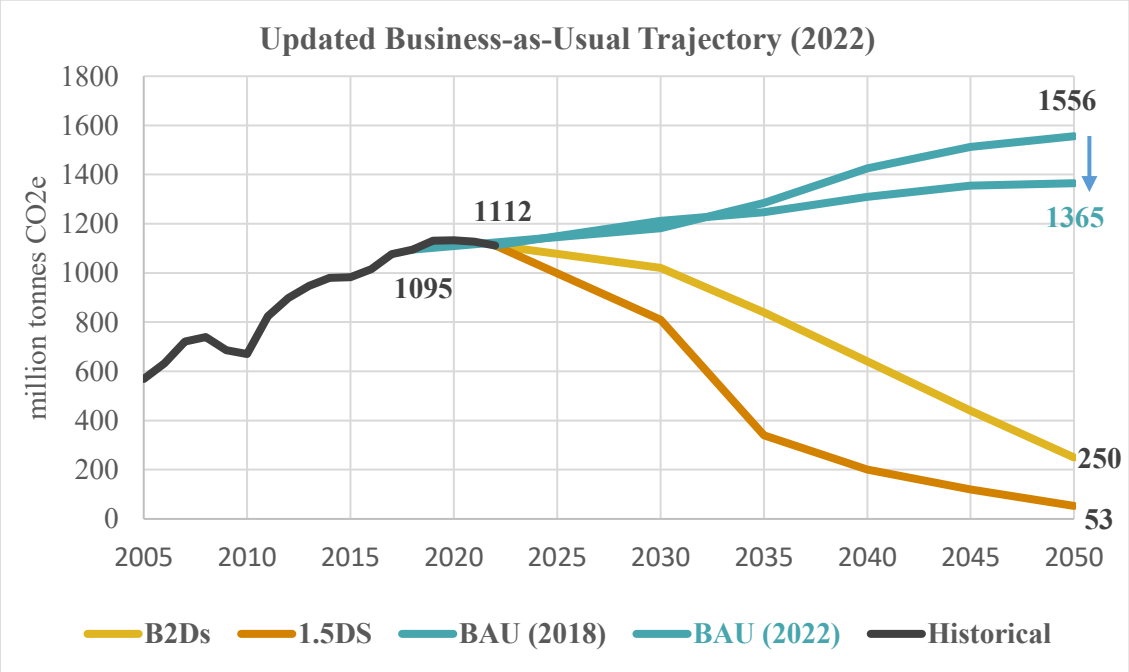

Figure 3. Updated Business-as-Usual Trajectory (2022).

The updated BAU trajectory for 2022 now suggests that under such a scenario aluminium industry greenhouse gas emissions would reach 1.365 billion tonnes CO_2e in 2050, down 14 % from the

2018 BAU trajectory which reached 1.556 billion tonnes CO_2e. This represents the long-term emissions reductions that may result from the projects already implemented.

However, Figure 3 also hints at the significant additional investment needed to reduce the BAU trajectory sufficiently to align with either of the decarbonisation scenarios (B2DS and 1.5DS). To meet the global climate change targets, a future BAU trajectory should align with the decarbonisation scenarios.

4. IAI's Greenhouse Gas Initiative

There are positive signs for the decarbonisation journey in the level of investments that have occurred and the impacts that can be observed in early data. As can be seen already, significant decarbonisation in the aluminium industry requires investments at a corporate level (though perhaps within the framework of supportive Government actions).

Competitive forces around markets, investments and corporate reputation help to drive these investments. To encourage ambition and transparency of performance, at COP28 held in Dubai in 2023, the IAI committed to transparently and publicly track ambition and progress in greenhouse gas reduction of all its member companies and the performance of the industry as whole [5].

Under the Initiative the International Aluminium Institute commits to:

- track and report on our member companies' ambitions and progress in greenhouse gas emission reductions.
- report total global greenhouse gas emissions of the aluminium industry, on a public and annual basis.

Each IAI member company has the right to independently choose the method and commitment content of their carbon emission initiative and may choose whether to comply with any part of the following commitment in accordance with "common but differentiated responsibilities".

The IAI's member companies are invited to publicly demonstrate their commitment by the following actions:

- State a long-term greenhouse gas emission reduction target by 31 December 2024 – preferably net-zero and preferably by 2050 – and a plan to achieve the target.
- Identify an interim greenhouse gas emission reduction milestone – ideally by 2030 – to ensure early progress can be tracked.
- Disclose progress annually, including all facilities and absolute Scope 1 & 2 emissions – and desirably also Scope 3 – utilizing the IAI Aluminium Carbon Footprint Methodology and the IAI Guidelines on Transparency – Aluminium Scrap as the calculation references.

Companies with aluminium investments but which do not have operational control may choose to publicly demonstrate their commitment by following the above actions at a whole-of-business level. IAI member companies who are minority shareholders in aluminium businesses can report progress using other calculation references to allow for consistency in their overall reporting.

Signatories currently include Aluminerie Alouette, Aluminium Bahrain (Alba), Alcoa Corporation, Companhia Brasileira de Alumínio (CBA), Emirates Global Aluminium (EGA), Hindalco Industries Limited, Norsk Hydro, Mitsubishi Corporation, Rio Tinto Aluminium, Rusal, Sohar Aluminium, South32 and Vedanta Aluminium.

Together these companies are currently responsible for 250 million tonnes of Greenhouse Gas emissions.

5. Conclusions

Early indications on the aluminium's industry decarbonisation journey show that significant investments are occurring. This has reduced emissions below previously estimated business-as-usual levels but have not yet brought the industry on to either of the decarbonisation trajectories that would contribute to achieving the objectives of the Paris Agreement.

The projects appear to be de-linking the trends in aluminium production (still growing) and greenhouse gas emissions (stabilising and slight decline). However, to meet global objectives, significant additional investment is required and the successful technology improvements need to be extrapolated from the early adopters of each technology to broader uptake in the global industry.

6. Acknowledgements

The outcomes presented in this paper are the latest in many years of continuing work undertaken by the IAI on greenhouse gas emission. The author would like to acknowledge the contribution of others particularly Marlen Bertram, Pernelle Nunez, Linlin Wu, and Chris Bayliss as well as the support and contribution of representatives from IAI member companies.

7. References

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