AUSTRALIAN
ALUMINIUM
COUNCIL LTD

info@aluminium.org.au

Department of Industry, Science and Resources (DISR)
https://consult.industry.gov.au/unlocking-green-metals

12 July 2024

Dear Minister

Re: A Future Made in Australia: Unlocking Australia's Green Iron, Steel, Alumina and Aluminium Opportunity

The Australian Aluminium Council (the Council) represents Australia's bauxite mining, alumina refining, aluminium smelting and downstream processing industries. The aluminium industry has been operating in Australia since 1955, and over the decades has been a significant contributor to the nation's economy. Department of Industry, Science and Resources has recently forecast[1] that earnings for Australian exports of aluminium, alumina and bauxite are expected to rise from $16 billion in 2023–24 to $18 billion in 2025–26. More than $14B of this comes from the alumina and aluminium industries, as value adding mineral processing sectors. The industry includes six large bauxite mines plus several smaller mines which collectively produce over 100 Mt per annum making Australia one of the world's largest producers of bauxite. Australia is the world's largest exporter of alumina with six alumina refineries producing around 21 Mt per annum of alumina. Australia is the seventh largest producer of aluminium, with four aluminium smelters and additional downstream processing industries including more than 20 extrusion presses and producers of metal powders and aluminium coatings. Aluminium is Australia's top manufacturing export. The industry directly employs more than 19,000 people, including 6,600 full time equivalent contractors. It also indirectly supports around 60,000 families predominantly in regional Australia.

Aluminium is one of the commodities most widely used in the global transition to a clean energy future[2]. It is also recognised for its importance to both economic development and low emissions transition. Aluminium use is highly correlated with GDP, so as countries urbanise, per capita use of aluminium increases. It is expected that by 2050, global demand for aluminium will nearly double[3]. While an increasing proportion will be met through recycled aluminium, there will still be a need for increased production of primary aluminium requiring a comparable increase in global bauxite mining and alumina refining rates.

Australia's natural resources including renewables, mineral reserves and highly skilled workforce can give Australia a comparative advantage in the production of green metals. Yet, as the Council has maintained throughout our dialogue with Government, the future of the industry in Australia cannot be taken for granted[4]. Key risks include high energy costs combined with a high cost to decarbonise industrial processes, proactive industry policy among competitor nations, as well as regulatory complexity and uncertainty.

The Council welcomes the opportunity to respond to the A Future Made in Australia: Unlocking Australia's Green Iron, Steel, Alumina and Aluminium Opportunity Consultation Paper (the Paper), as one part of the Government's consultation on Green Metals. The Council notes there is an intention to consult on the overall plan later in 2024. In its response to the Paper the Council will focus on responses to key questions. The Council also notes that its Members will respond directly to both the Paper and other aspects of the Green Metals consultation and the Council position should be considered alongside this input. The Council notes this consultation is occurring in parallel with other consultation on the Net Zero Plan and the establishment of the Net Zero Economy Agency and looks forward to a comprehensive and coordinated policy response across Government, which is required to support green metals now and into the future. In addition to this covering letter, this submission includes three parts:

A. Feedback on the Consultation Paper.
B. Aluminium Industry Decarbonisation Pathways.
C. References

The Council welcomes the inclusion of green metals, including alumina and aluminium, in the Government's Future Made in Australia (FMIA) agenda, to ensure these vital industries can continue to benefit communities and workers, as they have done for almost 70 years. These reforms, if well designed and delivered over a transformational time scale, should capitalise on Australia's comparative advantages, support the transition to net zero and strengthening economic resilience and security. This will be achieved through targeted public investment to provide economic incentives that garner private investment at a scale that develops priority industries in line with Australia's national interest. This targeted investment should provide the transitional support needed as Australia's infrastructure and energy systems develop, and energy returns to being competitive.

Australia is one of the very few countries which has bauxite mining, alumina refining, aluminium smelting and aluminium extrusion all within its borders, making aluminium one of only two commodities in which the raw materials are mined and processed all the way to a consumer product right here in Australia. The single biggest opportunity to decarbonise the energy intensive, vertically integrated Australian aluminium industry is through the combination of electrification or conversion to low emissions fuels for existing industrial processes and decarbonisation of the national electricity supply.

However, to support this industrial decarbonisation, Australia must be sufficiently competitive to be able to attract global decarbonisation investment. Recent analysis by the Council compared industry policy measures in Australia with other key aluminium and alumina producing jurisdictions[5] and found more is required to ensure appropriate policy settings are in place to support a positive future for this strategically important industry. The Council supports the use of targeted public investment in both decarbonisation and ensuring delivered energy costs are internationally competitive, as an important step in reducing long-term carbon exposure de-risking investment decisions and accelerating technology cost reductions through deployment and learning. This should be combined with Production Credits and a Transformational Infrastructure and Technology Fund to enable Australia to be competitive and attract global decarbonisation investment.

Governments also have a critical enabling role in addressing constraints to delivery of renewable energy projects including planning regulation, land access, and construction costs that are putting the industrial transition at risk due to tensions with competitiveness and scheduling. Planning systems, regulations and workforce development must also align with delivering projects required for shared net zero ambitions.

A suite of government policies and frameworks are required to decarbonise Australia's domestic manufacturing in order establish a 'green metal' industry in Australia. The most effective, in order, are:
1. Delivery of firmed and reliable, low emissions, internationally competitive energy;
2. Support for the capital investment for decarbonisation and the transition of energy contracts noting that this will need to be a combination of production credits and transformational capital funding;
3. Predicable streamlined approvals for the whole value chain from mine to market including infrastructure needed to ensure alumina and aluminium can continue to be made in Australia in the future.

The Council is happy to provide further information on any of the issues raised in this submission.

Kind regards,

Marghanita Johnson
Chief Executive Officer
Australian Aluminium Council
M +61 (0)466 224 636
marghanita.johnson@aluminium.org.au

A. Feedback on the Green Metals Consultation Paper

The aluminium industry has been operating in Australia since 1955. Australia's historic advantage in the aluminium industry stemmed principally from its substantial high quality bauxite reserves, early investment in an integrated industry supported by Government, historic energy advantage and access to a skilled workforce with expertise mining and mineral processing. While Australia maintains its bauxite reserves, it has lost its historic energy advantage and there is increasing pressure on a limited skilled workforce.

In his 2019 book, Superpower: Australia's Low-Carbon Opportunity, Ross Garnaut discussed Australia's potential to best utilise its abundant bauxite reserves by leveraging Australia's renewable energy potential to create a competitive advantage in aluminium production by reducing energy costs to produce low carbon aluminium. The Council believes that Government support is needed, in the form a production credit, until Australian energy costs reduce in line with projections. Similarly, Rod Sims has argued that turning Australia's bauxite into green aluminium using low-cost renewable energy could reduce global emissions by around 1%[6].

The key to success in these scenarios is:

1. Competitively priced and firmed, renewable energy is available and prioritised for use by industries such as the alumina and aluminium;
2. That Australian industry is sufficiently able to attract the necessary financial support during the transition, underpinned by Government support for the capital investment for decarbonisation and the transition of energy contracts noting that this will need to be a combination of production credits and transformational capital funding; and
3. Ensuring that Australia's bauxite resources continue to be able to be economically accessible.

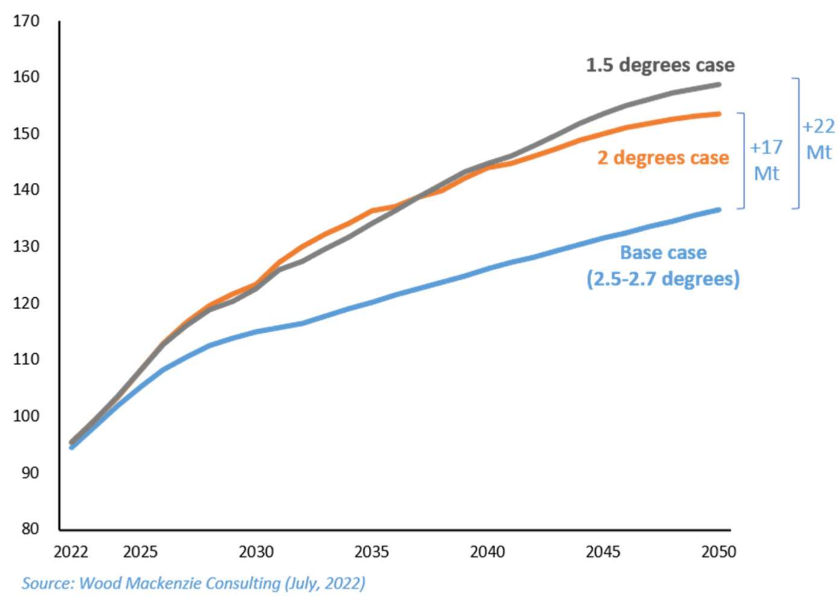
Australia's alumina and aluminium industries are located in key regional hubs[7], which have been identified as part of Australia's transition a net zero economy. These green metal industries can create the baseload and flagship offtake agreements in these key locations which can encourage additional investment and renewable energy to support other industries to be developed.

The Council's feedback focusses on responses to key consultation questions in the order they are posed in the Paper. The Council also notes that its Members will respond directly to both the Paper and other aspects of the Green Metals consultation and the Council position should be considered alongside this input.

The Green Metals Opportunity

Aluminium is one of the commodities most widely used in the global transition to a clean energy future[8]. It is also recognised for its importance to both economic development and low emissions transition. Aluminium use is highly correlated with GDP, so as countries urbanise, per capita use of aluminium increases. It is expected that by 2050, global demand for aluminium is expected to nearly double[9] (Figure 1). While an increasing proportion will be met through recycled aluminium, there will still be a need for increased production of primary aluminium requiring a comparable increase in global bauxite mining and alumina refining rates. As outlined in the Paper, Australia is the world's second-largest producer of bauxite and alumina and seventh largest producer of aluminium. However, producing substantial quantities today, does not mean supply chains are not vulnerable to change.

Figure 1. Aluminium Demand Under Varying Climate Scenarios (Mt)[10]



Australia is the world's second largest bauxite producer, producing around 100 Mt per annum or almost 25% of global production in 2023[11]. Of this, around 40 Mt is exported, with more than 98% going to China. The balance is refined to produce 21 Mt per annum of alumina (aluminium oxide) in Australia. Of this more than 85% is exported to a range of countries, with Australia being the world's largest exporter. Australia produces around 1.5 Mt of aluminium per annum, of which more than 90% is exported. There is some downstream manufacturing of aluminium in extrusion presses (around 150 kt capacity), metal powders (~10kt) and aluminium coatings (~10kt).

The supply chains outside Australia are increasingly concentrated, exposing Australia to vulnerabilities. For example, Table 1 shows Australia is positioned as the world's second largest producer of bauxite and alumina. However, this static view does not show that, just over 20 years ago, Chinese domestic production was approximately 11% of global capacity (Figure 3, Figure 4) and was largely vertically integrated with their domestic bauxite supply and alumina production. Nor does it demonstrate the changes in global bauxite sourcing with Guinea now the world's largest bauxite producer and exporter, principally to China, including some captive bauxite mines (Figure 2). Indonesian bauxite production is also highly sensitive to their domestic Government policies on mining.

Table 1. Top 5 Bauxite, Alumina and Aluminium Production Rankings 2023 (%)[12]

Ranking	Bauxite	Alumina	Aluminium
1	Guinea, 30%	China, 58%	China, 59%
2	Australia, 26%	Australia, 13%	India, 6%
3	China, 19%	Brazil, 8%	Russia, 5%
4	Brazil, 8%	India, 5%	Canada, 5%
5	India, 6%	UAE, 3%	UAE, 4%

The growth in capacity in China was largely driven by the development of captive coal resources to produce and supply power, particularly in Western China, subsidising prices to the aluminium industry[13]. Today, China's domestic aluminium and alumina production represents 59% of the global industry. China also imports 83% of global bauxite exports, including 98% of Australia's bauxite exports and Guinea, as the world's largest exporter of bauxite, exports principally to China, including from some captive bauxite mines. It is this dominance in other industries which has triggered efforts in other minerals, such as rare earths, for re-shoring of domestic production.

Increasingly, in the future, recycled aluminium will also be a key international measure of production and China already produces almost 40% of global recycled ingots (Figure 5). Oceania, which includes Australia and New Zealand, produces <0.1%.

Figure 2. Global Bauxite Production 1995-2022[14]

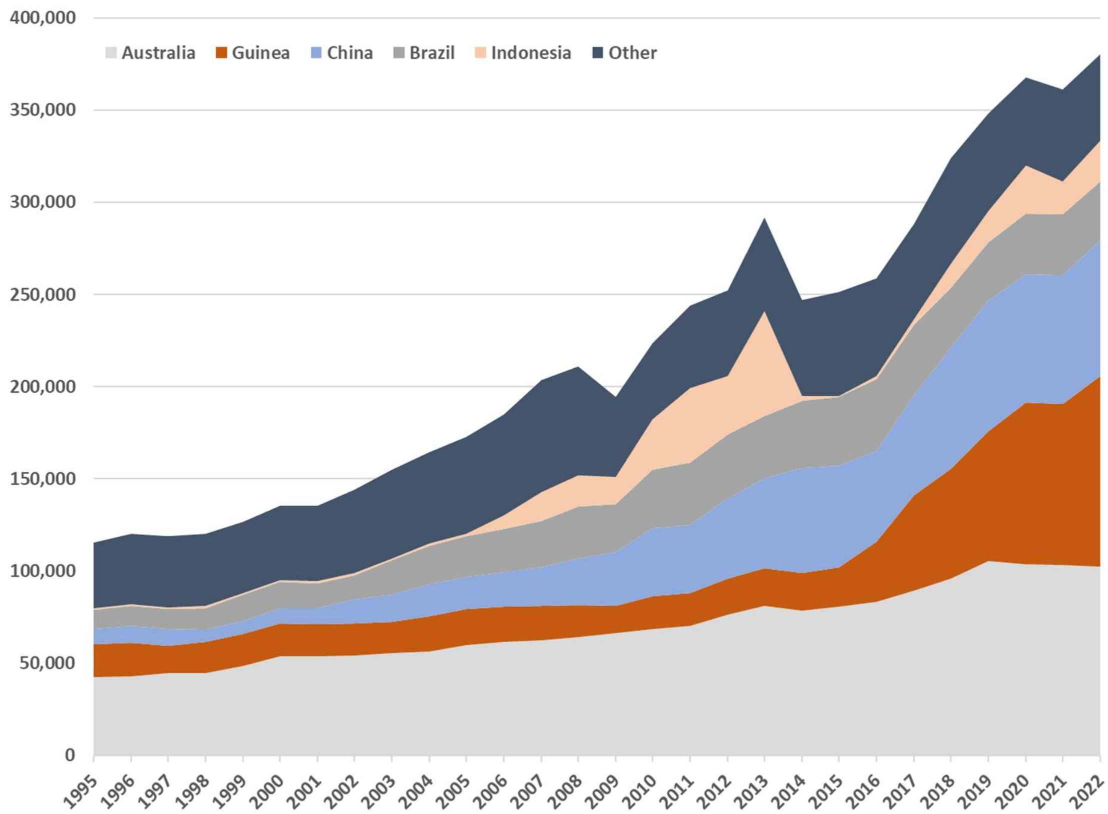


Figure 3. Global Primary Aluminium Production 1973-2022[15]

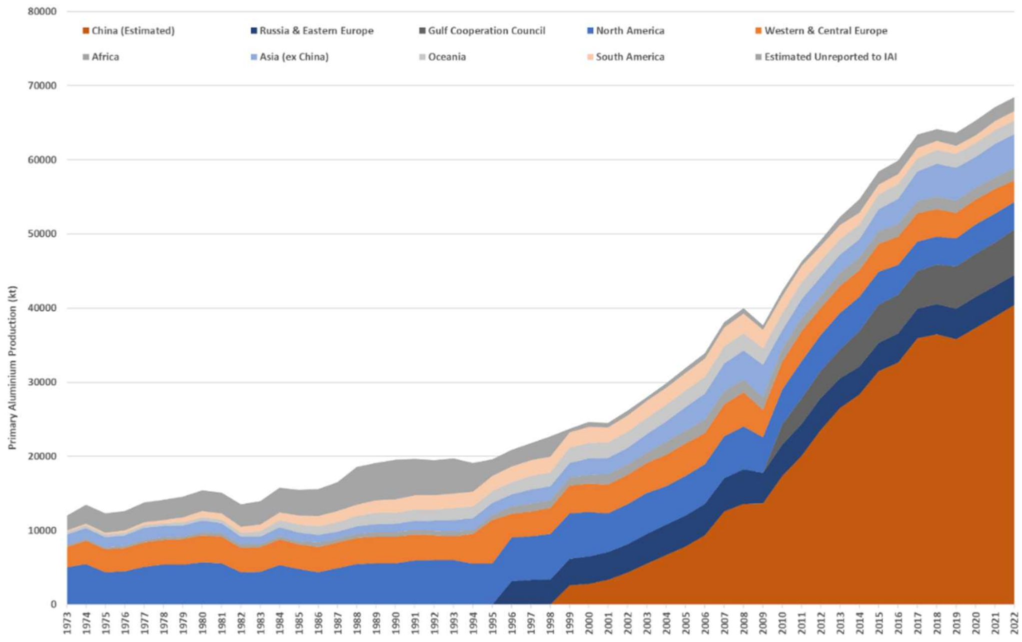


Figure 4. Global Alumina Production 1974-2022[16]

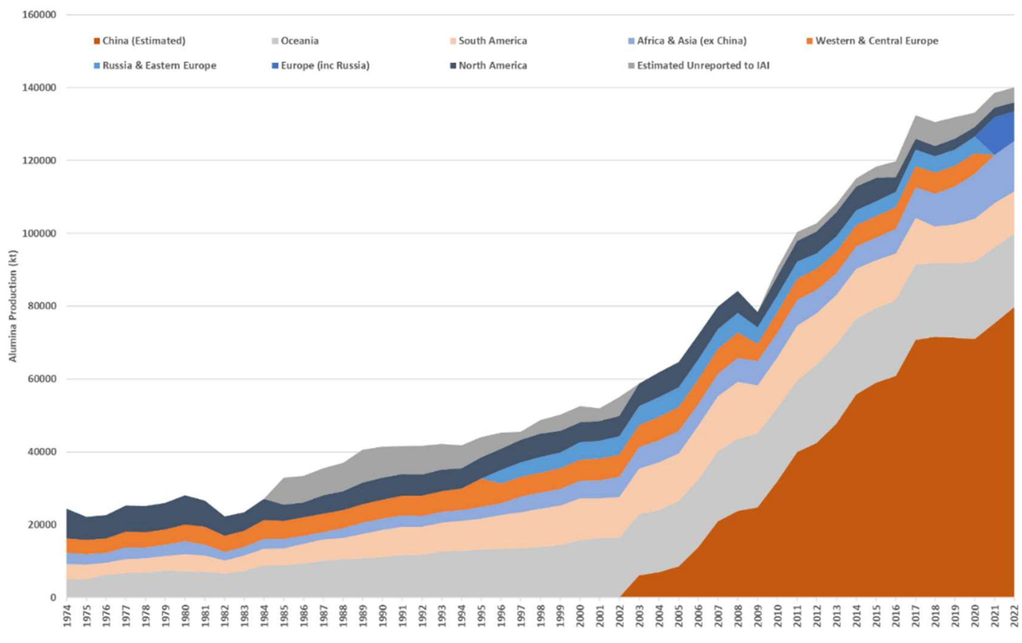
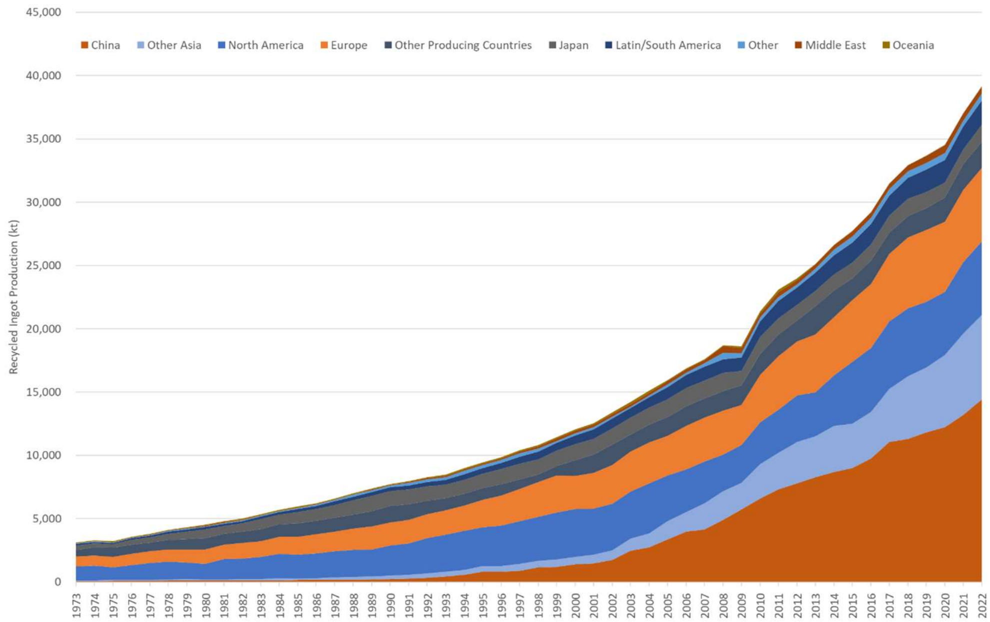


Figure 5. Global Recycled Ingot Production 1973-2022[17]



While DISR projects that Australia will be the world's largest producer of high purity alumina (HPA) by 2025, with 49% of global output, it is worth noting the scale of the global HPA market is in the order of 50-100 thousand tonnes compared to around 140 million tonnes per annum for metallurgical grade alumina.

In a global net zero economy, green metals will be in high demand

1. What insights do you have on green metals markets?

a. Expected current and future demand for green metals domestically and in key export destinations.

While there is some demand for low carbon alumina and aluminium, this is currently in small volume niche applications and is not yet, and not expected to in the near term, materialising at a commodity scale. This is expected to evolve over the time frame of the transition to a global net zero economy, but this is beyond the timescale of the transition of the Australian producers.

While there is a demand for "green aluminium", premiums for green aluminium, where they exist, are small, in the order of USD $10-100/t[18], while over the first 6 months of 2024, price for commodity aluminium varied from $2100-$2700/t[19]. The market is still immature and observations at the moment is that pricing is opportunistic. The Paper implies that consumers would pay a "green premium" which reflects the increase in production costs associated with emissions reductions. It is the experience of the industry that this is not the case, but that a green premium will only apply at scale when the demand for low carbon aluminium exceeds supply and is the market is willing to pay (See also response to Q18).

b. Australia's potential production volumes of green metals.

Australia's aluminium industry was established nearly 70 years ago due to historic advantages in substantial high quality bauxite reserves, early investment in an integrated industry supported by Government, historic energy advantage and access to a skilled workforce with expertise mining and mineral processing. While Australia maintains its bauxite reserves, it has lost its historic energy advantage and there is increasing pressure on a limited skilled workforce. Targeted investment should provide the transitional support needed as Australia's infrastructure and energy systems develop, and energy returns to being competitive.

While the Australian aluminium industry has been highly successful since its establishment and remains a major source of employment and export income, it has growth potential under the right policy settings. The bauxite mined in Australia each year could produce up to 40 Mt of alumina, which is nearly double our existing production which, in turn, could support aluminium output of 20 Mt – more than 13 times current levels. Australia is well placed to build on its aluminium supply chain to meet growing international demand. To do so, however, requires specific government policies:

1. Deliver internationally competitive supplies of clean energy;
2. Use of incentives to enable Australia to be sufficiently competitive to be able to attract global decarbonisation investment (discussed later in this Submission);
3. Prioritise the Australian aluminium value chain, as a Critical Mineral;
4. Environmental approval processes across the supply chain that appropriately balance the environmental rigour and protection with timelines that reflect commercial needs; and
5. Development of long-term strategic partnerships with likeminded countries.

These policies are outlined in greater detail in recent analysis undertaken by the Council[20].

c. Which countries/markets are green metals currently being sourced from and used in?

Low carbon aluminium is currently produced predominantly in countries and regions which have historic access to hydro electricity (or other firmed renewables) including Canada, Russia, Norway, Iceland, New Zealand and Tasmania. The two largest producing aluminium regions globally, China and Gulf Cooperation Council[21], use primarily thermal power sources for their aluminium smelting production (Figure 6). While data for Oceania does include New Zealand, this comprises only around 17% of the energy use.

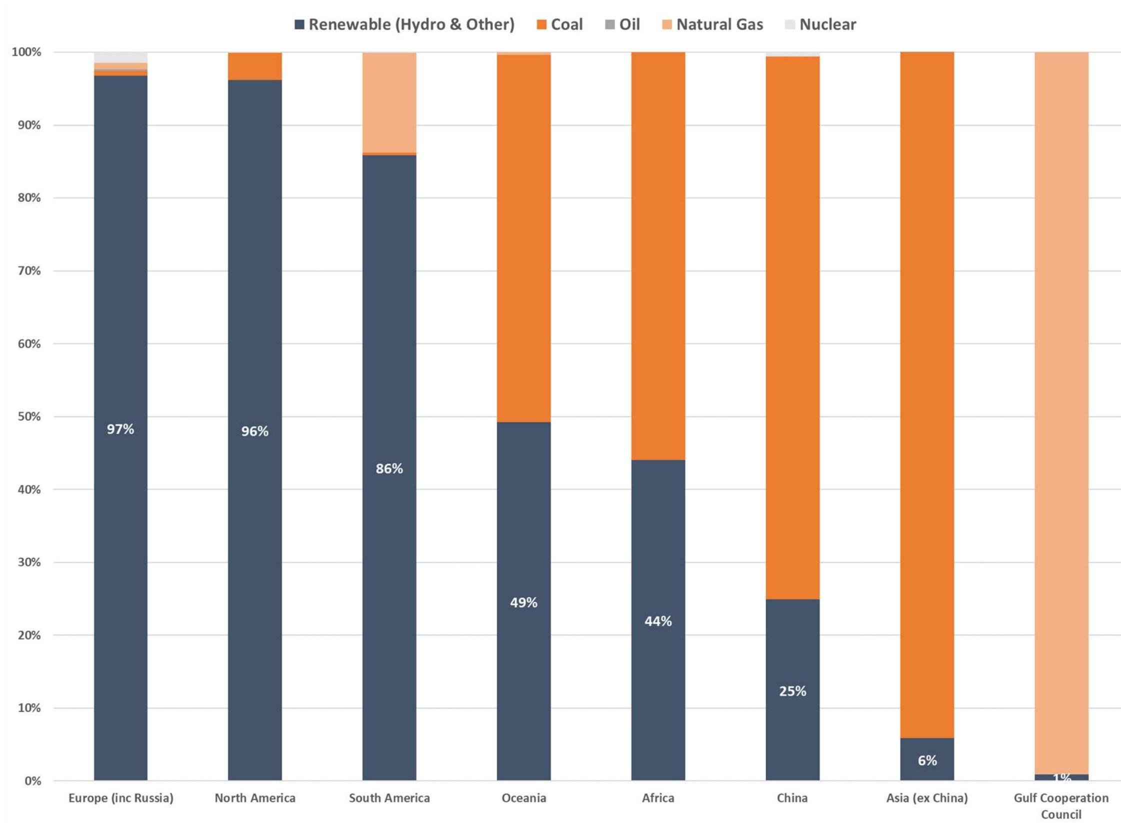


Figure 6. Primary Aluminium Smelting Power Consumption by Source 2022[22]

Australia's alumina already has some of the lowest emissions in the world, with an average scope 1 and 2 emissions intensity for alumina of <0.7 t CO_2-e/t compared to the global industry average of 1.2 t CO_2-e/t. For the most efficient alumina refineries abatement opportunities are also limited by the development of step change technology and/or the availability of low emissions, competitively priced, firmed electricity. Key decarbonisation technologies for refining are not expected to be available for commercial roll out until around 2030 or later[21]. While it is difficult to project the timescale for this change even the Innovator

Abatement Pathway of the ARENA Roadmap for Decarbonising Australian Alumina[23], does not show substantial abatement potential until close to 2030 (Figure 7).

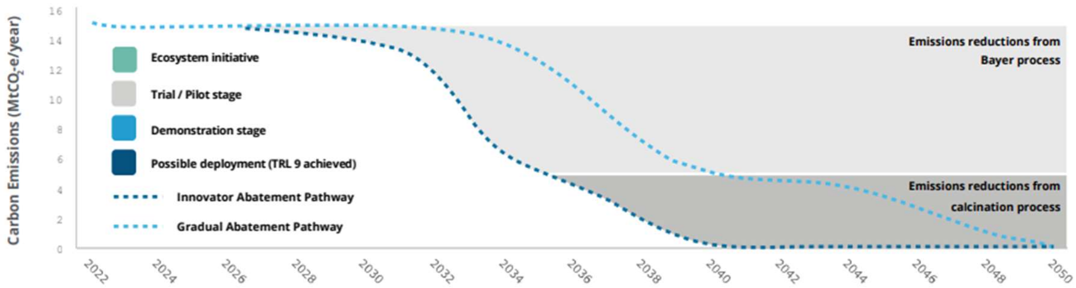


Figure 7. Alumina decarbonisation roadmap until 2050 with staging for key on-site and off-site ecosystem initiatives to achieve an 'Innovator Abatement Pathway (ARENA Roadmap)

e. Australia's capacity to source green metals from global supply chains
Australia's consumption of aluminium is small, due to a relatively low population and manufacturing base. Australia could readily source low carbon aluminium to meet its domestic needs, if it did not have its own supply base. However, doing so would mean the country would be missing out on economic advantages associated with value adding to its natural capital resources, such as bauxite.

f. Which countries or markets will provide the greatest international competition, or demand for Australian produced green metals?
Low carbon aluminium is currently produced predominantly in countries and regions which have historic access to hydroelectricity (or other firmed renewables) including Canada, Russia, Norway, Iceland, New Zealand and Tasmania.

Existing supplies of competitive, firmed low carbon electricity, which can be used to supply the transition of alumina refineries to alternate technologies are increasingly being deployed. For example, electric boilers have been installed at refineries in Ireland and Brazil, due to access to renewable electricity at scale[24].

2. How does metal recycling contribute to Australia's green metals industry in Australia?
Aluminium can be recycled again and again, almost infinitely, making it an incredibly sustainable material. Around 75% of the almost 1.5 billion tonnes of aluminium ever produced is still in productive use today as it can be recycled endlessly. Aluminium's life cycle provides significant benefits through recycling, saving 95% of the energy it would take to make primary aluminium metal.

Recycled aluminium is part of the global decarbonisation pathway for the sector, but it cannot fully meet aluminium demand today nor in 2050. Aluminium applications can have long use lives in sectors such as transport and infrastructure and that metal is not available for recycling in the short term. For example, cars can have lifetimes of over 20 years, and buildings over 50 years.

There are also a range of global references such as the Global Recycling Standard (GRS), ISO and International Aluminium Institute which aim to ensure the tracking and verifying the content of recycled materials in products and that claims about recycled content are accurate and verified.

a. What is the impact of metal recycling on reducing emissions from Australia's industrial sectors?
While secondary or recycled aluminium offers a lower emission pathway, as recycling aluminium uses only 5% of the energy, this does not recognise the potential limitations in this technology application in Australia due to the limited downstream manufacturing market. In many cases, recycled aluminium is provided directly to manufacturers such as the car industry, rolling mills etc. In the absence of these manufacturing industries, more work is required to quantify the true opportunity for Australia.

b. What are the opportunities to increase metal recycling in Australia? How could this be achieved?
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[25] which also provided aluminium remelt capabilities, so Australia has lost this manufacturing capability. Recycling (melting) of aluminium scrap requires expertise in scrap handling, sorting and melting. Scrap types where there is a risk of moisture entrapment require particular safety barries to be in place. Generally speaking, pre-consumer scrap can more easily be utilized in existing smelters Currently, specialist metal recyclers currently collect and export both pre- and post-consumer scrap for recycling. However, within the existing industry, pre-consumer scrap may offer an efficient feedstock for recycled billet product and an initial entry point into increased recycled content for Australian supply chains. The industry is exploring this further in 2024.

c. What impact does the export of scrap metal have on Australia's ability to develop a green metals industry and reduce emissions from existing industry?
Despite being a large primary aluminium producer, Australia imports almost 400kt aluminium product - including of 214 kt of sheet and plate, 89kt of aluminium extrusions, 70kt of alloyed primary aluminium and 25kt of foil. And Australia currently exports around 470kt of scrap aluminium a year[26]. It is believed that this includes around 30-40kt of pre consumer extrusion scrap. But much of the scrap being exported may also include the end of life of products imported into Australia (i.e. not manufactured domestically). There is currently limited visibility of this scrap (i.e. sources and alloys) and where its generated (i.e. states and regions), and forecast growth increases as products come out to the end of life to help give insights into the challenges which would be faced by Australia in developing domestic remelt capacity. Despite having a limited product stewardship obligation towards this material, the Council and its Members are currently assessing the scale of this and working to understand the technical, commercial and policy barriers in developing increased domestic remelt capacity.

3. What practices are used to verify and measure green metals? What are the limitations of these approaches?
There is no formal definition of the term "green metal" for application to the aluminium industry. Assuming that this implies 'low carbon', a carbon footprint of less than 4 CO_2e/t Al is a common reference[27], representing the very lowest achievable with currently available technologies. This is on the basis of a cradle to gate or mine to metal methodology[28].

The Aluminium Stewardship Initiative (ASI) estimates that only around a third of primary aluminium on the market today can be produced at levels which would be considered low carbon. Currently, the global average emissions intensity on the basis of mine to metal is 15.1 t CO_2-e / t Al. However, green premiums will only truly apply when the demand for low carbon aluminium exceeds supply and if the market is willing to pay. At this stage there is little evidence of this occurring at a commodity scale.

It is also worth noting that consideration of carbon content alone as a measure of "green metals" does not account for other environmental, social and governance issues which should also be accounted for in considering the total impact of the production of goods. The Council believes a more wholistic view on what is a "green" metal is appropriate.

The Council understands that the Government is considering a staged approach to defining green metals and these would be on a per tonne alumina and per tonne aluminium basis (i.e. not integrated). This could include:

- Comparisons with, and progress against, global average (e.g. 50%, 75%, 90%) – however, it is not clear how this accounts for changing global averages and potentially increasing in energy costs for existing renewable electricity consumers which do not actually result in emissions reductions; or
- Comparisons with, and progress against, current levels (e.g. 50%, 75%, 90%) - not clear how this would work for facilities with very low emissions intensities today, but which may have limited options in near term to decarbonise.

Australia is an attractive destination for new green metals investment

As noted in the International Policy Examples, the funding for aluminium is often based on its inclusion as a Critical Mineral (e.g. US and Canada). In Australia, none of bauxite, alumina and aluminium are currently considered Critical Minerals. Aluminium is included as a Strategic Material, but this listing lacks any other supporting policy framework. Australia's failure to address this is a lost opportunity in its policy setting framework. The Council believes the Strategic Materials list requires urgent review and would instead be better addressed as a part of the Critical Mineral List.

6. What is the scale of investment needed to convert existing facilities or establish new ones (including enabling infrastructure)?

Australia is in a global clean energy race, competing for both capital and skilled workers, while other nations undertake their own transition of their sectors such as aluminium. Compared to international competitors, Australia has low rates of investment relative to the size of its economy. Capital follows the strongest investment signals and Australia's energy and industry policy signals are currently too weak to attract globally relevant industrial abatement and investment capital.

The Mission Possible Partnership[29] highlighted that a global investment of approximately US$1 trillion will be required for the aluminium sector transition. Considering the size of the Australian aluminium industry (~3% of the global industry), an investment of US$30bn would be necessary to deliver the same outcome. The scale of investment will vary depending on site specific, technology and infrastructure but would be significant at a facility level. Policy support needs to be commensurate with the scale of these significant investments.

Green metals industries can support thriving communities and workers

8. What are the benefits to the local region or community when developing a green metals project? and
10. How can the government support industry to enable communities and workers to share in the benefits of transitioning to green metals?

Australia's existing aluminium industry is already predominantly located in regional Australia (Figure 8). The majority of the more than 19,000 employees live in the regions in which they work and there is often intergenerational employment at sites. In regions like Cape York, bauxite mines can have indigenous participation rates of 30%[30]. In the regions in which the Council's members operate the intent is to provide financial benefits but also education, training, cultural heritage protection and employment.

There are already workforce and skills shortages across many industries and regions that impact on the alumina and aluminium industry and will be exacerbated during the transition. The scale of the workforce and skills required for transformational abatement projects and new industries should not be underestimated, nor should the impacts of this on the pace of abatement. These challenges are, however, not unique to the aluminium sector and maintaining the existing assets in these regions will in fact help maintain a trained and agile workforce which can adapt to future opportunities.

Decarbonisation is an electrification story - large scale wind and solar, distributed solar, household and grid scale energy storage, increased electricity transmission and distribution, electric vehicles and the electrification of industry, in particular, mining and alumina refining. As a result, there will be significant demand for those with electrical skills including electrical discipline engineers, electricians, process control engineers and analyser technicians, electric vehicle mechanics. This demand will occur across all sectors in the economy. These skills are strongly linked to STEM subjects at high school and historically male dominated industries. These professions are likely to attract high salaries, good conditions and offer long term career prospects that are suitable for a range of employment arrangements including "fly-in fly-out", regional and metro-based roles, full and part time, site, office and home based locations. Ensuring there are enough suitably qualified workers will require the largest, and therefore most diverse, pool of talent. The promotion of STEM and the encouragement of both male and females into these careers is paramount to achieving decarbonisation. This should include re-training mature employees into these roles. Given the aluminium industries location in regional Australia this can help upskill thriving communities into the future.

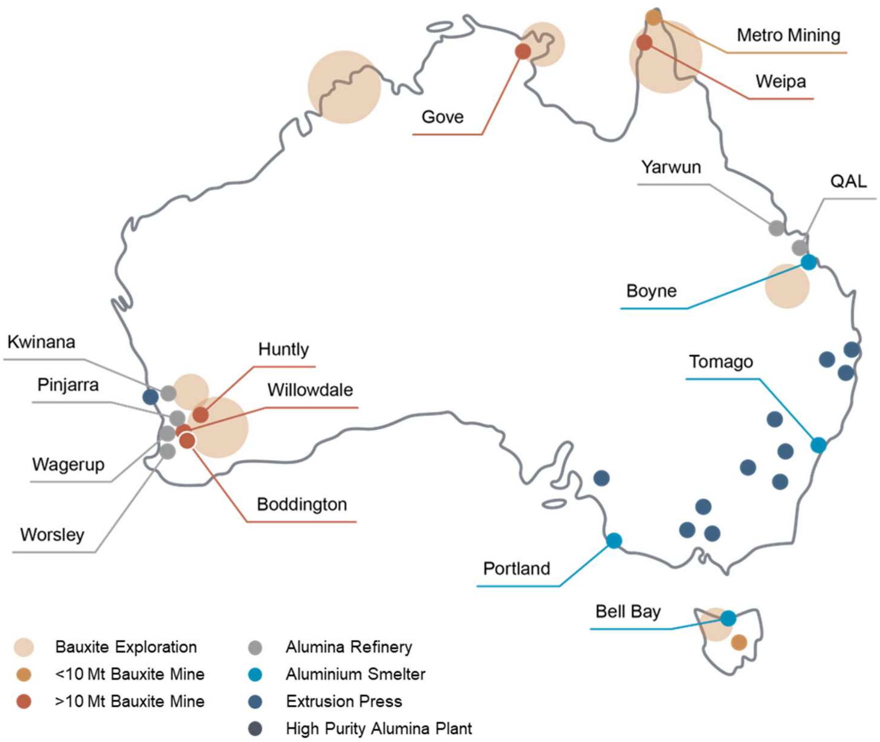


Figure 8. Aluminium Operations in Regional Australia

<u>Pathways and barriers to decarbonisation</u>

Attachment B outlines the industry's pathways to decarbonisation for both alumina and aluminium. As highlighted in the Paper, for both alumina and aluminium, these pathways require substantial amounts of competitively priced firmed renewable electricity. Even the conversion of aluminium smelters to inert anodes, which is not expected until beyond 2030, would only take place when a smelter was operating on an internationally competitive, long term, firm and low carbon electricity contract to underpin the scale of the investment needed.

While the Paper forecasts that Australia's renewable energy costs will be globally competitive in the long term, the short to medium term for existing industry is challenging. While the cost of variable renewable energy generation has fallen dramatically, the delivered cost (including transmission and distribution) of firmed electricity has not. The cost of firming renewable energy supply is likely to be one of the largest differentiators of Australia's future competitiveness for electricity-intensive industries.

At a high level, the barriers to investment include, but are not limited to:

1. Capital Requirements: Initial investments in new technologies, infrastructure, and process modifications require substantial capital, and Australia must be able to compete to attract this investment;
2. Return Variability: The financial returns on decarbonisation investments can vary, particularly in markets with varying carbon pricing or incentives;
3. Technological Stage: Some decarbonisation technologies are in early development phases, influencing the risk profile of investments;
4. Regulatory Conditions: The consistency and strength of regulatory frameworks across the value chain affect the viability of investments in zero-emission technologies in downstream assets.

5. Supply Chain Availability: The availability of raw materials, such as renewable energy at the required scale, consistency and price, can impact investment decisions.
6. Financing Accessibility: The ability to secure financing for large-scale decarbonisation projects varies and can influence investment feasibility.

Additionally, while the Council recognises that Australia is actively working towards its goal of achieving 82% renewable energy by 2030, there are significant challenges and uncertainties in the implementation which threaten to delay the ability of energy consumers to undertake the transition either from thermal energy to renewables or from fossil fuels to electrification:

- Regulatory and Planning Issues: Delays in planning and environmental assessments, along with the need for transmission network upgrades, are also bottlenecks;
- Renewable Capacity Addition: Australia needs to add about 7 GW of new renewable energy capacity annually, including both large-scale projects and small-scale installations like rooftop solar;
- Supply Chain and Labor: There are significant hurdles related to supply chain constraints and the availability of skilled labour; and
- Improving Grid Infrastructure: Upgrading transmission lines and streamlining grid connection processes are required.

These challenges apply not only in the National Electricity Market (NEM) but also in other grids such as the South West Interconnected System (SWIS).

12. What are the key barriers to investing in new green metals facilities or decarbonising existing facilities? Please indicate the level of priority for addressing each barrier.

Green Aluminium

Providing electricity is supplied consistently, with firm power, and at internationally competitive prices, aluminium smelting can be run on renewable electricity. As smelters are already electrified, no technological conversion is required. The carbon intensity of the Australian grid is declining rapidly, with this increased penetration of variable renewables. The owners of Australia's four smelters have signalled their intent (Table 2) to recontract renewable electricity at the end of their current terms (2025-2029) and through the increasing role for industry in systems support during the transition.

For all smelters globally, more than 95% of Scope 1 emissions could be eliminated with conversion to inert anodes and the industry has been working on inert anode technology development for many decades at a research scale. Elysis[31], a joint venture between Alcoa, Rio Tinto, Apple and the Quebec Government has been developing this technology[32]. The technology has the potential to be used at both new and existing smelters, including those in Australia. However, as articulated in the September 2022 Mission Possible Partnership report, the global rollout of inert anode technology is not anticipated to be widescale until post 2030[21]. There are, therefore, limited process emission abatement opportunities (<5%) for smelters until this technology is deployed and limited opportunities to bring this forward in Australia before 2030. See also Q16.

Green Alumina

Alumina refineries will require technology changes for both digestion and calcination processes to meet zero-emissions goals; either in the form of electrification or adaptation to use hydrogen for process heating. Barriers to the transition for alumina refineries differ from those in aluminium smelters and therefore the policy response required is different.

1. Investment support to overcome the capital cost of on-site transformation to low carbon production methods, including during technology development phases;
2. The need to upgrade regional electricity infrastructure to deliver the requisite energy to the sites in a low margin mid-stream industry; and
3. Production credit as Australia's energy returns to being competitive.

Alumina refining is an energy intensive process, using about 10.5 GJ per tonne produced. Digestion and calcination are the two most energy intensive steps, with digestion consuming around two thirds of this energy. Currently, this energy is largely derived from gas and coal, as well as electricity. All of Australia's alumina refineries have some combined heat and power generation (cogeneration) facilities which use coal, gas, or biomass fuels. Cogeneration is an efficient way to produce process heat from the waste steam from electricity generation, resulting in the refineries using, and in some circumstances also exporting, low emissions electricity.

The current consumption of around 220 PJ of energy, is currently derived from gas and coal in the refineries. This has the potential to be replaced by internationally competitive renewable electricity, subject to the successful development and commercialisation of refinery side technology (including thermal storage and Electric Boilers, hydrogen or electric calciners). This may convert to electricity requirements of 3-5GW[33] firm, depending on the technology applied in digestion and calcination. This would transform both the NEM and SWIS electricity markets.

However, this relies on not only the development of commercial and technological solutions for electrification of alumina refineries but also the development of sufficient competitively priced low emissions generation and storage, and transmission capacity at scale to match. The electrification of existing industry, combined with the development of new electricity intensive industries, such as hydrogen, will require substantial volumes of electricity delivered reliably, affordably and at scale. The Council is concerned that if technology development lags, or energy transmission and supporting infrastructure is delivered in the manner and at the pace it has been historically, this will become the rate limiting step in the transition[34]. For example, Worsley Alumina[35] have confirmed that a substantial expansion and modification of the energy grid would be required to deliver renewable power at the necessary scale for industrial users in the region (SWIS). Therefore, decarbonisation of Worsley Alumina may be in two stages, firstly conversion of the onsite boilers to natural gas and only in the longer-term application of new technologies to support increased electrification and renewable energy for the refinery, which would require broader investment in shared energy infrastructure in the region.

It is the internationally competitive cost of zero carbon electricity at industrial scale to facilities, which will enable the greatest transformation of the whole sector, including both alumina and aluminium. It is hoped that some technologies for refinery digestion may be able to be deployed prior to 2030. However, access to the required generation, storage and infrastructure outside the facility could be the rate limiting step in the electrification process. To assist with this, one solution is that Government could accelerate significant private investment in renewable generation, low-carbon industries and industrial decarbonisation projects by committing to upfront funding of transmission upgrades, that could be recovered from users (as needed) once operating.

15. What are the technologies are associated with meeting green thresholds?
Alumina refineries will require technology changes for both digestion and calcination processes to meet zero-emissions goals; either in the form of electrification or adaptation to use hydrogen for process heating. Development of this technology and its application will be stepwise as new technologies to reduce overall emissions become viable. The required thresholds for implementation will be differentiated by refinery (and processes within a refinery); locational access to energy, including supporting transmission infrastructure; the local emissions intensity of electricity supply and bauxite type. The investment required to implement these changes will be substantial.

The Australian aluminium and alumina industries are investing significant resources to identify, develop and commercialise complex new technologies that will enable fossil fuels, to be phased out of operations as soon as commercially possible. The timeline for reduction in fossil fuel consumption depends on time taken to successfully identify, develop and commercialise these processes, and to integrate into existing facilities accordingly as well as the availability of competitively priced electricity and associated infrastructure.

See also Q12 and Q16 for discussion of Elysis and Section B for overall pathways and links to detailed factsheets.

16. Are these technologies being developed or commercialised?
a. If yes, when do you expect these to be ready for commercial scale deployment?
b. If not, why not?
Alumina Technologies
Australia has more than 50 years of technical experience in bauxite mining and alumina refining technologies. This experience helps not only us, but our bauxite, alumina and aluminium customers, to reach their sustainability goals. Alcoa, Rio Tinto and South32's Alumina operations all have their global bauxite and alumina research headquarters in Australia, helping develop new technologies for the world

The Australian aluminium industry is already involved in both domestic research at a company, partnership (e.g. ARENA) and cooperative (e.g. HILT CRC) level (Table 2). The Australian industry also collaborates through international partnerships (e.g. Elysis) as well as the International Aluminium Institute's Alumina Decarbonisation work.

Through partnerships with the Australian Government, Australian alumina refineries are leading the development of technology development and commercialisation including double digestion[36], electric[37] and hydrogen[38] calcination. Through these partnerships, the industry has signalled its commitment to invest in decarbonisation of Australia's alumina refineries and developing technologies domestically.

Aluminium Technologies
Rio Tinto recently announced[39] that it will install technology issued under licence by the Elysis joint venture at its Arvida smelter in Québec. Rio Tinto will design, engineer, and build a demonstration plant equipped with ten pots operating at 100 kiloamperes (kA). The plant will be owned by a new joint venture in which Rio Tinto and the Government of Québec, through Investissement Québec, will invest $179 million (CAN$235 million) and $106 million (CAN$140 million) respectively as equity partners, for a total investment of US$285 million (CAN$375 million). The plant will have the capacity to produce up to 2,500 tonnes of commercial quality aluminium per year without direct greenhouse gas emissions, with first production targeted by 2027. It will be located adjacent to the existing Arvida smelter, allowing the use of the current alumina supply and casting facilities.

This facility will use the same technology that has been successfully demonstrated at the Elysis Industrial Research and Development Centre in Saguenay—Lac-St-Jean. This pilot operation at Arvida will be a critical step towards full scale industrialisation of the technology. The joint venture is continuing its research and development program to scale up the technology and has completed the construction of larger prototype 450 kA cells at the end of an existing potline at Rio Tinto's Alma smelter. Elysis has begun commissioning these industrial prototype cells, with the start-up sequence set to begin in 2024.

While this is a significant development for the global industry, the cost and timing of this pilot reinforce that the global rollout of inert anode technology is not anticipated to be widescale until post 2030.

Major planning and capital investment is required to develop and roll out technologies and connect to green energy inputs
17. What factors would enable the acceleration of metals decarbonisation? For producers, what levels of production would be feasible over time?
The single biggest factor in determining the location of future refining, smelting and manufacturing locations is reliable, internationally competitive, low emissions energy. New large scale renewable energy, firming and transmission assets to meet the needs of a decarbonising aluminium industry must be developed in a timely fashion to enable emissions associated with the industry to be reduced at scale. The Council believes that while the long term solution is renewable electricity, gas will have a necessary bridging role in lowering carbon emissions from refineries in the medium term, while low emissions alternatives are further developed and rolled out in the future.

The industry has indicated the trajectory of decarbonisation (Appendix B) and there are external limitations in going beyond this:

- The biggest opportunity to accelerate alumina and aluminium decarbonisation is to expedite the scale and pace of Australia's electricity transition, while ensuring this electricity is prioritised for use by value adding industry and is available at internationally competitive prices.
- Abatement opportunities in alumina refining are limited by the availability of not only electricity at scale but also the development of key decarbonisation technologies, which are not expected to be available for commercial roll out until around 2030 or later.
- Investment in transformational abatement in alumina refineries also needs to be supported by access to bauxite environmental approvals on commensurate time scales. For example, investment in a 20-30 year asset at an alumina refinery would need to be supported by surety of bauxite supply over the same period. See response to Q33.
- While gas may be seen as an interim alternative to coal use in alumina refining, in some regions, gas is not available as either physical supply or due to limitations in pipeline capacity to be an alternate fuel to coal in the foreseeable future. Increasing access to domestic supplies of gas and review of pipeline capacity may remove this current barrier.
- The global rollout of inert anode technology is not anticipated to be widescale until post 2030. There are, therefore, limited process emission abatement opportunities (<5%) for smelters until this technology is deployed and limited opportunities to bring this forward in Australia before 2030.

18. What are the best examples of a 'green premium' being established for low emissions products? What actions could improve demand for these products?

The Paper implies that consumers would pay a "green premium" which reflects the increase in production costs associated with emissions reductions. It is the experience of the industry that this is not the case, but that a green premium will only apply at scale when the demand for low carbon aluminium exceeds supply and is the market is willing to pay. At this stage, global production from low carbon (e.g. hydro and other renewable) sources exceeds global demand with almost 40% of global production being from low carbon electricity sources for aluminium smelting (Figure 9).

While there have been many public announcements about "green" (low carbon) metal supply, the volumes are small compared to even Australia's production let alone global production of aluminium at this stage.

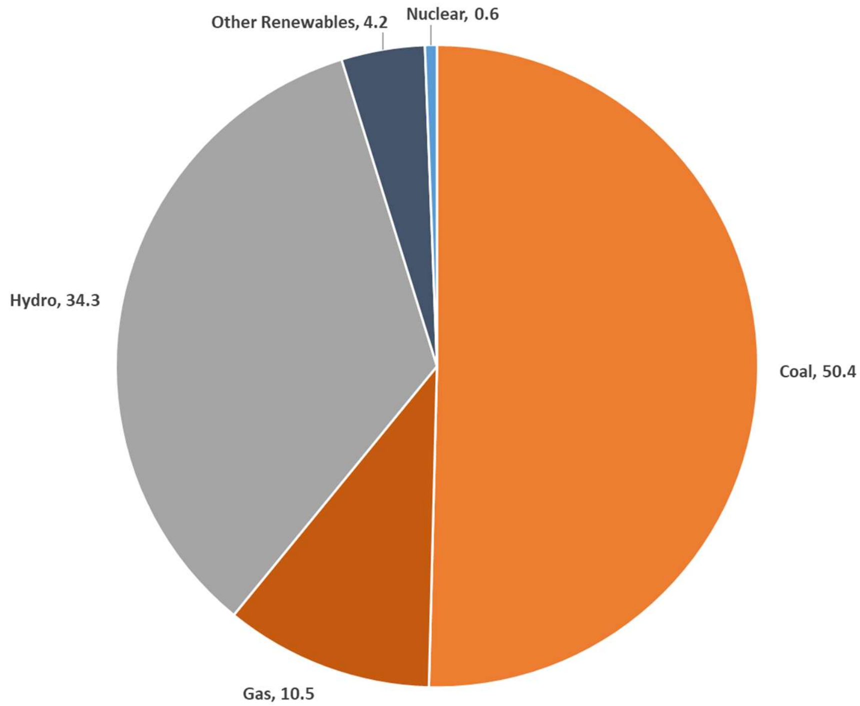


Figure 9. Global Primary Aluminium Smelting Power Consumption by Source (2022)[40]

The London Metals Exchange (LME), which is regarded as the global benchmark for aluminium pricing, has introduced a variety of sustainability measures[41], but has not yet signalled any intent to price aluminium differently based on these. The LME has indicated that for other metals, premature pricing of "green" materials could indeed fragment these markets and reduce overall liquidity[42].

Rather than consumers paying a green premium reflecting cost increases, there is a need for production incentives or similar supports, until market demand exceeds supply. Higher energy costs are not offset by a green premium.

20. How would adopting renewable energy and green hydrogen impact on your current costs and the commercial viability of your operations, if you were able to implement them right now?
a. How does this compare to interim or transition fuels?
Through the Yarwun Hydrogen Calcination Pilot Demonstration Program[43], the industry is aiming to demonstrate the viability of using hydrogen in the calcination process, where hydrated alumina is heated to temperatures of up to 1,000 degrees C. This also includes the construction of a 2.5MW hydrogen electrolyser at the refinery as well as the retrofit of refinery processing equipment. If successful, the program could pave the way for adoption of the technology at scale globally.

Hydrogen is not currently available at the scale or price which would make it a competitive alternate fuel. However, it may, in the longer term, have a role to play in high temperature processes such as alumina calcination. The timeframes for this, subject to its availability and price, are:

- Short-term (<5 years) - Pilot projects and small-scale use in specific processes.
- Medium-term (next decade): Potential adoption as hydrogen production and supply chains become more established; and
- Long-term (beyond 2040): Potential use of green hydrogen in alumina calcination, subject to significant advancements in hydrogen production technology and infrastructure.

<u>Current policy settings</u>

Support for research and innovation

The Australian aluminium industry is already involved in both domestic research at a company, partnership (e.g. ARENA) and cooperative (e.g. HILT CRC) level (Table 2). The Australian industry also collaborates through international partnerships (e.g. Elysis) and also the International Aluminium Institute's Alumina Decarbonisation work. While the Council welcomes the ongoing focus on research, it is worth nothing that research projects which have not yet commenced would be unlikely to deliver abatement in the next decade.

The Council believes further support is needed from Government for innovation and investment in new low carbon firming technologies. This could be one of the focuses of the Future Made in Australia Innovation Fund. This is particularly important for longer duration forms of energy storage, where mature technologies today (e.g. pumped hydro) are risky, prone to cost overruns and have long lead times. Ensuring a diverse technology mix within Australia's energy market could improve efficiency and reduce costs supporting the competitiveness of Australian energy intensive manufacturing industries.

Enabling policy

The Paper outlines that the Safeguard Mechanism is an enabling policy which incentivises existing facilities to invest in lower carbon production through tradeable Safeguard Mechanism credits awarded when they outpace their baselines, providing an additional revenue source. The Council notes that while the Safeguard Mechanism provides an incentive, until abatement technologies are available this incentive is as a "stick" rather than a "carrot". The Australian aluminium and alumina industries are investing significant resources to identify, develop and commercialise complex new technologies that will enable fossil fuels to be phased out of operations as soon as commercially possible. The timeline for these reductions depends on time taken to successfully identify, develop and commercialise these processes, and to integrate into existing facilities accordingly. Challenging market conditions currently facing the industry, including the Safeguard Mechanism costs and the capital requirements for decarbonisation, have led to the impairment of two Australian alumina refineries[44].

In the absence of a unified global carbon policy, carbon intensive, hard-to-abate sectors in Australia are competitively disadvantaged internationally. The Council notes that the Government is in parallel, reviewing the risk of carbon leakage[45] to the industry. All of Australia's bauxite mines, alumina refineries and aluminium smelters are trade exposed. This review is being conducted against a background of changing geopolitical risk and increasingly concentrated supply chains (Table 1) increase the risks of vulnerability outside Australia's control, including carbon leakage as other jurisdictions have lower or less transparent carbon policies in place. Australia's resource and industrial base has the potential to expand zero- and low-emissions industrial production, including of green alumina and aluminium, with economic benefits to match. However, for Australia to be successful in this, industry must receive the necessary support through the transition.

The Council recognises the Governments' concerns over perceived "double dipping" if reductions, which are funded by FMIA, result in creation of safeguard mechanism credits which are then fungible. However, the Council believes these concerns can be addressed in the policy design.

Energy as an input

As previously articulated, the estimated cost to transition the Australian aluminium industry is ~US$30b. The Council notes the scale of the investment in the expanded Capacity Investment Scheme ($67B) and the $20 billion Rewiring the Nation is of the order required to attract investment. While the Australian Government has committed to projects to unlock these opportunities for investors, they are not currently at the required scale. For example, while the Council appreciates the creation of a dedicated Powering the Regions Fund (PRF) Critical Inputs to Clean Energy Industries (CICEI) stream the program, at $400m, is currently two orders of magnitude smaller (relative to GDP) than similar programs in other jurisdictions like Canada, Europe and Japan. By comparison, with the PRF, under the Inflation Reduction Act the United States Department of Energy has recently announced[46] a US$500 M (AUD ~$760M) grant to a single facility - Century Aluminum to build the first greenfield domestic primary aluminium smelter in 45 years. This new facility will rely on carbon-free electricity and will more than double primary aluminium production in the U.S. This is seen as increasing the strategic ability of the U.S. to not only compete on a global scale, but to increase capacity to meet growing demand and be a source of the security and diversity of aluminium supply chains in the U.S.

The Council notes the recent increase in the Capacity Investment Scheme (CIS). The Council had been concerned that the 6GW initially proposed was insufficient and supports the revised CIS in its intent to deliver an additional 32GW of capacity and clean dispatchable capacity projects by 2030 to help fill the expected generation and reliability gaps. The Council believes that other Government incentives should similarly be reviewed to ensure they are fit for purpose to meet the challenges of the transition.

Additionally, it is becoming clear that a number of services historically provided by large energy users (such as smelters) including provision of minimum demand need to be better valued by the electricity market. Aluminium smelters already offer a range of services and functions which support the network over varying weather, network demand and operating conditions, including Reliability and Emergency Reserve Trader (RERT) and Frequency Control Ancillary Services (FCAS). Smelters' large and fast-acting interruptibility helps secure and restore stability to the network before and after contingencies occur. The industry has increasingly been called upon to support grid stability and reliability, as the challenges in managing the grid increase. Amongst the roles played by very large and continuous smelter loads are:

- Buffering the erosion of minimum demand periods;
- Support for the continued economic commitment and operation of large-scale synchronous generation (noting that de-commitment of synchronous units due to inadequate base demand levels can regularly remove large blocks of inertia and system strength from the system);
- Supply of certain essential system services, such as contingency FCAS;
- Potential participation in "backstop" reliability schemes such as RERT or Interim Reliability Reserve (IRR); and
- Enhancing system resilience through rapid unscheduled interruptibility in the case of extreme contingency events, which, like more extreme weather conditions, are occurring more frequently in the NEM and increasingly complex to match with dispatch in real time.

Only some of these services are explicitly remunerated. Some are not, and their overall "real option" value is not recognised – namely the flexibility that retention of these large loads provides in future choices of physical and economic mechanisms to stabilise the system and market. In the absence of these loads the measures required to maintain secure and resilient operation of the grid would require significant additional investment and cost to all consumers. While the Council recognises that the CIS is intended to incentivise new investments, the exclusion of demand response in this initial phase will exclude the participation of large industrial loads. These may have lower cost and efficient capacity which is not currently incentivised to be provided to the market. The Council believes this least cost delivery needs to be facilitated as it may be delivered more efficiently and quickly to the market than through the CIS.

There is no transition without transmission and in both the NEM and the SWIS effort is needed to continue to progress future state transmissions networks, to support the large volume of renewable energy required to offset not only existing coal fired generation, but also increased demand for facilities to electrify once this technology becomes viable. For example, the SWIS does not have the generation nor transmission capacity to electrify one alumina refinery, let alone three. The fundamental pillar of global competitiveness is low-cost renewable energy, firming and transmission. Despite recent announcements, such as the expansion of the CIS[47], the scale of the investment at this stage does not match the scale of investment of Australia's competitors.

<u>**Options to support an Australian green metals industry**</u>

Supply side options to accelerate green metals production

The Council has previously articulated that two forms of production incentive are required to contribute to reducing the green production cost gap:

1. **Production Credits.** This policy pathway is being used effectively in a range of jurisdictions, including the US, China, India and Europe, to incentivise production of low carbon products and inputs into the clean energy supply chain. The credits are typically priced in a manner that bridges the relevant regional or global low carbon production premium, through an implied cost of carbon required to support investment. The policy should be specifically relevant to aluminium metal production and could be doubly incentivised into domestic downstream manufacturing, such as extrusion; solar panel production etc.
2. **Transformational Infrastructure and Technology Funding**. The Government's existing grant funding through the PRF is currently two orders of magnitude smaller (relative to GDP) than similar programs in other jurisdictions like Canada, Europe and Japan. The scale being offered must be significantly increased with a fixed commitment to co-fund 50% of all low carbon industrial capital investment across existing and new assets for both on and off-site investment. This will allow industry to then cost efficiently and competitively demonstrate technological innovation and deliver regional infrastructure upgrades, such as transmission. This would be particularly relevant for the alumina industry, where the principal barriers to decarbonisation are:
    - the capital cost of on-site transformation to low carbon production methods; and
    - the need to upgrade regional electricity infrastructure to deliver the requisite energy to the sites in a low margin mid-stream industry.

Additionally, non-financial means of support – particularly the streamlining of regulatory approvals – are also critical to lowering investment barriers.

23. What approach and features do you consider to be most effective?
For example:
a. Which incentive would lead to the biggest increase in private investment in green metals production across production, investment, and innovation-linked incentives?

The single biggest factor in determining the location of future refining, smelting and manufacturing locations is reliable, internationally competitive, low emissions energy.

24. Are there parts of the value-chain that require particular support (for example, energy inputs, green alumina or iron inputs, or green aluminium or steel production)?
a. Should support be prioritised towards certain parts of the value chain in the first instance?

While Australia has a partially vertically integrated supply chain, each asset has different timing for current contract renewal, thresholds for technology implementation; locational access to energy including supporting transmission infrastructure; local emissions intensity of electricity supply and bauxite type (for refineries). Support should be provided in parallel across the industry, it would be disadvantageous to try and stage it by process type.

25. Where support is provided across a value chain, such as intermediate metal outputs, what design features are necessary to ensure support is effective for producers with different levels of vertical integration?

While different producers have different levels of vertical integration, these should be progressed on an asset by asset or facility by facility level. This will help lead to least cost implementation and abatement as companies can prioritise implementation at the sites most suited within their portfolio, noting that there are often different ownership and management structures within a group.

Demand-side actions to foster green metals markets

The Council looks forward to better understanding how the expanded Guarantee of Origin Scheme (GO) will be used for certification of "green" metals and how this will align with other existing industry certification schemes such as the Aluminium Stewardship Initiative (ASI), which covers multiple aspects of environmental, social and governance performance, including emissions and sustainability.

It is unclear what the timing is on Guarantee of Origin Consultation and how this will align with the Green Metals policy development. In considering how "green metals" will be defined, the Council urges consideration how non carbon measures, such as environmental standards, will be considered so that the there are no unintended consequences of production moving to countries which have lower standards.

The Council is concerned that much of the work to date on finance climate reporting and taxonomies, which may be used to inform GO schemes, has been led by the finance sector (e.g. banks) and Treasury and industrial producers have largely been involved only via public consultation towards the end of design phase. There is a risk the views of both producers and consumers of Australia's alumina and aluminium have not been adequately considered in the base case from which the GO will be developed. In the absence of a "green premium" in the short to medium term, the Council does not believe that a GO will be the best initial measure of success; but that the focus should instead be on directly lowering the cost of production of low carbon alumina and aluminium in Australia.

31. What demand side options would best drive confidence for green metals producers? Should the government consider regulation, procurement rules for government purchasing, voluntary targets or other demand options?

There are limited opportunities for aluminium procurement in Government purchasing, due to some limitations in downstream manufacturing (e.g. Australia no longer has rolling mills). The exception to this is aluminium extrusion such as in the solar sector.

For example, aluminium accounts for more than 88% of the metal in a solar panel. The aluminium frame and rail are examples of extrusions which can be made using existing manufacturing capability in Australia. For every GW of solar PV, 5.5 kt of aluminium extrusion is needed for frames and for every GW of rooftop solar, an additional 13 kt of aluminium extrusion is needed for rails and mountings. Aluminium frame and rail can be reused or recycled if circularity is considered in design. Installed solar in Australia will need more than 1.5 M tonnes of aluminium extrusion by 2050, creating a substantial increase in demand for both aluminium and extrusions. But today more than 70% all semi-finished aluminium used in Australia is imported and <3% of Australian extrusion capacity is supplied as solar rail and none as solar frame. Leveraging opportunities for Australian aluminium to be used in the development of a solar PV industry could see Australian bauxite become Australian made solar panels, which could be designed for end of life circularity. In addition, the upstream aluminium industry has a growing demand for renewables, which could further catalyse demand for solar PV manufacturing.

33. Are there any other issues or opportunities that can be addressed to unlock an Australia green metals industry?

Environmental Approvals

The industry is increasingly aware of delays, beyond the statutory timelines, for both new and post approval processes. These processes are also seeing increases in opening up of issues to the implementation of policy, which has not been passed as legislation such as Nature Positive, and post approvals opened not just on the clause in question. These delays in the current system are impacting on business confidence in Australia's policy environment. As a leader in sustainable mining practices, the aluminium industry supports regulations that meet the highest standards of environmental protection. Approval processes must reflect the commercial realities of long-life capital-intensive projects and provide efficient pathways for projects seeking approvals without diminishing regulatory standards. Failure to do so will see projects and production move offshore, often to countries with much lower environmental standards. Transitional arrangements for any existing projects or referrals must be clearly articulated. The long term future for the sector in Australia is positive but it is under near term stress.

Without mining, the world cannot reach net zero by 2050, and the minerals required to achieve our decarbonisation goals are of such magnitude that to reach net zero, we will need more mining, not less. While seeking to maintain Australia's highest standards for ESG, it is also worth considering that global demand will continue to be met from elsewhere if not provided by Australia. Australia's historic advantage in the aluminium industry stemmed principally from its substantial high quality bauxite reserves. The success of Australia's green metals industry requires an integrated system of policies, including those which support ongoing approval to mine Australia's bauxite reserves. The Council will make a submission to the current consultation on the Nature Positive (Environment Protection Australia) Bill 2024 [Provisions] and related bills[48] focused on constructive improvements to Australia's environmental approval framework.

Opportunities in Raw Material Sourcing

There may be additional opportunities in Australia domestically manufacturing raw materials which are currently imported inputs into its green metals supply chains. For example, caustic soda is a critical input into alumina refining (and other industries) but is currently 100% imported in Australia. A broader review of supply chains for energy intensive products currently imported into Australia may identify opportunities, like caustic, to increase domestic manufacturing, reducing supply chain risk while increasing sovereign capability.

B. **Aluminium Industry Decarbonisation Pathways**

The Mission Possible Partnership, in collaboration with the International Aluminium Institute, recently released Making Net Zero Aluminium Possible: A Transition Strategy for a 1.5°C-compliant Aluminium Sector[49] (the Strategy). The release of the Strategy was supported by the Council and its members. This work brought together companies across the global industry, including those operating across the value chain in Australia. The Strategy recognised that it is possible to meet rising aluminium demand, reduce emissions from the sector to net zero by 2050, and align with a 1.5°C target. The Strategy also highlighted that a global investment of approximately US$1 trillion will be required for the aluminium sector transition, including significant investment to supply the required zero-emissions electricity. Considering the size of the Australian aluminium industry (~3% of the global industry), this equates to an investment of US$30bn to deliver the same outcome. The Strategy outlines not only actions the industry needs to take, but also actions required by Governments to support this. In particular, developing policy that is predictable, stable and transparent to enable businesses to confidently plan for the substantial investment that comes with a commitment to decarbonisation. Governments also have a vital role to play designing markets to support the transition, particularly for the energy and electricity sectors.

The Australian Renewable Energy Agency (ARENA), in consultation with Alcoa, Rio Tinto and South32 has published a Roadmap for Decarbonising Australian Alumina[50]. The Roadmap identifies four key themes for decarbonisation that could transform the way alumina refineries consume and use energy by enabling the uptake of renewables and removing the use of fossil fuels. It also provides a framework for future policy and investment decisions and serves as a call to action to collaboratively transition the sector into an industry at the forefront of the transition to net zero.

In 2022, Scope 1 and 2 emissions from Australia's integrated aluminium industry (bauxite, alumina, aluminium) were about 33.7Mt CO2-e, which was 7% of Australia's national emissions (Figure 10). Energy typically accounts for 30-40% of the industries cost base, and therefore energy efficiency is a key focus of for these processes.

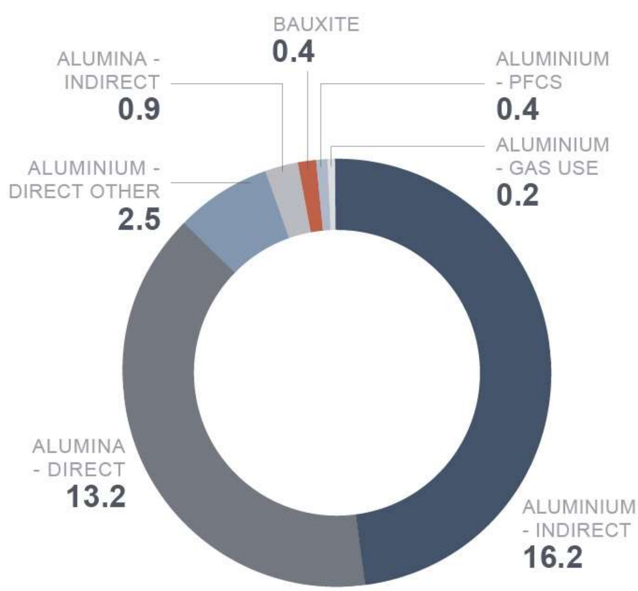


Figure 10. 2022 Industry Emissions (Mt CO_2-e)

Globally, there is a focus across industry to find solutions for the technology challenges required to decarbonise, including the use of hydrogen based technologies. There is an opportunity for Australia to lead the world in development and implementation of these technologies, capitalising on Australia's national advantages, providing jobs and value to the economy. The Council has produced a series of five detailed factsheets to help articulate the technology pathways:

1. Australia's role in a global aluminium decarbonisation pathway;
2. How Australian bauxite will help meet global demand for aluminium;
3. Australia's role in developing low carbon alumina refining technologies for the world;
4. The role of Australia's aluminium smelters in providing baseload stability in a decarbonising grid; and
5. Decarbonisation of Australia's electricity supply, which the Council sees as the single biggest opportunity to decarbonise the vertically integrated domestic aluminium industry.

The Council updates these factsheets annually; reflecting not only progress in decarbonisation in the industry; but also updating the industry's views of the evolution of decarbonisation technologies, based on research undertaken in Australia and through global partnerships. A summary of key Australian Aluminium industry initiatives is provided in Table 2.

Table 2 Key Australian Aluminium Industry Initiatives

Activity	Link
Affreightment Carbon Reduction	https://www.combinationcarriers.com/insights-and-news/2022/1/4/kcc-and-south32-conclude-first-sustainability-linked-contract-of-affreightment
ARENA Roadmap for Alumina	https://arena.gov.au/knowledge-bank/a-roadmap-for-decarbonising-australian-alumina-refining/
Electric Calcination Study	https://arena.gov.au/projects/alcoa-renewable-powered-electric-calcination-pilot/
Gladstone Renewable Request for Proposals / PPAs	https://www.riotinto.com/news/releases/2022/Rio-Tinto-calls-for-proposals-for-large-scale-wind-and-solar-power-in-Queensland https://www.riotinto.com/en/news/releases/2024/rio-tinto-to-drive-development-of-australias-largest-solar-farm-at-gladstone https://www.riotinto.com/en/news/releases/2024/rio-tinto-signs-australias-biggest-renewable-power-deal-as-it-works-to-repower-its-gladstone-operations
Gove Solar Farms	https://www.riotinto.com/en/news/releases/2024/two-new-solar-farms-for-gove-peninsula-as-rio-tinto-works-to-secure-more-sustainable-power
HILT CRC	Heavy Industry Low-carbon Transition Cooperative Research Centre https://hiltcrc.com.au/
Hydrogen Calcination Study	https://arena.gov.au/projects/rio-tinto-pacific-operations-hydrogen-program/
Hydrogen Pilot Plant	https://www.riotinto.com/news/releases/2021/Rio-Tinto-and-Sumitomo-to-assess-hydrogen-pilot-plant-at-Gladstones-Yarwun-alumina-refinery
Mechanical Vapour Recompression Study	https://arena.gov.au/projects/mechanical-vapour-recompression-for-low-carbon-alumina-refining/
Memorandum of Understanding between Tasmania and Rio Tinto	https://www.stategrowth.tas.gov.au/__data/assets/pdf_file/0010/334558/TAS-RIO_TINTO_MOU_Feb_2022.pdf
Mission Possible Partnership	https://missionpossiblepartnership.org/wp-content/uploads/2022/10/Making-1.5-Aligned-Aluminium-possible.pdf
Queensland Alumina Limited Double Digestion	https://minister.dcceew.gov.au/bowen/media-releases/330m-investment-australian-heavy-industry-future
Refinery of the Future	https://www.alcoa.com/global/en/stories/releases?id=2021/11/alcoa-to-design-an-alumina-refinery-of-the-future
Rio Tinto and GMG	https://graphenemg.com/gmg-riotinto-energysavings-battery/
Spinifex Wind Farm (Portland)	https://arena.gov.au/news/offshore-wind-could-power-portland-aluminium-smelter/ https://www.spinifexoffshore.com.au/#/
Tomago Aluminium Renewable Future	https://www.tomago.com.au/tomago-aluminium-future-renewable-energy-needs/

Activity	Link
Weipa Solar and Battery Capacity	https://www.riotinto.com/news/releases/2021/Rio-Tinto-to-triple-Weipa-solar-capacity-and-add-battery-storage-to-help-power-operations https://www.riotinto.com/en/news/releases/2023/rio-tinto-approves-new-solar-farm-and-battery-storage-to-power-its-amrun-bauxite-operations-on-cape-york
Worsley Boiler Conversion	https://www.south32.net/news-media/latest-news/worsley-alumina-converts-first-boiler-from-coal-to-natural-gas
Yarwun Hydrogen Calcination Pilot Demonstration Program	https://www.riotinto.com/en/news/releases/2023/rio-tinto-and-sumitomo-to-build-gladstone-hydrogen-pilot-plant-to-trial-lower-carbon-alumina-refining https://arena.gov.au/projects/yarwun-hydrogen-calcination-pilot-demonstration-program/

Corporate Ambitions

The major operators and joint venture participants in Australia's aluminium industry have the common ambition of net zero by 2050, supported by interim goals (Table 3). However, when comparing these targets with performance within Australia or at a facility level, it is worth noting that corporate ambitions are set at levels that are in line with their policies and subject to their accounting and transparency rules. All the Council's members' interim ambitions are for *both* Scope 1 and Scope 2, and the application of known technologies such as increasing renewable energy supply will be the major pathways for these to be achieved.

Table 3 Summary of Corporate Ambitions[51]

Company	Interim Goal (s)	Net Zero Ambition
Alcoa	30% reduction in scope 1 & 2 emission intensity by 2025 50% reduction in scope 1 & 2 emissions emission intensity by 2030 from 2015 baseline	Net zero by 2050
Rio Tinto	15% reduction in scope 1 & 2 emissions by 2025 50% reduction in scope 1 & 2 emissions by 2030 From a 2018 baseline (equity basis)	Net zero by 2050
South32	50% reduction in operational carbon emissions (Scope 1 & 2) by 2035 from FY21 baseline	Net zero by 2050
Alumina Ltd[52]	45% reduction in scope 1 and 2 emissions by 2030 (from a 2010 baseline)	Net zero by 2050
Hydro[53]	Reduction of 30% by 2030	Net zero by 2050

C. **References**

[1] https://www.industry.gov.au/publications/resources-and-energy-quarterly-june-2024
[2] https://www.worldbank.org/en/topic/extractiveindustries/brief/climate-smart-mining-minerals-for-climate-action
[3] International Aluminium Institute High Substitution Scenario
[4] https://news.alcoa.com/press-releases/press-release-details/2024/Alcoa-announces-curtailment-of-Kwinana-Alumina-Refinery-in-Western-Australia/default.aspx
[5] https://aluminium.org.au/wp-content/uploads/2023/11/Aluminium-Critical-Mineral-Report-Nov23.pdf
[6] https://iceds.anu.edu.au/news-events/news/australia%E2%80%99s-new-dawn-becoming-green-superpower-big-role-cutting-global-emissions
[7] https://www.pmc.gov.au/news/address-national-press-club
[8] https://www.worldbank.org/en/topic/extractiveindustries/brief/climate-smart-mining-minerals-for-climate-action
[9] International Aluminium Institute High Substitution Scenario
[10] Alumina Limited, Sep 2022
[11] https://aluminium.org.au/wp-content/uploads/2024/04/2023-Trade-Competitiveness-Factsheet-.pdf
[12] Data supplied by Department of Science, Industry and Resources and presented in https://aluminium.org.au/wp-content/uploads/2024/04/2023-Trade-Competitiveness-Factsheet-.pdf
[13] P23, https://www.antaike.com/uploadfiles/20120619/2012061915421737061.pdf
[14] Data supplied by Department of Science, Industry and Resources
[15] https://international-aluminium.org/statistics/primary-aluminium-production/
[16] https://international-aluminium.org/statistics/alumina-production/
[17] Data supplied by International Aluminium Institute
[18] Confidential communication provided to Australian Aluminium Council.
[19] https://www.lme.com/en/metals/non-ferrous/lme-aluminium#Price+graphs
[20] https://aluminium.org.au/wp-content/uploads/2023/11/Aluminium-Critical-Mineral-Report-Nov23.pdf
[21] https://international-aluminium.org/statistics/primary-aluminium-production/
[22] https://international-aluminium.org/statistics/primary-aluminium-smelting-power-consumption/
[23] https://arena.gov.au/assets/2022/11/roadmap-for-decarbonising-australian-alumina-refining-report.pdf
[24] https://climate.ec.europa.eu/system/files/2022-07/if_pf_2021_aal_seb_en.pdf and https://www.hydro.com/en/media/news/2022/alunorte-alumina-plant-fires-up-first-electric-boiler/
[25] https://news.alcoa.com/press-releases/press-release-details/2014/Alcoa-to-Close-Point-Henry-Aluminum-Smelter-and-Rolling-Mills-in-Australia/default.aspx
[26] https://aluminium.org.au/australian-industry/australian-trade-statistics/ derived from ABS data.
[27] https://aluminium-stewardship.org/low-carbon-aluminium
[28] https://international-aluminium.org/statistics/greenhouse-gas-emissions-intensity-primary-aluminium/
[29] https://missionpossiblepartnership.org/wp-content/uploads/2022/10/Making-1.5-Aligned-Aluminium-possible.pdf
[30] https://www.metromining.com.au/media/33566/metro-investor-presentation-noosa-conference-nov-2022.pdf
[31] https://www.elysis.com/
[32] Based on current smelter practices, it could be assumed that the timescale for conversion of a smelter would be 5-6 years. Conversion would also only be possible when combined with an internationally competitive, low emissions electricity contract.
[33] The potential renewable capacity required to meet this demand is likely 3 to 5 times this amount. https://arena.gov.au/assets/2022/11/roadmap-for-decarbonising-australian-alumina-refining-report.pdf
[34] https://www.worley.com/~/media/Files/W/Worley-V3/documents/our-thinking/from-ambition-to-reality/from-ambition-to-reality-report.pdf
[35] P73, https://www.south32.net/docs/default-source/all-financial-results/2022-annual-reporting-suite/sustainable-development-report-2022.pdf

[36] https://minister.dcceew.gov.au/bowen/media-releases/330m-investment-australian-heavy-industry-future
[37] https://arena.gov.au/projects/alcoa-renewable-powered-electric-calcination-pilot/
[38] https://arena.gov.au/projects/yarwun-hydrogen-calcination-pilot-demonstration-program/
[39] https://www.riotinto.com/en/can/news/releases/2024/rio-tinto-to-install-carbon-free-aluminium-smelting-cells-using-first-elysis-technology-licence
[40] https://international-aluminium.org/statistics/primary-aluminium-smelting-power-consumption/
[41] https://www.lme.com/en/about/responsibility/sustainability
[42] https://www.lme.com/api/sitecore/MemberNoticesSearchApi/Download?id=6ad52c6a-49bf-4e14-992e-1b1eb1924a30
[43] https://www.riotinto.com/en/news/releases/2023/rio-tinto-and-sumitomo-to-build-gladstone-hydrogen-pilot-plant-to-trial-lower-carbon-alumina-refining
[44]2023 Half Year Results - https://www.riotinto.com/en/invest/financial-news-performance/results
[45] https://www.dcceew.gov.au/climate-change/emissions-reduction/review-carbon-leakage
[46] https://www.energy.gov/oced/industrial-demonstrations-program-selections-award-negotiations
[47] https://minister.dcceew.gov.au/bowen/media-releases/delivering-more-reliable-energy-all-australians
[48] Submission will be available when released by the Committee from https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/NaturePositivebills
[49] https://missionpossiblepartnership.org/wp-content/uploads/2022/10/Making-1.5-Aligned-Aluminium-possible.pdf
[50] https://arena.gov.au/assets/2022/11/roadmap-for-decarbonising-australian-alumina-refining-report.pdf
[51]Sources: https://www.riotinto.com/en/sustainability/climate-change; https://www.alcoa.com/global/en/stories/releases?id=2021/10/advancing-sustainably-alcoas-2050-net-zero-ambition; https://www.south32.net/docs/default-source/exchange-releases/2021-south32-sustainability-briefing.pdf?sfvrsn=d8a76a71_2; https://www.hydro.com/en/media/news/2021/hydro-capital-markets-day-2021-sustainable-value-creation/
[52] Alumina Ltd are a JV participant in Alcoa World Alumina and Chemicals, which operate two mines and three refineries in Western Australia and has equity in the Portland Aluminium Smelter.
[53] Hydro is a JV participant in Tomago Aluminium Company.