Levelling the Playing Field for Carbon Emissions

How the EU's Carbon Border Adjustment Mechanism (CBAM) may impact companies in the aluminium sector – and potential unintended global consequences

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FOR PROFESSIONAL INVESTORS ONLY

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Introduction

The introduction of the EU's carbon border adjustment mechanism (CBAM) into EU legislation in 2023 was intended to reduce carbon emissions via global implications. Whilst some heralded it as key to protecting European industry, others focused more on the administrative and operational burden it placed on business, the restructuring of value chains and the potential resultant winners and losers. This paper seeks to build a nuanced picture of how CBAM may impact carbon emissions, as well as wider political and social systems.

We will firstly set the scene of EU carbon policy, explore potential impacts from phasing out EU ETS free allowances (both with and without the implementation of CBAM), before examining the implications of CBAM for the aluminium sector. Through case studies of three aluminium manufacturing companies, we will seek to understand variations in potential CBAM application and resulting risks and opportunities to business models, before finally exploring potential second and third order unintended consequences that were not captured in the CBAM policy construction.

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EU carbon policy background

The EU Emission Trading Scheme (EU ETS) was first launched in 2005 and sought to create a market for high-emitter sectors to buy and trade carbon emissions allowances within the European Union. Over time, the EU ETS has become a cornerstone of new agendas, for example the net-zero European Green Deal that was launched in 2019. The vast majority of revenues raised from auctioning the allowances are used by Member States for climate, renewable energy and energy efficiency related purposes (76% between 2013 and 2022)[1] with the remainder allocated to repaying the NextGeneration Covid recovery programme and providing capital for the EU's Innovation Fund and Modernisation Fund.

By seeking to charge high-emitting industries for their carbon emissions, a significant risk arose: companies moving high-emission operations, for example, factories, to non-regulated jurisdictions where carbon emissions do not have a related financial liability; this concept is commonly known as 'carbon leakage'.

One EU strategy for mitigating the risk of carbon leakage was via the provision of free carbon allowances to certain high emitting industries that are captured within the EU ETS but were considered at high risk of moving facilities abroad (for example those that are very energy-intensive with limited ability to pass on costs to customers).

In 2021, the European Commission sought to strengthen their 2030 climate ambitions and adopted the Fit for 55 package. By 2030, the package aims to reduce greenhouse gas emissions by at least 55% versus 1990 and increase the emission reduction target of EU ETS sectors from 42% to 61%.

One way in which the EU will encourage this is a stepped phase-out of the previously discussed free emission allowances, thus materialising the carbon costs for companies and once again elevating the risk of carbon leakage.[1] In the absence of CBAM (to be discussed below), Regnan hypothesises potential pathways of such a strategy to include the following (please note this is non-exhaustive):

Key concepts:

EU Emission Trading Scheme

Objective to: "makes polluters pay for their greenhouse gas emissions, helps bring emissions down and generates revenues to finance the EU's green transition".[2]

The scheme is a 'cap & trade' system, which means that the government sets an emissions cap and issues a certain quantity of emission allowances. Emitters must hold allowances for every ton of greenhouse gas they emit, and may buy and sell allowances, creating a market and establishing an emissions price. The scheme has developed since inception and now covers around 40% of EU emissions.[3]

European Green Deal

The European Union is "striving to become the world's first climate-neutral continent by 2050"[3]. The Green Deal seeks to ensure that there are no net emissions of greenhouse gases by 2050 whilst ensuring economic growth is decoupled from resource use and no person or place is left behind.

Innovation Fund

EU fund for climate policy with a focus on energy and industry that is expected to amount to €40 billion from 2020 to 2030.[4] It awards grants to innovation projects through calls for proposals and auctions.

Modernisation Fund

EU fund that supports the modernisation of energy systems in 13 lower-income EU member states, with the aim to help these states achieve their targets. Revenues come from 2% of the total auctioned EU ETS allowances for 2021-30 under the EU ETS and additional allowances transferred to the Modernisation Fund by beneficiary Member States; this amounted to €5.4bn in 2022.[5]

[1]www.eea.europa.eu/en/analysis/indicators/use-of-auctioning-revenues-generated
[2]climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en
[3]climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en#:~:text=Striving%20to%20become%20the%20world's%20first%20climate%2Dneutral%20continent%20by%202050.&text=The%20EU%20aims%20to%20be,to%20the%20European%20Climate%20Law%20.
[4]climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund/what-innovation-fund_en
[5]/www.eea.europa.eu/en/analysis/indicators/use-of-auctioning-revenues-generated .

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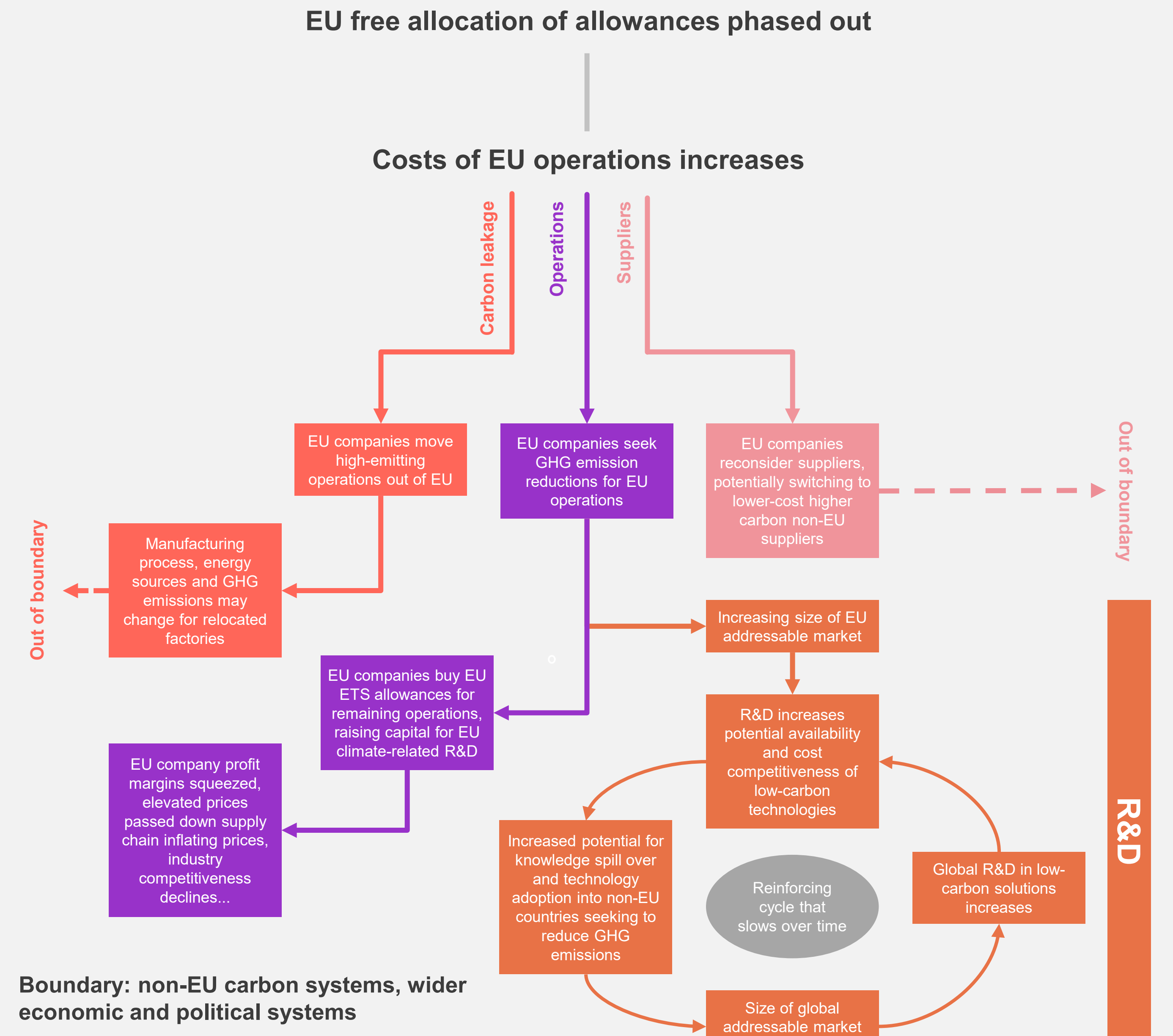
EU carbon policy background (cont'd)



Source: Regnan.

[1]https://www.europarl.europa.eu/news/en/press-room/20221212IPR64527/climate-change-deal-on-a-more-ambitious-emissions-trading-system-ets

The EU Carbon Border Adjustment Mechanism (CBAM)

To combat the aforementioned risk of carbon leakage, the European Commission therefore launched the EU Carbon Border Adjustment Mechanism (CBAM). The commission states the intended outcome of CBAM is to:

"put a fair price on the carbon emitted during the production of carbon intensive goods that are entering the EU, and to encourage cleaner industrial production in non-EU countries".[1]

In practice, CBAM requires exporters to the EU to report their carbon emissions from production on a quarterly basis. EU importers will use this information to purchase the corresponding amount of carbon certificates at a price determined by the weekly average EU ETS price. This aims to equalise the cost of buying from an EU firm and a non-EU firm for specific products within the EU ETS sectors (c. 50% of the emissions in ETS covered sectors are currently in scope)[2], to ensure that EU firms remain competitive whilst preventing carbon leakage. Companies may therefore seek to optimise the carbon efficiency of operations in order to strategically position themselves versus peers and increase market share; companies may be at risk of losing market share if they lag behind on strategy and implementation.

CBAM will be phased in over the 2026-2034 period at the same pace that the EU phases out EU ETS free allocation of allowances[3]:

Key concepts:

Benchmark values

A benchmark is utilized to determine the free allocation of allowances for installations and is established on the average greenhouse gas emissions intensity (CO_2 per tonne of product) of the top 10% of most efficient installations for a particular product. Consequently, the most efficient installations can receive all their necessary allowances for free, while inefficient installations had to compensate for any excess emissions they produce.

Embedded emissions

Emissions that must be considered in the CBAM reporting

'Simple' versus 'complex' goods

'Simple' goods are produced from input materials that are considered to have zero embedded emissions – so the total emissions are from entirely the emissions during the production of that good.

Social Climate Fund

The fund provides funding for Member States to support the most vulnerable groups and ensure they are not left behind in the green transition.

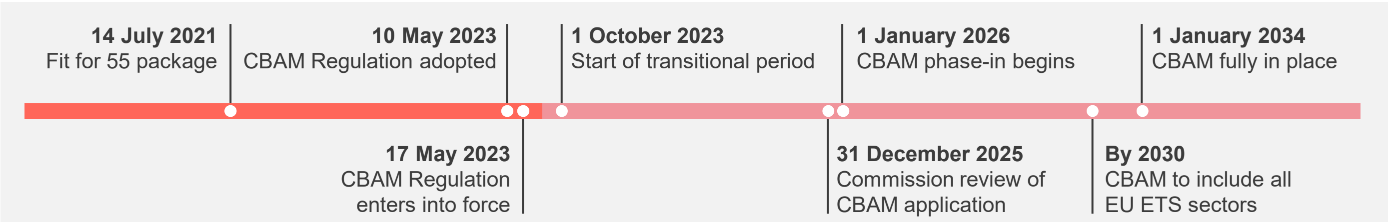
2026	2027	2028	2029	2030	2031	2032	2033	2034
2.5%	5%	10%	22.5%	48.5%	61%	73.5%	86%	100%

[1] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#:~:text=The%20EU's%20Carbon%20Border%20Adjustment,production%20in%20non%2DEU%20countries. https://taxation-customs.ec.europa.eu/document/download/013fa763-5dce-4726-a204-69fec04d5ce2_en?filename=CBAM_Questions%20and%20Answers.pdf
[2] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7719
[3] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

The EU Carbon Border Adjustment Mechanism (CBAM) (cont'd)

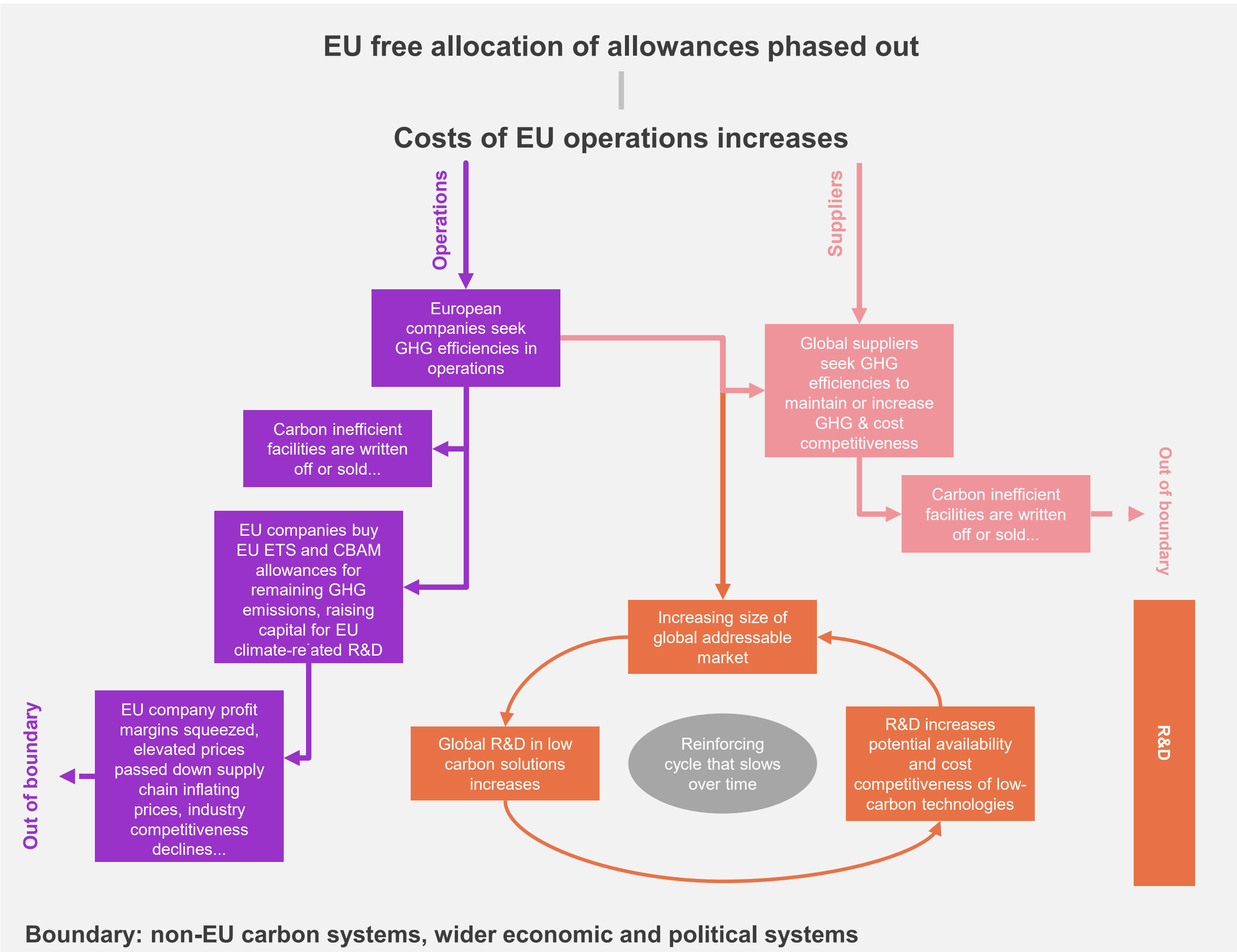
Revenues raised from the auction of CBAM certificates are expected to be split between the EU budget (75%) and Member states (25%). Whilst there are uncertainties in terms of quantum, part of the revenues allocated to the EU budget will go towards repaying the NextGenerationEU COVID-19 recovery plan passed in 2020, as well as the Social Climate Fund.

The timeline for CBAM implementation is as follows:



Source: epthinktank.eu/2023/12/01/carbon-border-adjustment-mechanism/cbam-implementation-timeline/

Regnan hypothesises potential consequential pathways of CBAM implementation to include the following (please note this is non-exhaustive):



Source: Regnan.

Sectoral application of CBAM: Aluminium

Despite the number of free carbon allowances that have remained available for European aluminium producers within the EU ETS system, there is evidence of potential carbon leakage already having taken place. The European industry group, European Aluminium, states around a third of primary smelting volume capacity in Europe has so far been closed and replaced by facilities outside Europe,[1] with 54% of aluminium imported versus 9% EU primary production.[2] Whilst less is produced domestically, aluminium will continue to play an important role in the EU's low carbon transition, with European aluminium demand expected to increase from 9 million metric tonnes (mt) a year to 18 million mt per year by 2050.[3]

Aluminium industry decarbonisation background

Aluminium is considered a 'hard to abate sector' and over the past decade, the average direct greenhouse gas (GHG) emission intensity has declined at an average of 2% per year.[4] European primary production has led global decarbonisation efforts and reduced their average direct carbon intensity by 55% versus 1990 by focusing on reducing perfluorinated compounds (PFCs) emissions produced during the smelting process (down 97%) and reduce carbon anode consumption.[5] Further abatement of emissions to achieve the 2050 net zero targets set out in the European Green Deal remains a challenge due to technological gaps, predominantly due to the significant energy required for electrolysis in the smelting process (electricity accounted for 61.4% of primary aluminium emissions in 2022)[6] and challenges in moving away from the carbon anodes.[7] However, technologies are slowly being developed to resolve these across the value chain (see next slide for examples).[8]

[1] european-aluminium.eu/wp-content/uploads/2022/08/07-10-2021-european-aluminium_prelim-1.pdf
[2] european-aluminium.eu/about-aluminium/aluminium-industry/
[3] european-aluminium.eu/about-aluminium/aluminium-industry/
[4] https://www.iea.org/energy-system/industry/aluminium
[5] european-aluminium.eu/wp-content/uploads/2022/10/sample_vision-2050-low-carbon-strategy_20190401.pdf
[6] international-aluminium.org/statistics/greenhouse-gas-emissions-intensity-primary-aluminium/
[7] www.climateadvisers.org/wp-content/uploads/2024/02/Climate-Advisers-Atlantic-Council-Decarbonizing-the-Aluminum-Market_Challenges-and-Opportunities.pdf
[8] /www.iea.org/energy-system/industry/aluminium

Sectoral application of CBAM: Aluminium (cont'd)

Aluminium value chain breakdown with emission sources and decarbonisation solutions

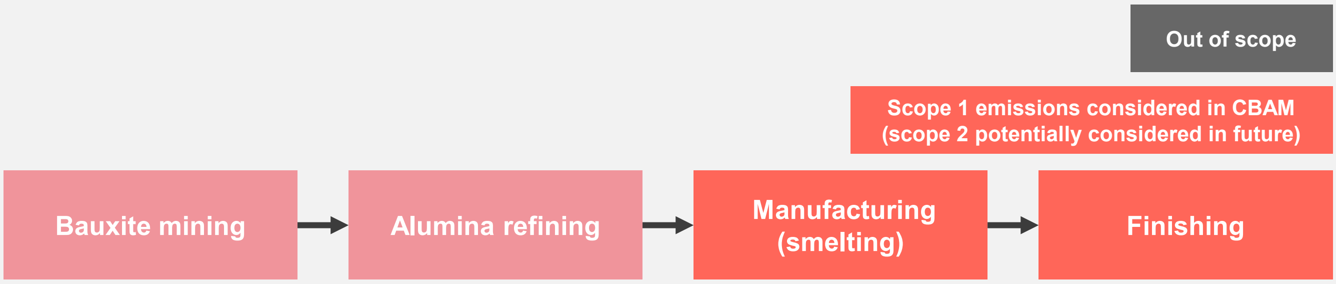
<table>
<tr><th>Value chain stage</th><th>Mining</th><th>Refining</th><th>Manufacturing (smelting)</th><th>Finishing</th></tr>
<tr><td>Description</td><td>Aluminium-bearing ore (bauxite) is mined</td><td>Bauxite undergoes the 'Bayer Process' to produce aluminium oxide (alumina)</td><td>Most commonly the 'Hall-Heroult' process is used to turn alumina into aluminium blocks through electrolysis</td><td>Aluminium blocks are remelted and alloys added, if required.</td></tr>
<tr><td>Global % GHGs</td><td>0.3%</td><td>18.64%</td><td>80.25%</td><td>0.71%</td></tr>
<tr><td>Sources of GHG</td><td>Primarily CO_2 where energy for extraction of bauxite is produced using fossil fuels.</td><td>Primarily CO_2 where energy to reach high temperatures is produced using fossil fuels</td><td>Primarily CO_2 where energy for smelting is produced from fossil fuels. PFCs, tetrafluoromethane and hexafluoroethane are also released via carbon anodes and alumina depletion</td><td>Primarily CO_2 where energy for shaping and treating the aluminium is produced using fossil fuels</td></tr>
<tr><td rowspan="4">Solution examples</td><td rowspan="4">Out of scope</td><td>Alternative thermal heat technologies such as concentrated solar, biomass, electrification and hydrogen</td><td>Inert anodes that do not degrade and produce pure oxygen</td><td>More efficient processing that increases yields, for example using digitalised production</td></tr>
<tr><td colspan="2">Carbon capture & storage</td><td>Electrification and hydrogen to replace fossil fuels</td></tr>
<tr><td colspan="2">Use of aluminium chloride rather than alumina to keep chlorine and carbon in closed loop</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Energy storage & flexibility solutions to vary production when demand is low</td></tr>
</table>

Sources: https://international-aluminium.org/statistics/greenhouse-gas-emissions-aluminium-sector; https://www.aluminiumleader.com/production/how_aluminium_is_produced; IEA

For a full list of current decarbonisation technologies, alongside their current stage of development as assessed by the IEA, please see the appendix.

Sectoral application of CBAM: Aluminium (cont'd)

Scope of CBAM application for the aluminium sector



CBAM will only be applied to specific aluminium products within these elements of the value chain (for a full list of products, please see the appendix).

From 2026, only direct emissions will be considered to have CBAM financial obligations for the aluminium industry, more specifically:

Value chain stage	Gases considered	Source
Manufacturing (smelting)	Direct carbon dioxide and perfluorocarbons (CF_4, C_2F_6)	Fuel use, consumption of electrodes/ anodes, flue gas treatment, use of soda ash, limestone
Finishing	Direct carbon dioxide emissions only	Fuel use, flue gas treatment

The EU has committed to including indirect emissions (i.e. those created during electricity generation) "as soon as possible"[1], although it will likely be a lengthy process with opposition from aluminium producers. We see business models being able to adapt to changing policy, particularly around electricity generation; all companies discussed later in this paper are already sourcing renewable energy contracts as part of their decarbonisation strategies, ahead of the CBAM requirement.

[1]https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2023:130:FULL

Risk and opportunities arising from CBAM: three aluminium company case studies

Whether, and to what extent, CBAM presents a risk or opportunity to companies varies according to factors including geographic and materials exposure, business model, carbon intensity and preparedness for the climate transition. For aluminium companies, as previously discussed, those that operate within the smelting/ manufacturing or finishing stages of the value chain and emit less/ have lower embedded emissions than peers may be well positioned to expand their market share versus higher polluting peers. Here we demonstrate how three companies in the same industry are uniquely positioned to respond to the CBAM.

Hydro

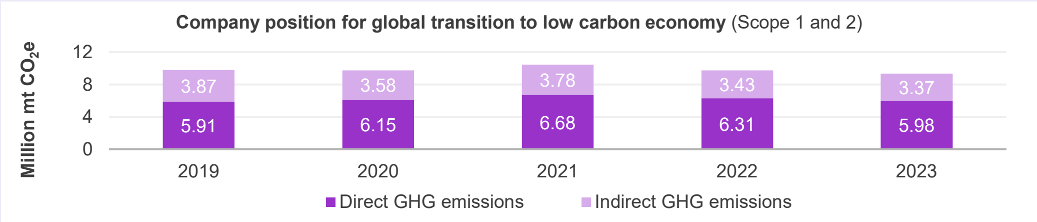
CASE STUDY

Norsk Hydro ASA engages in producing and supplying alumina and primary aluminium. It operates through the following segments: Hydro Bauxite and Alumina, Hydro Aluminium Metal, Hydro Extrusions, Hydro Energy, Hydro Metal Markets. The company was founded in 1905 and is headquartered in Oslo, Norway.[1]

Regnan assessment of overall position for transition to low carbon economy and CBAM

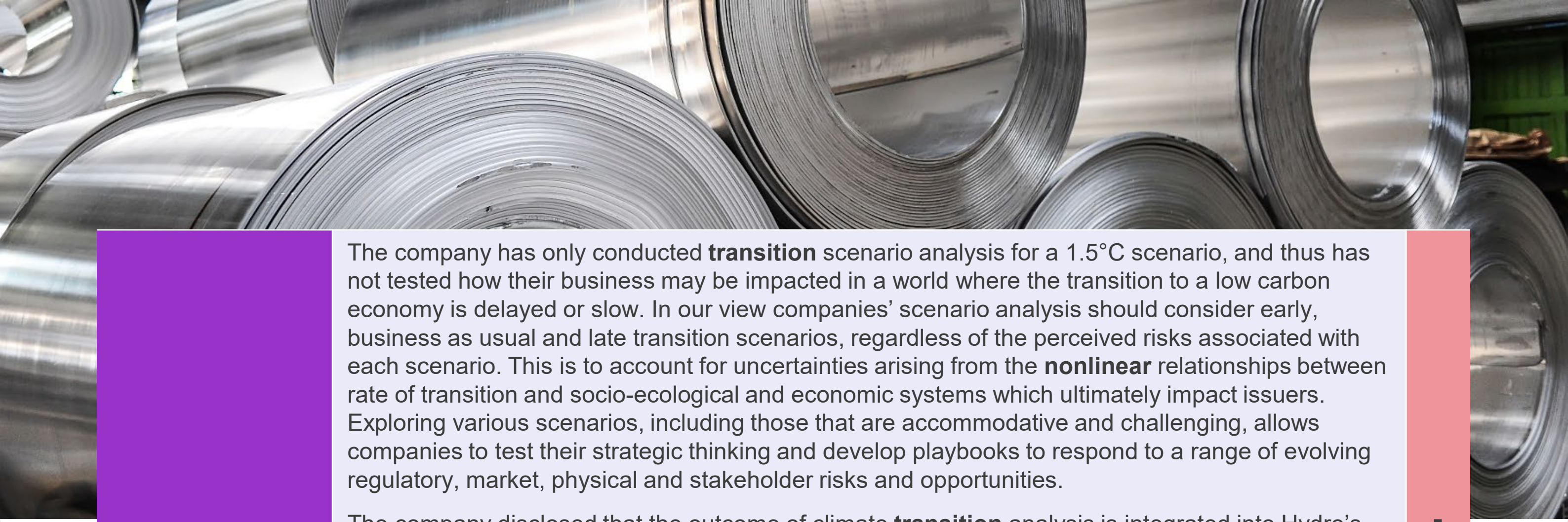
Hydro is well positioned to maintain and increase the proportion of aluminium sold into Europe and benefit from any ‘green premium’ available for low-carbon aluminium. Of particular note is their active involvement in public policy, strong marketing positioning, high availability of renewably powered electricity (via owned hydropower facilities and long-term contracts), significant R&D into scope 1 emission reduction technologies (with market-leading 2030 target of industrial-scale demonstration of HalZero) and focus on expanding recyclable aluminium capabilities.

Company position for global transition to low carbon economy

Product mix	The business is fully focused on the aluminium value chain, which is considered critical to the transition to low carbon economy.	✓
Strategy & Targets	Targets: 30% reduction in scope 1 & 2 by 2030 and net zero by 2050. 30% reduction in upstream scope 3 (purchased goods and services in primary aluminium and extrusions only) per metric tonne aluminium delivered to market by 2030, all against a 2018 baseline.[2] All targets are on an ownership equity basis, i.e. proportional to their ownership in joint venture facilities. As Hydro is 100% aluminium focused and seeks to reduce carbon intensity of all aluminium produced, please see “production facilities & energy sourcing” and “R&D” in the CBAM section below for further information on strategy.	✓
Performance	**Carbon emissions:**  Source: p.31 2023 Annual report. In 2023, Hydro’s total scope 1 and 2 were 6.5% lower than the 2018 baseline on an ownership equity basis, with a mixed trend.[3] On an intensity basis, scope 1 & 2 emissions have decreased 23.6% between 2019 – 2023 (data not available for 2018) and while some volatility is noted, the trend is improving.[4] Total Scope 3 emissions have decreased 36.4% over the 2018-2023 period.[5] Upstream scope 3 emissions reduced 39.2%[6], primarily due to conscious sourcing of metal, lower quantity of metal sourced and lower production of primary aluminium. The 2030 target has already been achieved, which raises the question of whether the target is sufficiently challenging. We do note, however, that should production increase, the company’s position versus targets may change.	!

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]FactSet.
[2]2023 Annual report,, p.28.
[3]2023 Annual report,, p.28.
[4]2019 figure (53.8 mt CO2e / NOK million) and 2023 figure (41.4 mt CO2e/ NOK million) pg. 84, 2023 Annual report.
[5]2023 Annual report, p.28.
[6]2018 figure (19.64m mt CO2e) and 2023 figure (11.95m mt CO2e) 2023 Annual report, p.83.



Scenario analysis	The company has only conducted **transition** scenario analysis for a 1.5°C scenario, and thus has not tested how their business may be impacted in a world where the transition to a low carbon economy is delayed or slow. In our view companies' scenario analysis should consider early, business as usual and late transition scenarios, regardless of the perceived risks associated with each scenario. This is to account for uncertainties arising from the **nonlinear** relationships between rate of transition and socio-ecological and economic systems which ultimately impact issuers. Exploring various scenarios, including those that are accommodative and challenging, allows companies to test their strategic thinking and develop playbooks to respond to a range of evolving regulatory, market, physical and stakeholder risks and opportunities. The company disclosed that the outcome of climate **transition** analysis is integrated into Hydro's climate strategy, strategic decision making and lobbying on climate-related policies. While the company integrates the current EU ETS carbon price and expectations regarding carbon price evolution into internal decision making and financial and operational decisions, the company does not appear to have disclosed how these dynamics are integrated into its scenario analysis. There is some evidence of consideration of regulatory and policy risks in scenario analysis. The company has tested **physical** risks of climate change under their 'current' scenario (corresponding to a c.1°C scenario) higher temperature 2.5°C and 4.3°C scenarios, in part due to having suffered flooding at their Alunorte alumina refinery in 2016. The company announced they updated their physical climate risk assessment in 2023 and are committed to integrating the findings into their risk management framework.	!
Physical impacts of climate change on hydroelectricity generation	Hydro's hydroelectric plants are situated in Norway (in the map in the appendix). We see Norwegian hydroelectric operations, located in higher latitudes, to be relatively less exposed to climate impacts than those located in sub-tropical regions. Precipitation is generally expected to increase in all scenarios, across all seasons. Standardized Precipitation Evapotranspiration Index ([SPEI]- see appendix for more details) is normal to mildly wet across all scenarios. Maximum number of consecutive dry days also remains largely unchanged.[1] The analysis by Regnan is also supported by academic literature, Scandinavia is expected to increase their hydropower output by 15-20% as climate change materialises.[2] It is noteworthy, in the longer term, for catchments dependent on snowfall and glacial melt, higher averages temperatures may mean that increased glacial melt will increase flow over the next 20-30 years, and decrease thereafter because of reduced glacial mass. Please see the appendix for supporting infographics.	✓
Capital allocation	Hydro spent 35% of 2023 CapEx on EU taxonomy-aligned activities and a further 8% of taxonomy-eligible, totalling c.US$841m. The company has not disclosed a longer-term decarbonisation CapEx strategy.[3]	✓
Management	Integrated into executive management's remuneration and is a quarterly KPI on CEO's balanced scorecard.	✓
Influence	Hydro appears to support climate action policy, conditional to maintaining economic competitiveness. The company interacts frequently with EU policy consultations and is generally supportive of market-based instruments, such as emission trading, as well as the EU Fit for 55, 55% emission reduction target for 2030. In recent consultations, Hydro have been focused on preventing carbon leakage, although initially appear to be against CBAM in current format (due to belief that structure would not optimally minimise carbon leakage), instead advocating for the continuation of existing carbon leakage measures i.e. free allowances[4]. The company publishes their industry association memberships[5], although it is unclear how often they review these memberships.	✓

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]https://climateknowledgeportal.worldbank.org/watershed/339/climate-data-projections
[2]Lehner, B., Czisch, G. and Vassolo, S., 2005. The impact of global change on the hydropower potential of Europe: a model-based analysis. Energy Policy, 33(7), pp.839-855.
[3]NOK 9,317m exchange rate as of 02/05/2024 Source: 2023 Annual report, p.114
[4]www.hydro.com/Document/Doc/Regulatory%20carbon%20leakage%20presentation,%2016%20November%202020.pdf?docId=566482
[5]www.hydro.com/en-GB/sustainability/our-approach/governance/sustainability-partnerships/

CBAM

Hydro

CBAM-applicable business:[1]

Aluminium manufacturing, aluminium finished product production.

Total aluminium production capacity:[2]**:**

2.03m mt

European union exposure:	c. 65% aluminium production[3] and 39% total revenues[4]	
CBAM-related public activity	Actively supporting and engaged in the discussion including responding positively to the European Commission consultation in 2020[5] and publicly criticising the consideration of recycled aluminium as zero-carbon.[6]	
Product offering	Hydro has a range of branded low-carbon aluminium products carrying a carbon footprint below 4t CO_2e per mt of aluminium, as well as many integrating recycled content.[7]	
Product offering	Product	Total carbon intensity (kg CO_2e/kg Aluminium)
Product offering	Hydro recycled aluminium	5.7
Product offering	Hydro REDUXA	4, 3 or 2
Product offering	Hydro CIRCAL (at least 75% post-consumer scrap recycled content)	1.9
Product offering	Near-zero carbon aluminium (100% recycled content)	0.5
Production facilities & energy sourcing	Production facilities consist of five fully owned facilities in Norway, three majority-owned facilities in Slovakia, Qatar and Brazil and two minority-owned facilities in Australia and Canada, a significant proportion of which use renewable energy (over 70% primary aluminium production covered by renewables, 100% renewable in Norway, sourced from subsidiary Hydro Energy). Hydro operates 40 hydropower plants to support their operations in Norway, with a combined installed capacity of 13.7 TWh per year. Furthermore, the company operates a wind farm and purchases more than 9 TWh of renewable power annually in the Nordic market via long-term contracts.[8]	
R&D	The company is conducting significant amounts of R&D into direct-emission-reduction technologies, for example, Hydro's HalZero project is focused on the development of converting alumina to aluminium chloride prior to electrolysis, eliminating the need for a carbon anode (see appendix for more information on technologies), and intend to have an industrial-scale demonstration by 2030. The company also partnered with Everfuel to coordinate development and operate electrolysers to produce hydrogen from renewable to replace natural gas for heating. The company is also in the early stages of looking into "closed pots", a technology which would enable carbon capture from more concentrated steams and are aiming for industrial scale pilots by 2030.	
R&D	Hydro also integrates post-consumer aluminium scrap into finished products and expanding their capabilities in this area has been a key focus for Hydro, with aluminium recycling operations increasing 38% in 2023 to 444k tonnes and a target of 850-1200 thousand tonnes of recycled post-consumer scrap by 2030 (the company acquired Alumental in July 2023 in order to increase their access to post-consumer scrap by c.150,000 tonnes per year).[9] The company is also currently researching how to combine process scrap with postconsumer scrap recycling. The company also opened a new recycling plant based in Michigan opened in November 2023, to supply the U.S. market with 120,000 tonnes of recycled aluminium each year – similar projects are being built in Hungary, Germany and Spain. Hydro has been investing to expand their selection of finished aluminium products, for example working with customers such as Mercedes-Benz, Polestar, Porsche and Volvo to decarbonise bespoke aluminium products.	

[1]https://taxation-customs.ec.europa.eu/system/files/2023-11/CBAM%20Guidance_EU%20231121%20for%20web_0.pdf
[2]Annual report 2023, p.267. Figures represent company's proportional share for part-owned facilities.
[3]Annual report 2023, p.266.
[4]Annual report 2023, p.175.
[5]ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-EU-Green-Deal-carbon-border-adjustment-mechanism-/F510326_en
[6]www.hydro.com/en/about-hydro/stories-by-hydro/greenwashing-via-cbam-loopholes-threaten-european-green-products-market/
[7]www.hydro.com/Document/Doc/Hydro%20REDUXA%20brochure.pdf?docId=548546 ; www.hydro.com/en-GB/media/news/2023/hydro-delivers-first-near-zero-aluminium-for-european-building-and-construction-market/ ; www.hydro.com/en-GB/aluminium/products/low-carbon-and-recycled-aluminium/low-carbon-aluminium/
[8]All figures from Annual report 2023.
[9]All figures Annual report 2023, p.15.

CASE STUDY

South32 Ltd. operates as a metal and mining company. 47.9% of revenues are from Asia/ Pacific, 25% from Europe, 15.7% from Africa & Middle East and 11.4% from the Americas. It operates through bauxite, nickel and other metal ore mining (such as copper, zinc, manganese, silver and lead), alumina production and aluminium manufacturing. Operations are in Australia, South Africa, Mozambique and South America with a development project in North America. The company was founded in 2015 and is headquartered in Perth, Australia.[1]

Regnan assessment of overall position for transition to low carbon economy and CBAM

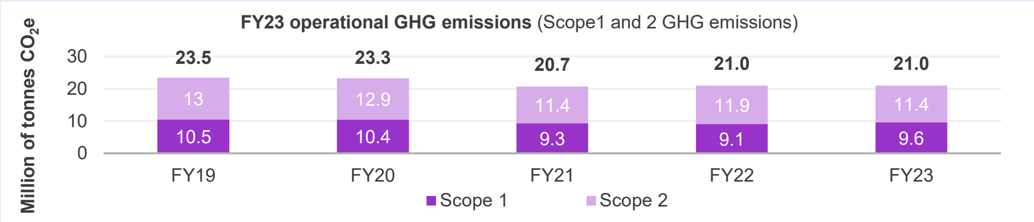
Overall, we view that CBAM poses a risk to South32's European exports. While the Mozal and 40% non-operated Brazil facilities are generally well positioned to maintain their current European exports due to low-carbon electricity generation (on the basis the company is able to renew renewable energy contracts), the company expects the percentage of Hillside's aluminium produced exported into Europe to reduce and be redirected to other parts of the world due to the high carbon intensity. The company may be able to offset this if more production from the non-operated Brazil facility's production is sold into Europe and if South32 restructures supply routes. With just three key manufacturing facilities, and current positioning close to their own alumina refineries, we do not expect South32 to move or divestment the aluminium assets. We do not expect the company's R&D efforts to lead to significant scope 1 emission reductions, and rather the company will integrate commercially available technologies from industry developments. We view that it is very unlikely that South32 will enter the growing recycled aluminium market, due to its place within the value chain.

Company position for global transition to low carbon economy

Product mix	Well positioned in terms of metals being mined for use in the transition to low carbon economy: aluminium, zinc, copper, nickel and manganese, with focus and growth on these areas. Furthermore, the company announced in February 2024 they are going to divest their Illawarra Metallurgical Coal business (currently 22% of revenues) to focus on low-carbon businesses, for example investing in copper and zinc development projects. The deal is expected to be completed 2024.[2]	✓
Strategy & Targets	Target: Medium term target to halve scope 1 & 2 by 2035 versus 2021 baseline. Overall "goal"[3] of net zero across scope 1, 2 & 3 GHG emissions by 2050. No short-term target has been established as the company is "not confident that [they] would achieve sufficiently material GHG emissions reductions within the timeframe".[4] A clear focus on emission reduction at four facilities that account for 92% of scope 1 and 2 emissions. The priority is Hillside, the facility is responsible for 57% of scope 1 & 2 emissions. The Mozal facility is currently using hydroelectric power, however, the current contract with provider, MOTRACO (a transmission JV between South Africa's Eskom and the national electricity utilities of Mozambique and Eswatini), is due to expire in 2026 and the company is seeking to extend it. They intend to pursue technology solutions over the longer term, including inert anodes and anode coating technology through programmes such as Innovate32, which seeks to collaborate with other companies, industry groups and research organisations. It must be noted that evidence of progress is limited.	✓

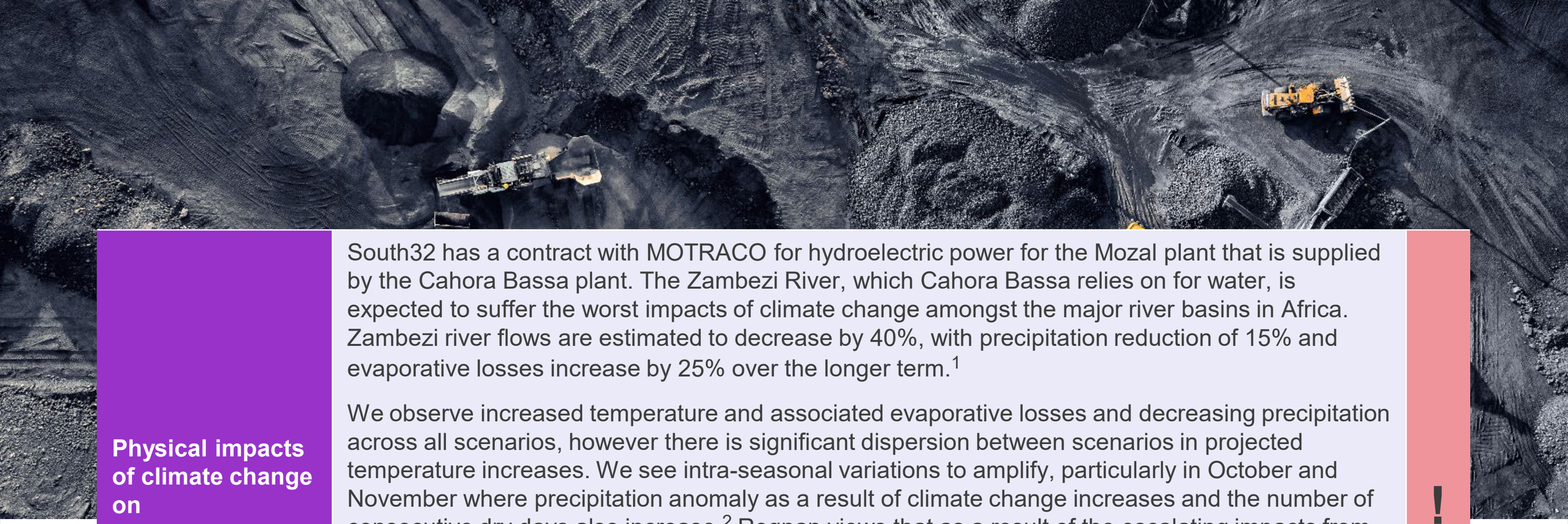
Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]FactSet.
[2]www.south32.net/docs/default-source/exchange-releases/illawarra-metallurgical-coal-sale-update-0x8e5157337f1e6d92.pdf?sfvrsn=8b5b40cf_0
[3]"goal" defined as: "an ambition to seek an outcome for which there is no current pathway(s), but for which efforts will be pursued towards addressing that challenge, subject to certain assumptions or conditions." source: https://www.south32.net/sustainability/climate-change
[4]www.south32.net/docs/default-source/general-library/climate-change/climate-change-action-plan-2022.pdf?sfvrsn=2d543f1b_1

Performance	**Carbon emissions:**  Source: p.101 Sustainable Development Report 2023. 2023 Scope 1 & 2 carbon emissions have reduced 7.9% since 2018, and 2.8% since 2021 baseline. Trend is moving in the right direction for meeting 2035 scope 1 & 2 target, albeit slowly. Scope 3 emissions reduced 36.5% between FY20 and FY21 due to divestment of their South African Energy Coal and Tasmanian Electro Metallurgical Company businesses and are 44% lower than FY19.[1]	✓
Scenario analysis	South32 has considered two **transition** scenario pathways include one base case (at least 2°C warming) and a 1.5°C scenario. In the base case, in the short-medium term, the base case applies a carbon price in key operating regions based on existing regulations such as the Australia Safeguard Mechanism, the South African carbon tax, and Europe via CBAM (we can also expect other countries to integrate their own CBAM-like mechanisms). Reflecting the company's view of a persistent gap between government and corporate pledges and current trajectories, a US$64 2040 carbon price is applied across all Scope 1 and 2 emissions.[2] The company then employs scenario analysis aligned with 1.5°C scenario to stress test the forecasts over the longer term, integrating he carbon price trajectory provided in the IEA NZE scenario of US$250 per tonne for advanced economies with net zero emissions pledges; US$200 per tonne for emerging markets and developing economies with new zero emissions pledges; and, US$180 per tonne for other developing economies in 2050. Assumptions upon which S32 bases the 1.5°C scenario include 100% EV penetration (with 40% more aluminium than ICE vehicles, and the proliferation of renewables generation increase six-fold by 2050- whilst estimates vary significantly, we deem for these to be reasonable assumptions. For **physical risk**, broad scenarios are considered (pathways aligned with between 1.1-2.6°C [broadly aligns with transition base case] and 2.6-4.8°C)[3] and analysis conducted for physical risks to asset locations, supply chains and logistics infrastructure. This has been integrated into material risks reviews, including supply chains, considered as part of life of operation plans (including closure planning) and embedded into the company's broader governance framework, although action plans to mitigate potential impacts could be further developed (we understand that the consideration of physical climate risks into the material risk reviews aims to determine how to mitigate, transfer, accept or control the risk).[4]	✓

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]www.south32.net/docs/default-source/annual-reporting-suite/2023/sustainable-development-report-2023.pdf?sfvrsn=2e57d4d2_4
[2]www.south32.net/docs/default-source/annual-reporting-suite/2023/sustainable-development-report-2023.pdf?sfvrsn=2e57d4d2_4, p.95
[3]https://www.south32.net/docs/default-source/general-library/climate-change/climate-change-action-plan-2022.pdf?sfvrsn=2d543f1b_1, p76
[4]www.south32.net/docs/default-source/annual-reporting-suite/2023/sustainable-development-report-2023.pdf?sfvrsn=2e57d4d2_4, p.95



Physical impacts of climate change on hydroelectricity generation	South32 has a contract with MOTRACO for hydroelectric power for the Mozal plant that is supplied by the Cahora Bassa plant. The Zambezi River, which Cahora Bassa relies on for water, is expected to suffer the worst impacts of climate change amongst the major river basins in Africa. Zambezi river flows are estimated to decrease by 40%, with precipitation reduction of 15% and evaporative losses increase by 25% over the longer term.[1] We observe increased temperature and associated evaporative losses and decreasing precipitation across all scenarios, however there is significant dispersion between scenarios in projected temperature increases. We see intra-seasonal variations to amplify, particularly in October and November where precipitation anomaly as a result of climate change increases and the number of consecutive dry days also increase.[2] Regnan views that as a result of the escalating impacts from climate change, the Cahora Bassa hydroelectric plant is at heightened risk of load shedding or similar. Our analysis has not considered the entire upstream of the Zambezi basin. Our analysis is limited to the Tete region. However, our findings in Tete are generalisable across the Zambezi basin, with academic research supporting the findings. In a drying climate hydropower generation is expected to decrease by 6% over the near term and 13% in the longer term.[3] Please see the appendix for supporting infographics.	!
Capital allocation	While relatively minimal in absolute terms, decarbonisation investments are expected to increase in the future US$6m to improve energy efficiency in FY22, US$30m (c.2.4% EBIT) in FY23 and $40m and US$90m in FY24 and FY25 respectively is expected.[4] Changes to the portfolio of assets is expected under the recently announced selling of coal assets and focus on low-carbon transition materials. South32 has made significant portfolio changes since inception in 2015. Climate change is integrated into capital allocation framework through project returns and protection of portfolio value through carbon price assumptions and transition risk assessment. A dedicated carbon markets team was established in FY22.	!
Management	Demonstration that climate is integrated into governance structure: board oversight, CEO ultimately responsible, part of long term incentive plan (LTIP) for lead team.	✓
Influence	South32 demonstrates collaboration with industry peers via initiatives such as the Electric Mine Consortium (founding member), BluVein (accelerating transition of heavy mining fleets to electrification) (funding partner), Heavy Industry Low-Carbon Transition Cooperative Research Centre (HILT CRC) (founding member) and Long Duration Energy Storage Council (participant).[5] South32 is generally publicly supportive of climate action policy and is involved in advocacy via several industry associations. South32 publishes a list of current industry associations on an annual basis and reviews alignment on an ongoing basis. South32 CEO Graham Kerr is the part of the leadership team of Minerals Council of Australia (MCA) [6], an organisation which has previously been widely considered to be misaligned with the climate transition. Regnan engaged with the company on the topic in 2022, and the company provided assurances that being so closely involved in the association is important to maintain understanding of their positioning, and that South32 offers important insight to MCA whilst helping to keep the association more aligned with the transition to low carbon economy. The company undertakes annual review of member industry associations' positions on climate change, which is leading practice. [7] Based on this review, the company has determined that MCA is, on balance, aligned with South32.	!

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]Uamusse, M.M., Tussupova, K. and Persson, K.M., 2020. Climate change effects on hydropower in Mozambique. Applied Sciences, 10(14), p.4842.
[2]climateknowledgeportal.worldbank.org/watershed/339/climate-data-projections
[3]Arias, M.E., Farinosi, F. and Hughes, D.A., 2022. Future hydropower operations in the Zambezi River basin: Climate impacts and adaptation capacity. River Research and Applications, 38(5), pp.926-938.
[4]www.south32.net/docs/default-source/annual-reporting-suite/2023/sustainable-development-report-2023.pdf?sfvrsn=2e57d4d2_4, p.92
[5]www.south32.net/docs/default-source/general-library/climate-change/climate-change-action-plan-2022.pdf?sfvrsn=2d543f1b_1
[6]https://minerals.org.au/about/
[7]https://www.south32.net/about-us/corporate-governance/industry-associations

CBAM

CBAM-applicable business:[1]
Aluminium manufacturing

Total aluminium production capacity – South32 share basis :[2]
1.268m mt

<table>
<tr><td>European union exposure:</td><td colspan="5">0% al. operations; c.45% of sales volume and 55% of total revenue from al. manufacturing sold into Europe.[3] This includes, 100% of Mozal facility (33% of aluminium manufacturing tonnage) around 30% of Hillside and a small (but increasing) proportion of the non-operated Brazilian JV's (25% of tonnage) exports.</td></tr>
<tr><td>CBAM-related public activity</td><td colspan="5">CBAM was discussed in South32's 2023 sustainability report, acknowledging the impacts on aluminium (and ferro nickel as a pre-cursor for steel). The company is currently updating their reporting processes to meet the transitional phase reporting obligations and continuing to monitor the regulation, without disclosing how this will impact their strategy. However, they do note that they need to manage the risk of losing access to customers and markets in the near-term while pursuing low-carbon energy solutions (despite CBAM not applying to scope 2 emissions i.e. energy used to produce electricity, at least in the near term). South32 responded to the European Commission's consultation, highlighting areas that they consider require refinement or clarification and to improve alignment with other reporting guidance.</td></tr>
<tr><td>Product offering</td><td colspan="5">Unlike peers, South32 does not have any branded low-carbon aluminium products, however, does achieve carbon intensity of 3 tonne CO2e/tonne of aluminium from their Mozal facility which can be sold into low-carbon markets.[4]</td></tr>
<tr><td rowspan="4">Production facilities & energy sourcing R&D</td><td>Operation</td><td>Annual capacity (tonnes)[5]</td><td>CO_2 intensity[6]</td><td>European exports</td><td>Energy source</td></tr>
<tr><td>Hillside

South Africa</td><td>720k</td><td>16.8
t CO_2-e/ t production</td><td>c. 30%</td><td>Coal-based power supplied from the South African grid (Eskom); current agreement expires in 2031 & will be complex to find low carbon alternative due to high energy demand. Currently in discussion with Eskom on nuclear</td></tr>
<tr><td>Mozal
(63.7% ownership)

Mozambique</td><td>580k</td><td>3
t CO_2-e/ t production</td><td>100%</td><td>Hydroelectric energy; S32 are working to extend the hydroelectric power contract beyond current expiration date of 2026.</td></tr>
<tr><td>Alumar
(40% ownership)

Brazil</td><td>447k</td><td>N/A- assume low due to energy source</td><td>At least partially to Europe</td><td>Powered by 100% renewable power from wind, solar and hydro</td></tr>
</table>

[1]https://taxation-customs.ec.europa.eu/system/files/2023-11/CBAM%20Guidance_EU%20231121%20for%20web_0.pdf
[2]www.south32.net/what-we-do/our-commodities/aluminium-alumina-bauxite#:~:text=Hillside%20Aluminium%20is%20the%20largest,capacity%20of%20720kt%20per%20year.Figures represent company's proportional share for part-owned facilities and includes Brazil Aluminium once fully ramped up.
[3]Figures provided directly by the company.
[4]Sustainability Databook 2023. Annual capacity reflects 100% ownership
[5]Annual report 2023.
[6]Sustainability Databook 2023.

CBAM

CBAM-applicable business:[1]	Total aluminium production capacity – South32 share basis :[2]
Aluminium manufacturing	1.268m mt

R&D	S32's decarbonisation focuses predominantly on minimising the carbon intensity of their electricity generation, which, whilst not captured in the first stage of CBAM pricing from 2026, are expected to be in the near-medium future. In terms of direct scope 1 emissions, the company is focusing on AP3XLE energy efficiency technology (pot lining) implementation in the shorter term, choosing to monitor industry development of earlier stage technologies such as inert anodes, which would enable zero-direct-emission aluminium to be produced. The company announced they were researching the use of alternative biomass fuels sources in 2018, and modest amounts were used at the alumina refining stage in 2022.[7] South32 is also unable to produce zero-emission aluminium by way of integrating recycled scrap (considered by CBAM to have zero embedded emissions), as the company focuses on primary aluminium smelting and does not currently have any exposure to aluminium recycling.

[1]www.south32.net/docs/default-source/annual-reporting-suite/2018/environment.pdf?sfvrsn=30b276fb_3

Rio Tinto

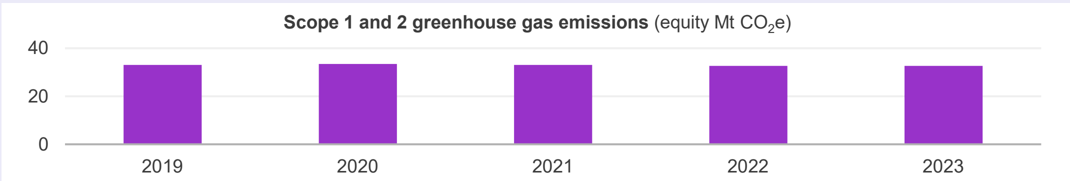
CASE STUDY

Rio Tinto Plc engages in the exploration, mining, and processing of iron ore, aluminium, copper, and minerals. The Iron Ore segment supplies iron ore mining and salt and gypsum production. The Aluminium segment produces bauxite, alumina and primary aluminium. The Copper segment offers gold, silver, molybdenum and other by-products. The Minerals includes products such as borates, salt and titanium dioxide feedstock. Rio also engages in marine operations. The company was founded in 1873 and is headquartered in London, the United Kingdom.[1]

Regnan assessment of overall position for transition to low carbon economy and CBAM

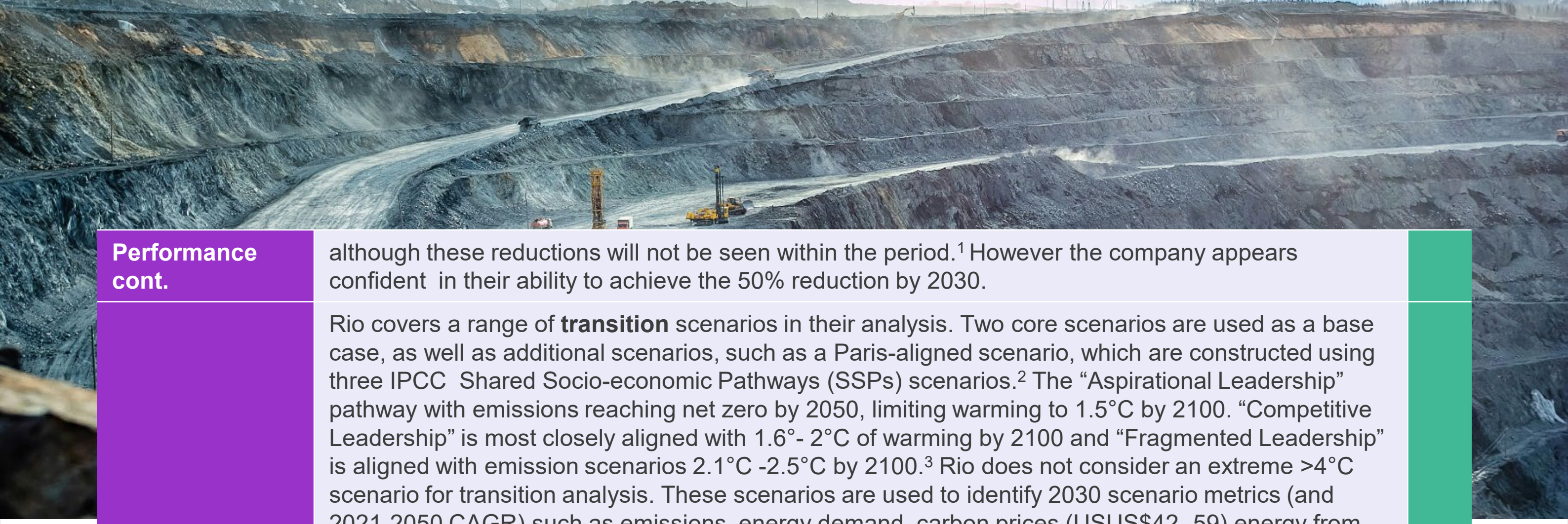
We view that Rio is well positioned to expand exports into Europe resulting from their low carbon economy transition strategy, low-carbon branded aluminium, significant availability of electricity generated from renewables (self-generated or from low-carbon grids), as well as significant R&D via collaborations that seek to tackle sources of significant scope 1 emissions.

Company position for global transition to low carbon economy

Product mix	The company is well positioned in terms of asset portfolio: Rio Tinto divested their last coal assets in 2018 and, in addition to aluminium (21% segmental revenue), are refocusing on materials that enable the energy transition, such as the mining of copper, minerals and iron ore (2023 revenues: 12%, 10% and 57%% total segmental revenue respectively).[2]	✓
Strategy & Targets	Targets: Absolute scope 1 & 2 versus 2018 baseline: -15% by 2025, 50% by 2030, net zero by 2050. Net zero emissions from shipping by 2050 and 50% intensity reduction by 2030 due to the introduction of dual fuel net zero carbon vessels into their portfolio by 2030. The company is committed to helping suppliers and customers reach net zero by 2050 and reduce scope 3 emission from their Iron Ore Company of Canada operations ore production by 50% by 2035 versus 2022, although does not have an overall scope 3 emissions target.[3] Dual focus on shorter term efficiencies & switching to renewables where possible, plus sizeable investment for developing technologies for future. The company identifies several technologies for which "industry breakthroughs" will be needed in order to achieve net zero between 2040-2050.[4] Six abatement programmes across areas of the business, tackling the most carbon intensive areas: repowering pacific aluminium operations (refining and smelting), alumina processing, aluminium anodes, renewable energy, minerals processing and diesel transition. The company is also focusing on automation which has carbon emission benefits. Finally, the company is working with value chain players to reduce emissions, participating in over 40 collaborations at this point, including China Baowu to decarbonise the value chain, multiyear agreements with low-carbon suppliers and a collaboration to build a hydrogen plant.[5] 53% of iron ore is sold to steel producers with 2050 net zero targets.[6]	✓
Performance	**Carbon emissions:**  Source: p.22 AR 2023. While the company's overall scope 1 & 2 emissions have remained roughly flat since 2019, suggesting they are not currently aligned with these targets, we acknowledge reduction is not likely to be linear. The reduction seen so far is as a result of renewable power installations, although RIO highlighted that it is difficult to progress renewable power installations due to the amount of government and local community support. The company has disclosed that by 2025 they expect to have made sufficient financial commitments to abatement projects that will achieve more than the 15% reduction target,	!

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]FactSet.
[2]Annual report, p.173.
[3]Rio Tinto Climate Change Report 2023.
[4]Rio Tinto Climate Change Report 2023, p.12.
[5]Rio Tinto Climate Change Report 2023.
[6]Rio Tinto Climate Change Report. p.27.



Performance cont.	although these reductions will not be seen within the period.[1] However the company appears confident in their ability to achieve the 50% reduction by 2030.	
Scenario analysis	Rio covers a range of **transition** scenarios in their analysis. Two core scenarios are used as a base case, as well as additional scenarios, such as a Paris-aligned scenario, which are constructed using three IPCC Shared Socio-economic Pathways (SSPs) scenarios.[2] The "Aspirational Leadership" pathway with emissions reaching net zero by 2050, limiting warming to 1.5°C by 2100. "Competitive Leadership" is most closely aligned with 1.6°- 2°C of warming by 2100 and "Fragmented Leadership" is aligned with emission scenarios 2.1°C -2.5°C by 2100.[3] Rio does not consider an extreme >4°C scenario for transition analysis. These scenarios are used to identify 2030 scenario metrics (and 2021-2050 CAGR) such as emissions, energy demand, carbon prices (USUS$42- 59) energy from electricity, global wind and solar capacity and electric vehicle sales. Such outcomes are then used evaluate the impact of the energy transition to the portfolio and stress-test investment decisions. Whilst no shadow carbon price was disclosed in the Climate Change 2023 report, the 2022 report disclosed US$75 per mt CO2e, with growth rates between 2.9-9.3%, is used in internal decision making, for example as part of investment for large capital projects, although not used as yet for smaller energy efficiency investments. We view US$75 to be an appropriate shadow carbon price to use.[4] **Physical** impacts of climate change have also been modelled for each asset in the portfolio and wider value chain, and also include intermediate and high emissions scenarios for 1.1°C-2.6°C and 2.6°C-4.8°C by 2100.[5]	✓
Physical impacts of climate change on hydroelectricity generation	Our analysis on Rio Tinto's hydroelectric plants in Kitimat, British Columbia and Saguenay-Lac-Saint-Jean, Quebec, Canada sees a modest increase in precipitation on all scenarios, normal SPEI and no major changes to maximum consecutive dry days.[6] Flow changes are mostly driven by glacial melt. driven by increasing temperatures, which are expected to increase intra-seasonal flows in the shorter term and reduce longer term flows as glacier coverage reduces.[7] Notwithstanding these projections we note low snowpack levels, preceded by a drought (40% below normal in 2023) resulting in B.C hydro importing power.[8] This is indicative of the cumulative and interconnected nature of climate impacts. However, we see Canadian hydroelectric operations, located in higher latitudes, to be relatively less exposed to climate impacts than those located in sub-tropical regions. Please see the appendix for supporting infographics.	✓
Capital allocation	Currently decarbonisation investments totalled US$425m in 2023 versus US$299m in 2022. 2024 is expected to be US$750m in total. Capex guidance to 2030 is US$5-6bn total, with US$1.5bn from 2024-2026 (RT spent US$7.1bn in total capex in 2023).[9]	✓
Management	Integrated into governance structure: board oversight, with CEO responsible for delivering the Climate Action Plan. Climate is a short term incentive plan (STIP) & LTIP metric involved for management including CEO and other senior management.[10]	✓

Well managed	Room for improvement	Potential risk to company
✓	!	×

[7]Rio Tinto Annual Report 2023, p.22.
[2]Intergovernmental Panel on Climate Change is the United Nations body for assessing the science related to climate change.
[3]Annual report 2023, p.47.
[4]Climate Change Report 2022, p.19.
[5]Annual report 2023, p.57.
[6]https://climateknowledgeportal.worldbank.org/watershed/339/climate-data-projections
[7]https://climateatlas.ca/map/canada/frostdays_2030_85#la0t=53.98&lng=-92.86&z=4
[8]https://vancouversun.com/news/local-news/bc-hydro-trim-production-drought)
[9] Climate Change Report 2023, p.34.
[10]Annual report 2023, p.45.

Influence	As previously mentioned, Rio is part of over 40 collaborations with other value chain players in order the industry's emissions profile. Rio Tinto has been generally supportive of climate-related policies in Australia and the introduction of carbon prices, although appeared to also advocate for provisions that would weaken[1] the Australian Safeguard Mechanism Reforms that aim to reduce Australia's emissions by 43% by 2030.[2] In terms of advocacy via industry associations, RIO publishes annual industry association reviews, and identified one, the National Mining Association, as not aligned to RIO's climate and energy policy[3] although remains on the Board at this time[4]. In 2022 Rio Tinto did terminate membership of the Queensland Resources Council that has actively lobbied against reform in Australian climate policy.[5] In March 2024 Rio Tinto undertook lobbying of the Australian Government via a letter that sought to obstruct and prevent climate considerations in the reform of the Australia Environment Protection and Biodiversity Conservation Act (EPBC).[6] This came to light due to a freedom of information request from Greenpeace and led to the ACCR disengaging from year-long discussions with the company.[7] The company failed to keep stakeholders informed on their political lobbying and as such we monitor how the company attempts to manage stakeholder relations post-revelation. Rio Tinto are also on the leadership team for the Minerals Council of Australia (MCA), an organisation which has previously been widely considered to be misaligned with the climate transition.[8]	!

Well managed	Room for improvement	Potential risk to company
✓	!	×

[1]www.riotinto.com/en/sustainability/climate-change/climate-position
[2]www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism
[3]Rio Tinto Industry Association Disclosure 2022.
[4]Rio Tinto Industry Association Disclosure 2023.
[5]Rio Tinto Industry Association Disclosure 2022.
[6]https://www.pmc.gov.au/sites/default/files/foi-logs/foi-2024-109.pdf
[7]https://www.accr.org.au/news/rio-tinto-climate-hypocrisy-accr-to-disengage-following-revelation-of-lobbying-the-prime-minister-on-climate-trigger/
[8]https://minerals.org.au/about/

CBAM

Rio Tinto

CBAM-applicable business:[1]
Aluminium manufacturing

Total aluminium production capacity - RT share basis (2023):[2]
3.272m mt

European union exposure:	6% aluminium operations (ISAL smelter); 5.3% of all sales.[3]
CBAM-related public activity	Acknowledges the regulation, the risk of supply chain reconfiguration and the creation of opportunities for operations renewables.
Product offering	Rio's brand, RenewAl, was the world's first certified low CO2 primary aluminium brand, with a carbon intensity of 4 tCO2e/t or below, depending on the facility.[4]
Production facilities & energy sourcing R&D	The company has 11 fully-owned or majority owned and 3 non-majority aluminium manufacturing (smelting) facilities based in Canada, Iceland, New Zealand, Oman and Australia.[5] The majority of facilities use renewable electricity (hydro), either self-generated (owned hydropower plants generate most of electricity needs in Canada) or bought from the grid.[6]
R&D	Rio Tinto has a significant focus on developing transformational technologies through JVs, such as ELYSIS with Alcoa and Apple, and Matalco with Giampaolo Group. Using ELYSIS technology, Rio Tinto will install carbon free aluminium smelting cells at its Arvida smelter in Québec, Canada, which will enable Rio to produce zero-direct-emission aluminium by eliminating all direct greenhouse gases from smelting. This will support the ongoing development of the ELYSIS technologies and allow Rio Tinto to build expertise in the installation and operation of such technologies.[7] Rio are also partnering with Carbfix to implement a CCUS technology at the ISAL aluminium smelter in Iceland. If Rio is to produce this aluminium at a facility that uses renewable power, such aluminium will have a zero emission footprint. Another way in which zero direct emissions can be achieved is through the integration of recycled aluminium (which CBAM deems has zero embedded emissions), to which Rio are increasing exposed; company has non-managed JVs in US and Canada as well as a fully-owned remelt furnace in Quebec completed in 2022. They also offer a 'closed loop aluminium recycling' offering to North America customers, which includes a scrap take-back solution, which can be integrated and resold. Consistent efforts to decarbonise their aluminium supply led to Rio being the first in the industry to be certified for producing "responsible" aluminium by the Aluminium Stewardship Initiative, which also enables for aluminium to be traced through the system, which will be useful in the context of CBAM reporting for downstream players.

[1]https://taxation-customs.ec.europa.eu/system/files/2023-11/CBAM%20Guidance_EU%20231121%20for%20web_0.pdf
[2]Annual report 2023, p. 297.Figures represent company's proportional share for part-owned facilities.
[3]Annual report 2023.
[4]RenewAl factsheet.
[5]RT fact book addendum 2023.
[6]Rio Tinto website.
[7]https://www.riotinto.com/en/news/releases/2024/rio-tinto-to-install-carbon-free-aluminium-smelting-cells-using-first-elysistm-technology-licence.

CBAM: potential unintended consequences – Policy avoidance

CBAM has been designed to have global implications for policy and carbon emissions, with secondary impacts for businesses and society. We now explore second or third order consequences that may emerge that are not directly captured with in the policy set-up.

Policy avoidance: value chains are restructured to avoid CBAM; global carbon emissions remain largely unchanged

Movement of EU facilities to outside Europe (carbon leakage)

Whilst carbon leakage of facilities selling into the EU may be limited as a result of CBAM, a lack of export relief may mean European exporters may still relocate facilities to outside of the EU in order to maintain price competitiveness with companies not impacted by CBAM. Depending on emission intensity of the grid and local manufacturing considerations and carbon policies, this may increase global carbon emissions.

We do note, however, that countries outside of the EU may not be willing for companies to relocate facilities to their country. Global primary aluminium industry group, International Aluminium, estimates that China (that produced 59.1% of global aluminium in March 2024)[1] is currently operating close to the government's maximum capacity. Alongside reported power availability shortages, this is leading to reports that Chinese smelters are looking to transfer capacity abroad, for example to Southeast Asia.[2]

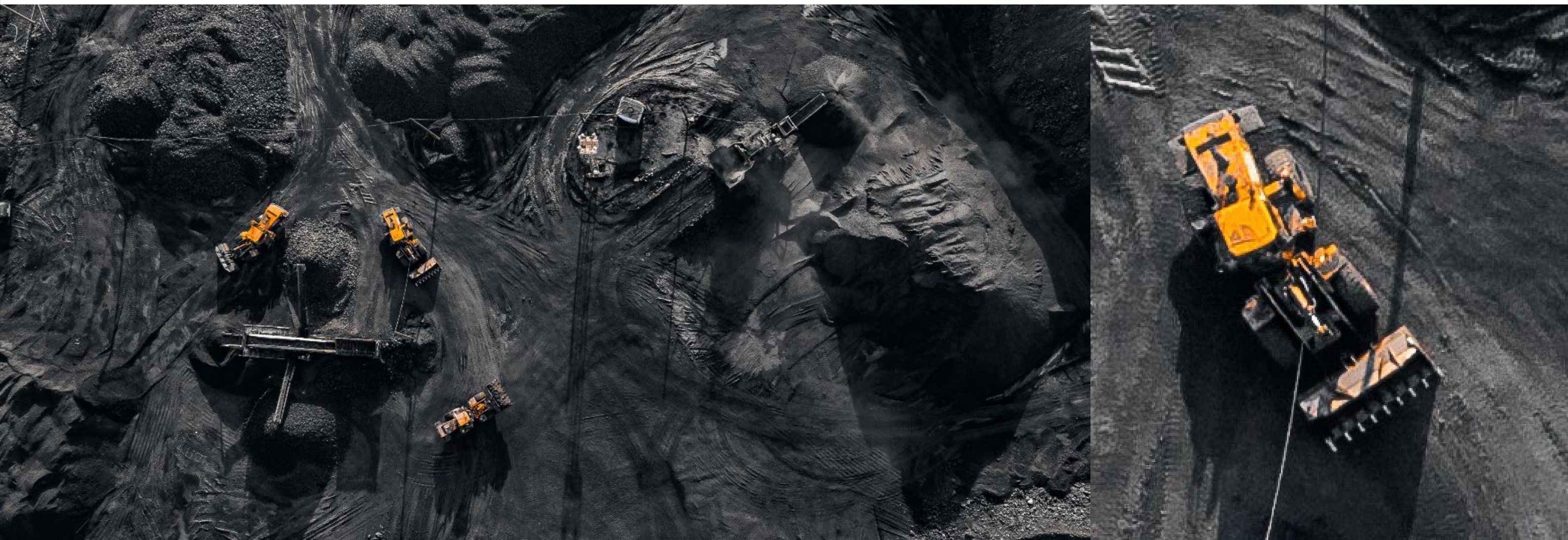
Split of global trade flows for homogenous products and corresponding two-tier price market

Trade flows may be redefined as low carbon production is sent to the EU, with remaining production sent to other high emission intensity jurisdictions that do not have carbon-related regulation yet. Overall, the quantity of low-carbon and high-carbon aluminium does not change significantly, product is simply re-routed, and global carbon emissions do not materially change. With homogenous products such as commodities, this may create a two-tier price environment for the same product. There is already evidence of a green premium' in Europe, although due to low demand, this has been minimal.[3] The following trade flows may be strengthened:

1. Countries with low-carbon grids and more likely to have low-carbon technology selling into Europe
2. Non-regulated jurisdictions selling into non-regulated jurisdictions: Non-EU companies may prioritise selling into non-regulated markets that do not require operational investment.

Whilst some impacts may be felt quickly, for example diverting of existing low-carbon/ high-carbon products to appropriate markets, some companies may restructure or even relocate their businesses in order to access such premiums.

[1]international-aluminium.org/statistics/primary-aluminium-production/
[2]www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/031924-chinas-yunnan-struggles-with-power-supply-stokes-fear-among-aluminum-sector#:~:text=Amid%20Yunnan's%20struggles%20and%20China's,%2C%20most%20recently%2C%20to%20Indonesia.
[3]Example: www.bloomberg.com/news/articles/2021-02-05/european-aluminum-buyers-are-starting-to-pay-up-to-go-green



CBAM: potential unintended consequences – Social & political

Exploitation of CBAM 'loopholes' versus the EU ETS system, impacting procurement decisions and failing to reduce carbon emissions

CBAM designates that embedded emissions must be considered for certain, but not all, products and elements of the value chain in impacted industries. For example, while embedded emissions must be considered and paid for in aluminium manufacturing, they do not need to be considered for downstream finished products such as vehicle wheels. Consequently, European vehicle original equipment manufacturers (OEMs) may source vehicle wheels from outside the EU where there is no financial cost associated with embedded emissions, as opposed to sourcing from European wheel producers who have paid the cost for their carbon via the EU ETS.

This may in turn lead to businesses moving production of that product out of the EU, leading to divestments and vertical integration (i.e., selling a CBAM-exempt finished aluminium products rather than raw aluminium material).

Other CBAM loopholes are also evident at the sector level. Referring back to the aluminium industry, CBAM denotes that all re-melted industrial scrap aluminium is assigned zero emissions, regardless of the emissions involved in the primary production or involved in the remelting process. This differs from the EU ETS, where EU companies must pay the carbon price for all aluminium, including industry scrap. Whilst the CBAM approach encourages importers to choose recycled aluminium over primary for imports (lower carbon per tonne), it may have unintended consequences such as encouraging non-EU producers to generate scrap to be remelted, and import this scrap metal into the EU, as well as redirecting scrap metal towards the EU and reducing the requirement for manufacturers to develop green technologies. Furthermore, this loophole undermines European primary smelters, with 75% of EU primary aluminium requirements potentially being provided through non-EU recycling of process scrap.[1] Furthermore, non-EU recyclers may benefit from this more than EU recyclers, as they can input lower-cost, higher-emission scrap for remelting and produce the same, zero-emission product, thus boosting their cost competitiveness.

Another potential CBAM loophole is that whilst EU-ETS emissions are verified via third party, CBAM does not require this. This may lead to non-EU emissions being inaccurately recorded, encouraging EU companies to choose companies that are reporting lower-emissions due to lower import costs, whilst emissions are higher in reality.

Social & political: CBAM raises social and political tensions within Europe with knock-on impacts such as the softening of climate-related policies

Societal discontent resulting from CBAM implementation may place pressure on governments and political parties to soften climate related legislation, particularly in light of upcoming elections. There have been several relevant recent examples of policy softening following societal dissent, including when several European Member State governments backtracked on agriculture-related green policies following protests from farmers in February 2024. This ultimately has slowed the pace of European decarbonisation.

Pathways through which we see CBAM may heighten social tensions include:

Inflation

As shown in our hypothesised pathways above, the phase out of free EU ETS allowances and the purchase of CBAM allowances will raise costs for corporates in impacted industries. As a result, profit margins may be squeezed, prices increased and passed down the supply chain, having an inflationary impact and raising prices for end consumers.

Furthermore, without export relief, European industry may be less competitive in global markets, leading to discontent by industry and company stakeholders.

Unjust transition

CBAM may create an 'unjust transition' in a number of ways, including for companies with limited resources. European companies with limited resources may view the measuring, monitoring and reporting of CBAM as too burdensome and be struggle to remain operational Generally, there are no exemptions to reporting requirements, except for very low value consignments of up to €150 and some military imports.

[1]CRU, Hydro Analysis, Arkwright research "Making CBAM work for the EU Aluminium Industry", p. 18.

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CBAM: potential unintended consequences – Geopolitical

Costs involve initial fees for setting up processes such as tracking and measuring embedded emissions, ensuring supply chain transparency, or getting third-party verification for emissions data. Additional resources in the form of additional technology and systems to collect and manage carbon emission data may also be required.

Geo-political: Retaliation by non-EU countries minimises collaboration and progress on local and global carbon agreements

Within its design, the European Commission explicitly states that CBAM seeks to ensure a level playing field for European and rest-of-the-world companies and was designed 'to be compatible with WTO-rules".[1] However, as shown in this paper, CBAM will likely impact companies and countries to differing extents and countries may gain or lose exporting power, which may fuel geopolitical tensions.

Due of trade flow changes described on page 24, companies may close operations and reduce economic activity in higher emission intensity countries, which are often developing and dependent on growing economies in order to transition their grids. In order to not be disadvantaged and be able to operate in higher-value markets with a green premium, companies with higher carbon intensities may seek to maintain their market share in Europe by reducing their prices so that, once the European importer pays CBAM costs, the exporter remains cost competitive. This may reduce profit margins, the company's ability to generate attractive investment return, and ability to invest in decarbonising technologies or elsewhere in their business. The risk of negative economic impacts is particularly high for countries for which CBAM industries are a material percentage of total industry, and a high-carbon grid; for example, fertilisers are 18% of Morocco's export value and aluminium is 22% of Mozambique's export value.[2]

Knock on social implications of this 'unjust transition', may heighten political tensions in impacted countries. For example, South32's Hillside facility in South Africa Hillside directly employs2,500 people directly and supports an estimated additional 26,500 in a province that has 33% unemployment rate, while also providing a constant baseload demand for the national grid.[3] However, Hillside is reliant on South Africa's high-emitting coal-based grid, making production from this facility potentially of lower value and reducing the attractiveness for South32 to maintain the facility. The current energy agreement expires in 2031 and it is Regnan's understanding that South32 is finding it challenging to source a low carbon alternative due to the high energy demands of the facility and limited local options. Should it close, the local communities may be negatively impacted and this may elevate social and political tensions within the country and between the country and Europe.

This concept of heightening of geo-political tensions is supported by the World Trade Organisation's World Trade Report 2023, which highlighted a significant increase in concerns from the Council for Trade in Goods between 2015 and 2022 regarding unilateral environmental measures, such as CBAM, resulting in worsening tit-for-tat responses and a more fragmented world dominated by trade blocs.[4] As such, we may see increased carbon related tariffs, protectionist attitudes towards exports and countries forming trade alliances. A recent example of such tensions is recent EU/ China discussions on carbon taxes and EV subsidiaries.[5] This may negatively impact collaboration on global carbon agreements and discourage other jurisdictions from implementing carbon policies, thus slowing the pace of global decarbonisation.

[1]https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#:~:text=The%20CBAM%20is%20designed%20to,lasts%20between%202023%20and%202026.
[2]Calculated using data from: trendeconomy.com/data/commodity_h2?commodity=76,TOTAL&indicator=TV,tv_wrld_share&trade_flow=Export,Import&time_period=2022
[3]Sustainable Development Report 2022, p.83
[4]www.wto.org/english/res_e/booksp_e/wtr23_e/wtr23_e.pdf
[5]EU to investigate 'flood' of Chinese electric cars, weigh tariffs | Reuters; China urges EU to ensure new carbon tax complies with WTO rules | Reuters

Conclusion

As the EU policy environment tightens and the free allocation of EU ETS allowances are phased out, the introduction of CBAM is intended to encourage European companies to maintain operations within the EU, while applying global pressure for companies exporting into the EU to seek lower carbon solutions. For the aluminium industry, as a result of factors such as geographic and materials exposure, business model type, carbon intensity and preparedness for the climate transition, CBAM will pose differing types and magnitudes of risks and opportunities.

Despite the key objectives of CBAM, second and third order environmental, social and political impacts of the policy may create a much more mixed outcome. For example, companies may act to circumvent CBAM where possible, social tensions may arise as a result of inflation or the unjust transition heightening local political tensions, and global trade relationships may worsen.

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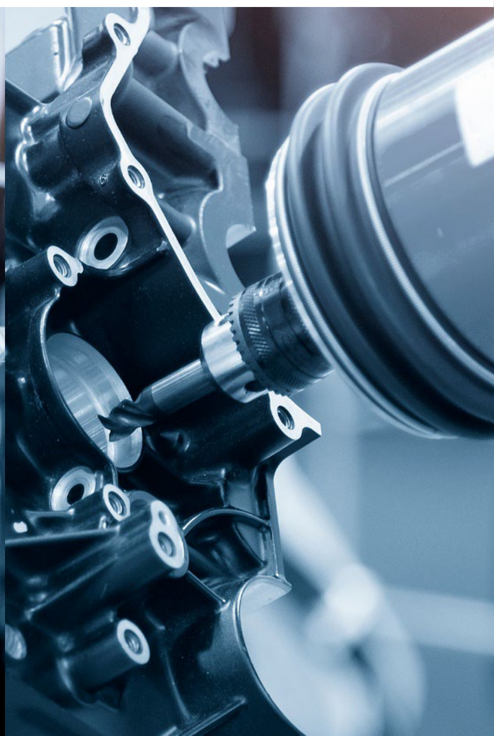
Appendix

Bayer process:

1. Bauxite crushed, washed and dried
2. Sodium hydroxide dissolves bauxite
3. Mixture is filtered and transferred to a tank
4. Solution cools and aluminium hydroxide particles added to stimulate growth of solid aluminium hydroxide crystals
5. Aluminium hydroxide crystals settle, are washed and heated to remove excess water

Hall -Heroult process:

1. Alumina dissolved in a bath of molten cryolite
2. Electric current passed through carbon anodes into the alumina. Carbon from anode reacts with oxygen in the aluminium oxide, producing CO2 and releasing aluminium
3. Electricity keeps temperature at >2000dC, enabling alumina to separate into aluminium and oxygen
4. Molten aluminium transferred to a casthouse to be formed into blocks



Emission abatement technologies (IEA)

Stage	Technology		Description	Readiness
2	Bayer process alternative fuels:	Concentrated solar	The Bayer process (turning bauxite into alumina) requires temperatures of 100-250°C in digestion and 1000°C in calcination which is currently from fossil fuels. Alternative technologies thermal heat input may be able to replace fossil fuels.	3. Concept needs validation
		Biomass fuel		7. Pre-commercial demonstration
		Electrification		7. Pre-commercial demonstration
		Hydrogen for heat		4. Early prototype
2/ 3	Carbon capture & storage		Capture CO_2 during aluminium refining and smelting. Until this time challenged by the very low concentration of CO_2 in the exhaust gases from the process.	3. Concept needs validation
2/3	Heat exchangers control heat loss of smelting pots and vary production levels, increasing or decreasing electricity consumption by 25%		Heat exchangers enable the smelter to increase power consumption at times when demand and prices are low, effectively 'storing' electricity in molten aluminium so that electricity consumption can be reduced at times of high demand and prices. This would help with managing the power grid's demand and supply fluctuations, particularly as increasing amounts of variable renewable energy are added to the grid.	7. Pre-commercial demonstration
3	Used aluminium chloride in process (rather than alumina) prior to electrolysis and keep chlorine and carbon are in closed loop		Converting alumina to aluminium chloride prior to electrolysis by keeping chlorine and carbon in a closed loop recycles and reuses carbon and chlorine, eliminating emissions of CO_2 and emitting oxygen instead.	3. Concept needs validation
3	Multipolar cell with lower operating temperatures and higher current densities, reducing energy consumption by 40% (must be paired with inert anodes)		While conventional Hall-Héroult cells used for aluminium electrolysis have a single-pole arrangement, multipolar cells could be produced by using bipolar electrodes or having multiple anode-cathode pairs in the same cell. They have lower operating temperatures and higher current densities, potentially reducing energy consumption by 40%. Their formulate requires pairing with inert anodes (see below)	5. Large prototype
3	Inert anodes (i.e. releasing oxygen rather than carbon dioxide)		Primary aluminium smelting currently relies on carbon anodes, which produce CO_2 as they are consumed during the electrolysis process (the anodes themselves participate in the reaction by 'pulling' oxygen atoms away from alumina - AL2O3 - to produce pure aluminium, and are used up over time. CO_2 is also emitted during the production of anodes, which require baking in an oven or furnace. Inert anodes made from alternative materials instead produce pure oxygen instead of CO_2 and do not degrade.	7.Pre-commercial demonstration
4	Reduction of metal forming losses through additive manufacturing		Reducing yield losses in manufacturing (e.g. sheet metal in the automotive industry) would reduce material demand and, in turn, emissions from material production. Additive manufacturing, a digitalised production process in which three-dimensional objects are produced by successively adding material by layer, can help. By its nature it leads to minimal material losses compared to processes that cut an object from larger pieces of material. It also facilitates design of lighter-weight parts.	9. Commercial operation in relevant environment
4	Ancillary process alternati ve fuels	Electrification	Used to provide high temperature heat for ancillary processes in aluminium manufacturing, such as using plasma torches for as a heating source in cast houses' finishing processes (ex. rolling).	3. Concept needs validation
		Hydrogen		4. Early prototype

Source: www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide?selectedSector=Aluminium)

Aluminium products that are considered for CBAM

EU product (CN) codes	Description
7601	Unwrought aluminium
7603	Aluminium powders and flakes
7604	Aluminium bars, rods and profiles
7605	Aluminium wire
7606	Aluminium plates, sheets and strip
7607	Aluminium foil
7608	Aluminium tubes and pipes
7609 00 00	Aluminium tube or pipe fittings
7610	Aluminium structures: aluminium plates, rods, profiles, tubes etc., prepared for use in structures
7611 00 00	Aluminium reservoirs, tanks, vats, and similar containers
7612	Aluminium casks, drums, cans, boxes and similar containers
7613 00 00	Aluminium containers for compressed or liquefied gas
7614	Stranded wire, cables, plaited bands etc. (not electrically insulated)
7616	Other articles of aluminium

Source: European Commission.

Standardised Precipitation-Evapotranspiration Index (SPEI)

Categorisation	SPEI values
Extremely wet	SPEI ≥ 2
Severely wet	1.5 ≤ SPEI < 2
Moderately wet	1 ≤ SPEI < 1.5
Mildly wet	0.5 < SPEI < 1
Normal	-0.5 ≤ SPEI ≤ 0.5
Mild drought	-1 < SPEI < -0.5
Moderate drought	-1.5 < SPEI ≤ -1
Severe drought	-2 < SPEI ≤ -1.5
Extreme drought	SPEI ≤ -2

Source: World Bank

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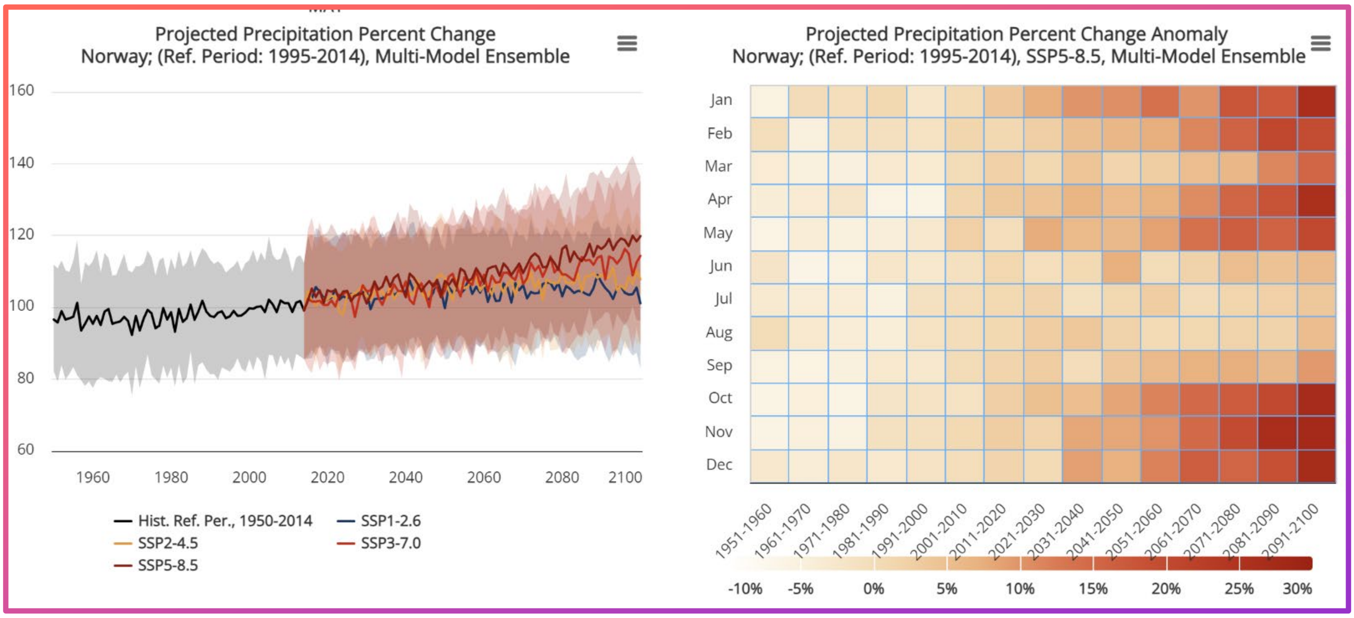
Physical impacts of climate change on hydroelectricity generation to enable green aluminium: Hydro ASA

Location of hydroelectricity plants (not comprehensive)

Source: World Bank.

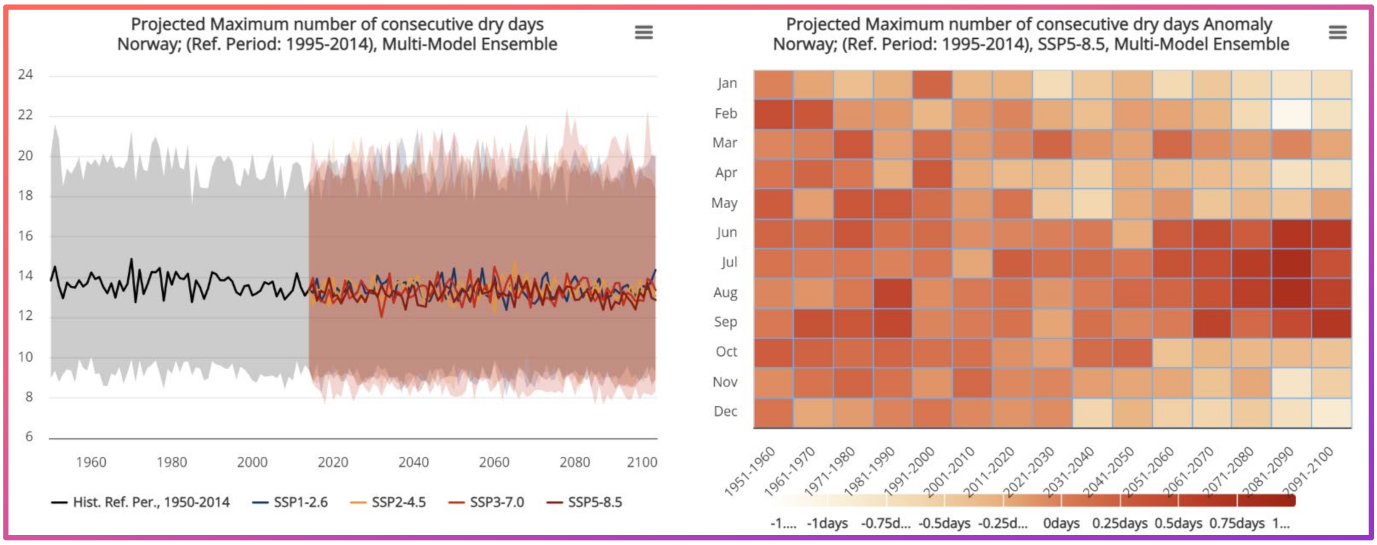
Physical impacts of climate change analysis

Precipitation Percent Change 2040 – 2059 SSP5-8.5



Source: World Bank.

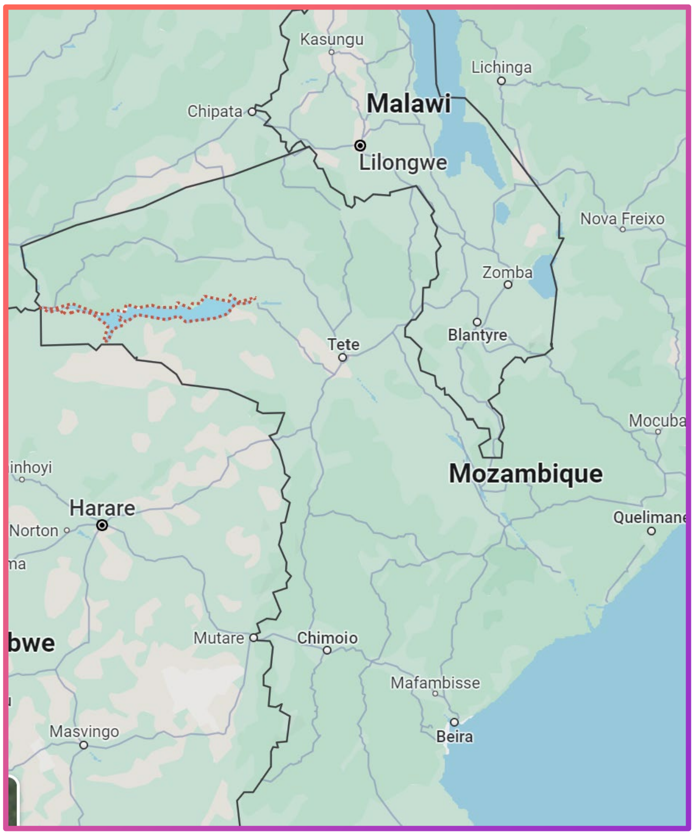
Maximum number of consecutive dry days



Source: World Bank.

Physical impacts of climate change on hydroelectricity generation to enable green aluminium: South32

Location of the Cahora Bassa area (red dot)



Source: Google maps

Hydropower plants situated along the Zambezi river

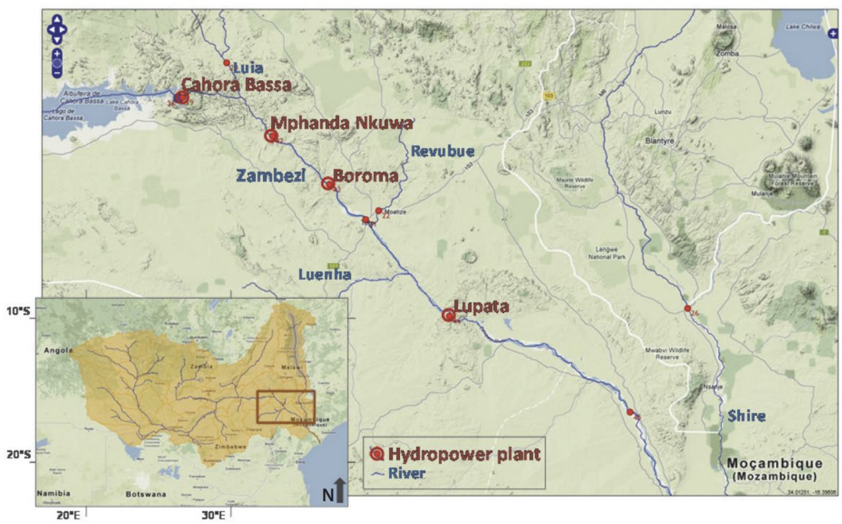
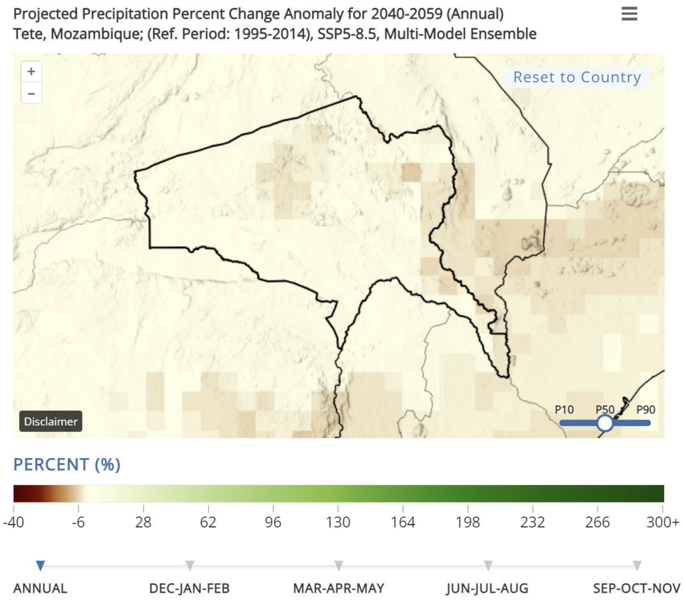


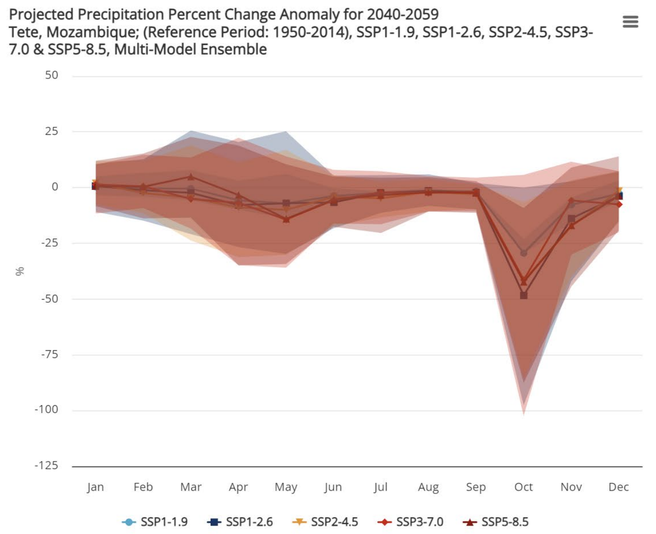
Figure 1
Study area: Zambezi basin and Lower Zambezi downstream of Cahora Bassa (adapted Zambezi DSS screenshots)

Source: Arias, Farinosi & Hughes, 2022.

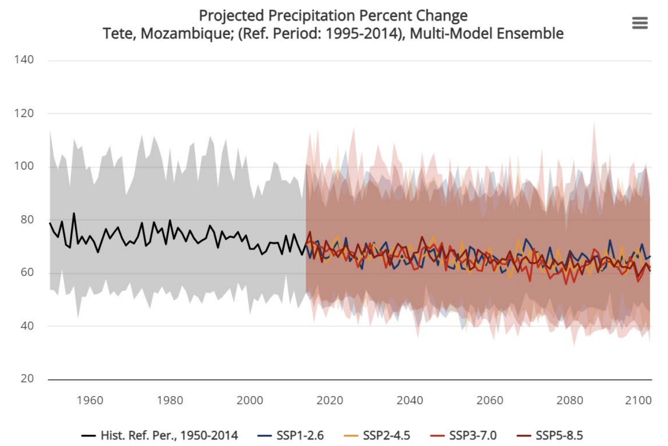
Physical impacts of climate change analysis

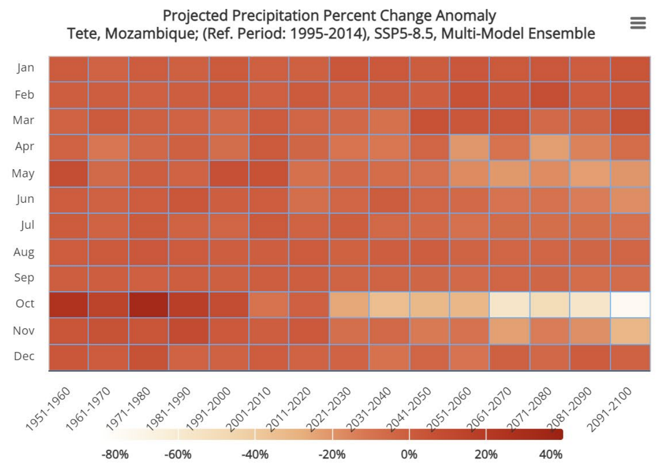
Precipitation Percent Change 2040 – 2059 SSP5-8.5





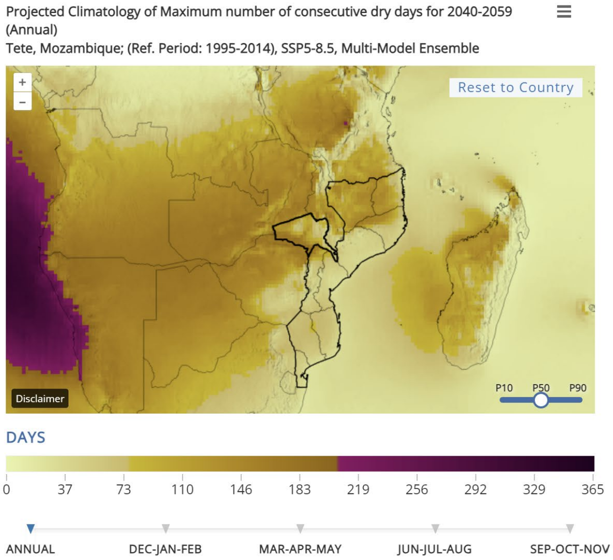
Source: World Bank.

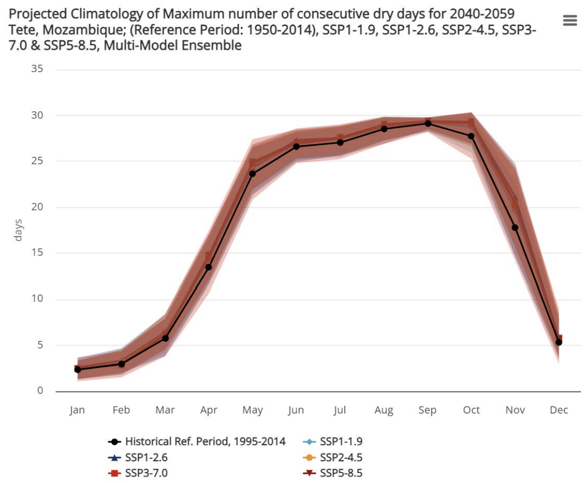


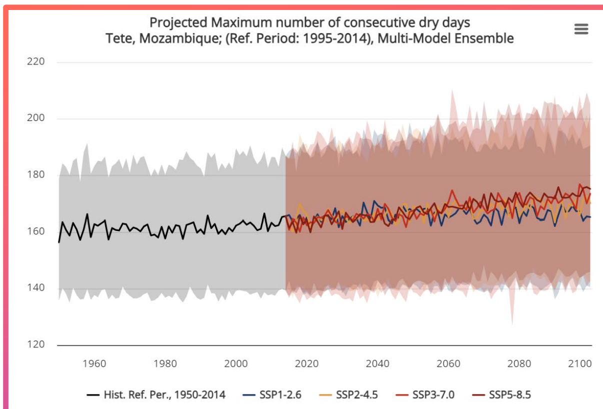


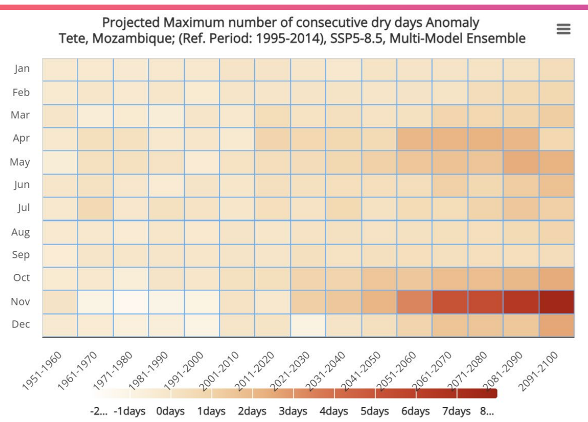
Source: World Bank.

Dry days



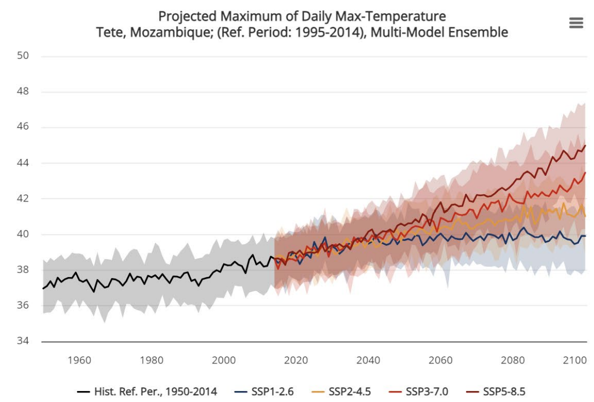


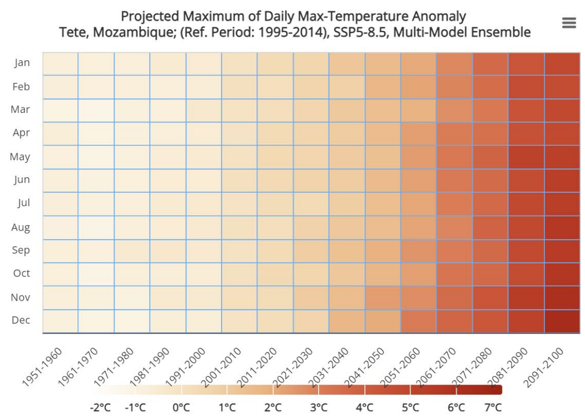




Source: World Bank.

Temperature



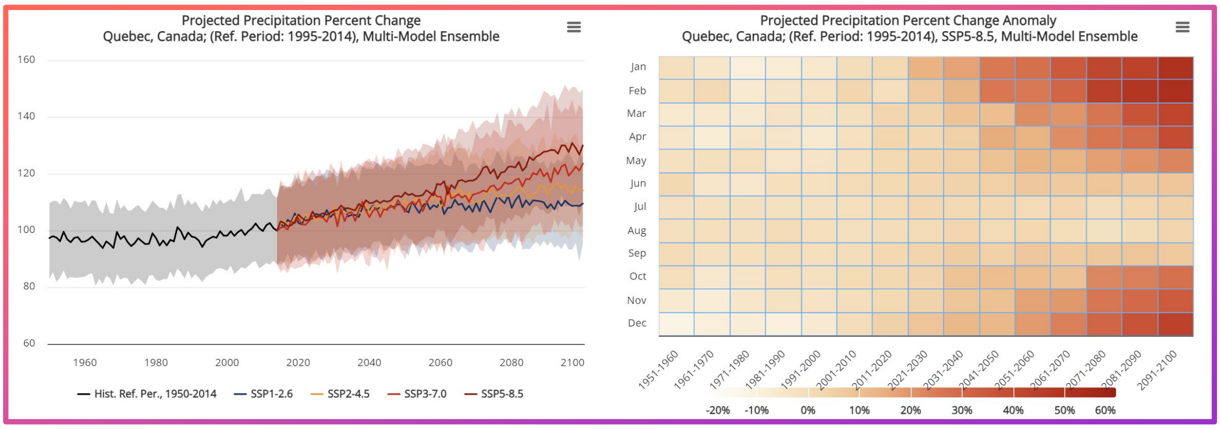


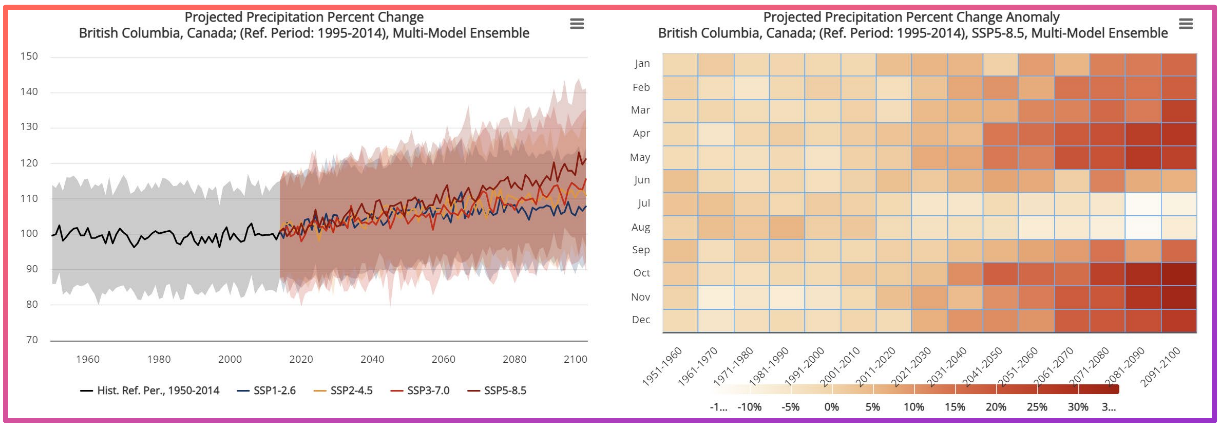
Source: World Bank.

Physical impacts of climate change on hydroelectricity generation to enable green aluminium: Rio Tinto

Physical impacts of climate change analysis

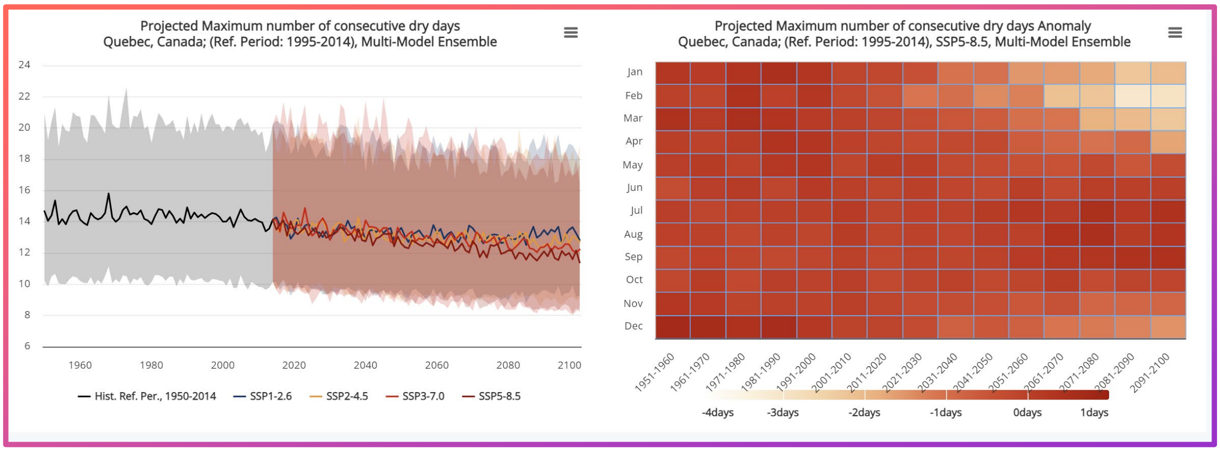
Precipitation Percent Change 2040 – 2059 SSP5-8.5

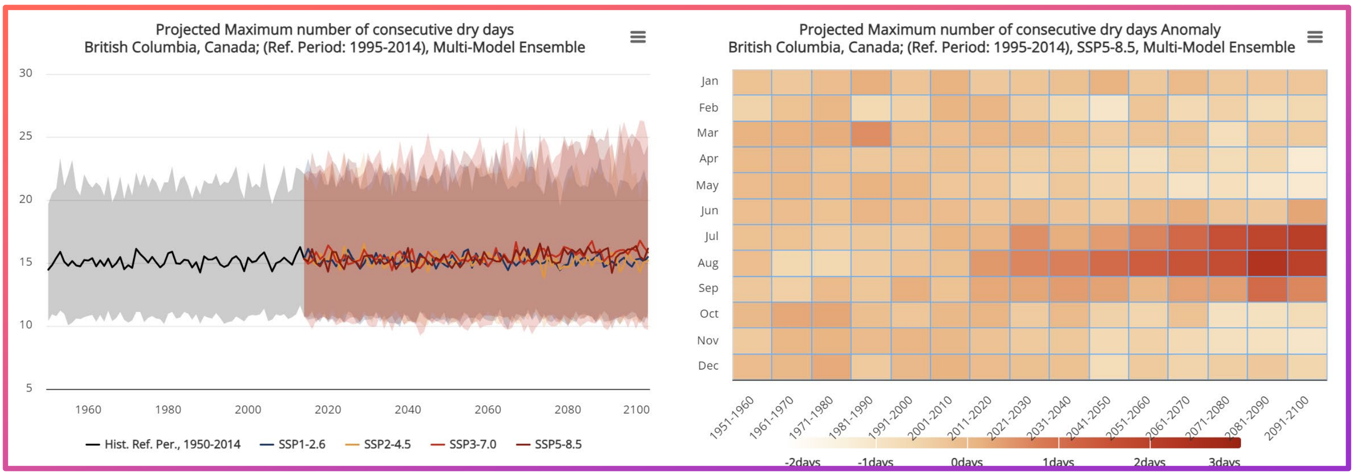




Source: World Bank.

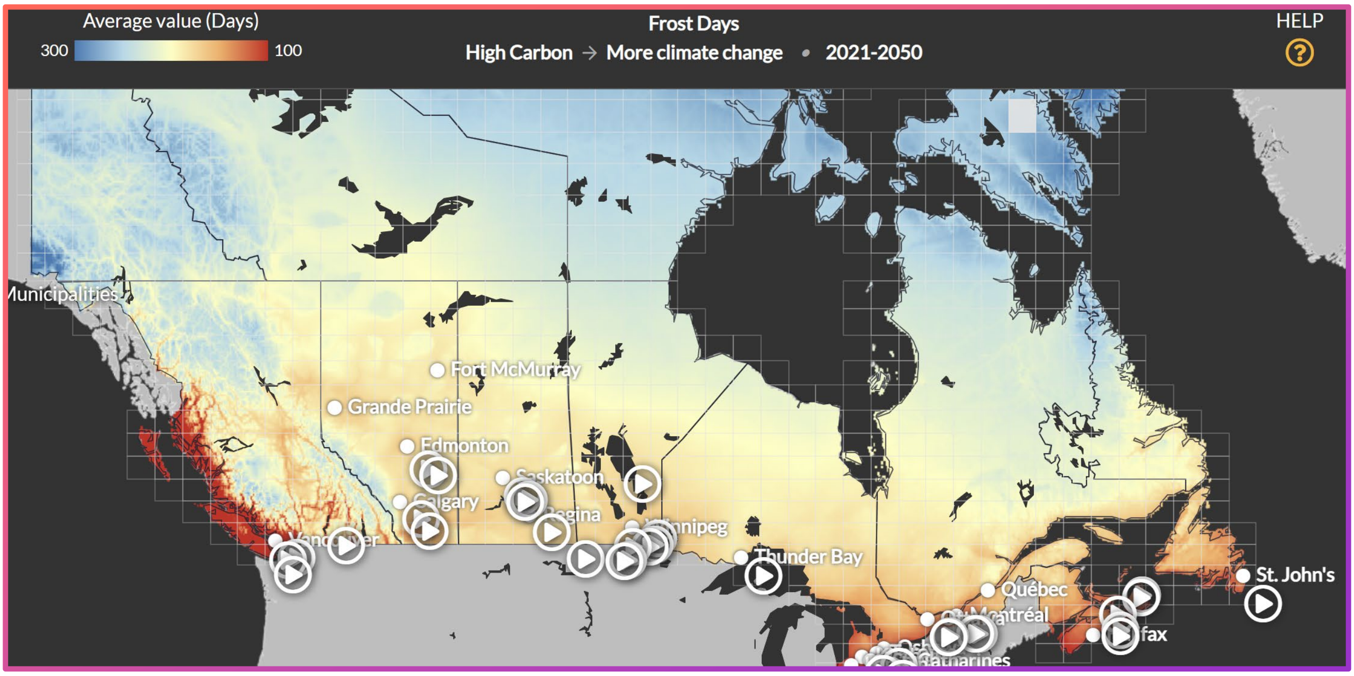
Consecutive dry days





Source: World Bank.

Frost days contributing to glacial melt



Source: Climate Atlas

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