Chief Executive's statement

While there is broad consensus on the need to tackle climate change, there has not yet been sufficient action globally. Governments, civil society organisations, companies and investors converged at COP26 to reset their ambition to reduce emissions and work in partnerships to transform our economy to net zero. I was fortunate to attend the summit and came away from it more convinced than ever that Rio Tinto is an integral part of the solution to climate change. It was clear in Glasgow that this is the decade for action. The determination for action from the world's largest economies was particularly significant.

In 2021, we launched our new business strategy, with the low-carbon transition at its heart. Through this strategy, we are ready to make an increasingly important contribution. The rapid shift to a lower-carbon world offers a unique opportunity for us to grow in the materials that will enable the energy transition and remain an attractive investment for decades to come. It will create additional demand for our products including copper, lithium, high-grade iron ore and aluminium, which are all vital for low-carbon infrastructure. However, we recognise that the carbon footprint of metals and minerals is significant, so we must decarbonise our operations and work with our customers on our strategy to tackle emissions across the full value chain. This is an important part of what we consider impeccable environmental, social and governance (ESG) performance – we can gain competitive advantage by providing low-carbon products that enable our customers to decarbonise.

We have set out a Climate Action Plan and have a clear and challenging decarbonisation strategy to achieve our targets. We now need to see our strategy translating into actions – this won't be easy; inevitably there are risks and dependencies to delivering our mitigation projects. Our people understand our operations best, and they will bring innovation and solutions to the challenge of reaching net zero over the coming decades. This is why I am focused on building a culture where all our people feel trusted and empowered to drive change. With the world's focus on tackling climate change, there's no better time to be at Rio Tinto.

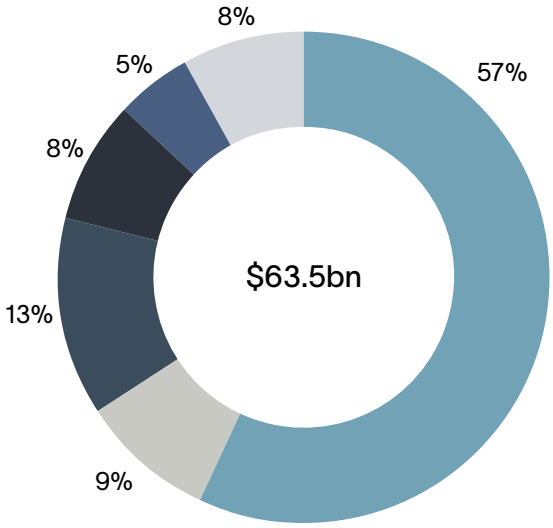
Jakob Stausholm
Chief Executive

We are ready to make an important contribution to tackling climate change and have put the low-carbon transition at the heart of our business strategy.

Our business at a glance

Our business comprises a portfolio of world-class assets that help meet society's needs and generate strong cash flow through the cycle.

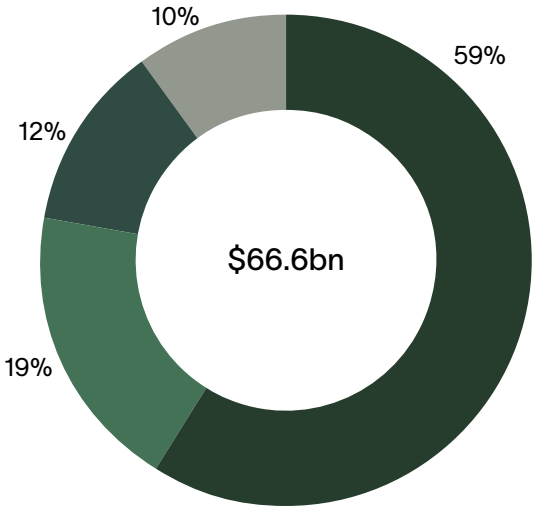
Consolidated sales revenue by destination



Our key assets are located in close proximity to our major markets:

- China
- Asia[1]
- United States of America
- Japan
- Europe
- Other

Gross revenue by product



- Iron ore $39.6bn
- Aluminium $12.7bn
- Copper $7.8bn
- Minerals $6.5bn

	Iron ore	Aluminium	Copper	Minerals
Mines	17	4	3	6
Smelters	0	14	1	0
Processing plants[2] & refineries	0	4	0	4
Mt CO_2 emissions	3.0mt	21.9mt	2.2mt	3.4mt
Rio Tinto share of production	Iron ore 266.8Mt (2020:275.5mt)	Bauxite 54.3mt (2020:56.1mt) Aluminium 3,151kt (2020:3,180kt)	Mined copper 493.5kt (2020:527.9kt)	Titanium dioxide slag 1,014kt (2020:1,120kt)
Underlying EBITDA	$27.6bn (2020:$18.8bn)	$4.4bn (2020:$2.2bn)	$4.0bn (2020:$2.1bn)	$2.6bn (2020:$1.7bn)

1. Excluding China and Japan.
2. Covering processing plants engaged in the material transformation of input products with total Scope 1 and 2 emissions greater than 100,000 tonnes CO_2

Our strategy and approach to climate change

Our strategy is informed by a deep analysis and understanding of global megatrends across dimensions related to geopolitics, society and technology. These trends set the context for our industry and influence commodity choices for the future of our business as well as expectations about how we produce them.

Climate change has formed part of our strategic thinking and investment decisions for over two decades and was a fundamental component in our strategy development process in 2021. Recently, there has been a rapid shift in the external context on tackling climate change. This includes the increasingly ambitious emissions targets set by many governments in the lead up to COP26; developments in low-carbon technologies, such as renewables and electric vehicles, and their falling costs; as well as the increasing international co-ordination on climate policies, including carbon pricing.

In parallel, society's expectations continue to rise. Companies extracting minerals must reduce their impact on the environment and host communities and go beyond regulatory obligations to drive the development of more sustainable value chains. An emerging theme in tackling these issues is the circular economy, which is built around avoiding and reducing waste and pollution, keeping products and materials in use, and regenerating natural systems. The highly recyclable nature of our products, potential utilisation of waste streams, and re-use of assets could create considerable near- and long-term growth and partnership opportunities as the world tackles climate change.

We have put the low-carbon transition at the heart of our business strategy: combining investments in commodities that enable the energy transition with actions to decarbonise our operations and value chains. As a result of this, our strategy and approach to climate change are supported by strong governance, and we are building our processes and capabilities to enable us to reach net zero emissions by 2050.

Part 1 of this report, our fourth in line with the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), details our 2021 performance on climate change across four areas:

- Producing materials essential for the low-carbon transition
- Reducing the carbon footprint of our operations
- Partnering to reduce the carbon footprint of our value chains
- Enhancing our resilience to physical climate risk

In Part 2, we outline our updated Climate Action Plan, targets, goals and priorities for the short, medium and long term towards our commitment to reach net zero by 2050.

Our scenarios and 1.5°C

We use global scenarios in our strategy and capital allocation processes to stress test our portfolio and investment decisions under alternative macroeconomic settings and commodity outlooks. We do this with a comprehensive and robust scenario framework structured around three global forces: geopolitics, society and technology. One of our three scenarios has a temperature outcome of well below 2°C, and although this is aligned with the goals of the Paris Agreement it is not as ambitious as a 1.5°C trajectory. These scenarios are reviewed every year as part of our Group strategy engagement with the Board and inform our efforts to build a strong and resilient business as well as leverage new trends and opportunities.

As part of our scenario process we also consider external scenarios, such as the IEA new NZE2050 scenario which has a temperature outcome of 1.5°C. This scenario shows that the primary energy intensity of global GDP would need to fall by 4.5% each year to 2030, electricity share of final energy demand would need to rise to 28% by 2030, and emissions from the power sector would need to fall by 60% over the same period. This would represent a much faster energy transition over the next decade than is assumed in our scenarios, requiring a very high level of co-ordination in climate policies across sectors and countries.

Our scenario analysis shows that our portfolio is well positioned to perform strongly in the low-carbon transition, with significant upside potential for commodities such as copper, hydro-based aluminium and battery minerals if the transition outpaces our scenario expectations.

For further details see our 2020 Climate Change Report: https://www.riotinto.com/invest/reports

Part 1

Progress in 2021

Producing materials essential for the low-carbon transition

One of the three key elements of our business strategy is to grow in materials enabling the energy transition. Reaching net zero emissions globally will ultimately rely on increasing the supply of a range of metals and minerals supporting the development of clean technologies and associated infrastructure.

Low-carbon transition materials

At COP26, over 40 countries, including the UK, US, China, India, Japan and Australia, launched the *Breakthrough Agenda* – a commitment to work together to accelerate the development and deployment of clean technologies and sustainable solutions by 2030. The *Glasgow Breakthroughs* focus on four key sectors considered vital in meeting the Paris Agreement goals: **clean power, zero emissions vehicles, low-emission steel** and **green hydrogen**. Our portfolio is intrinsically linked to these technologies.

Each commodity we produce has a vital role to play in the low-carbon transition. Copper demand will rise with the renewable electrification of energy, and lithium will be a fundamental ingredient in electric vehicle batteries and grid-firming energy storage solutions.

Demand for aluminium will grow for uses like energy-efficient lightweight vehicles, and steel will also be essential in a range of applications, from high-speed rail networks, to wind and solar support structures and green hydrogen production facilities.

Our commodities will also continue to support urbanisation and the creation of energy-efficient urban centres. Cities in China, India and across Africa will continue to expand, with an additional 2.3 billion people expected to urbanise globally by 2050. This, along with growing incomes, will increase demand for materials essential for everyday life.

Sustainable and circular value chains

In many important applications, there are no practical alternatives to the commodities we produce. With increasing material needs for the energy transition, it is vitally important that we work with our partners and customers to create "greener" products and more transparent and sustainable value chains. Beyond our emissions footprint, we incorporate a broad range of environmental and social considerations in every investment decision and will continue to assess our contribution towards the United Nations Sustainable Development Goals (UN SDGs).

We also have an important role to play in the circular economy. Aluminium and copper are in essence infinitely recyclable. Furthermore, steel is currently one of the most widely recycled materials and is commonly used in long-life applications. By keeping our products in use, minimising waste and regenerating natural systems we can help develop more sustainable value chains in the longer term.

While the circular economy presents a risk to primary metal demand growth in some markets, it also offers new development opportunities for our business.

Materials for low-carbon transition

Global
Rio Tinto

Iron ore / steel

	Product	Emissions
8t	Total material moved	
	10,000Mt	
2t	Iron ore	
	2,400Mt @63% Fe	70Mt CO_2e 0.03 tCO_2e/t ore
	277Mt @61% Fe	3.6Mt CO_2e[4] 0.01 tCO_2e/t ore
1t	Ore-based steel[1]	
	1,250Mt	2,700Mt CO_2e 2.2 tCO_2e/t steel
	Scrap-based steel[1]	
	700Mt	350Mt CO_2e 0.5 tCO_2e/t steel
	Total emissions	3,120Mt CO_2e 1.8 tCO_2e/t

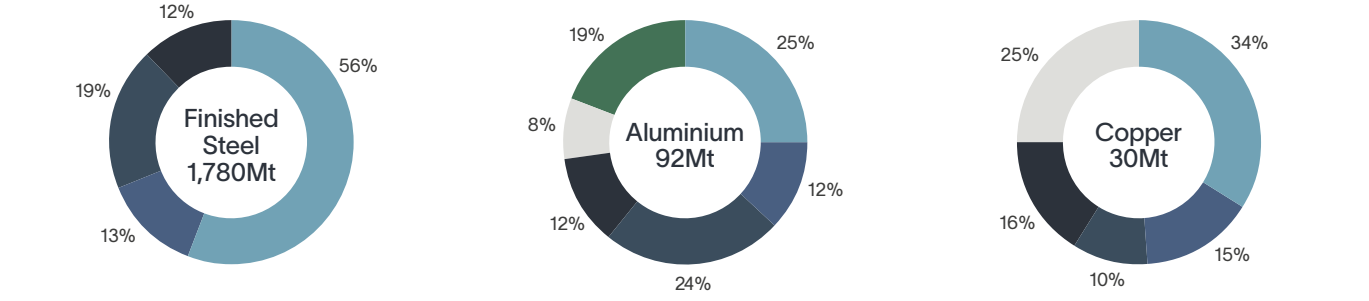
Aluminium

	Product	Emissions
16t	Total material moved	
	1,000Mt	
5t	Bauxite	
	360Mt @47% Al_2O_3	4.7Mt CO_2e 0.02 tCO_2e/t ore
	54Mt @49% Al_2O_3	0.8Mt CO_2e 0.01 tCO_2e/t ore
2t	Alumina	
	130Mt[2]	160Mt CO_2e 1.2 tCO_2e2/t Al_2O_3
	7.9Mt	5.7Mt CO_2e 0.7 tCO_2e/t Al_2O_3
1t	Primary aluminium	
	67Mt	780Mt CO_2e 11.6 tCO_2e/t Al
	3.2Mt	15.4Mt CO_2e 4.9 tCO_2e/t Al
	Secondary aluminium	
	26Mt	13Mt CO_2e 0.5 tCO_2e/t Al
	Total emissions	958Mt CO_2e 10.4 tCO_2e/t

Copper

	Product	Emissions
600t	Total material moved	
	12,000Mt	
210t	Copper ore[3]	
	4,300Mt @0.6% Cu	70Mt CO_2e 2.7 tCO_2e/t Cu
	100Mt @0.6% Cu	2.0Mt CO_2 3.3 tCO_2e/t Cu
1t	Primary refined copper	
	20.5Mt	32Mt CO_2e 1.6 tCO_2e/t Cu
	0.2Mt	0.2Mt CO_2e 1.1 tCO_2e/t Cu
	Secondary copper	
	9.5Mt	4.7Mt CO_2e 0.5 tCO_2e/t Cu
	Total emissions	107Mt CO_2e 3.6 tCO_2e/t

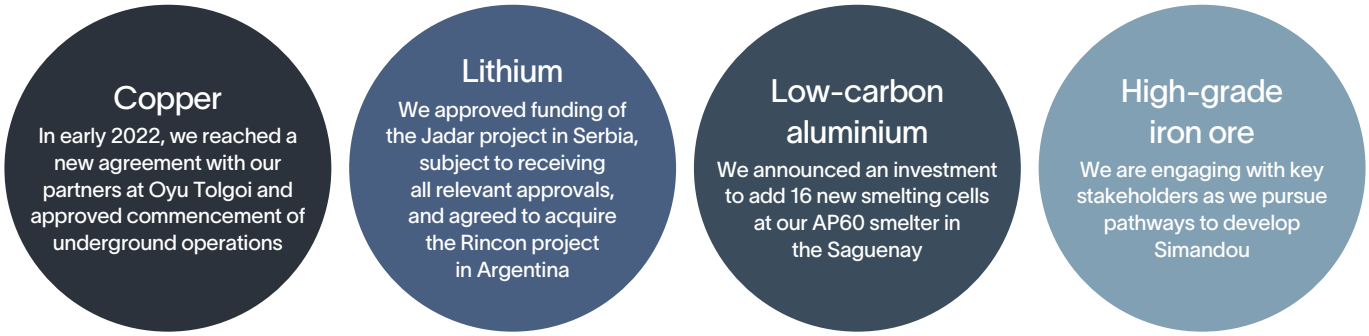
Demand by sector



1. Ore- and Scrap-based steel are notional categories based on Rio Tinto estimates of raw material inputs for different steel production pathways
2. Smelter Grade Alumina only
3. Copper ore product before processing
4. Rio Tinto total iron ore emissions include equity-basis emissions from our Pilbara operations and from IOC

Sources: Rio Tinto analysis and estimates, CRU, Wood Mackenzie, International Aluminium Institute

Key developments across our portfolio in 2021



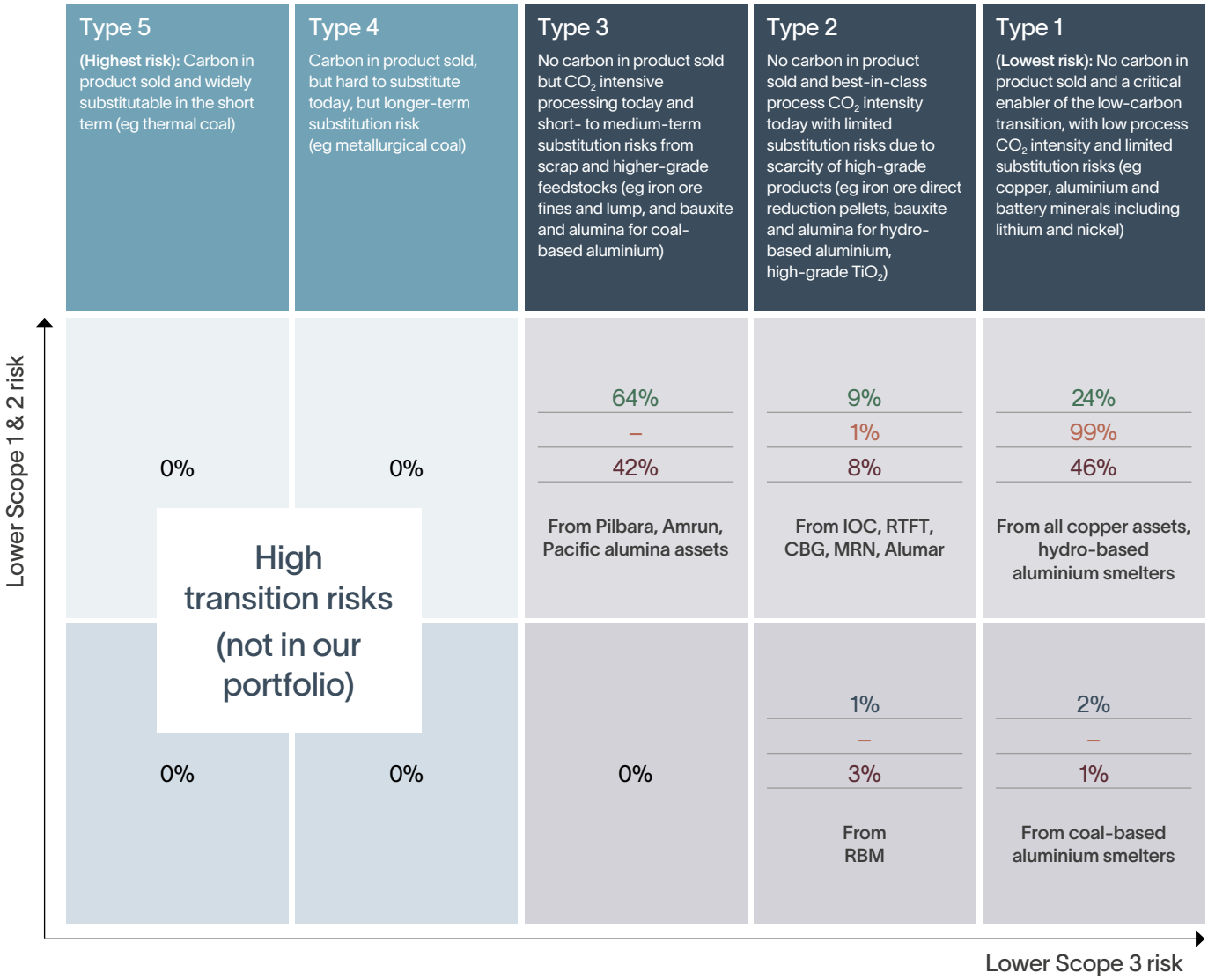
Although climate change presents clear growth opportunities for our commodities, it also presents both physical and transition risks to our portfolio. The transition to a low-carbon economy will have profound implications not only on the commodities we produce, but how we produce them – particularly when considering fossil-fuel-based steel and aluminium production. This creates considerable opportunities for our business, but also presents clear risks if we fail to align our projects and products with a net zero future.

Our portfolio risks and opportunities in the low-carbon transition

Role in the low-carbon transition	Opportunities	Risks
Copper is an essential ingredient in renewable electrification. Its superior electrical conductivity makes it vital for use in most low-carbon technologies. Electric vehicles typically contain four times more copper than internal combustion engine vehicles. Meanwhile, solar and wind power systems consume 3-6 tonnes of copper per megawatt of installed capacity versus around 1 tonne for thermal power.	– World-class greenfield and brownfield copper project pipeline – Recovery of additional copper and by-products from existing orebodies and legacy tailings	– Stringent environmental and social approval constraints for new projects (near- to long-term risk)
Lithium is a vital ingredient in lithium-ion batteries used in electric vehicles and other energy storage applications such as grid firming for renewable projects. In a net zero trajectory, over 50% of vehicle sales could be electric by as early as 2030 – reaching up to 65 million units. This would imply around 3 million tonnes of lithium demand compared with just 350,000 tonnes today.	– Strong market outlook for lithium projects – Recovery of critical minerals by-products from existing orebodies	– Uncertainty surrounding the evolution of different battery technologies (long-term risk) – Stringent environmental and social approval constraints for new projects (near- to long-term risk)
Aluminium is essential for light-weighting of energy-efficient transport solutions and is infinitely recyclable. 60% of the world's aluminium production in 2020 was powered by coal. The competitiveness of green aluminium relative to fossil-fuel-based aluminium will escalate in a carbon-constrained world, leading to strong demand for cleaner sources.	– Low-cost hydro-based smelters will grow their distinct structural advantage – Opportunities from ELYSIS™ technology – Improved traceability and accreditation	– Ability to secure competitive large-scale firmed renewable electricity to re-power coal-based aluminium smelters (medium-term risk)
Steel is the fundamental building block of energy-efficient urban centres and a vital ingredient for low-carbon infrastructure and transport. Green steel will require high-grade iron ore. Replacing of conventional coal-based steel and cement with green steel will allow substantial reductions in greenhouse gas emissions, including a potential 60% reduction in China's construction sector.	– Strong resilience from high grade iron ore products from the Pilbara, Iron Ore of Canada (IOC) and Simandou – Opportunities to target direct reduction ores and green-hydrogen-based iron in renewable advantaged regions	– Accelerated scrap utilisation reducing primary iron demand (near- to long-term risk) – Pressure on lower-grade ore with higher level of impurities (medium-term risk)

Classifying our portfolio

Transition risks are linked to value-chain emissions – or Scope 3 risks – associated with each commodity. We classify commodities into five categories:



Percentage share of Group:

Revenue (%)

Growth capex[1] (%)

Operating assets (%)

IOC: Iron Ore Company of Canada (high-grade iron ore pellets, high-grade concentrate)
RTFT: Rio Tinto Fer et Titane (Sorel-Tracy Quebec metallurgical complex produces iron and titanium with materials from QMM)
QMM: QIT Madagascar Minerals (based in south eastern Madagascar, produces ilmenite, rutile, zircon)
MRN: Mineração Rio do Norte, a bauxite mine in Brazil (joint venture)
Alumar: Alumina refinery in Sao Luis Brazil (joint venture)
CBG: Compagnie des Bauxites de Guinée (joint venture)

Last year 24% of our revenues came from assets in the lowest carbon segment of our framework – low emissions projects that produce materials essential to the low-carbon transition. Crucially, we have continued to direct almost all of our growth capex to this segment. We also announced our ambition to increase our growth capital up to $3 billion annually in 2023 and 2024 with a priority focus on commodities that are essential for the drive to net zero. This will ensure we maintain a strong growth pipeline as more governments and customers commit to ambitious emissions reduction targets.

1. Excludes sustaining and replacement capex.

Reducing the carbon footprint of our operations

We are accelerating the decarbonisation of our assets to strengthen our alignment with the goals of the Paris Agreement and aim to reduce our emissions by 50% by 2030. In 2021, our Scope 1 and 2 emissions fell to 31.1Mt CO_2e, equivalent to a 4% reduction against our 2018 equity emissions baseline.

We first set emissions intensity targets in 2010 for the period to 2015 covering more than 95% of our Scope 1 and 2 emissions from our managed assets. These targets were subsequently raised and extended to 2020. In 2020, we set new targets to reduce absolute emissions by 15% and emissions intensity by 30% relative to our 2018 equity emissions baseline by 2030, including both managed and non-managed operations.

As part of our new Group strategy, we now aim to achieve the 15% absolute reduction target five years earlier, by 2025, and have more than tripled our 2030 target to reduce emissions by 50%. These targets replace our emissions intensity target. We will continue to adjust the 2018 baseline to exclude reductions achieved by divesting assets in future, and to account for acquisitions.

Article 2 of the Paris Agreement sets out its main aims, which include holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C. In the Glasgow Climate Pact adopted at COP26, governments resolved to pursue efforts to limit the global temperature increase to 1.5°C. The Pact states that this "requires rapid, deep and sustained reductions in global greenhouse gas emissions, including reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases". This is consistent with the IPCC's Special Report on 1.5°C that sets out multiple pathways to limiting warming to 1.5°C which average around net zero emissions by 2050.

While there is no universal standard for determining the alignment of targets with the Paris Agreement goals, we assessed the alignment of our targets with 1.5°C with the following:

- Estimated equity emissions in 2010 were 44.5Mt CO_2e. Subtracting divestments between 2010 and 2018 brings this total to 35.0Mt CO_2e. Our 2030 target is therefore equivalent to a 53% reduction from our 2010 equity emissions (excluding divestments).
- Our 2030 target exceeds the resolution made by governments at COP26 to reduce emissions by 45% by that date.
- Our commitment to reach net zero emissions by 2050 and our interim targets align with the science-based pathways set out in the IPCC's Special Report on 1.5°C.
- The Science Based Targets initiative (SBTi) states that "the minimum reduction required for targets in line with 1.5°C scenarios is 4.2% in annual linear terms". Although we do not expect a linear trajectory to our target, this equates to 50% reductions over the period 2018-2030 (to the nearest percentage)[1].
- Carbon offsets and removals are expected to form a limited part of our decarbonisation strategy.

Based on this assessment, we conclude that our Scope 1 and 2 targets for 2030 are aligned with efforts to limit warming to 1.5°C which is aligned with the stretch goal of the Paris Agreement.

Our Scope 1 and 2 emissions in 2021

Our absolute emissions in 2021 were 31.1Mt CO_2e (2020: 31.5Mt CO_2e), 4% below our 2018 equity emissions baseline. The reductions achieved since 2018 are primarily the result of switching to renewable electricity contracts at Kennecott copper in the US and the Escondida mine in Chile (managed by BHP; Rio Tinto owns 30%), and also relate to unplanned operational disruptions in 2021 at Richards Bay Minerals (RBM) in South Africa and the Kitimat aluminium smelter in Canada.

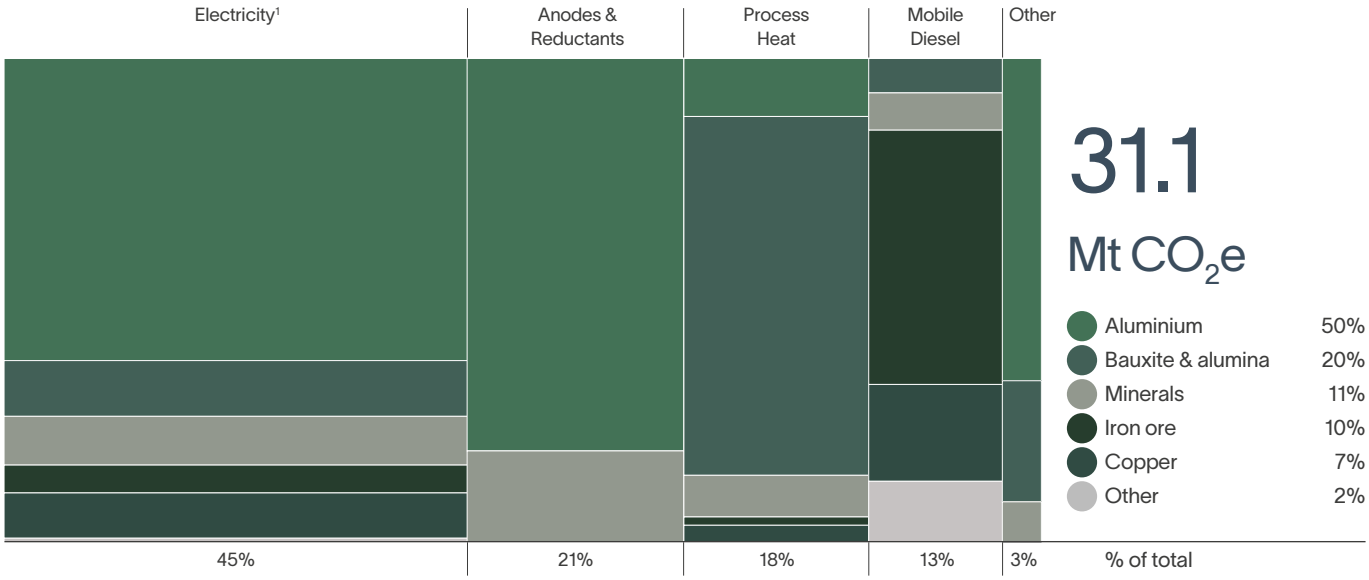
The four most significant sources of our operational emissions are electricity 45% (both purchased and generated), carbon anodes and reductants in aluminium smelting and titanium dioxide furnaces 21%, fossil fuels for heat at our processing plants and alumina refineries 18%, and diesel consumption in our mining equipment and rail fleet 13%. The carbon intensity of our assets varies widely across our portfolio, and largely reflects the balance between mining and processing activities. Most of our assets already sit at the low end of their respective commodity carbon intensity curves. Operations with a predominant mining and logistics focus are less carbon intensive, while refining and smelting operations are high-temperature, energy-intensive processes.

Consequently, approximately 70% of our emissions today are from our aluminium business. Largely because of the high energy intensity of the aluminium business, our Group-wide consumption of electricity is about four times that of other global diversified mining majors. However, our share of renewable electricity – 75% (2020: 75%) across our managed operations – remains significantly higher than our peers.

In 2021, we further integrated our Scope 1 and 2 decarbonisation strategy and review of asset-by-asset mitigation options with our financial planning process. We progressed studies across a broader range of emissions reduction opportunities at all our product groups and approved 0.26Mt CO_2e of new abatement projects. This was above the target 0.22Mt CO_2e of approvals set in our Group ESG short-term incentive plan (STIP) objectives for 2021. The approved projects included small renewable projects at Weipa, QIT Madagascar Minerals (QMM) and Kennecott, as well as several energy efficiency projects and small low-carbon technology pilots. With a renewed focus on our more ambitious 2025 and 2030 targets, and as the maturity of our abatement projects pipeline continues to develop, we expect a significant step-up in abatement projects approvals in 2022. Our short-, medium- and long-term decarbonisation strategy is set out in the Climate Action Plan in Part 2 of this report[2].

1. SBTi Corporate Manual V2.0 (December 2021): While the Science Based Targets initiative has additional criteria on the inclusion of Scope 3 and the exclusion of offsets, the only reference we make here to their method is the minimum linear reduction in their Absolute Contraction Approach. https://sciencebasedtargets.org/resources/files/SBTi-Corporate-Manual.pdf
2. We define short-term as 1 year, medium-term as up to 2030 and long-term as beyond 2030.

2021 Scope 1 and 2 emissions by operations and source (equity basis)



Aluminium: The aluminium smelting process requires significant quantities of electricity and produces emissions from the use of carbon anodes. Although most of our smelters are supplied by renewable electricity, the Boyne and Tomago smelters in eastern Australia are supplied predominantly by coal-fired power generators. The two main sources of emissions in the alumina refining process are from the coal and natural gas used for heat and calcination.

In 2021, our Aluminium product group's absolute greenhouse gas emissions (21.9Mt CO_2e) were 1% lower than in 2018. Contributions to this reduction include improvements in processing efficiency, an increased use of hydroelectric boilers in refining, and a reduction of production at the Kitimat smelter due to a labour action. The 2021 emissions intensity of our managed Atlantic smelters, powered by hydroelectricity, was 2.17t CO_2e per tonne of aluminium compared with a global average of approximately 11.6t CO_2e per tonne of aluminium. The carbon intensity of our Vaudreuil refinery is the lowest in the world today at 0.26t CO_2e per tonne of alumina – compared to a global average of 1.2t CO_2e per tonne of alumina.

At Weipa, we continued to advance the decarbonisation of our bauxite business, with approval to install an additional 4MW of solar and a 4MW / 4MWh battery. This will more than triple the local electricity network's solar generation capacity.

Minerals: Our titanium dioxide business is energy intensive and sources hydropower in Canada but relies on coal-fired power at RBM in South Africa. The titanium smelting process also consumes carbon electrodes. In 2021, our Minerals product group's absolute greenhouse emissions were 3.4 Mt CO_2e, a reduction of approximately 8% from 2018 levels. The decrease in emissions was mainly driven by reductions in production and energy at RBM due to halted operations.

We are introducing a renewable energy plant that will power our QIT Madagascar Minerals (QMM) operations. In July 2021, QMM signed an agreement with CrossBoundary Energy for a $6MW_{AC}$ solar plant and 12MW wind turbine facility. The plant will also supply the majority of the power to the town of Fort-Dauphin. Construction for the solar plant is expected to begin in 2022 with the start of operations scheduled in the same year. Construction of the wind power plant is planned to commence in 2022 and will become operational by 2023.

Iron Ore: Emissions from our iron ore operations in the Pilbara, Western Australia, are related to the natural gas used to generate power for the mines and processing plants, and from the diesel consumed by our mining and rail fleet. In 2021, our Iron Ore product group's absolute greenhouse gas emissions were 3.0Mt CO_2e (on an equity basis), an increase of 0.34Mt CO_2e compared to the 2018 emissions baseline, driven largely by an increase in diesel emissions due to increased haul distances, waste-to-ore ratios and material movement.

Construction of our first 34MW solar plant at the Gudai-Darri mine and 45MW battery system at Tom Price continued in 2021 and marks an important step in reducing our carbon footprint in the Pilbara. The solar plant will deliver approximately one third of Gudai-Darri's average electricity demand[1] and is a first step in a broader programme to leverage the Pilbara's natural advantages in solar and wind resources and deploy renewable power at the gigawatt scale.

Copper: Diesel for trucks and electricity are the main sources of emissions in our copper business. Our Kennecott copper mine in the US purchases renewable electricity certificates, and Escondida in Chile started to transition to renewable power in 2021. The Oyu Tolgoi mine in Mongolia is currently supplied by coal-fired power from China. In 2021, our Copper product group's greenhouse gas emissions were 2.2Mt CO_2e, a reduction of 1.2Mt CO_2e or 35% compared to our 2018 emissions baseline.

At Kennecott, we approved the replacement of eight haul trucks with lower emission engines, as well as a trial to understand the potential for using renewable diesel, for completion in 2022. We also received approval for the detailed design of a 30MW solar power plant to be constructed in two phases: 5MW to be completed by 2022, and the plant to be expanded by 25MW by 2025.

In 2021, we worked with ENGIE on an emissions reduction pilot study at the Winu project in Australia to better understand existing and emerging technologies for improving renewable power to our operations.

1. In the press release dated 16 February 2020, the solar plant was stated as delivering approximately 65% of Gudai-Darri's average electricity demand. Since the announcement, changes in Gudai-Darri's demand profile have occurred and the solar plant contribution has reduced to one-third.

Partnering to reduce the carbon footprint of our value chains

Our products are essential enablers of the energy transition and a net zero world. We operate in energy- and carbon-intensive value chains – particularly steel and aluminium production – and are working with our customers on the technologies needed to address the resulting emissions. Steel is a vital material for industry, construction, transportation and low-carbon infrastructure and, with limits to the availability of recyclable steel, our iron ore products have an important future role to play – but we must support our customers as they work to decarbonise steel production.

Emissions related to the processing of the iron ore, bauxite and alumina sold to our customers in the steel and aluminium sectors remain by far our largest sources of Scope 3 emissions. These are the value chains that we have prioritised for our partnership approach and we provide more detail in our Climate Action Plan on each of these sectors, including our Scope 3 goals and customer engagements plans.

Just as we are stepping up our Scope 1 and 2 reduction efforts, we are also sharpening our focus on our Scope 3 goals, which are explicitly linked to executive remuneration. Our approach is based on global collaboration and close partnerships with our customers, suppliers and even competitors, to develop innovative technologies to reduce carbon emissions.

In 2019, we launched our flagship partnership with China Baowu Steel Group (Baowu) and Tsinghua University, and we now have partnerships and initiatives with POSCO, Nippon Steel, BlueScope and others focused on the transition to net zero emissions across our value chain. Our specific goals and 2022 objectives for these partnerships are set out in Part 2 of this report.

Our Scope 3 emissions in 2021

Our Scope 3 emissions were 554Mt CO_2e in 2021 (down from 570Mt CO_2e in 2020) and around 95% of this is from the processing of iron ore, bauxite and other products by our customers. 94% of these processing emissions take place at our customer facilities in China, South Korea, Japan and other countries that have pledged to be carbon neutral by around mid-century. As our customers start to align with their governments' pledges, we note that about 28% of our iron sales are directly to steel producers that have already set public targets for their Scope 1 and 2 emissions (our Scope 3), and have ambitions to reach net zero by around mid-century.

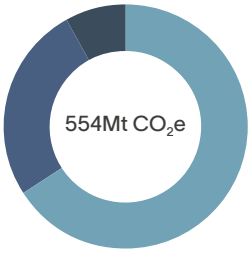
Estimating our Scope 3 emissions remains challenging. In most cases we cannot directly measure relevant inputs and relevant customer- and supplier-specific emissions reporting is not accessible. In 2021, we continued to enhance our approach to quantifying our Scope 3 emissions with more representative emission factors for the aluminium value chain. We now use factors that are specific to the region where our products are processed. This is more accurate than using the global average factor and reflects the higher emission intensity of aluminium production in Asia. In addition, we now consider all bauxite and alumina we buy and sell instead of just the net bauxite and alumina sold. Consequently, we are accounting for more tonnes of product processed through our value chain, both upstream and downstream.

Overall, these changes increased our reported 2020 bauxite and alumina Scope 3 emissions from 116 to 154Mt CO_2e for that year. This dropped to 144Mt CO_2e in 2021 due to improvements in the carbon intensity of refining and smelting, as well as a reduction in bauxite sold. Scope 3 emissions related to our iron ore fell from 376Mt CO_2e in 2020 to 365Mt CO_2e in 2021, due to changes in product mix and a reduction in iron ore sold.

The full details of our updated approach to estimating Scope 3 emissions and our assumptions are available in our separate 2021 Scope 1, 2 and 3 Emissions Calculation Methodology Report on our website.

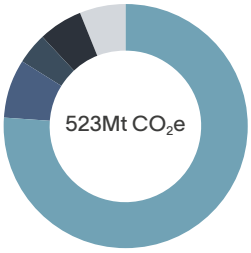
2021 Scope 3 emissions by category (equity basis)

	Mt CO_2e
Processing of iron ore	364.6
Processing of bauxite and alumina	144.5
Purchased goods	16.3
Capital goods	1.9
Fuel-related activities	2.9
Upstream and intercompany transportation	5.9
Downstream transportation	2.7
Processing of salt	7.2
Processing of TiO_2 feedstocks	4.9
Processing of copper concentrate	0.5
Processing other sold products	1.6
Travel, commuting and waste	0.5



2021 Scope 3 emissions from product processing by country

	Mt CO_2e
China	399.0
Japan	41.3
South Korea	20.8
Other countries with net zero pledges	30.6
Other countries without net zero pledges	31.6



2021 progress on our Scope 3 goals

Our 2020 Climate Change Report set out our Scope 3 goals, medium-term targets and 2021 objectives. Progress on our 2021 objectives, which formed part of our Group ESG short-term incentive plan (STIP) metrics, is summarised below. We met all objectives except number two.

	2021 objective	Progress
1.a	Progress low-carbon steelmaking projects and research with Baowu as part of $10 million commitment in late 2020 to advance our partnership with Baowu and Tsinghua University	During 2021, the partnership has implemented the Rio Tinto-Baowu Climate Change Collaborative Agreement and the parties have agreed to invest in a microwave lump drying pilot plant. In December, the partnership held its second "China low-carbon steel conference", bringing together representatives across the China steel industry to identify transition pathways for the sector. In addition, we joined the Global Low-Carbon Metallurgical Innovation Alliance, established by Baowu and comprising 62 companies, universities and research institutions from 15 countries.
1.b	Develop work programme and identify joint low-carbon steelmaking technology projects with Nippon Steel Corporation (Nippon Steel) in Japan, as part of climate MoU signed in December 2020	During 2021, we further developed our scope of work and have started work on seven projects that will continue into 2022, including short-term blast furnace improvement projects and collaboration on marine transportation of iron ore between the two parties.
1.c	Establish new steel value chain partnership	We established a partnership with POSCO and are exploring decarbonisation opportunities including integrating Rio Tinto's iron ore processing technology with POSCO's steelmaking technology. We established a partnership with BlueScope Steel (BlueScope) and plan to assess the use of green hydrogen at the Port Kembla Steelworks in Australia in a direct reduction process with Pilbara iron ores and then separate the slag in an electric melter to produce molten iron suitable for use in basic oxygen steelmaking process.
2	Assess feasibility of green hot briquetted iron (HBI) production with hydrogen from hydro-electricity in Canada with Paul Wurth and SHS Steel	We reconsidered our approach to assessing the feasibility of green hydrogen-based direct reduced iron in eastern Canada and unwound our collaboration with Paul Wurth and SHS by mutual agreement. Instead we started a Rio Tinto-led order of magnitude study for a plant producing up to 2 million tonnes of green hot briquetted iron (HBI). Completion of the study has been delayed into early 2022. Prime potential sites have been identified, and a more comprehensive understanding of the available hydrogen and direct reduction technology options has been gained. Early engagement with key project stakeholders has also been made, with positive feedback.
3	Progress industrial-scale ELYSIS™ technology research and development following construction of first industrial pilot in late 2020	In 2021, the ELYSIS™ Industrial Research and Development Center passed a significant milestone in the development of this new technology with the first industrial-scale smelting of zero-carbon aluminium. This uses a full industrial design at a size comparable to small smelting cells operating in the industry today. In November, we also announced the start of construction of larger commercial-size cells at our Alma aluminium smelter in Quebec. These prototype cells are expected to become operational in 2023.
4	Approve introduction of LNG dual-fuel vessels to our shipping portfolio	In 2021, we signed charterparty contracts to add nine LNG dual-fuel Newcastlemax vessels to the portfolio from the second half of 2023, which will deliver lifecycle CO_2e reductions of 15-20% (50kt CO_2e per annum).

Enhancing our resilience to physical climate risk

Our assets, infrastructure, communities and broader value chains are exposed to the impacts of extreme weather events associated with climate change, as evidenced by our experience of events such as drought, flooding, heat waves and fires that are occurring globally. While the immediate exposure to extreme weather events (acute climate risk) is addressed by product-group-level risk assessments and study guidance, the longer-dated risk exposure to chronic changes in climate is less well understood given the inherent uncertainty in future climate projections. Managing physical climate change risk through risk-based adaptation practices is essential to enhance the resilience of assets and communities.

Taking and managing risk responsibly is essential to operating and growing our business safely, effectively and sustainably. Managing our risks effectively ensures we deliver our strategic priorities and strengthen our social licence by focusing on becoming the 'best operator', achieving impeccable ESG performance and excelling in development.

Our Group's strategy, values and risk appetite inform and shape our risk management and internal controls framework. We embed risk management at every level of the organisation to effectively manage threats and opportunities to our business, host communities and our impact on the environment. While risk management is the accountability of our leaders, all employees are empowered to identify and manage risks at the point that they arise in their business (within the first line). Our Board and Executive Risk Management Committee provide oversight of our principal risks and the Audit Committee monitors the overall effectiveness of our system of risk management and internal controls. The Principal Risks and Uncertainties section of our Annual Report considers both physical climate risks and low-carbon transition risks.

We measure and mature the effectiveness of our risk management practices through our risk management system. This system is built up of six core elements that are continually improved to ensure that we are effectively managing current risks and preparing for emerging risks.

As such, we set expectations that all our leaders and team members understand their risks, assess them in line with our values and Group policies and procedures, and respond. Where risks are material to the Group, they are escalated to the Risk Management Committee for oversight, and, as appropriate, to the relevant Board committees and the Board. Enhancing our resilience to physical climate risks is an important component of our climate change strategy.

We use scenarios such as those developed by the Intergovernmental Panel on Climate Change (including the Representative Concentration Pathway 8.5 which has the highest warming) to inform our assessments of the probability and potential impact of these physical risks in the future. A desktop physical risk exposure assessment was conducted in 2018 and a summary of this assessment was published in our 2019 Climate Change Report. The analysis highlights that some of our operations have a high exposure to physical climate risk variables, and that these are material to Group revenue.

Developing physical risk guidance in 2021

Following the Group-wide exposure assessment, the next stage has been to conduct asset-level risk assessments to confirm the effectiveness of our controls. This work was paused in 2020 due to the prioritisation of the COVID-19 response and restrictions on travel to our sites. In 2021, the Energy and Climate Change Centre of Excellence and Risk Area of Expertise have been preparing to engage the product groups for detailed risk assessments in 2022. Activities undertaken include:

- Developing a physical risk assessment guidance note to support product groups on how to conduct a physical risk assessment. This leverages existing risk management processes and systems for tracking actions.
- Piloting a physical risk assessment at the Winu copper project in Western Australia. The methodology was piloted with a physical risk assessment being conducted over the project's scope of operations, logistics route to the port, and the port. The assessment highlighted the importance of participants having access to physical climate projections in a form that is readily understandable. A second key learning was the importance of community participation in the process to ensure risks were adequately identified and addressed. Lastly, the Winu assessment highlighted that many climate risk exposures identified were in fact causes or risk multipliers for existing risks.
- Prioritising assets for future physical risk assessments. The Pilbara and the Saguenay (aluminium and hydro assets) were identified as priority areas for assessment in 2022, which aligns with the findings of the 2018 exposure assessment.

Physical risk programme implementation in 2022

The Pilbara is an area with exposure to extreme weather including cyclones, flooding, drought and extreme heat. In mid-2022, the Iron Ore product group will conduct three workshops (depending on COVID-19 restrictions) to separately cover coastal port and mine operations, inland mining operations and infrastructure (power, rail and roads).

The Aluminium product group has identified priority assessments at Vaudreuil and in the Saguenay where hydro-reservoir exposure to future climate variability could impact operations through both too little and too much water.

Managing acute physical risk in the Pilbara

Our 2019 report describes the series of controls in place to manage the threat of extreme weather at our iron ore operations in the Pilbara in Western Australia. In 2020, we continued our work to enhance asset resilience at these operations and started site construction works for a project to strengthen the Cape Lambert A jetty and wharf, and this work continued during 2021. These works also include replacing berthing and mooring dolphins, longitudinal strengthening of the jetty and protective coating remediation. The replacement of berthing and mooring dolphins is well advanced and is expected to be complete in early 2022 followed by the longitudinal strengthening works and finally the protective coating remediation of the jetty by mid-2022 to bring these current projects to an end. These controls will result in a significant improvement in structural integrity and asset life associated with our operations in the marine port environment.

The Dampier Resilience Project has moved into implementation and is progressing through engineering and procurement activities with a site mobilisation in mid-2022. The project is forecast to be completed in late 2023. The scope of the project is to upgrade the 220kV transmission line between the Yurrayli Maya power station and Port Dampier, and develop a new bulk supply substation at Kangaroo Hill and 33kV distribution connections to Dampier. This critical project replaces assets at end-of-life with new, fit-for-purpose and resilient infrastructure to ensure power network stability, reliability and security.

Part 2

Our Climate Action Plan

In 2021, the Board announced its intention to put a Climate Action Plan (CAP) before shareholders and seek a non-binding advisory vote on the company's ambitions, emissions targets and actions to achieve them. We will continue to publish our progress on climate change annually in line with the recommendations of the TCFD. This will include details of in-year implementation against the CAP and we are committed, as a matter of course in any given year, to regular engagement with shareholders and other stakeholders on our low-carbon transition strategy and its implementation. In view of the time horizons contemplated by the CAP, it is proposed that we would hold an advisory vote in relation to the CAP every three years. If we propose significant changes to the plan, we would put the amended plan to an advisory vote at the next AGM.

The Board is fully aligned with this action plan and believes it will deliver value for our shareholders, our customers and wider society.

1. Scope 1 and 2 emissions targets and roadmap

We have committed to reach net zero by 2050 and have set ambitious interim targets relative to our 2018 equity emissions baseline:

- to reduce greenhouse gas (GHG) emissions by 15% by 2025; and
- to reduce GHG emissions by 50% by 2030.

Actions

We will review and update our marginal abatement cost (MAC) curve annually to maintain a comprehensive technical and commercial assessment of our mitigation options.

To achieve our 50% reduction target by 2030, we aim to:

- Deploy solar and wind renewables at scale:
  - Install 1GW renewables to support supply to our Pilbara iron ore operations; and
  - Work with state and federal governments, power companies, and renewable developers to dramatically increase renewables generation in eastern Australia, aiming to develop green repowering solutions for the Boyne Island and Tomago smelters.
- Advance the abatement projects in our MAC curve such as the deployment of zero emissions trucks and the use of hydrogen at our alumina refineries.
- Use a $75/t CO_2e internal carbon price to incentivise energy-efficiency investments and identify new mitigation projects.
- Scale up the ELYSIS™ technology to be available for installation from 2024. ELYSIS™ is currently constructing the first commercial-scale prototype cells of the inert anode technology, at Rio Tinto's Alma smelter in the Saguenay.
- Build capability to develop carbon offset projects using nature-based solutions and CO_2 mineralisation at or near our operations. We will follow the mitigation hierarchy and expect offsets to play a limited part in our decarbonisation strategy.

As noted in the implementation plan, there are risks and dependencies to delivering the projects needed to achieve our 2025 and 2030 targets. In support of our roadmap and as we look beyond 2030, we are also investing and partnering in the development of new technologies needed for the decarbonisation of our hard-to-abate emissions.

2. Scope 3 emissions goals and customer engagement

The best way for Rio Tinto to contribute to the net zero transition is to work in partnerships to help shape demand for low-carbon metals and minerals. Our approach to addressing Scope 3 emissions is to engage with our customers on climate change and work with them to develop and scale up the technologies to decarbonise steel and aluminium production.

Steel value chain

The future trajectory of our Scope 3 emissions is dependent on our customers' decarbonisation roadmaps, which in turn will be guided by technology development and government policies, including carbon pricing. The Net Zero Steel Initiative (NZSI) has developed a set of scenarios to explore such potential pathways in the steel sector. Should the industry follow the NZSI Tech Moratorium scenario, we estimate that Rio Tinto's iron ore-related Scope 3 emissions would fall by 23% by 2035 and 42% by 2040, relative to our 2020 emissions.

Close to 95% of our Scope 3 emissions are generated in countries that have carbon neutrality pledges and about 28% of our iron sales are directly to steel producers that have already set public targets for their Scope 1 and 2 emissions (our Scope 3), and have ambitions to reach net zero by around mid-century. We will monitor this metric and report progress on an annual basis.

In 2022, we commit to engage with all our direct iron ore customers, representing approximately 75% of our iron ore sales and related Scope 3 emissions, to share information on our respective climate change goals and roadmaps, and actively seek areas of mutual collaboration on pathways to net zero, such as those highlighted in our iron and steel decarbonisation goals.

These engagements will add to our current approach to work in partnerships with customers, including Baowu, Nippon Steel, POSCO and BlueScope, as well as technology providers, research institutes and universities to progress the following iron and steel decarbonisation goals:

- Support our customers' blast furnace optimisation, with potential carbon emission reductions of up to 30%.
- Explore future carbon neutral pathways for our Pilbara iron ores through:
  - existing and new technologies to beneficiate Pilbara ores;
  - a proprietary low-carbon research project using microwave energy and sustainable biomass as a reductant; and
  - assessing a mid-grade direct reduced iron (DRI) produced with green hydrogen and processed in an electric melter.
- Pursue a project to produce hot briquetted iron (HBI) with high-grade iron ore and hydro-based green hydrogen in Canada.
- Find a pathway to develop Simandou to meet the future demand of high-quality iron ore for low-carbon steelmaking technologies.

Aluminium value chain

As a leading producer of low-carbon aluminium, we are actively involved in the decarbonisation of the value chain from bauxite to alumina and primary metal production. About 74% of our Scope 3 emissions related to the downstream processing of bauxite and alumina sold to our customers is from the use of electricity, predominantly in China. The remainder is from the energy use for process heat at the alumina refineries of our bauxite customers and from the use of carbon anodes in aluminium smelting. Our plan is to address these through:

- A commitment to engage with all our bauxite customers to seek areas of mutual collaboration in alumina decarbonisation projects, leveraging existing technical support relationships;
- The continued development of the ELYSIS™ inert anode technology, with the goal to have it available for installation at our smelters from 2024, following construction of large-scale commercial prototype cells at our Alma smelter in the Saguenay by 2023; and
- Leveraging START, a new standard we launched in 2021 for transparency and traceability across the aluminium value chain, to support customer and consumer demand for sustainable products.

Shipping

We have an ambition to reach net zero emissions from shipping of our products by 2050 and expect to meet the International Maritime Organization (IMO) decarbonisation goal of 40% reduction in shipping emissions intensity by 2025, five years ahead of the IMO deadline. We expect to introduce net zero emission vessels into our portfolio by 2030, and in the meantime we are focusing on:

- Improving existing vessels' efficiency, including for our own vessels;
- Increasing our use of transition fuels that deliver short to medium-term carbon emission reductions, through biofuel trials and the introduction of LNG dual-fuel vessels in our chartered fleet; and
- Partnering to support the development of fuels that have the potential to deliver net zero solutions, such as green ammonia.

3. Capital allocation alignment with our 1.5°C decarbonisation strategy

We are committed to align our future capital expenditure with our 2025 and 2030 Scope 1 and 2 emissions targets. Our Scope 1 and 2 targets and our commitment to reach net zero emissions by 2050 are aligned with efforts to limit warming to 1.5°C, which is aligned with the stretch goal of the Paris Agreement. We estimate that we will invest $7.5 billion in capital between 2022 and 2030 to deliver our decarbonisation strategy (approximately $1.5 billion over the period 2022 to 2024).

We also expect our incremental operating expenditure to support the CAP to be in the order of $200 million per year, including research and development initiatives. For example, we plan to spend about $50 million on our iron and steel decarbonisation initiatives in 2022.

We aim to phase out the purchase of diesel haulage trucks and locomotives by 2030.

We are focusing our growth capex on commodities that enable the energy transition, including copper, battery materials, aluminium and high-grade iron ore.

4. Climate policy engagement

We continue to encourage our industry associations to align their advocacy with the goals of the Paris Agreement. We review the climate advocacy of our industry associations each year, publish this review on our website and consider it when we decide whether to renew our membership. This review includes:

- The purpose of the association and the value that the membership may provide to Rio Tinto and its investors;
- The adequacy of governance structures within the industry association; and
- The policy positions and advocacy of the industry association.

5. Climate governance

The Board approves the Group's approach to climate change and monitors progress in the delivery of the strategy. The Chief Executive is responsible for developing the Group's business strategy, planning, investment, risk management and delivering the CAP approved by the Board.

In the short-term incentive plan (STIP), safety, environment, social and governance matters including climate change are now assigned an explicit performance weighting of 35%, of which 20% relates to safety. The "E" component is 5% of the STIP and relates entirely to climate change performance objectives. In 2022, we will assess these at the Group level against two categories of objectives:

- Progress on our Scope 1 and 2 targets: deliver our Group-wide short-term abatement target for Scope 1 and 2 emissions of 0.8Mt CO_2e in 2022 (2.5% of STIP) – the utilisation of offsets is not included in these remuneration outcomes; and
- Progress on our Scope 3 goals: the achievement of specific milestones relating to steel decarbonisation, zero-carbon aluminium, and shipping (2.5% of STIP).

6. Just transition

We are committed to supporting a just transition to a low-carbon economy that is socially inclusive and provides decent work and livelihoods. Our commitment to implementing core business and human rights standards, including the UN Guiding Principles on Business and Human Rights (UNGPs), will continue to be integrated into our decarbonisation plans and actions.

7. TCFD disclosure

We support the TCFD recommendations and are committed to aligning our disclosures with the Climate Action 100+ (CA100+) Net Zero Company Benchmark by 2023. There are some elements of the benchmark that are still under development and we will work with CA100+ and our investors to develop an approach that is applicable to the diversified mining sector.

Implementing our Climate Action Plan

Scope 1 and 2 targets and roadmap

In early 2021, our Executive Committee embarked on a new strategy process, taking into consideration changes to our external context and a detailed diagnostic of our business. This review gave us the confidence that we could, and should, accelerate the transition of our operations towards net zero by 2050 and set more ambitious medium-term targets.

The rapid shift in the external context on climate change was a key component of the strategy development process. This includes the increasingly ambitious emissions targets that many governments set in the lead up to COP26; developments in low-carbon technology and the falling costs of many of them, particularly renewables and electric vehicles; and changes in consumer sentiment. Our new ambitions were also informed by our latest analysis and understanding of decarbonisation projects and opportunities across the Group, captured in our marginal abatement cost curves.

Our 2025 and 2030 targets

We have brought forward our target of a 15% reduction in absolute Scope 1 and 2 emissions from 2030 to 2025 and established a new target to achieve a 50% reduction by 2030.

Our four main sources of emissions are related to electricity, process heat, anodes and reductants, and diesel. Our 2030 targets are informed by a bottom-up, asset-by-asset analysis of mitigation options considering each of these sources. Our Energy & Climate Change Centre of Excellence worked with our product groups to develop the business-as-usual baseline and the analysis of potential emissions reduction opportunities across our portfolio.

Between now and 2030, the Group-wide analysis highlights that the two most important decarbonisation levers are: first, switching the electricity we generate and purchase to renewables; and secondly, optimising processing plants in our alumina and minerals operations to reduce emissions from process heat.

These reduction opportunities are:

- Pilbara renewables (1.1Mt CO_2e);
- Pacific Aluminium Operations repowering (approximately 5.2Mt CO_2e);
- The projects included in our marginal abatement cost (MAC) curve which is updated each year (4.3Mt CO_2e); and
- Energy efficiency reductions that are too small for the MAC curve and other options such as the reductions achieved by the initial deployment of ELYSIS™ and offsets (4.1Mt CO_2e).

We also have several initiatives under way to develop low-carbon solutions that will reduce and displace the use of diesel in our rail and mobile fleets, but at this stage we do not expect material emission reductions from these before 2030.

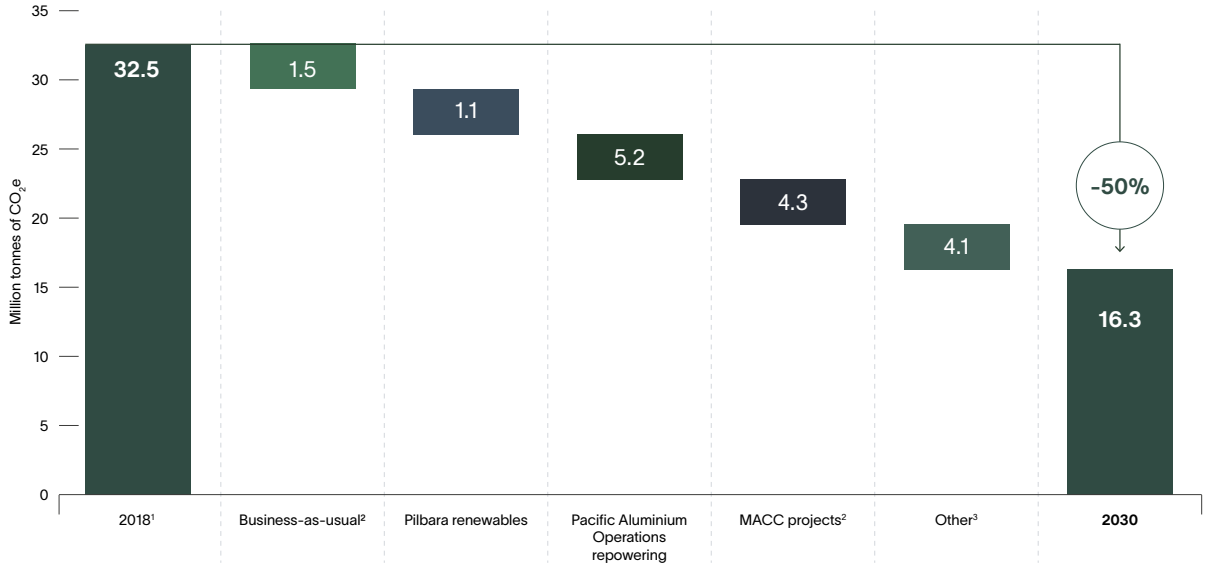
There are risks and dependencies to delivering the projects to achieve our 2025 and 2030 targets. Many of the abatement projects identified are at early stages of development and it may be months or years before they reach final investment decision, construction and operation. Others may be dependent on local approvals or require collaboration with a wide range of stakeholders to achieve the large-scale low-carbon transformation that we are aiming for.

Pilbara renewables

In the Pilbara, we have one of the world's largest micro grids, underpinned by 480MW of gas-based power capacity. The solar plant we approved at Gudai-Darri in 2020 is expected to come online in 2022, avoiding emissions of approximately 90,000t CO_2e per year. We want to accelerate the transition by targeting the rapid deployment of 1GW of wind and solar renewables.

Delivery of 1GW of renewables in the Pilbara will support abatement of approximately 1Mt CO_2, with two-thirds driven by the displacement

Decarbonisation roadmap to 2030



1. 2018 Scope 1 and 2 emissions equity baseline, adjusted for divestments.
2. The business-as-usual changes in emissions are the result of volume growth, asset closures and other operational factors.
3. Projects from our Marginal Abatement Cost Curve.
4. Other, including energy efficiency, ELYSIS™ and carbon offsets.

of gas-fired power generation, and the remaining abatement through the early electrification of our mobile fleet and the transition away from diesel. Beyond 2030, the full electrification of our Pilbara system, including all trucks, mobile equipment and rail operations, will require further gigawatt scale renewable deployment combined with advances in fleet technologies.

Pacific Aluminium Operations repowering

The Boyne smelter and Gladstone power station in Queensland and the Tomago smelter in New South Wales all operate in coal-based power grids. These facilities account for 28% of our Scope 1 and 2 emissions and more than half of our emissions from electricity use. Green repowering solutions are essential to the long-term sustainability of these operations. The scale of the smelters' electricity use means that their transition must take into account the impacts on the broader grid and overall system requirements. This requires complex technical, commercial and political negotiations balancing the needs of multiple stakeholders. In October 2021, as an initial step in this process, we signed a Statement of Cooperation with the Queensland government to develop central Queensland into an industrial and advanced manufacturing hub, helping to deliver a more sustainable future for the area by fast-tracking renewables and attracting new green industries.

The Marginal Abatement Cost curve

Our updated 2021 MAC curve to 2030 includes 63 projects with potential abatement of 4.3Mt CO_2e. The highest cost abatement opportunities are shown on the right side of the chart and require carbon price support to break even. Our longer-term net zero analysis indicates that higher carbon prices than shown here are needed for projects that will address harder-to-abate emissions post-2030.

Although our abatement portfolio has increased in size since 2020, the abatement achieved by projects with a positive NPV (at a carbon price of $0) has stayed relatively consistent at 2.4Mt CO_2e. In addition, about 30% of the reductions are from projects that require further technology development and more than 40% of the reductions are from projects at the conceptual stage of execution readiness. So, we face continuing challenges to improve the commercial returns and overall readiness of many of our abatement projects. The commercial returns of abatement projects will also be influenced by the level of local carbon prices, which currently remain relatively low in many of the countries where we operate.

Energy efficiency and other projects

As a significant consumer of energy, we will use an internal carbon price of $75 per tonne of CO_2 to drive improvements in energy efficiency across our assets and to identify new abatement projects. These are likely to be smaller projects or changes in operating practices that can reduce our energy costs and our emissions and are not included in the MAC curve. This final category also includes the reductions achieved by the initial deployment of ELYSIS™ and limited use of offsets from projects developed at and near our sites.

Progress towards our 2025 target

We have so far reduced our Scope 1 and 2 emissions by 1.4Mt CO_2 against our target baseline, from 32.5Mt CO_2 in 2018 to 31.1Mt CO_2 in 2021. The switch to renewable contracts at the Kennecott and Escondida copper operations accounted for about 1.2Mt CO_2 of those reductions to date.

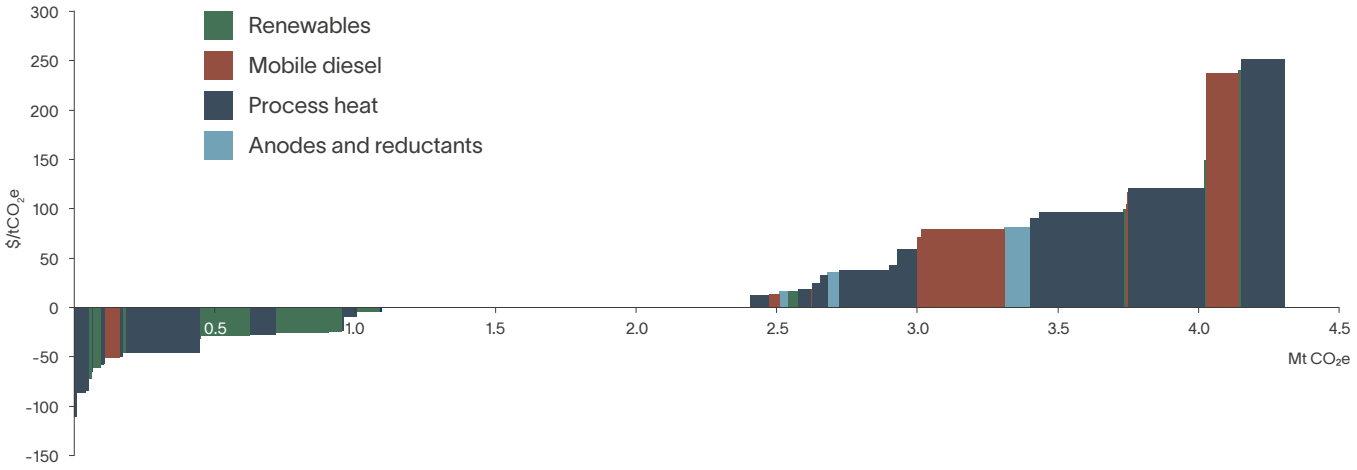
Temporary operational disruptions, such as at Richards Bay Minerals and Kitimat, have also contributed to lower emissions in 2021. We expect these to bounce back as operations return to full production, and we also expect carbon emissions increases at some of our sites as we grow production between 2021 and 2025.

Overall, we therefore estimate a need to plan, develop and implement 4.4Mt CO_2 of abatement projects to meet our 15% emissions reduction target by 2025.

This is an ambitious target with just three years for design, planning and physical construction of these projects to generate carbon reductions in 2025. We still have much work to do to progress our abatement projects and successfully deliver on our target. At the start of 2022, the maturity of our abatement projects pipeline is reflected by the following categorisation of the 4.4Mt CO_2 of abatement required by 2025:

- 0.3Mt CO_2 from projects already approved but not yet executed;
- 1.1Mt CO_2 from projects yet to be approved but in advanced planning;
- 3.0Mt CO_2 from projects in early stages of design and planning or yet to be fully identified.

Marginal Abatement Cost Curve for Scope 1 and 2 emission abatement to 2030



Note: excl. PacOps repowering, ELYSIS and energy efficiency improvements

Net zero by 2050

In addition to the extensive work to progress and execute projects to meet our 2030 targets, we are also setting up the foundations for the next wave of abatements needed to reach net zero emissions across our operations by 2050. Although we have the outline of a broad pathway to net zero, we do not have all the solutions today. We are investing in research and development of many different low-carbon technologies across our carbon footprint, including plasma torches, alternative fuels, zero emission vehicles, inert anodes and the use of hydrogen.

Decarbonising power

A continued shift to renewables is central to meeting our 2030 targets and will remain an important area of focus beyond 2030, as we increasingly electrify our processes and mobile fleets – these will need to be supplied by green energy. Further repowering with renewables must be done in a way that reduces costs and maintains security of supply. Integration technologies and storage will be critical to the success of achieving a higher penetration of renewable energy.

Long duration (>8 hours to <150 hours) energy storage will be required as we decarbonise our businesses through the adoption of renewable power from wind and solar sources as they become the dominant source of energy. In 2021 we became an anchor member of the newly created Long Duration Energy Storage Council that was launched at COP26. Through the Long Duration Energy Storage Council, we aim to partner with technology providers, industry and services customers, equipment manufacturers, capital providers and low energy system integrators and developers to discover how these technologies and their materials' requirements can support us and society to decarbonise our energy systems.

The Oyu Tolgoi (OT) Board, comprising Rio Tinto, Turquoise Hill Resources (TRQ) and the Government of Mongolia, reached an agreement that will move the underground copper project forward. It also approved an Electricity Supply Agreement to provide OT with a long-term source of power from the Mongolian grid. In meeting OT's commitment to sourcing power domestically, Rio Tinto will work with the Government to support long-term renewable energy generation in support of the Mongolian grid.

Decarbonising anodes and reductants

Emissions from the use of anodes such as in our aluminium smelters are 6.4Mt CO_2e today and a longer-term challenge. We established the ELYSIS™ partnership in 2018 with Alcoa and with support from Apple and the governments of Canada and Quebec to develop the world's first carbon-free aluminium smelting process, using inert anodes instead of carbon.

Having achieved the first industrial scale smelting of zero-carbon aluminium at the ELYSIS™ Industrial Research and Development Center, work is now focused on scaling up of the ELYSIS™ technology towards the demonstration of even larger commercial-size cells in 2023. Construction of these prototype cells is underway at the end of an existing potline at Rio Tinto's Alma smelter. The smelting cells will operate on an electrical current of 450 kA, which is the commercial scale for many large, modern aluminium smelters.

Decarbonising process heat

Our Processing Centre of Excellence is particularly focused on our process heat challenge, which will likely play out over several decades in some of our harder-to-abate operations in alumina, iron ore pelletisation and titanium dioxide. Technologies like hydrogen or plasma torches, which can use renewable energy, may provide a pathway to replace fossil fuels for heat and steam. Our current focus is to develop technologies and look for opportunities to pilot them. Four plasma torches were ordered in 2021 for a trial at the pelletising plant at IOC in Canada.

In 2021, we formed two partnerships to research using hydrogen to reduce emissions in alumina refining: a study with the Australian Renewable Energy Agency to assess hydrogen use in industry and support a co-ordinated approach to developing a local supply chain, and a study with Sumitomo Corporation into building a hydrogen pilot plant at our Yarwun alumina refinery in Gladstone, Australia.

Decarbonising mobile diesel (vehicles and rail)

Mobile diesel is our fourth-highest carbon emission source at approximately 13% of total emissions. We completed analysis and concept modelling of emissions sources and energy needs at our fleet and have identified and prioritised zero emissions pathways. We are working to accelerate development of the required technology for switching to clean energy sources.

In 2021 we launched the Charge On Innovation Challenge as Founding Patrons, alongside Vale and BHP and facilitated by Austmine. This global initiative challenges technology innovators to develop concepts for large-scale haul truck electrification systems to help the mining sector to reduce its consumption of diesel fuel and significantly cut emissions from surface mine operations. We are also fast-tracking the development of zero-emission mining haulage solutions, including autonomous haul trucks, through partnerships with key suppliers Komatsu and Caterpillar.

We are also trialling the use of battery-electric trains to address the emissions from our rail fleet. We have purchased four 7MWh FLXdrive battery-electric locomotives ahead of initial trials in the Pilbara in early 2024. The locomotives, used to carry ore from the company's mines to its ports, will be recharged at purpose-built charging stations at the port or mine. They will also be capable of generating additional energy while in transit through a regenerative braking system.

Offsets and CO_2 mineralisation

Given the high cost of emissions reductions and lack of commercially viable low-carbon alternative technology for parts of our business, our long-term commitment is for our operations to be net zero emissions by 2050, rather than zero emissions. While we are prioritising emissions reductions at mines and smelters, we are also exploring the potential role of Nature-Based Solutions (NBS) and carbon capture and mineralisation. Carbon offsets and removals are expected to form a limited part of our decarbonisation strategy – as they are at the bottom of the mitigation hierarchy – and we are developing our internal capability to create a portfolio of offset projects. In 2021 we conducted a Group-wide assessment of the biodiversity and carbon potential of our landholding. We have identified several opportunities to develop carbon offsets at and near our sites such as in Madagascar, near QMM operations. These projects could also bring community and biodiversity benefits and we will continue to assess the opportunity in 2022.

We are starting to explore carbon capture and mineralisation options leveraging our exploration and geological expertise. Carbon mineralisation is now being used at large scale in Iceland and promises to be a key technology in meeting global climate goals. We partnered with Carbfix to capture carbon and permanently store it underground at our ISAL aluminium smelter in Iceland.

We have also launched a partnership with climate technology and research bodies to develop the ability to store carbon as rock at the Tamarack nickel project in Minnesota. The geology of the Tamarack site holds the potential to permanently store large amounts of carbon captured from the atmosphere or from hard-to-abate industries by mineralising it through natural chemical reactions.

Scope 3 goals and customer engagement

The best way for Rio Tinto to contribute to the low-carbon transition is to work with our customers to help shape demand for low-carbon metals and minerals. We need to tackle our Scope 3 emissions, as we fully appreciate that to thrive in the long term, we need to be part of net zero value chains.

Our approach to addressing Scope 3 emissions is to engage with our customers on climate change and work with them to develop the technologies to decarbonise steel and aluminium production. Our ability to control these emissions is limited, so we want to work in partnerships, as the best solutions will come from global collaboration. In addition, we are working with our suppliers and shipowners to reduce emissions from other parts of our value chain. In 2022, we are committing to step up our engagements with our iron ore and bauxite customers, aiming to cover over 50% of our total Scope 3 emissions.

The steel value chain

Steel is one of the most efficient construction materials and has an essential role to play in the development of low-carbon infrastructure, transportation and buildings. Steel has a similar carbon footprint to hydro-based aluminium today, on a per tonne of product basis. However, with close to 2 billion tonnes of crude steel produced globally in 2021, the industry overall emits over 3 billion tonnes of CO_2 annually, equivalent to around 8% of global carbon emissions.

The transition of the steel value chain towards net zero carbon emissions will require an increased use of recycled scrap material to optimise the current blast furnace process route in the near term as well as the development of new technologies with net zero carbon potential for deployment over the medium to longer term.

We anticipate an increase in the use of steel scrap, especially in China as the scrap pool rises, although this will depend on quality and quantity. However, we expect that more than half of future crude steel production will remain based on iron ore (compared to about two thirds today). Meanwhile, blast furnace optimisation will be driven by the use of higher-grade ores, including iron ore lumps and pellets, as well as the replacement of pulverised coal injection with hydrogen and the oxygen enrichment of the blast air enabling gas recycling.

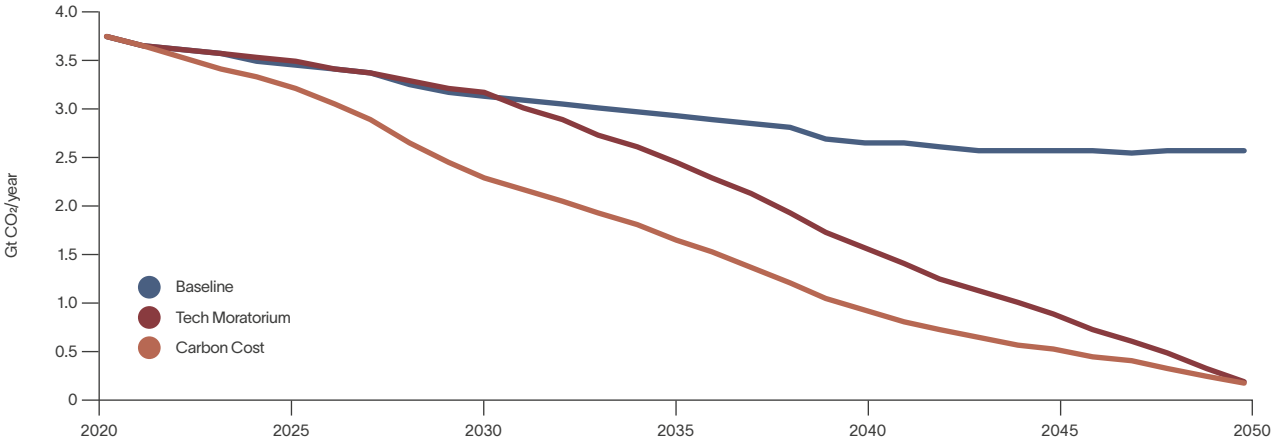
There is no proven process route at industrial scale to produce a net zero solution to steel today, but the industry is pursuing the development and scaling up of a range of new technologies, including hydrogen-based direct reduction iron feeding directly into an electric arc furnace or into a basic oxygen furnace via an intermediary melter step, direct smelting, the use of sustainable biomass, carbon capture, storage and use (CCSU), as well as more speculative technologies such as electrolysis. The speed and scale of deployment of these new technologies will be dependent on technological breakthroughs, trends in capital intensity to close the cost gap with existing production methods, and government policies, including carbon prices.

The low-carbon transition pathway of the steel industry is uncertain today, but can be explored and better understood through scenarios. One such example is the scenario analysis presented in the Net-Zero Steel Sector Transition Strategy report[1] published in October 2021 by the Net Zero Steel Initiative (NZSI). NZSI is an industry platform, part of the Mission Possible Partnership, that brings together stakeholders across the whole steel supply chain to help put the sector on a path to net zero emissions by mid-century. In this report, NZSI considers 20 technology archetypes and the decision making process to deploy these at individual steel plants based on lowest total cost of ownership. The analysis compares two pathways that deliver net zero emissions from the steel sector by 2050 against a baseline business-as-usual scenario:

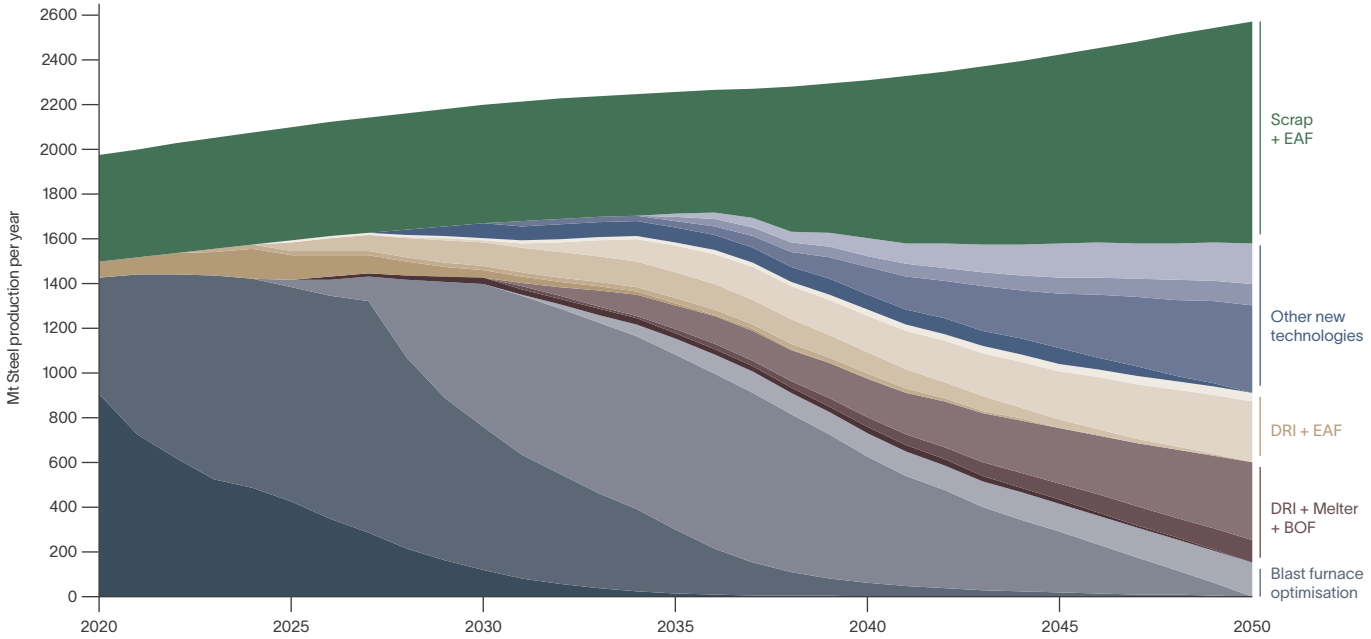
- Carbon Cost scenario: with a global carbon price (or policies equivalent to a carbon price) applied across all emissions and all geographies, rising globally from \$9/t CO_2 in 2023 to \$250/t CO_2 by 2050.
- Tech Moratorium scenario: restricting major investment decisions post-2030 to technologies that are compatible with reaching a net zero outcome by 2050.

1. https://missionpossiblepartnership.org/wp-content/uploads/2021/10/MPP-Steel-Transition-Strategy-Oct-2021.pdf

Steel sector carbon emissions by NZSI scenario



NZSI Tech Moratorium Scenario Technology Pathway



Blast furnace (BF/BOF[1])
- Average technology
- Best available technology (BAT)
- BAT with H2 injection
- BAT with carbon capture and storage of utilisation (CCS/U)

DRI[2] + Melter + BOF
- Natural gas based
- Natural gas with CCS/U
- 100% green hydrogen

DRI[2] + EAF[3]
- Natural gas based
- Natural gas and bio-methane
- Natural gas and green hydrogen
- 100% green hydrogen
- Natural gas and CCS/U

Other new technologies
- Smelting reduction
- Smelting reduction with CCS/U
- Electrolysis + EAF
- Electrowinning + EAF

1. Blast Furnace / Basic Oxygen Furnace
2. Direct Reduced Iron
3. Electric Arc Furnace

The two NZSI net zero-aligned scenarios result in different carbon emission pathways for the steel industry, ranging from 15% to 37% emission reductions by 2030 (in Tech Moratorium and Carbon Cost respectively), and in excess of 55% by 2040, compared to the NZSI 2020 baseline. Assuming that the steel industry follows the NZSI Tech Moratorium scenario, our own analysis indicates that Rio Tinto's iron ore-related Scope 3 emissions would fall by 23% by 2035 and 42% by 2040 from our 2020 baseline of 376Mt CO_2, accounting for expected production growth at our Pilbara operations in Western Australia and the Iron Ore Company of Canada, and assuming the development of our Simandou project in Guinea.

The NZSI analysis presents one view on a global basis and does not capture all the regional and commercial constraints to the deployment of new technologies. Nevertheless, it is a credible and useful illustration of the complexity and challenges faced by the steel industry to reach net zero by 2050. Asset-by-asset choices across a range of technology options will be dependent on local factors including capital intensity and the availability of competitive renewable energy, hydrogen, sustainable biomass or CO_2 storage.

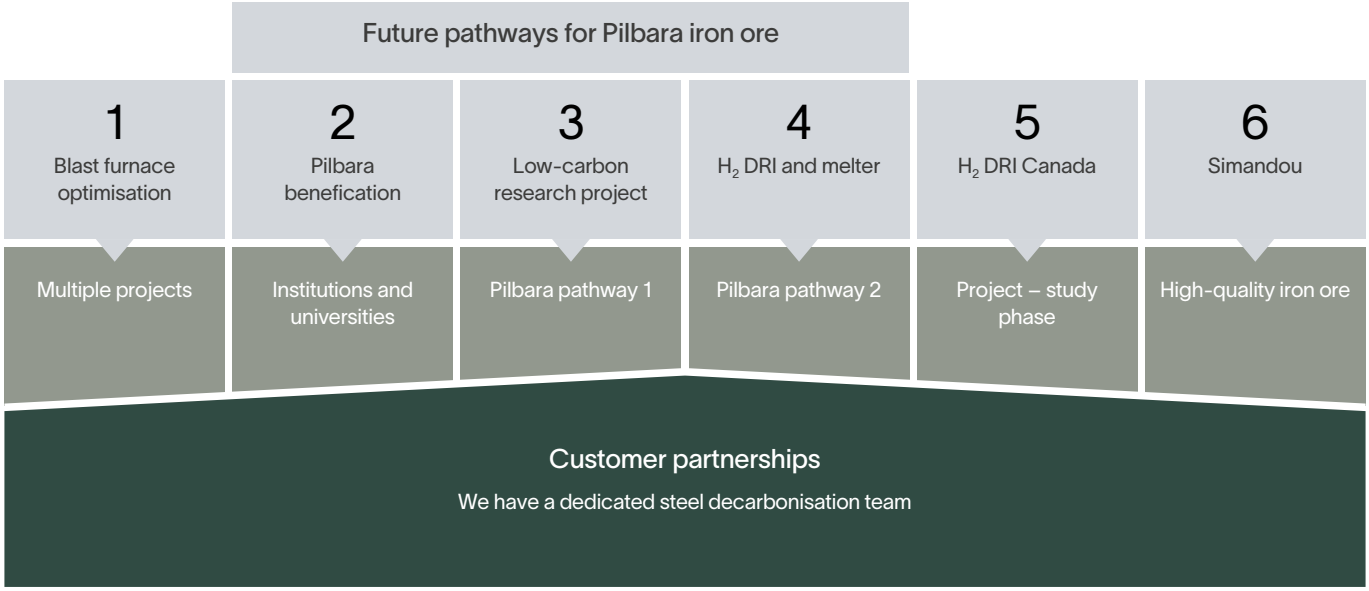
We recognise we have a role to play to support the development of technologies that can accelerate the transition of the steel sector towards net zero. Our approach is to pursue and support a range of decarbonisation options aligned with the technology pathways highlighted by the NZSI analysis, through proactive partnerships with our customers, suppliers, universities and research institutes. We have consolidated these initiatives under six focus areas, with coordination from a dedicated steel decarbonisation team within our Commercial group.

In 2019, we launched our flagship partnership with China Baowu Steel Group and Tsinghua University in China, and we have since announced collaborations with Nippon Steel in Japan, POSCO in South Korea and BlueScope in Australia. These partnerships are encouraging the sharing of ideas, deepening collaborations and focused on individual projects that cut across the overall decarbonisation priorities of the steel industry. Beyond these four partnerships we are also working across the value chain with other customers, technology providers, universities and research institutes as well as engaging with governments regionally and nationally to progress our iron ore and steel decarbonisation goals. These are summarised below, together with short-term objectives for 2022.

In addition, we are engaging our iron ore customers about their Scope 1 and 2 emissions, decarbonisation plans and targets. There has been a rapid shift in sentiment in the sector in the past two years and this topic is often at the top of the agenda in our meetings with customers. More than 90% of our iron ore-related Scope 3 emissions are from customers in countries that have pledged to reach carbon neutrality by 2050-60. Today, about 28% of our iron sales are directly to steel producers that have already set public targets for their Scope 1 and 2 emissions (our Scope 3), with ambitions to reach net zero emissions by around mid-century and interim targets for the 2030s. We will update this percentage in future reports. These producers include the customers with whom we are already partnering to find technology solutions to decarbonise steel production.

In 2022, we commit to engage with all our direct iron ore customers, approximately 75% of our sales and iron ore Scope 3 emissions, to share information on our respective climate change goals and roadmaps, and actively seek areas of mutual collaboration on pathways to net zero, such as those highlighted in our iron and steel decarbonisation goals. Beyond our direct sales we will also seek to engage with customers who buy our iron ore on a spot basis, through trading companies or from our China portside operations, recognising the greater challenges in tracking the point of final consumption and therefore sharing information.

Our focus areas for iron and steel decarbonisation



Goals	Partnerships	2022 objectives
1. Blast furnace optimisation		
99% of our iron ore is processed through the blast furnace route today, the optimisation of which could result in potential carbon emission reductions of up to 30%. We must work with our customers to help them generate those savings as an intermediary step.	Our existing partnerships with Baowu, Nippon Steel and POSCO are largely focused on blast furnace optimisation as an initial stage, especially around the optimal use of lump ores and pellets.	We are participating in the funding of a microwave lump drying pilot plan at one of Baowu's production sites. With Nippon Steel, we will conduct some lab-scale test work for lump ores and explore a new grade of pellets.
2. Pilbara beneficiation		
Our Pilbara blend products have been optimised for the blast furnace process route and have impurities that might be more difficult to manage in emerging green steel technologies. These impurities must be removed upfront via beneficiation or during processing. Our goal is to explore how much upgrading of the ore can be done effectively prior to metallurgical processing.	We are working with institutions and universities such as the Australian National University (ANU), together with our in-house Bundoora Technical Development Centre, on the development of new technologies to characterise and process Pilbara iron ores.	We plan to complete a review of the qualities and characteristics of iron ore products suited to future low-carbon process routes, and the cost implications of producing those in the Pilbara. Based on this analysis we will prioritise and start testing a range of product options in lab-scale and pilot plant settings across different technology solutions.
3. Low-carbon research project		
Over the past decade we have been researching a method of processing Pilbara ores using microwave energy and sustainable biomass as a reductant. The process produces a pig iron type product for either an electric arc furnace or basic oxygen furnace. The overall steelmaking process has the potential to be carbon neutral or even carbon negative with additional carbon capture and storage.	The low-carbon research project is based on proprietary technology, which we have been developing together with the University of Nottingham in the United Kingdom and tested at a lab-scale facility in Germany.	We plan to complete laboratory test work using Pilbara ores in the first half of 2022, with a subsequent third-party review of results. We plan to start scaling up the technology and design a continuous pilot plant (CPP) for approval before the end of 2022.
4. Pilbara H2 DRI and melter		
An alternative to the beneficiation of Pilbara ores is the production of a mid-grade DRI product, with an intermediary electric melter step to remove impurities before processing into steel in an electric arc furnace or basic oxygen furnace. The use of renewable electricity and green hydrogen in the DRI process provides a pathway to net zero iron and steel.	Our partnership with BlueScope is to investigate the use of green hydrogen to directly reduce Pilbara iron ores into a product that could then be processed in an electric melter. The partnership leverages BlueScope's experience in using electric melters in New Zealand, and our knowledge in ore preparation and direct reduction.	We plan to conduct a joint concept study to investigate the scale, process details and economics of constructing a pilot plant at BlueScope Port Kembla Steelworks in Australia to produce molten iron from our Pilbara ores via a green hydrogen direct reduction and renewable energy electric melter route.
5. Canada H_2 DRI		
The direct reduction of high-grade iron ore pellets is already an available technology today using natural gas as a reductant to produce a low-carbon iron product that can be directly processed in an electric arc furnace. Switching from natural gas to green hydrogen would make this a net zero process route.	We are engaging with direct reduction technology providers, leading hydrogen producers and the Governments of Canada and Quebec as we pursue early-stage studies of a project to produce HBI with hydro-based green hydrogen and high-grade iron ore pellets from the Iron Ore Company of Canada (IOC).	We plan to complete an order of magnitude study in early 2022 and subject to reviews and approvals we expect to commence the next phase of study for this project by the middle of 2022, including the consideration of partnership options.
6. Simandou		
The shift to new, green, technologies will require more high-quality iron ore and we pursuing pathways to developing our high-grade Simandou deposit in Guinea. The resource contains a significant proportion of ore that can meet direct reduction specifications.	Rio Tinto is pursuing the Simandou project in joint venture with the Government of Guinea as well as Chinese partners through Chalco Iron Ore Holdings, including Chinalco and Baowu.	We continue to engage with key stakeholders, including the Government of Guinea. A new drilling programme has commenced and some early development works are expected to be carried out in 2022.

The aluminium value chain

Aluminium is a lightweight material essential to the low-carbon transition across a range of end-use sectors including transportation, green energy infrastructure, packaging and buildings. However, the aluminium smelting process is energy intensive and across its full value chain the aluminium industry emits about 1 billion tonnes of CO_2e annually. As one of the leading global producers of low-carbon aluminium, our effort to further decarbonise our assets is core to our engagement with the industry and our customers on Scope 3 emissions from the sale of our bauxite and alumina.

We operate assets across each step of the aluminium value chain, and have committed to decarbonise these assets as part of our 1.5°C aligned Group-level targets. In addition, we are actively involved with the International Aluminium Institute (IAI) and the Aluminium Stewardship Initiative (ASI) in the development of a 1.5°C pathway for the aluminum industry, and we are committed to support the transition. The key steps are broadly defined in the IAI "Aluminium Sector Greenhouse Gas Pathways to 2050"[1] report published in September 2021 and cover the decarbonisation of electricity and direct emissions as well as a focus on recycling and resource efficiency.

Recycling and resource efficiency

Aluminium is infinitely recyclable, without loss of properties, and with a significantly reduced carbon footprint compared to primary production. The recycling of post-consumer scrap today is estimated to avoid about 300 million tonnes of annual CO_2e emissions. Increased recycling rates and reduced metal losses during processing and melting activities are expected to further reduce the carbon intensity of the sector. However, aluminium recycling rates are already high, in excess of 90% in some key end-use sectors, and the production of primary aluminium is therefore expected to continue to grow in the coming decades to meet overall demand.

Electricity decarbonisation

Over 60% of the primary aluminium industry's carbon emissions are related to the use of electricity in the smelting process, of which more than two thirds originate from China given the country's share of global production and its predominant reliance on coal-based power. As a large proportion of our bauxite and alumina sales are to customers in China, indirect emissions from the use of electricity account for 74% of our related Scope 3 emissions.

Our ability to influence emissions from these sources is extremely limited, especially regarding the overall decarbonisation process of China's power grid. Some aluminium producers in China currently draw power from captive thermal power stations and have already started to relocate some production capacity to regions such as southwest China with hydro-based power options today. In addition, as the overall power grid decarbonises it is possible that some smelters will shift from captive to grid power over time. Renewable power solutions such as wind and solar are readily available, although a challenge for the aluminium industry is the sourcing of firmed green power given the limited interruptibility of the aluminium smelting process.

Direct emissions

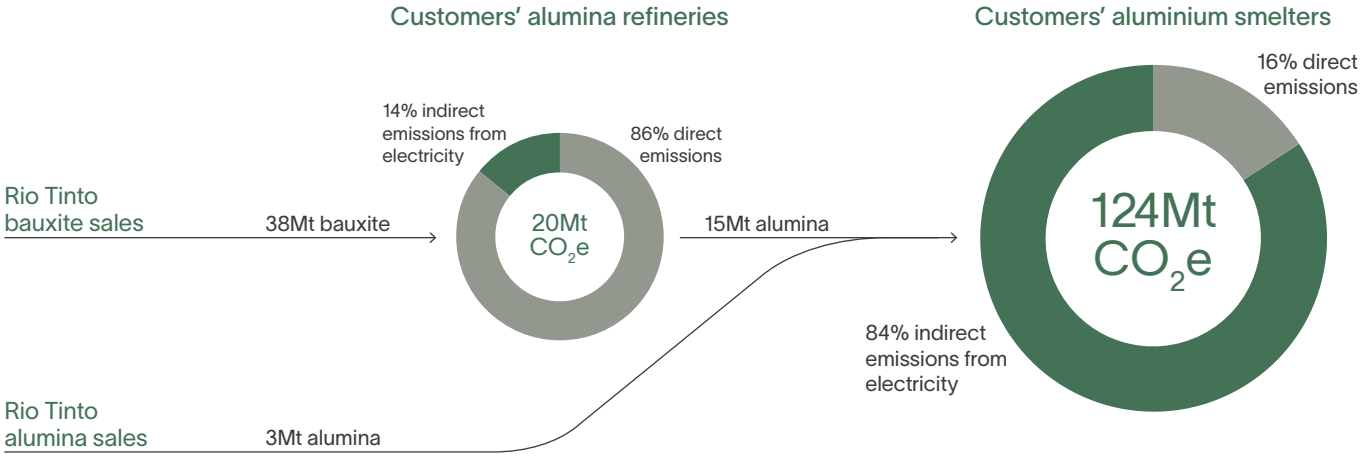
Beyond the use of electricity, emissions are mostly related to the combustion of carbon anodes in the aluminium smelting process and the use of energy for process heat in the alumina refining process. These emissions sources each account for about 14% and 12% respectively of Scope 3 emissions related to our bauxite and alumina sales.

Our work on inert anode technology through the ELYSIS™ joint venture is progressing towards industrial scale and is also part of our Scope 1 and 2 decarbonisation roadmap. Construction of large commercial-scale demonstration cells operating on an electric current of 450kA is underway at the end of an existing potline at our Alma aluminium smelter in Quebec, keeping the development pathway on track for the technology to be available for installation from 2024.

Meanwhile, in the context of alumina refining, we lead the way in the use of renewable electricity at our Vaudreuil refinery in Quebec and are exploring hydrogen calcining technology at Yarwun in Australia. In addition, an essential element of our marketing offering in bauxite and alumina is technical support. Our technical teams continuously engage with our customers to support optimal processing conditions of our products in their facilities. In China, we see continued positive engagement in this area, strengthened by China's environmental protection initiatives and stated peak carbon and carbon neutral goals. We commit to actively engage in 2022 with all our bauxite customers to explore more opportunities to improve the energy efficiency of their alumina refining processes and seek potential areas of mutual collaboration in alumina decarbonisation projects.

Beyond our Scope 3 boundary, we are also engaging with our customers' customers further downstream in the value chain. End users in the transport, packaging and electronic sectors are seeking a transparent, sustainable and verifiable supply chain – this is driven by consumer demand as well as our customers' own commitments towards net zero. In 2021, we launched START, a new standard in transparency and traceability for the aluminium industry, enabling customer demand for low or zero carbon products to be supported through verifiable ESG credentials via secure blockchain technology.

Downstream bauxite and alumina Scope 3 emissions



Direct/indirect emissions apportioning indicative using International Aluminium Institute (IAI) Primary aluminum life cycle

1. https://international-aluminium.org/resource/aluminium-sector-greenhouse-gas-pathways-to-2050-2021/

Shipping

In 2021, emissions from the bulk maritime shipping of our products were 7.6Mt CO_2. This includes Scope 3 emissions of 4.9Mt CO_2 from about 230 chartered vessels and 2.3Mt CO_2 from customer-managed freight, as well as Scope 1 emissions of 0.4Mt CO_2 from 17 Rio Tinto-owned vessels. Over 72% of our total bulk shipping emissions are related to the shipping of iron ore, 22% to the shipping of bauxite and the remainder related to other products and raw materials supply.

We have an ambition to reach net zero emissions from shipping of our products by 2050 and expect to meet the International Maritime Organization (IMO) decarbonisation goal of 40% reduction in shipping emissions intensity by 2025, five years ahead of the IMO deadline. We expect to introduce net zero emission vessels into our portfolio by 2030, and in the meantime we are focusing on:

- improving existing vessels' efficiency;
- increasing our use of transition fuels that deliver short- to medium-term carbon emission reductions; and
- partnering to support the development of fuels that have the potential to deliver net zero solutions.

Vessel efficiency

Between 2022 and 2024, we plan to conduct a range of modifications to Rio Tinto's owned vessels, which are collectively expected to deliver more than 10% of carbon emission reduction. These include applying high-performance paints to reduce friction, modifications of the propellers, and installing swirl ducts enhancing energy efficiency. In addition, we continue to work with our shipowners to improve the operational and technical efficiency of our chartered vessels and we plan to test new innovative solutions.

Transition fuels

In 2021, we signed charterparty contracts for nine LNG dual-fuel Newcastlemax vessels which will be delivered in the second half of 2023. We will also be starting an extended biofuel trial with one of our owned vessels in early 2022. We will use a B30 biofuel blend of vegetable oils (excluding palm oil or palm oil residues), waste oils, and animal fats, with the potential to reduce lifecycle CO_2e emissions by 26%.

Net zero fuels

Green ammonia has the potential to support net zero shipping, but engines to use ammonia as a fuel are not yet available, and significant efforts will be required to develop appropriate regulation, scale up fuel production, and support bunkering infrastructure. In 2021, we joined an industry group led by ITOCHU to study common issues related to the use of ammonia as a maritime fuel. Further to this, in January 2022 we signed a Joint Development Agreement in partnership with ITOCHU, K-Line, NS United and Nihon Shipyard to develop an ammonia vessel design and further collaborate on the development of the ammonia supply chain.

Capital allocation alignment with our decarbonisation strategy

We will align our capital expenditure plans with our long-term carbon emissions reduction targets, which are in line with the Paris Agreement's objective of limiting global warming to 1.5°C. Having divested the last of our coal businesses in 2018, we are orienting our growth capex towards materials that enable the energy transition, including copper, lithium and high-grade iron ore. Our ambition is to increase our growth capital up to $3 billion per year in 2023 and 2024, developing new options and finding innovative ways of bringing projects onstream faster.

We expect to invest around $500 million in each of the years from 2022 to 2024 on decarbonisation projects, mainly relating to the repowering of the Pilbara. Decarbonisation investment across the rest of the Group will accelerate from 2025, bringing our best estimate to around $7.5 billion this decade. This capex includes full decarbonisation of the Pilbara electricity system, an initial deployment of ELYSIS™ and other abatement projects. These projects will deliver a range of economic outcomes but in aggregate are value accretive at a very modest carbon price. Most importantly, they safeguard the integrity of our assets over the longer term and reduce the risk profile of our cash flows.

We will also work with third parties through long-term contracts. For our standalone Pilbara system, at least initially, it makes sense for us to fund renewables, but we may also leverage third-party investments, particularly where our assets are grid connected. This is the more likely solution for our two coal-powered smelters in Australia, which would require the deployment of 4-6GW of solar and wind power on an equity basis as well as robust firming, so this is not included in the $7.5 billion capital expenditure noted above. These decisions will of course go through the same rigorous investment process we have for all our projects and we will remain open-minded about the right mix of direct investment and third-party contracts.

We have introduced an internal carbon price of $75/t CO_2 to provide the incentive to accelerate the delivery of capital investment in abatement projects and energy-efficiency improvements. There will be incremental operating expenditure on building new capabilities, energy-efficiency initiatives, and research and development in the order of $200 million a year. In 2022, we plan to spend about $50 million on our iron and steel decarbonisation initiatives. This does not include spend for the replacement of carbon-intensive opex with zero-carbon alternatives. Having divested the last of our coal businesses, we are also phasing out investment in some other carbon-intensive assets. By 2030, we aim to phase out the purchase of diesel haulage trucks and locomotives.

Climate policy engagement

In 2015, we supported the adoption of the Paris Agreement and the long-term goal to limit global average temperature rise to well below 2°C and to pursue efforts to limit warming to 1.5°C.

Government policy that creates the right framework for change is critical, coupled with real business action and societal shifts. A challenge as serious as climate change requires transparency, collaboration and a shared contribution to the solution.

Summary of our positions on climate and energy policy

1	We accept the mainstream climate science assessed by the Intergovernmental Panel on Climate Change.
2	We support the Paris Agreement and ambitions to reach net zero by 2050. We acknowledge that in the Glasgow Climate Pact, governments resolved to pursue efforts to limit the global temperature increase to 1.5°C which "requires rapid, deep and sustained reductions in global greenhouse gas emissions, including reducing global carbon dioxide emissions by 45 per cent by 2030 relative to the 2010 level and to net zero around mid-century, as well as deep reductions in other greenhouse gases".
3	We acknowledge that business has a role to play in addressing and managing the risks and uncertainties of climate change.
4	We believe that effective climate policies should incentivise the private sector to invest in low-carbon technology while maintaining the competitiveness of trade-exposed industries.
5	We recognise the importance of adaptation and resilience to a changing climate.
6	Where climate policies are implemented, we support the use of market mechanisms, including carbon prices.
7	We do not advocate for policies that undermine the Paris Agreement or discount Nationally Determined Contributions (NDCs).
8	We promote our climate and energy policy positions in discussions with our industry associations.

Significant global and regional progress on climate change will only happen when everyone – business, governments, investors, civil society organisations and consumers – plays their part. Our own approach to climate change requires active engagement on relevant policies with a range of stakeholders in the countries where we operate.

Working with our industry associations

Industry associations play an important role in policy development, sharing best practice and developing standards. Our approach to engaging with industry associations has been approved by the Rio Tinto Board. Responsibility for comparing Rio Tinto's positions with those of individual industry associations is delegated to management on a "comply or explain" basis.

In 2021, our Chief Executive chaired a subcommittee of CEOs at the International Council on Mining and Metals (ICMM) to review and update ICMM's position statement on climate change. A coordinated, joint response by the whole industry is essential to meet the challenge of climate change, and the statement reaffirms our commitment to the goal of net zero emissions by 2050 or sooner. We have made this collective commitment because we believe many of the sustainability challenges facing our industry, and the planet, require collective action to solve. The ICMM statement also includes a commitment for all members of ICMM to set Scope 3 targets by the end of 2023, such as the ones we have proposed in our Climate Action Plan.

Recognising that industry associations' views will not always be the same as ours, we monitor the advocacy of all our industry associations and periodically review our memberships. This assessment includes:

- the purpose of the association and the value that membership may provide to Rio Tinto and its investors;
- the adequacy of governance structures within the industry association; and
- policy positions and advocacy.

In 2021, we supported a shareholder-requisitioned resolution on industry association memberships and enhanced our approach to reviewing and engaging with our industry associations on climate advocacy. Our annual review of all our industry association memberships supplements this report and can be found on our website.

Industry association policy and advocacy alignment

Where our membership is significant, we will work in partnership with industry associations to ensure that their policy positions and advocacy are consistent with our own public position and the Paris Agreement. In accordance with the provisions governing the monitoring of our industry association memberships, we will review our support and membership of industry associations where they do not align with our own public position and the Paris Agreement.

Climate governance

Climate change is a material and strategic topic for Rio Tinto and is therefore part of ongoing discussion and analysis at the most senior levels of management and the Board. It is also a key topic when the Board and Executive Committee engage with investors and civil society organisations.

The Board approves our overall strategy, our policy positions and the Climate Change Report. It sets the short-, medium- and long-term emissions targets and monitors performance against the targets and operational resilience. The Chairman is the Board member responsible for our overall approach to climate change.

The Sustainability Committee has oversight of key sustainability areas that may be impacted by climate change, such as biodiversity and water, including the effectiveness of associated controls. The Sustainability Committee also reviews industry association engagement. Other Board committees also address particular climate issues such as how we consider our scenarios in our Financial Statements (Audit Committee) or the integration of climate-related performance metrics into short-term incentive plans (Remuneration Committee).

We base our appointments to the Board on merit, and on objective selection criteria, with the aim of bringing a range of skills, knowledge and experience to Rio Tinto. We aim to appoint people who will help us address the operational and strategic challenges and opportunities facing the company and ensure that our Board is diverse in terms of gender, nationality, social background and cognitive style. The key skills and experience of our Board are set out in the Annual Report. This explicitly assesses Board competencies for climate-related threats and opportunities, using the following criteria: knowledge and understanding of climate science, low-carbon and energy transition and climate-related public policy. Six directors meet one or more of the criteria above.

The Chief Executive is responsible for delivering the strategy approved by the Board. Risk management, portfolio reviews, capital investments, annual financial planning and our approach to government engagement all integrate our approach to climate change and target execution considerations. The Chief Executive led a strategy process with the Executive Committee in mid-2021 which puts the low-carbon transition at the heart of our business strategy.

The Planning Review Committee focuses on our short-term (12 months) and medium-term (up to 10 years) plans and integrates the new growth and decarbonisation strategy into the financial planning process. The Chief Technology Officer, the Executive Committee member accountable for delivering our Scope 1 and 2 emissions targets, works closely with the product group Chief Executives to implement the mitigation projects. The Chief Technology Officer also oversees the Energy & Climate Change Centre of Excellence, a newly established Energy Development team (which focuses on developing large-scale renewable power options) and the low-carbon research and development work led by the Chief Scientist.

Strengthening the link between executive remuneration and our climate performance

Since 2018, our Chief Executive's performance objectives in the short-term incentive plan have included delivery of the Group's strategy on climate change. These are cascaded down into the annual objectives of relevant members of the Executive Committee, including the product group Chief Executives, and other members of senior management. In 2021, the business achieved the approval of 0.26Mt CO_2 of abatement projects (and exceeded the total 0.5Mt CO_2e targeted for 2020 and 2021). The approved projects included small renewable projects at Weipa, QIT Madagascar Minerals (QMM) and Kennecott, as well as several energy efficiency projects and small low-carbon technology pilots. We also delivered three out of the four Scope 3 goals. In 2022, safety, environment, social and governance matters, including climate change, are assigned an explicit performance weighting of 35% in the STIP, of which 20% relates to safety. The 'E' component is 5% of the STIP and relates entirely to climate change performance objectives. In 2022, we will assess these at the Group level against two categories of objectives:

1. Progress on our Scope 1 and 2 targets (2.5%)

   Total projects to be approved in 2022 are expected to reduce emissions in 2025 by 0.8Mt CO_2e. Over half of the abatement is from renewables and the average scale of these projects is higher than in 2021.

2. Progress on our Scope 3 goals (2.5%)

   Steel decarbonisation

   - Commence phase 2 of a study to produce hot briquetted iron production with green hydrogen in Eastern Canada;
   - Complete laboratory test work on low-carbon research project using Pilbara ores and obtain a third-party review of the results. Present and communicate these results to customers and the market. Obtain approval to commence construction of the continuous pilot plant.

   Zero-carbon aluminium – Identify potential sources of raw material feedstock for inert anodes, define a work plan to develop a viable electrode production process, and determine technology deployment plan across our smelters.

   Shipping – Collaborate with shipowners to enhance the reporting of emissions with actual figures rather than factored estimates.

Further detail is available in the remuneration section of our 2021 Annual Report.

Board engagement on climate change in 2021

Climate change and the low carbon transition are routinely on the Board's agenda, including as part of strategy discussions, risk management, accounting and executive remuneration.

- Endorsed our strategy to put the low-carbon transition at the heart of our business
- Approved 2025 and 2030 Scope 1 and 2 targets, our net zero commitment and our Scope 3 goals
- Remuneration Committee approved revisions to the way climate change is integrated into executive incentives
- Engaged with investors and civil society organisations following the publication of our strategy and new 2030 targets
- Approved 2020 Climate Change Report and approach to industry associations
- Approved the decision to put a non-binding, advisory Say on Climate resolution to the 2022 AGMs, and endorsed the approach to be taken on the resolution

Just transition

As the world continues to advance the Paris Agreement, managing the human risks to, and opportunities generated by the transition to a low-carbon economy will be crucial. The Paris Agreement highlights this point, emphasising the need to take "into account the imperatives of a just transition of the workforce and the creation of decent work".

We are committed to supporting a just transition that is fair, socially inclusive, recognises the specific risks to marginalised and Indigenous groups within host communities, and that helps provide opportunities for continued access to decent work, good health and sustainable livelihoods.

We have an important role to play in this transition, including through early and ongoing identification of risks and opportunities within our operations and in our value chain; engaging in social dialogue and stakeholder engagement to support fair and inclusive practices; and participating in relevant and emerging policy developments.

As we further evolve our business strategy to contribute to, and thrive in, a low-carbon future, we will work to understand any potential impacts – positive and negative – on human rights, particularly those of vulnerable groups, as we navigate how advancements in new low-carbon technologies and new operational processes change the way we work. This includes engaging with Traditional Owners as we develop and scale up wind and solar projects that occupy large areas of land. Identifying such impacts is part of our human rights due diligence process and is consistent with our broader commitment to implement core business and human rights standards into our decarbonisation plans and actions – including the UN Guiding Principles on Business and Human Rights, the ILO Declaration on Fundamental Principles and Rights at Work, and the UN Declaration on the Rights of Indigenous Peoples.

In some cases, accelerating emission reductions could lead to early plant closures and in turn, reducing employment opportunities with our company. This could have a particularly negative impact on remote communities that rely on mining and industrial activities for their livelihoods. In these situations, we will engage as early as possible with host governments and communities to identify potential adverse impacts and facilitate their options for ongoing social and economic benefit. We will to support our workers to transition to other opportunities either with Rio Tinto, other resource companies in different locations, or to transition to new industries altogether.

The recently closed Argyle Diamond mine provides an example of how we are partnering with Indigenous representative organisations to support future business. We have awarded over $60 million of contracts to Traditional Owner businesses to support the assets' transition to their next use, which is likely to be Traditional Owner-led agribusiness. We have also actively worked to redeploy our Argyle employees to other Rio Tinto sites or supported them to transition to other jobs through our `Life after Argyle Program'.

Each of our operations is required to develop a closure plan prior to the commencement of operations and to maintain this across the life of asset, informed by community, Traditional Owners and regulator expectations regarding future land use and their social, cultural and environmental objectives for the transition to viable post-mining land use. This plan forms the basis to calculate the closure liability at each of our assets, which is publicly reported as the Group closure provision. This year we have enhanced our disclosure on provisions for close-down and restoration costs and environmental clean-up obligations, which at 31 December 2021, were $14.5 billion (31 December 2020: $13.3 billion).

To further support communities in the social and economic transition post-closure, in 2021 we committed to investing $18 million over the next 10 years to support the work of the Cooperative Research Centre for Transition in Mining Economies and have invested over $10 million on innovation to improve the ongoing social and economic opportunities from closed sites.

We also co-founded Regeneration Enterprises in 2021, a joint venture with US-based NGO RESOLVE. The enterprise will help deliver enhanced environmental and community outcomes from our closed and legacy sites through remining wastes and developing carbon and biodiversity credits to provide ongoing economic benefits to host communities while delivering enhanced environmental outcomes. Our initial $2 million start-up investment in 2021 will be supplemented with additional project-related investment of over $14.5 million in 2022.

Another important way we can support progress toward a just transition is by actively and constructively collaborating with others. For this reason, in addition to working with civil society, supply chain partners, host communities and governments, in 2022 we will also join with like-minded global companies in a collaboration by Business for Social Responsibility (BSR) and the B Team. This coalition will create tools and guidance to help enable a more worker- and community-centred transition to a net zero economy.

TCFD disclosure

We support the recommendations from the TCFD and also welcomed the CA100+ Net Zero Company Benchmark when it was published in 2020. We are committed to continue to align our climate change disclosures with both these frameworks. We are also working with CA100+ as it develops its approach to evaluating diversified mining companies against that benchmark.

The CA100+ calls on companies to reduce emissions by 45% relative to 2010 levels by 2030, which aligns with the emissions pathway described in the Intergovernmental Panel on Climate Change report on 1.5°C. Our target to reduce absolute Scope 1 and 2 emissions by 50% compared with 2018 levels[1] by 2030 exceeds this objective.

How we have considered our climate change scenarios in our Financial Statements

The Directors have considered the relevance of the risks of climate change and transition risks associated with achieving the goals of the Paris Agreement when preparing and signing off the company's accounts. The narrative reporting on climate-related matters is consistent with the accounting assumptions and judgments made in this report. The Audit Committee reviews and approves all material accounting estimates and judgments relating to financial reporting, including those where climate issues are relevant.

In developing its commodity price forecasts, the Group considers three strategic scenarios with differing underlying assumptions about geopolitics, technology and society. As existing climate policies in many countries are not aligned with achieving the Paris Agreement, only one of the three strategic scenarios assumes a temperature increase of well below 2°C. The three scenarios include differing assumptions on carbon pricing and result in differing commodity price forecasts. Our central case commodity price forecasts represent a blend of the three scenarios. As a consequence, our central case is not aligned with the goals of the Paris Agreement. These central case commodity price forecasts are used pervasively in our financial processes including impairment testing, estimating remaining economic life, and discounting closure and rehabilitation provisions.

We have disclosed sensitivity information based on cash flows flexed for the carbon and commodity price forecasts generated by the one scenario that we believe is consistent with achieving the goals of the Paris Agreement. These sensitivities indicate that, in relation to impairment testing for example, higher recoverable amounts would have been determined had we applied commodity price forecasts aligned with the Paris Agreement.

In addition to commodity price forecasts, given the significant investment we are making to abate our carbon emissions, we have also considered the potential for asset obsolescence, with a particular focus on our investments in the Pilbara, but no material changes to accounting estimates have been necessary. The closure date and cost of closure is also sensitive to climate assumptions, but no material changes have been made in the year specific to climate change.

1. Our 2030 target covers >95% of our Scope 1 and 2 emissions and is relative to our 2018 equity emissions baseline.