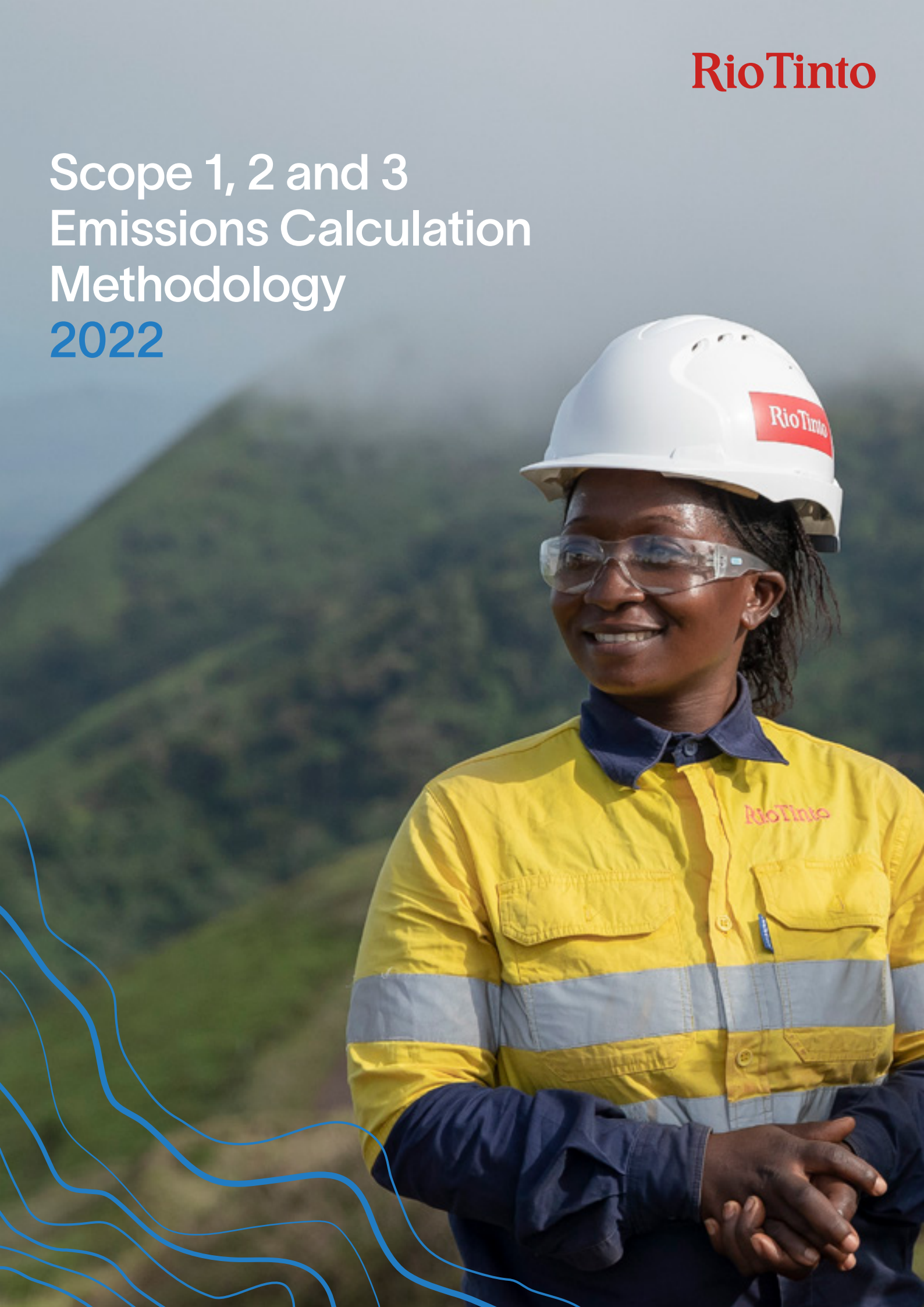
RioTinto

Scope 1, 2 and 3 Emissions Calculation Methodology 2022



About this document

This document describes the approach used to prepare our 2022 Scope 1, 2 and 3 greenhouse gas (GHG) emissions inventory.

Scope 1 emissions are direct GHG emissions from operations in which we have an equity interest. Scope 2 emissions are indirect emissions from the generation of purchased energy at these operations. Our 2022 Scope 1 and 2 emissions data is reported and disclosed in detail in our *2022 Climate Change Report*. In this report, we have included details of how our Scope 1 and 2 emissions inventories were prepared, along with details outlining how our 2030 climate targets are calculated.

To identify and calculate Scope 1 and 2 emission sources across our operations, we have used the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)'s *Greenhouse Gas (GHG) Protocol: A Corporate Accounting and Reporting Standard (Revised Edition) (2015)*.

Scope 3 emissions are indirect GHG emissions generated as a result of activities undertaken either upstream or downstream of our operations. To identify and calculate Scope 3 emission sources across our operations, we have used the WRI and WBCSD's *GHG Protocol: A Corporate Accounting and Reporting Standard* (Revised Edition) (2015), *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2013)* and the *Technical Guidance for Calculating Scope 3 Emissions* (version 1.0). These documents are available at https://ghgprotocol.org.

We engaged KPMG, to provide the directors of Rio Tinto with reasonable assurance on Scope 1 and 2 data, and limited assurance on the Scope 3 emissions estimates and other selected subject matters set out in this report.

Gudai-Darri, the Pilbara, Western Australia.

Contents

Our operations are located on land and waters that have belonged to Indigenous peoples for thousands of years. We respect their ongoing deep connection to Country and recognise their vast knowledge of the land, water and environment. We pay respects to Elders, both past and present, and acknowledge the important role Indigenous peoples play within our business and our communities.

Visit riotinto.com to find out more

Cover | Simandou iron ore project, Guinea.

Scope 1 and 2 emissions

Organisational boundary

Rio Tinto plc and Rio Tinto Limited combined (Rio Tinto) use Scope 1 and Scope 2 emissions definitions that are consistent with the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)'s *Greenhouse Gas (GHG) Protocol: A Corporate Accounting and Reporting Standard (Revised Edition) (2015)*[1].
This standard defines Scope 1 greenhouse gas (GHG) emissions as direct GHG emissions from facilities owned or controlled by an operator, including fuel use, onsite electricity generation, anode and reductant use, process emissions and land management. GHG emissions from the generation of electricity, heat or steam brought in from third parties are defined as Scope 2 (indirect emissions).

Scope 1 and 2 emission factors for our Australian operations are consistent with the Australian *National Greenhouse and Energy Reporting (Measurement) Determination 2008*. For non-Australian operations, factors from the *Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (2006)* are used for Scope 1, and where possible, factors for Scope 2 are sourced from the electricity supplier or the appropriate regional and subregional factors.

Consolidating GHG emissions data

Historically, we reported our GHG emissions using the operational control approach. From 2020, we have used an economic interest (equity) approach against a 2018 baseline.

Where we do not have operational control, we work with the relevant operators to source emissions data. If we are unable to source data for a full year, we estimate data using the trend in available data and observable comparable data at any of our managed operations.

Reporting on a control basis accounts for 100% of GHG emissions from operations where we have operational control (managed operations). GHG emissions from operations that are not controlled by us (non-managed operations) are excluded from the consolidation.

Reporting on an equity share basis accounts for all GHG emissions in accordance with our economic interest in an operation, which includes managed and non-managed operations.

Scope 1 and 2 – 2025 and 2030 target calculation methodology

In 2021 we announced Scope 1 and 2 targets to reduce carbon emissions by 15% by 2025 and 50% by 2030. Our targets apply to our Scope 1 and 2 emissions and are relative to our 2018 equity emissions baseline.

We use the equity share approach to consolidate our total Scope 1 and 2 emissions, to which we would apply the benefit of our use of high integrity offsets. Each year we will provide details on our performance against these targets by reporting the percentage change for the relevant year compared to our emissions baseline in 2018 in our *2022 Sustainability Fact Book* and *2022 Climate Change Report*.

In specific circumstances, we may apply appropriate adjustments to the 2018 baseline data. Acquisitions and divestments will result in a commensurate adjustment to the baseline to include (acquisition) or exclude (divestment) emissions from relevant operations from the baseline.

Permanent closure of assets will not result in any adjustment to the baseline. Similarly, we will not adjust the baseline if our global production increases from the expansion of existing operations or new projects. The emissions from these growth projects form part of our total inventory and are accounted for in our emissions targets.

In circumstances where we adjust the baseline, we then apply the adjustment to the entire year. This is consistent with guidance in the Protocol, to ensure a like-for-like comparison between the 2018 baseline and the current year of reporting.

Scope 1 and 2 emissions are reported in three ways in the published Sustainability Fact Book tables:

1) Scope 1 and 2 emissions – Equity basis. Equity share approach with emissions unadjusted.

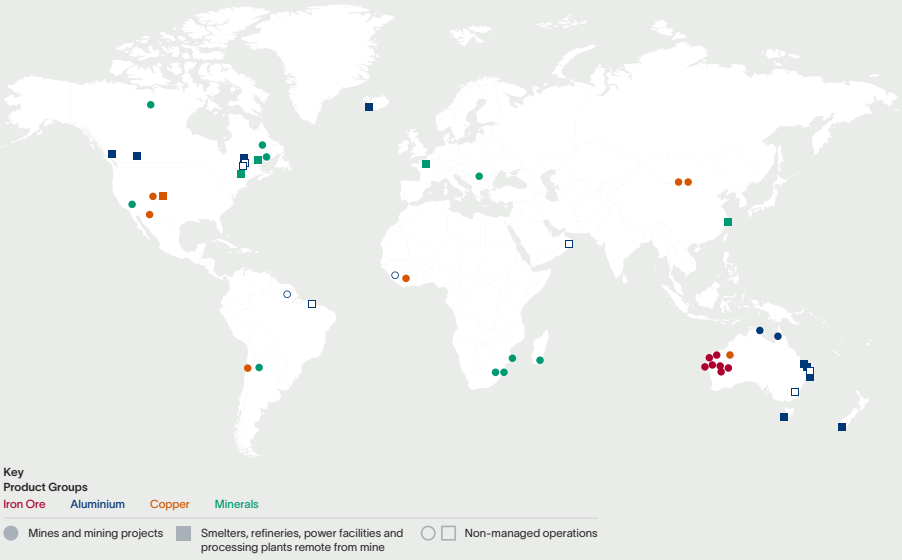
2) Scope 1 and 2 emissions – Equity basis. Performance against target.

Equity share approach with emissions adjusted in 2018 base year and current year baseline adjusted.

3) Scope 1 and 2 emissions – 100% managed basis. Control approach with emissions unadjusted.

The main difference between the two equity approaches in the current reported year is that the baseline emissions (performance against target) will apply a full year of emissions from a change in asset ownership, whereas the equity basis will represent emissions from the change in asset ownership on the date the change legally occurred.

Managed and non-managed operations



1. Available at https://ghgprotocol.org.

Scope 2 emissions reporting methods

Scope 2 emissions are indirect emissions from acquired and consumed electricity, steam or heat. At Rio Tinto this is primarily from purchased electricity.

As renewable electricity markets have been evolving globally, so have the Scope 2 GHG reporting methodologies. The WRI's amendment to the *GHG Protocol Corporate Standard, GHG Protocol Scope 2 Guidance* (the Scope 2 Guidance), now defines a market-based and a location-based approach to Scope 2 emissions reporting.

The location-based method uses the average emissions intensity of electricity grids on which the energy is consumed from. This is how Rio Tinto predominantly reports Scope 2 emissions as it is the basis of many legislative reporting requirements such as National Greenhouse and Energy Reporting (NGER) in Australia, and the factors are traceable and publicly available from reputable sources.

The market-based method is a way of being able to account for the emissions associated with a specific power contract. Where the legal rights to renewable energy certificates have not been obtained, companies using this method must report using a residual mix factor (RMF). This is calculated using the average emissions intensity of the grid excluding any renewable claims made by other power consumers on the grid (eg sold renewable energy certificates by the generator).

The Scope 2 Guidance recommends companies report a dual set of Scope 2 emissions using both market-based and location-based methods.

We are undertaking work to move towards dual market-based and location-based Scope 2 reporting in the future and to align with the GHG Protocol Scope 2 Guidance principles of using the "most appropriate, accurate, precise and highest quality emission factors for each method". This will have a bearing on our emissions baseline as well as our reported emissions.

In the 2022 inventory we have continued to use the same reporting assumptions as 2021, including many location-based factors in instances where there is no contractually purchased renewable energy.

We purchased renewable electricity certificates at Kennecott Copper and Resolution Copper in the US and switched to renewable electricity contracts at the Escondida mine in Chile (managed by BHP, Rio Tinto owns 30%). These operations have zero Scope 2 emissions in our inventory.

Scope 1 and 2 emissions summary

Scope 1 and 2 emissions – equity basis

Equity GHG emissions – million tonnes carbon dioxide equivalent (Mt CO_2e)	2022	2021	2020	2019	2018
Total Scope 1 and 2 GHG emissions	30.3	31.0	31.7	31.4	33.7
Scope 1 emissions	22.8	22.8	22.9	23	24.4
Scope 2 emissions	7.5	8.2	8.8	8.4	9.3

Note that our 2022 equity emissions and our 2018 baseline do not include the additional equity share of the Oyu Tolgoi mine that was purchased in mid-December 2022. Historical Scope 1 and 2 emissions have been restated to reflect improvements in data quality. Queensland Alumina Limited (QAL) is 80% owned by Rio Tinto and 20% owned by Rusal. However, as a result of QAL's activation of a step-in process following the Australian Government's sanction measures, Rio Tinto is currently entitled to utilise 100% of the capacity at QAL, but paying 100% of the costs for as long as that step-in continues. Our 2022 equity emissions and our 2018 baseline include QAL emissions on the basis of Rio Tinto's 80% ownership. In 2022, the additional emissions associated with the step-in were 0.53Mt. Rusal has commenced proceedings challenging the validity of the step-in and the sanctions regime may change over time, such that the duration of the step-in remains uncertain.

2022 equity GHG emissions by product group and source (Mt CO_2e)	Electricity[1]	Anodes & Reductants	Process Heat	Mobile Diesel	Other	2022 Total emissions (Mt CO_2e)
Aluminium	9.5	5.0	5.2	0.3	1.2	21.1
Aluminium (Pacific)	7.7	1.7	0.2	0.0	0.2	9.7
Aluminium (Atlantic)	0.5	3.3	0.3	0.0	0.7	4.8
Bauxite & Alumina	1.2	0.0	4.7	0.2	0.3	6.5
Minerals (includes Iron Ore Company of Canada)	1.6	1.4	0.7	0.3	0.0	4.0
Iron Ore (includes Dampier Salt)	0.8	0.0	0.1	2.2	0.0	3.1
Copper	0.5	0.0	0.2	0.8	0.0	1.5
Other (includes Shipping and corporate functions)	0.1	0.0	0.0	0.5	0.0	0.6
Total	**12.5**	**6.3**	**6.2**	**4.1**	**1.2**	**30.3**

Note: The sum of the categories may be slightly different to the Rio Tinto total due to rounding.

1. Electricity includes imported power and own generation; process heat includes diesel consumption from stationary sources such as pumps; mobile diesel sources are haul trucks, locomotives and other mining fleet.

Scope 1 and 2 greenhouse gas emissions - equity basis. Performance against target

Equity GHG emissions (Mt CO_2e)	2022	2018
Baseline scope 1 & 2 emissions	**30.3**	
2018 emissions target baseline (adjusted for acquisitions & divestments)		32.5

Scope 3 emissions

The 2022 Scope 3 emissions inventory has been prepared on an equity basis, taking into account our economic interest in all managed and non-managed operations.

The Scope 3 Standard divides Scope 3 emissions into 15 categories covering activities both upstream and downstream of our operations.

Of these categories, Category 10 – Processing of Sold Products – accounts for about 94% of the identified emissions across our value chains. Accordingly, this report focuses on the calculation boundary, methodology and data sources used to estimate these emissions.

We have estimated emissions from downstream processing of iron ore, bauxite, alumina, titanium dioxide, salt and copper concentrate using a combination of internal emissions modelling, regional- and industry-level emission factors, and internal production and shipment data.

Category 4 transport and distribution includes emissions from shipping our products in Rio Tinto-chartered vessels. Category 9 includes shipping our products in customer-chartered vessels.

Building on the work of 2020 and 2021, we have made some changes and improvements to calculation methodologies that represent a higher level of maturity and accuracy in Scope 3 emissions reporting. We continue to strive for increased precision and accuracy of Scope 3 reporting and the inclusion of customer- and supplier-specific data where possible.

Key improvements to the 2022 reporting include:

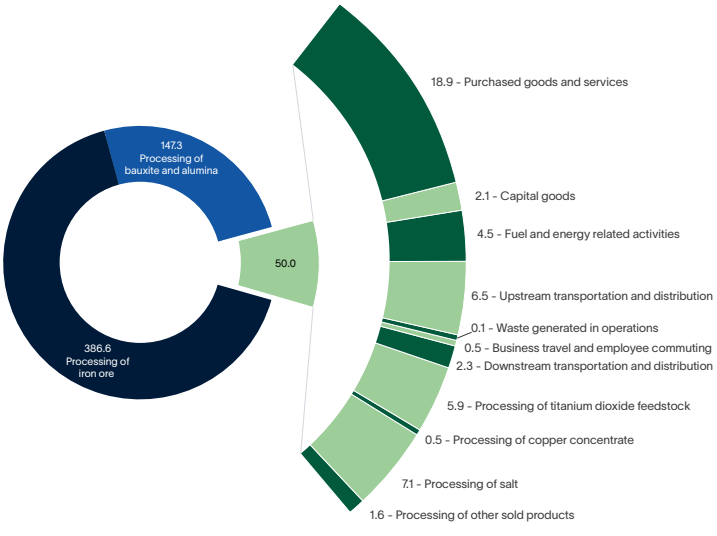
- Use of actual voyage distances and fuel used on a voyage-by-voyage basis for time-chartered marine vessels and some spot vessels. In our 2021 reporting, we used recent average energy efficiency operational indicators (EEOI) for time-chartered vessels and port-to-port distances.
- Implementation and use of SeaCarbon portal to capture marine voyage level emissions more accurately.
- More accurate distance reporting using AIS data for voyages without actual fuel consumption.
- Inclusion of customer-related data in our aluminium value chain processing.
- Segregation of additional higher emission purchases to apply direct emissions factors to. This includes alloys used in aluminium smelting, AlF_3 and a refresh to the coke and pitch emissions calculations to align with our internal Life Cycle Analysis and recent Scope 3 guidance from the International Aluminium Institute.
- Greater sourcing of business travel data from major providers.

The methodology and inventory presented in this report provide relevant details related to the emissions in our operations and value chains, as published in our *2022 Annual Report* and our *2022 Climate Change Report* available on our website.

Total equity Scope 3 GHG emissions ($Mt CO_2e$)	2022	2021 Restated	2020 Restated
Scope 3 - Upstream	32.6	32.3*	30.4*
Scope 3 - Downstream	551.3	526	545.8*
Total	**583.9**	**558.3**	**576.2**

* Numbers restated from those originally published to ensure comparability over time

Sources of Scope 3 equity greenhouse gas emissions ($Mt CO_2e$)		2022	2021 Restated	2020 Restated
Upstream emissions				
1.	Purchased goods and services	18.9	19.5[1]	19.3[1]
2.	Capital goods	2.1	1.9	1.4
3.	Fuel and energy related activities	4.5	4.5[2]	4.5[2]
4.	Upstream transportation and distribution	6.5	5.9	5.1
5.	Waste generated in operations	0.1	0.1	0
6. & 7.	Business travel and employee commuting	0.5	0.4	0.14
8.	Upstream leased assets	Not applicable[4]	Not applicable	Not applicable
Downstream emissions				
9.	Downstream transportation and distribution	2.3	2.7	3.0
10.	Processing of sold products			
	Iron ore	386.6	364.6	376.4
	Bauxite & alumina	147.3	144.5	152
	Titanium dioxide feedstock	5.9	4.9	5.8
	Copper concentrate	0.5	0.5	0.6
	Salt	7.1	7.2	6
	Other	1.6	1.6	2
11.	Use of sold products	Not applicable[3]	Not applicable	Not applicable
12.	End of life treatment of sold products	Not applicable[4]	Not applicable	Not applicable
13.	Downstream leased assets	Not applicable[4]	Not applicable	Not applicable
14.	Franchises	Not applicable[4]	Not applicable	Not applicable
15.	Investments	Not applicable[5]	Not applicable	Not applicable
Total		**583.9**	**558.3**	**576.2**



Note: The sum of the categories may be slightly different to the Rio Tinto total due to rounding.

1. Approximate equivalent 2020 and 2021 figures for purchased goods and services for high emission goods including alloys, coke and pitch used in aluminium smelting have been re-estimated using the 2022 methodology and provided to allow comparability over time. These re-estimates have greater uncertainty than the 2022 reported data.
2. Fuels updated to include bunker fuel for time-chartered vessels and more complete non-managed site data. Re-estimated for 2020, 2021 based on 2022 assumptions. These re-estimates have greater uncertainty than the 2022 reported data.
3. Not applicable since Rio Tinto does not produce fossil fuels or manufacture products applicable to this category.
4. Not applicable since Rio Tinto does not lease significant upstream and downstream assets or have franchised operations. In relation to end of life treatment, our products, and end use materials from our products, are predominantly recycled.
5. This category is for reporting emissions from company investments not already reported in Scope 1 and 2. Rio Tinto reports using the equity share approach, so all Scope 1 and 2 emissions from managed and non-managed investments are included in Scope 1 and 2 reporting and Scope 3 emissions within other applicable categories of Scope 3 reporting.

Processing of sold products

The majority of our exposure to Scope 3 emissions is from the processing of sold products, mainly related to our iron ore, bauxite and alumina, titanium dioxide, copper and salt value chains. To make these emissions easier to understand, we have provided additional information about the estimation of emissions in these value chains.

We have a diverse global customer base with different operating approaches, technology deployment, electricity grid emissions factors and other business inputs that affect the estimation of emissions in our value chains. These complexities, combined with our diverse portfolio of products, require specific emissions calculation methodologies for each of the iron ore, bauxite and alumina, copper, salt and titanium dioxide value chains.

Our calculation methodology is specific to our products, each impacting the attributable emissions in their value chain according to their characteristics. In calculating these emissions estimates, we apply a level of conservatism where specific data is not readily available. We do not account for any emissions credits where our products displace similar products with a higher emissions footprint.

Processing of iron ore

Iron ore shipments[1] (2022, Mt equity share)		Attributable steel production (2022, Mt steel)		Emissions per tonne of steel (t CO_2e per t attributable steel)		Estimated iron ore value chain emissions (Mt CO_2e, equity share)
287.9		178.0	x	2.172	=	386.6

Processing of iron ore into steel is the largest contributor to our Scope 3 emissions. The two primary steelmaking routes are the blast furnace (BF/BOF) integrated system and the electric arc furnace (EAF).

Around 99% of our iron ore is processed in the BF/BOF steelmaking route, which uses iron ore, metallurgical coal and other additives to produce steel. The remainder is processed with natural gas to produce direct reduced iron (DRI) for conversion to steel in an EAF. We supply only the iron-based inputs to steelmaking processes, which contain no carbon, but making steel is carbon intensive due to the consumption of metallurgical coal, natural gas and electricity from local grids (which typically rely on fossil fuel power generation).

The BF/BOF steelmaking route is complex and varies at each of our customers' facilities. These complexities contribute to different operating and carbon efficiencies and, ultimately, varying emissions intensities at the facilities that process our iron ore products. We have taken a conservative approach to capturing these differences while ensuring our modelling accounts for the different emissions profiles associated with our suite of iron ore products.

Calculation boundary

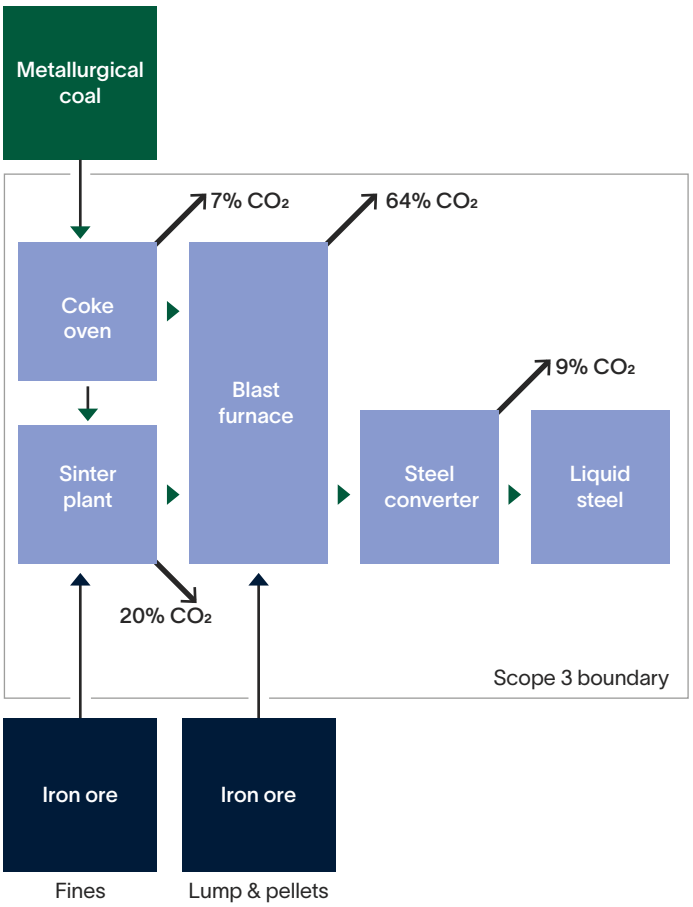
We have developed a steelmaking energy and mass balance model to estimate emissions from processing of iron ore into a liquid steel product by both the BF/BOF and DRI/EAF processes. Each of our 12 iron ore products are analysed within this model based on respective ore grades, mineral chemistry and moisture content.

The model captures the activities incorporated at a typical steelmaking facility, recognising that this varies by customer and region. The emissions boundary used to prepare this estimate includes emissions from the four primary sources of BF/ BOF steelmaking: the production of coke, iron ore sintering, blast furnace operations and final steel conversion.

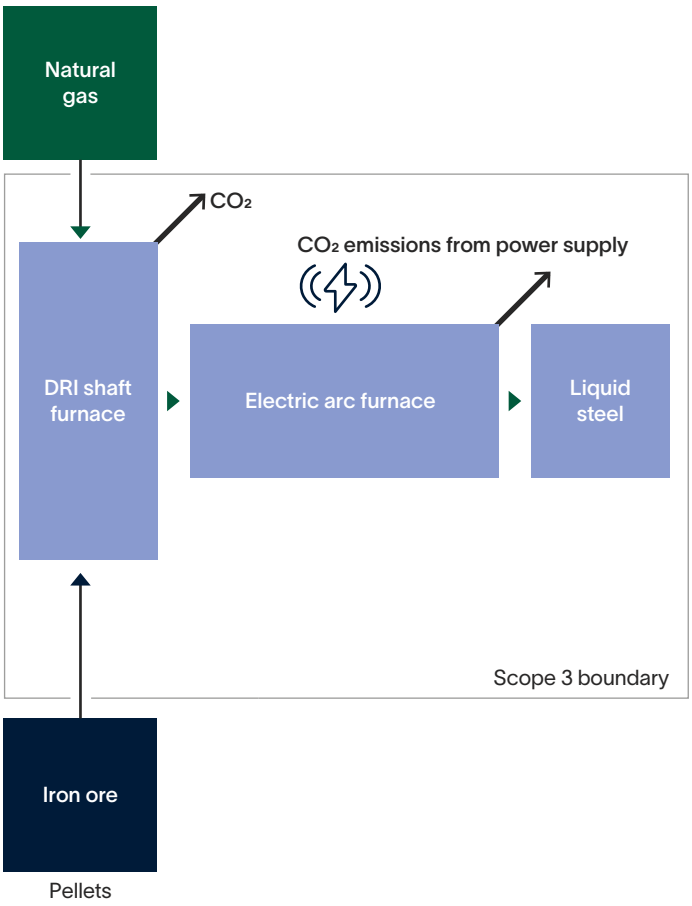
For DRI/EAF-processed steel, we have included direct emissions and emissions associated with electricity used. For both steelmaking routes, we have employed conservative model assumptions on technology deployment, closed-loop energy efficiency and regional grid factors across the regions in which our customers operate.

1. Iron ore shipments are net of unsold product in portside trading facility.

Integrated blast furnace route (BF/BOF)



Electric arc furnace route (EAF)



Calculation methodology

We use typical industry parameters when modelling to consider the energy needed in each step of the steelmaking process relative to the grade of iron ore, flux materials and the corresponding volume of coke required. Our approach to calculating emissions from steelmaking attributes emissions to four elements of the integrated process: the production of coke, ore sintering, blast furnace operations and final steel conversion.

Within our calculation boundary, the coke plant is at the beginning of the process and uses heat energy to convert metallurgical coal to coke used in the steelmaking process. Emissions in this process represent about 7% of our calculated downstream emissions (or approximately 27Mt CO_2e), despite the absence of our products in this part of the steelmaking process.

The sinter plant is used to prepare fines ores for the blast furnace through a heat-based agglomeration process. Lump ore and pelletised products are screened and largely bypass the sinter plant process, reducing the associated emissions. Emissions attributable to sintering represent about 20% of our calculated downstream emissions.

The blast furnace uses coke to heat and reduce iron ore (typically Fe_2O_3) to liquid iron. This reduction process is completed with carbon-based products in all global blast furnaces and, as such, results in the emission of CO_2. Around two-thirds of our iron ore downstream emissions are emitted in this process.

The steel converter removes the final impurities from the liquid iron generated in the blast furnace using oxygen and lime flux inputs. Emissions in this process represent about 9% of our calculated downstream emissions.

Integrated steelworks employ a complex variety of processes and energy uses. In our model, the conversion of energy into emissions is based on parameters and typical operating values from relevant published technical papers and International Energy Agency (IEA) global averages, as set out in the references. These calculations are consistent with the approach taken in the *GHG Protocol Tool: Calculating Greenhouse Gas from Iron and Steel Production* published by the WRI and WBCSD.

Data sources

Iron ore product grades are determined using laboratory analysis for the ore shipments. Shipment volumes are from site operational data for fines, lump and pellets as used for compiling our published annual results for managed and non-managed operations.

The energy and mass balance model is an internally produced model using key assumptions representative of typical steelworks operating parameters and typical coke and metallurgical coal specifications.

References

Comparison of Energy Consumption and CO Emissions for Three Steel Production Routes – Integrated Steel Plant Equipped with Blast Furnace, Oxygen Blast Furnace or Corex – Jiayuan Song, Zeyi Jiang, Cheng Bao and Anjun Xu.

IEA Emission Factors:
Database documentation (2019)

Thermochemical Data of Pure Substances, Third Edition – Prof.-Dr. Ing. Ihsan Barin

Rio Tinto Fourth Quarter Operations Review 2022

Item	Range (by product)	Example (Pilbara Blend™ Fines)	Rio Tinto portfolio	Description
Iron ore production (million tonnes, equity share)				
2022 iron ore shipments[1]		111.1	287.9	We produce a range of iron ore products from our Pilbara and Iron Ore Company of Canada operations. Data sourced from Rio Tinto shipments data for the year ended 31 December 2022.
Processing iron ore to steel (million tonnes)				
2022 attributed steel production		68.5	178	By analysing the different characteristics of our products, including iron grade, minor elements and moisture, we have estimated the steel production attributable to our iron ore.
Processing of iron ore to steel – emission factor (tonnes CO_2e per tonne steel)				
Emissions associated with the production of coke	0.12 – 0.17	0.16	0.16	Emissions are estimated using average global grades of metallurgical coal and typical coke oven efficiencies.
Emissions associated with ore sintering	0.04 – 0.65	0.54	0.44	The sinter plant is primarily used to agglomerate fines ore. Lump and pellets are screened, with much of this product bypassing the sinter plant.
Emissions associated with the blast furnace	1.31 – 1.55	1.36	1.38	The energy required in the reduction of iron ore is the largest emissions contributor. Variations in these emissions are modelled relative to the iron content and gangue components of the ore.
Emissions associated with final processing in steel converter (BOF)	0.21	0.21	0.21	Emissions in the steel plant are reasonably consistent across our products.
Emissions per tonne of attributable steel (tonnes CO_2e per tonne liquid steel)		2.26	2.172*	Emission factors sourced from our energy and mass balance modelling of iron ore processing. * Includes a contribution from DR pellets used in DRI+EAF process.
2022 iron ore value chain emissions (million tonnes CO_2e, equity share)				
Total Scope 3 GHG emissions from processing of iron ore (Mt CO_2e equity share)		155	386.6	Total estimated emissions from processing of our iron ore to produce steel. Calculated on a product basis by applying the specific product emission factors to the 2022 shipment volumes of each product.

1. Iron ore shipments are net of unsold product in portside trading facility.

Processing of bauxite and alumina

Downstream emissions attributable to bauxite sales
(Category 10, Mt CO_2e)

147.3

Downstream emissions attributable to alumina sales
(Category 10, Mt CO_2e)

Upstream emissions attributable to bauxite and alumina purchases
(Category 1, Mt CO_2e)

1.2

Estimated Scope 3 emissions from sales and purchases of bauxite and alumina
(Mt CO_2e, equity share)

148.5

The processing of bauxite and alumina into aluminium is the second largest contributor to our Scope 3 emissions. For 2022 reporting, we have calculated Scope 3 emissions looking at the value chain of each of our bauxite and alumina operations and accounting for all upstream and downstream emissions.

This methodology allows full value chain transparency, and when we and our customers and suppliers reduce Scope 1 and 2 emissions it will more clearly demonstrate the improvement over time. It also provides the pathway for greater accuracy of Scope 3 reporting using site-specific emission factors, conversion ratios and regional emission factors instead of global factors and conversions. The 2022 reported numbers incorporate some customer- and supplier-specific emission factors.

In our global value chain, bauxite is converted to alumina via the Bayer process. The emissions associated with this process are primarily driven by the emission factors associated with the fuel used in steam generation and calcination of alumina, and the electricity supply at our customers' refineries.

Processing alumina into aluminium uses the Hall-Héroult process, which is electro-intensive and releases process CO_2 emissions from the use of carbon anodes in the electrolytic production of aluminium. From the 2021 CRU Group data, the average emissions to convert alumina to aluminium are at 12.00t CO_2e per tonne of aluminium. This average accounts for both low-carbon hydroelectricity-supplied smelters and smelters that operate in regions with high-carbon-intensity electricity. The majority of the emissions are to do with electricity consumption or generation of electricity consumed by the operations. The remainder are from the baking and consumption of carbon anodes, process emissions and fuel consumption.

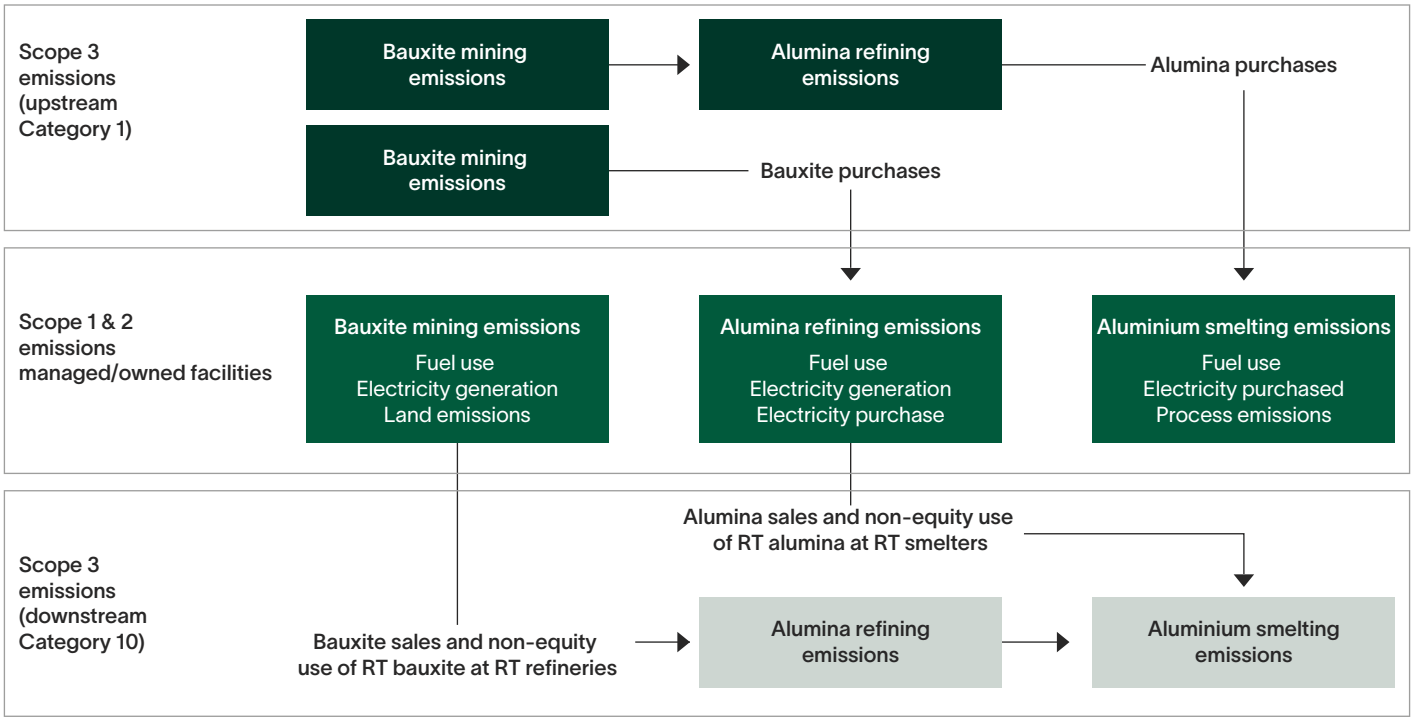
We operate production facilities across this value chain from bauxite extraction to alumina refining and aluminium smelting.

The calculation of emissions is inclusive of all three processing steps: bauxite mining, alumina refining and aluminium smelting. Smelting emissions are inclusive of the hot metal casting and billet homogenisation processes. Where we have equity ownership, the emissions upstream and downstream are reported as Scope 1 and 2.

Where we sell or purchase third-party bauxite and alumina, the emissions are reported as Scope 3 emissions.

Our vertically integrated supply chain produces aluminium with a significantly lower carbon footprint than the global average, due primarily to the hydropower electricity used by our Canadian aluminium smelters.

In 2022, we have improved the accuracy of reporting by applying emission factors relevant to our bauxite and alumina customers and suppliers. Where customer or supplier specific data is not available, we have applied CRU Group data for emissions intensities, using average regional data with emissions from our facilities excluded. Regional emission factors for our bauxite and alumina customers located in Asian countries are much higher than the global average. For example, according to CRU Group data, average China smelting emissions are approximately 30% higher than the global average t CO_2e/t aluminium. Our largest area of uncertainty in emissions in this value chain is attributed to aluminium smelting operations where our bauxite customers supply their processed alumina.



Calculation boundary

Emissions from the processing of bauxite and alumina include third-party processing of our bauxite into alumina and then into aluminium cast products, as well as third-party processing of our alumina into aluminium cast products.

Due to the various processing routes, and their comparatively low emissions, we have not included the downstream processing of our aluminium into different end-use products in this estimate.

To assess our exposure to Scope 3 emissions in this value chain, we have calculated emissions from both the purchases and the sales of bauxite and alumina across the equity position within our managed and non-managed operations. Where applicable, non-equity share of actual emissions from our joint ventures (not already covered in Scope 1 and 2 emissions reporting) are included.

Within the calculations, we have preferentially used more accurate customer facility-specific data (where known) and regional emission factors for calculating downstream processing of sold bauxite and alumina (Category 10), and upstream processing of purchased bauxite and alumina (Category 1).

Outside this value chain, we also produce specialty alumina products for use in other processes. These are produced in small quantities and considered final products with minimal associated downstream emissions from processing.

Calculation methodology

The approach is as follows:

Emissions from	Conversion ratio	Emissions intensity
Bauxite sales	Bauxite-to-alumina ratio: – Facility-specific data, where available from internal Life Cycle Assessment (LCA). – Otherwise, regional International Aluminium Institute (IAI) conversion factor. – Otherwise, global IAI conversion factor of 2.69t bauxite/t alumina. Alumina-to-aluminium ratio: – Facility-specific data, where available from internal LCA. – Otherwise, regional IAI conversion factor. – Otherwise, global IAI conversion factor of 1.92t alumina/t aluminium.	Of alumina refining: – Facility-specific data, where available. – Otherwise, regional 2021 CRU Group data (average excluding Rio Tinto assets). – Otherwise, global 2021 CRU Group data (average excluding Rio Tinto assets 1.32t CO_2e/t alumina). Of aluminium smelting: – Facility-specific data, where available. – Otherwise, regional 2021 CRU Group data (average excluding Rio Tinto assets). – Otherwise, global 2021 CRU Group data (average excluding Rio Tinto assets 12.00t CO_2e/t aluminium).
Alumina sales	As above for alumina-to-aluminium ratio in bauxite sales.	As above for aluminium smelting emissions in bauxite sales.
Bauxite purchases		Of bauxite mining: – Facility-specific data, where available. – Otherwise, regional 2021 CRU Group data (average excluding Rio Tinto assets).
Alumina purchases	Alumina-to-bauxite ratio: – Facility-specific data, where available from internal LCA. – Otherwise, regional IAI conversion factor. – Otherwise, global IAI conversion factor of 2.69t bauxite/t alumina.	Of alumina refining: – Facility-specific data, where available. – Otherwise, regional 2021 CRU Group data (average excluding Rio Tinto assets). – Otherwise, global 2021 CRU Group data (average excluding. – Rio Tinto assets) 1.32t CO_2e/t alumina. – As above for bauxite mining emissions in bauxite purchases.

The emission factors used in the calculation are taken from CRU Group data on 2021 emissions totals for all non-Rio Tinto global alumina refineries and aluminium smelters. These emissions totals have been divided by the total production from these facilities to determine the production-weighted global average emission factors for converting bauxite through to aluminium, and alumina to aluminium.

The table shows the methodology of emissions from bauxite and alumina sales in a simplified form.

Item	Calculation steps	Rio Tinto portfolio	Description
2022 sales (million tonnes, equity share)			
Bauxite sales	A	39Mt	Sales of bauxite to third parties.
Alumina sales	B	4Mt	Sales of alumina to third parties.
Conversion factors			
Bauxite: Alumina	C	2.69	International Aluminium Institute, Life Cycle Inventory (2022).
Alumina: Aluminium	D	1.92	International Aluminium Institute, Life Cycle Inventory (2022).
Processing-related emission factors (tonnes CO_2e per tonne of input material)			
Bauxite-to-alumina intensity (t CO_2e/t alumina)	E	1.32	CRU Group dataset (2021), global average (excluding Rio Tinto assets).
Alumina-to-aluminium intensity (t CO_2e/t aluminium)	F	12.00	CRU Group dataset (2021), global average (excluding Rio Tinto assets).
2022 aluminium value chain emissions (million tonnes CO_2e)			
Emissions from processing of bauxite sales	A ÷ C x E + A ÷ C ÷ D x F		Emissions associated with processing of bauxite to alumina and then further to aluminium.
Emissions from processing of alumina sales	B ÷ D x F		Emissions associated with processing of alumina to aluminium.
Total Scope 3 GHG emissions from processing of bauxite and alumina (Mt CO_2e equity share)		147.3	Total estimate emissions from processing of bauxite and alumina. This is reported in Category 10.

The table shows the methodology of emissions from bauxite and alumina purchases in a simplified form.

Item	Calculation steps	Rio Tinto portfolio	Description
2022 purchases (million tonnes, equity share)			
Bauxite purchases	G	0.9Mt	Purchases of bauxite from third parties.
Alumina purchases	H	1.6Mt	Purchases of alumina from third parties.
Conversion factors			
Bauxite: Alumina	C	2.69	International Aluminium Institute, Life Cycle Inventory (2022).
Alumina: Aluminium	D	1.92	International Aluminium Institute, Life Cycle Inventory (2022).
Processing-related emission factors (tonnes CO_2e per tonne of input material)			
Bauxite mining intensity (t CO_2e/t bauxite)	I	0.018	CRU Group dataset (2021), global average (excluding Rio Tinto assets).
Bauxite-to-alumina intensity (t CO_2e/t alumina)	E	1.32	CRU Group dataset (2021), global average (excluding Rio Tinto assets).
2022 aluminium value chain emissions (million tonnes CO_2e)			
Emissions from processing of purchased bauxite	G x I		Emissions associated with the mining of purchased bauxite.
Emissions from processing of purchased alumina	H x E + H x C x I		Emissions associated with the processing of alumina and mining of the bauxite used to refine that alumina.
Total Scope 3 GHG gas emissions from purchased bauxite and alumina (Mt CO_2e equity share)		1.2	Total Scope 3 estimate emissions from purchased bauxite and alumina. This is reported in Category 1.

Data sources

Bauxite and alumina volumes are sourced from sales quantities based on bill of lading records for shipments of bauxite and alumina shipped to and from managed and non-managed operations. These are consistent with our *2022 Annual Report*.

References

Rio Tinto Fourth Quarter Operations Review 2022

International Aluminium Institute, Appendix A Life Cycle Inventory (global) to the publication Life Cycle Inventory Data and Environmental Metrics (2019 data, published 2022)

CRU Group Commodity Market Analysis (2021)

Processing of titanium dioxide feedstocks

Titanium dioxide production (2022, Mt equity share)		Emission factor (tonnes CO_2e per tonne product sold)		Estimated TiO_2 value chain emissions (Mt CO_2e, equity share)
1.2	x	4.9	=	5.9

We are involved in the titanium dioxide (TiO_2) supply chain through our interests in QIT Madagascar Minerals (QMM) in Fort Dauphin in Madagascar, Richards Bay Minerals (RBM) in South Africa, and Lac Tio in Canada, as well as smelters at RBM and Sorel-Tracy in Canada. These operations generate products for the TiO_2 pigment industry.

Our TiO_2 business provides the main feedstock for the TiO_2 pigment industry, which is used in a wide range of industrial and consumer products including paints, plastics, cosmetics, paper, rubber, ceramics and textiles.

Calculation boundary

We treat emissions from mining, mineral processing, smelting and refining TiO_2 feedstock as Scope 1 and 2 emissions.

Our Scope 3 emissions estimate incorporates the emissions associated with the conversion of mineral sands and feedstock to TiO_2 pigment. The Scope 3 emissions from processing ilmenite are not included in this calculation.

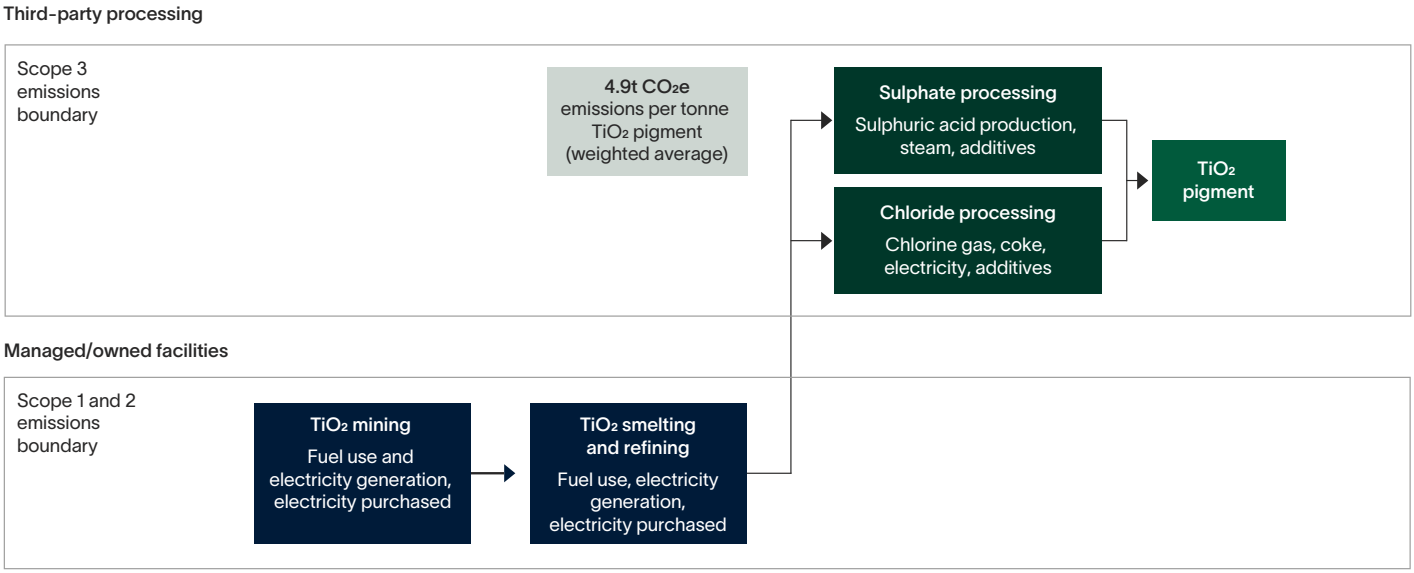
TiO_2 pigment is produced through two main processes, sulphate and chloride, using a wide selection of TiO_2 feedstocks such as ilmenite, titania slag, and natural rutile.

As TiO_2 pigment has a diverse range of downstream applications, we have not included emissions associated with downstream processing of TiO_2 pigment. The conversion process from feedstock to 100% pure TiO_2 refined pigment generates the majority of the value chain emissions and is the downstream boundary of our estimate.

Calculation methodology

The Titanium Dioxide Manufacturers Association (TDMA), an organisation that represents more than half of the global production of TiO_2, has calculated the average mine-to-gate carbon footprint of all their global production facilities. We use this to estimate our customer value chain emissions.

The global average emission factor calculated by the TDMA includes emissions related to processing TiO_2 feedstock into TiO_2 pigment, considering both typical processing routes, sulphate or chloride. Our total annual production volumes are assessed against the TDMA average emission factor to estimate our Scope 3 emissions. We acknowledge that our Scope 1 and 2 emissions double up somewhat within this Scope 3 calculation. The source factor used in the 2021 inventory was 4.9t CO_2e/t pigment and this has remained the same in 2022.



Data sources

Equity share production volumes have been obtained from reported production TiO_2 feedstocks from managed and non-managed operations.

Our emission factor has been sourced from the TiO_2 industry average carbon footprint as published by the Titanium Dioxide Manufacturers Association.

References

Rio Tinto Fourth Quarter Operations Review 2022.

Titanium Dioxide Industry Average Carbon Footprint, TDMA.

Processing of copper concentrate

Net copper concentrate production
(2022, Mt equity share)

Emission factor
(tonnes CO_2e per tonne copper)

Estimated copper value chain emissions
(Mt CO_2e, equity share)

0.3 x 1.64 = 0.5

We are involved in the copper value chain through our interests in Kennecott in the US, Oyu Tolgoi in Mongolia and Escondida in Chile. These operations produce copper concentrate and refined copper.

Calculation boundary

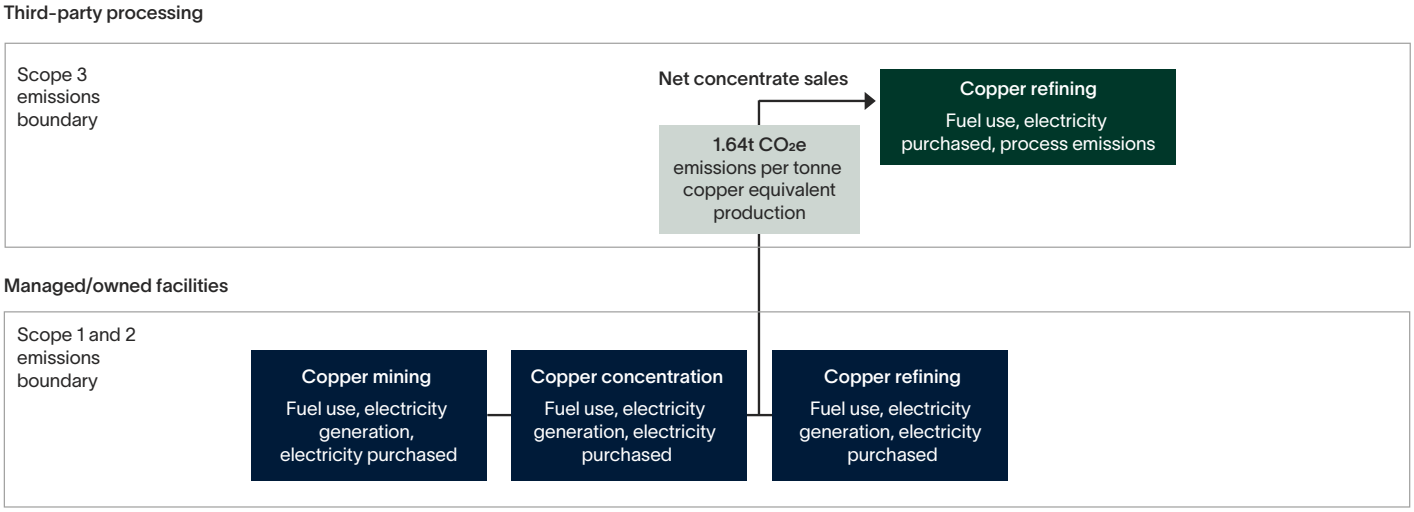
The emissions captured within our Scope 3 estimate include processing of our net sales of copper concentrate into refined copper. We do not sell copper ore without first converting it to copper concentrate. The emissions associated with mining, concentrating and, where applicable, refining copper at our operations are included in our Scope 1 and 2 emissions reporting.

Our calculation boundary concludes with the production of copper cathode (refined copper). At this stage, copper can be converted to various products, including wire, tube or sheet. Due to the various processing routes, and their comparatively low emissions, we have not included the downstream processing of our refined copper into different end-use products in this estimate.

Calculation methodology

The emissions from mining and concentrating copper ore are highly variable due to differences in open cut and underground mines, as well as the emission factors of the electricity consumed in the mining and concentrating processes. Life Cycle Assessments for copper that capture mine-to-gate emissions from copper extraction to final product are subject to these variations and, as such, include large variations in the emission factors proposed in the use of Scope 3 assessment of copper products.

Our calculation uses a regional factor that is representative of the processing of our copper concentrate by our customers. The factor in the paper referenced below is 5.88t CO_2e/t Cu for all processing stages from mining to refining. Using the emissions breakdown in the paper, the emissions associated with processing of copper concentrate into refined copper have been determined to be 1.64t CO_2e/t Cu. We have used this emission factor for the copper refining process and applied this to our net copper concentrate sales.



Data sources

The net copper concentrate is calculated by subtracting refined copper from copper concentrate volumes. Data is sourced from site production records as reported in our *2022 Annual Report*, where refined copper is copper (refined) and copper concentrate is copper (mined).

Because many of our copper concentrate sales are to customers in China, our emission factor has been adapted from the technical paper: *Assessing the future environmental impacts of copper production in China: Implications of the energy transition.*

References

Assessing the future environmental impacts of copper production in China: Implications of the energy transition, Di Dong, L van Oers, A Tucker, Evan der Voet, 2020, Table 5.

Processing of salt

Salt production
(2022, Mt tonnes equity share)

5.8

Estimated salt processing emissions
(Mt CO_2e, equity share)

7.1

Our Dampier Salt operations are located in Western Australia and comprise three salt operations at Dampier, Port Hedland and Lake MacLeod. The majority of our salt production ends up in chlor-alkali processes and the manufacturing of caustic soda and chlorine.

Calculation boundary

The emissions captured within our Scope 3 estimate include processing of our salt into refined products on an equity basis.

Calculation methodology

The emission factor applied to the amount of production estimated to have been used in chlor-alkali processes is 2.03t CO_2e/t NaOH, sourced from SimaPro V9 Life cycle database. To apply this factor to sodium chloride, the molar mass ratios were used to give an equivalent t CO_2e/t NaCl and adjusted for % of moisture. The amount of caustic that our customers would likely produce from our salt is then multiplied by the emission factor.

Manufacturing salt through processes such as those used in the paper and pulp industry is lower in emissions intensity than those used in chlor-alkali processes. We have estimated GHG emissions from salt in these other processing applications.

Data sources

Production volumes are taken from managed site production quantities of salt. This data is used for compiling our *2022 Annual Report* production data.

References

SimaPro V9 Life cycle database: Sodium Hydroxide, 50% in H2O, production mix, at plant/RER U/AusSD U (Method: IPCC 2013 HWP 100a V1.03).

Purchased goods, capital goods and fuels

Calculation boundary

The majority of upstream Scope 3 reporting falls into Categories 1, 2 and 3 which relate to the cradle-to-gate emissions from purchasing of all operating goods and services, consumables, raw materials, fuels, electricity and items and services purchased for capital purchases.

The boundary and data used for calculating these emissions include all business purchases and spend.

Calculation methodology

The GHG Protocol references a spend-data tool and method on their website, called the Quantis Scope 3 evaluator tool.

While using a spend-based tool is an approved and commonly used method of calculating Scope 3 emissions from purchases, it is limited in term of translating value chain decarbonisation actions into reported Scope 3 emissions reduction.

We are improving the accuracy and clarity of these reporting categories each year and our approach is the following:

- Review major purchases and raw materials inputs into each production process.
- Identify which of these are higher-emission purchases.

In 2022, we separated out additional categories to more closely align the Scope 3 inventory with our aluminium Life Cycle Analysis as well as consideration and use of the new International Aluminium Institute Scope 3 guidance.

Specific Scope 3 emissions are calculated using consumption quantities for:

- Use of explosives, lime, anodes, coke, pitch, cathodes, caustic soda, aluminium fluoride and alloys in aluminium smelting. Calculating emissions from alloys used in aluminum smelting using alloy specific emission factors instead of spend data and a re-alignment of the coke and pitch emissions methodology have been two of the more significant improvements in 2022.
- Purchases of bauxite and alumina.
- Fuels and electricity consumed in operations.

Once an emissions source is identified and calculated on a quantity multiplied by emission factor approach, it is separated out from the spend data to avoid being double counted.

A variety of emission factor sources are used for these higher emission purchases, including International Aluminium Institute Life Cycle Assessment (LCA) guidance, LCA databases, Australian and UK Government factors and supplier specific factors.

Transport and distribution of fuel and electricity is included in Category 3. Transport of purchased goods, materials and consumables are included in Categories 1 and 2.

Some non-managed site cost and materials are estimated using costs or quantity data from similar production facilities.

In 2022 we included bunker fuel which is a significant amount of emissions. This fuel is purchased by Rio Tinto and used in time-chartered marine vessels.

Spend data categories from our business systems have been evaluated in detail and mapped to GHG Protocol Quantis Scope 3 evaluator tool categories, https://ghgprotocol.org/scope-3-evaluator. We used the 2016 conversion factors from Quantis (which were the most recent available at the time of publication).

Transportation and distribution of products

Transportation and distribution of sold products are reported across two separate Scope 3 categories depending on the party who pays for and arranges the transport. Category 4 and Category 9 together report total Scope 3 GHG emissions from upstream transportation and distribution of sold products including iron ore, bauxite, alumina, aluminium, salt, and TiO_2 feedstocks, copper concentrates and copper cathode-related products.

Category 4 includes all inbound transport, all inter-company transport that we have paid for, and all outbound product transport that we have chartered and paid for, such as under "Cost, Insurance and Freight" (CIF, CRF) or similar terms and spot vessels. This includes road, rail, air and marine transport.

Category 9 Includes emissions from the transport and distribution of our products where freight has been arranged by our customers or others (such as under Free on Board (FOB) or similar terms).

Bulk marine transportation and distribution of iron ore, bauxite, alumina and salt contribute approximately 5Mt CO_2e of Category 4 emissions and 2Mt CO_2e of Category 9 emissions. The balance of emissions are from shipping and of other products, third-party containerised shipping, and road and rail transportation of other products. These categories exclude emissions from Rio Tinto-owned vessels (this is included in Scope 1 emissions).

Emissions equals distance moved or fuel consumed multiplied by the relevant emissions factor.

Transport and distribution upstream and managed (Category 4) approach

For time-chartered vessels and spot vessels, data is now captured through a centralised marine emissions platform called SeaCarbon that enables counterparties to report Voyage-specific bunker consumption used to calculate Scope 3 emissions.

Where actual emission values are not available in SeaCarbon, emissions are calculated through the use of standard International maritime Organisation (IMO) energy efficiency operational indicator (EEOI) factors specific to vessel size.

SeaCarbon AIS (satellite) estimates for distances are used; if AIS estimates are not available, then port-to-port distances are used.

For road, rail and air transport, UK Government Scope 3 emissions factors were used.

Category 4 also includes some spend-based emissions from warehousing of purchased products and distribution centres calculated using Quantis spend tool.

Transport and distribution downstream (Category 9) approach

Where data has been obtained from customer-supplied transport of products, it is used in the Scope 3 emissions calculations.

A similar hierarchy of data accuracy approach is applied to Category 9 with voyage-specific data used first, and if not available, then published IMO factors are used.

Where possible, port-to-port distances and city-to-city distances are used in preference. Where not available, country-to-country distances are used.

Calculation methodology – all Scope 3 Standard emissions categories

Category		Mt CO_2e (equity share)	Calculation boundary	Calculation methodology	Data sources
1	**Purchased goods and services**	18.9	Includes emissions associated with relevant purchased goods and services. Excludes emissions associated with other Scope 3 categories: capital goods (Category 2); fuel and energy (Category 3); transport (Category 4); business travel and employee commuting (Categories 6 and 7).	Spend data method using operating business costs for managed sites on equity basis using the Quantis Scope 3 evaluator tool emission factors. Specific Scope 3 emissions are calculated for consumables and raw materials with higher Scope 3 emissions. Non-managed site costs are estimated using costs from similar production facilities.	Spend data from our business systems paired with GHG Protocol Quantis Scope 3 evaluator tool, https://ghgprotocol.org/scope-3-evaluator. The 2016 conversions from Quantis are used (which were the most recent available at the time of publication).
2	**Capital goods**	2.1	Includes emissions associated with the upstream goods and services purchased or acquired by the business for capital projects.	Spend data method using operating business costs for managed sites on equity basis using the Quantis Scope 3 evaluator tool emission factors. Non-managed site costs are estimated using costs from similar production facilities.	Spend data from our business systems paired with GHG Protocol Quantis Scope 3 evaluator tool.
3	**Fuel and energy-related activities**	4.5	Includes emissions from the production and transportation of purchased fuels, including natural gas, diesel, coal and energy sources not included in Category 1. This includes transmission losses from purchased electricity. In 2022 we added bunker fuel purchases for time-chartered vessels.	Factors are sourced from the *Australian National Greenhouse Accounts (NGA)* Scope 3 factors emissions tables for fuels and the *UK Government Scope 3 tables*.	Fuel and energy consumption data from Rio Tinto business systems combined with NGA factors and UK Government factors.
4	**Upstream transportation and distribution**	6.5	Total Scope 3 GHG emissions from upstream transportation and distribution of iron ore, bauxite, alumina, aluminium, salt, and TiO_2 feedstocks, copper concentrates and copper cathodes related products. Includes all inbound transport, all inter-company transport paid for by us and all outbound product transport paid for by us (eg under cost, insurance and freight (CIF, CFR) or similar terms). Includes emissions from bulk marine shipping, containerised shipping, road and rail transport of sold products. Excludes emissions from Rio Tinto owned vessels (this is included in Scope 1 emissions).	Company shipping quantities, vessel types and route data are used in the calculations. For shipped materials, the International Maritime Organization (IMO), Fourth GHG study has been used for emission factors. For trucked materials, the UK Government conversion factors are used. For time-chartered vessels and some spot vessels, individual vessel emissions are calculated from reported voyage bunker consumption. Where specific bunker data is not available, standard IMO vessel emission factors are used with the distance and tonnage carried. Some transport emissions based on spend data and Quantis emissions factors are also included in this section.	Upstream transport records sourced from our business systems and combined with the IMO, Fourth GHG study for ships. *IMO GHG Study 2020 – Final Report* Secretariat and UK Government conversion factors. Distances are estimated using Seacarbon AIS, Dataloy, or standard distance tables as maintained in the Veson Integrated Rio Tinto Marine Operations System (IMOS). For logistics distances, we use Google Maps. Emissions data of time-chartered vessels and some spot vessels from SeaCarbon are based off actual bunker consumptions. These bunker consumptions are then converted. These factors are consistent with the IMO GHG Study for ships.
5	**Waste generated in operations**	0.1	Estimated emissions for third-party landfill, waste processing and wastewater. Our processes do not generate biodegradable waste. Site-based landfill and water treatment are included in Scope 1 reporting if applicable.	Estimates of domestic waste and wastewater sent to third-party facilities multiplied by the UK Government Scope 3 factors.	UK Government Scope 3 emission factors. Rio Tinto's *2022 Sustainability Fact Book* which outlines our quantities of third-party landfill and water processing.
6 & 7	**Business travel and Employee commuting**	0.5	Includes domestic and international flights, road and rail travel as well as travel services, such as hotels and taxis. Employees commuting to remote sites is included in Scope 3 business travel, and includes company-arranged charter flights. Company buses and cars are reported as Scope 1 emissions. Remainder of employee commuting to and from work has been estimated.	Air travel for fly-in, fly-out (FIFO) has been included in business travel. Emissions reports have been provided by the corporate Rio Tinto travel provider, and estimates have been made for the few sites that do not use this provider. Business travel and employee commuting emissions using spend data and Quantis emissions factors are also included in this section. Remainder of employee commuting is calculated using average commute travel modes and employee numbers.	UK Government Scope 3 emission factors Flight emissions are provided by the Rio Tinto travel provider and the major airlines we charter with.
8	**Upstream leased assets**	Not applicable		We do not lease significant upstream assets.	

Category		Mt CO_2e (equity share)	Calculation boundary	Calculation methodology	Data sources
9	**Downstream transportation and distribution**	2.3	Total Scope 3 GHG emissions from downstream transportation and distribution of sold products. Includes emissions from the transport and distribution of our products where freight has not been arranged by us (eg under Free on Board (FOB) or similar terms). Includes emissions from bulk marine shipping, containerised shipping, road and rail transport of sold products.	As per Category 4.	As per Category 4.
10	**Processing of sold products** – Iron ore – Bauxite & alumina – Titanium dioxide – Copper – Salt – Other	 386.6 147.3 5.9 0.5 7.1 1.6	Includes emissions related to the processing of iron ore, bauxite, alumina, TiO_2 feedstocks, copper concentrate and salt. "Other" includes an estimate for processing emissions related to our other products, including molybdenum and minor minerals. High-purity products like gold, silver and diamonds, which are low volume and have minimal amounts of further processing, are considered not material.	Emissions calculated as described in this report.	
11	**Use of sold products**	Not applicable	Emissions from fuels and feedstocks or from sold products that directly consume energy, eg engines.	This category is not applicable since we do not produce any fossil fuels or manufacture products applicable to this category.	
12	**End of life treatment of sold products**	Not applicable		Our products include metals and minerals with minimal emissions at end of life. Final products related to our material value chains (steel, aluminium and copper) produce materials with established recycling industries.	
13	**Downstream leased assets**	Not applicable		This is not applicable since we do not lease significant downstream assets.	
14	**Franchises**	Not applicable		This is not applicable since we do not have franchised operations.	
15	**Investments**	Not applicable	Equity share of emissions from our non-managed assets are reported in Category 15 and Scope 1, 2 and 3 so these are not double-counted. Investments such as the Rio Tinto Pension Fund UK are managed by third parties.	This is not applicable since we report Scope 1, 2 and 3 on an economic interest (equity) basis. Emissions from investments both managed and non-managed are included in reporting of Scope 1 and 2 and across Categories 1-10 in Scope 3.	

Scope 1, 2 and 3 (value chain) emissions 2022

Rio Tinto Scope 1, 2 and 3 (value chain) emissions 614.2Mt CO_2e (2022, equity basis)

This representation of our emissions shows the Scope 3 upstream emissions, Scope 1 and 2 emissions and the Scope 3 downstream emissions from our overall operations on an equity basis.

Upstream emissions 32.6Mt CO_2e

Scope 3	Mt CO_2e
Cat 1 Purchased goods (spend data)	9.0
Cat 1 Bauxite & alumina purchases	1.2
Cat 1 Higher emission purchases (eg caustic, lime, explosives coke, pitch, anodes)	8.7
Cat 2 Capital goods	2.1
Cat 3 Fuels	4.5
Cat 4 Transport (includes Rio Tinto chartered vessels)	6.5
Cat 5,6,7 Waste, business travel & commuting	0.6

Scope 1 and 2 emissions 30.3Mt CO_2e

Scope 1 and 2	Mt CO_2e
Scope 1	22.8
Scope 2	7.5

Downstream emissions 551.3Mt CO_2e

Scope 3	Mt CO_2e
Cat 9 Transport (includes customer chartered vessels)	2.3
Cat 10 Processing	
– Iron ore	386.6
– Bauxite & alumina	147.3
– TiO_2 feedstocks	5.9
– Copper	0.5
– Salt	7.1
– Other	1.6

Emissions (indicative) breakdown by Product Group

Product group	Upstream Scope 3 (Cat1-3,5-7) Mt CO_2e	Marine transport (Scope 3, Cat 4&9) Mt CO_2e	Logistics transport (Scope 3, Cat 4&9) Mt CO_2e	Scope 1 & 2 emissions Mt CO_2e	Processing of sold products (Scope 3) Mt CO_2e	Total Scope 1,2 & 3 Mt CO_2e
Total	**26.1**	**7.3**	**1.4**	**30.3**	**549.0**	**614.1**
Iron ore (includes Pilbara iron ore and Dampier Salt)	5.9	4.9	0.1	3.1	382.3	396.3
Aluminium	13.5	1.9	0.5	21.1	147.3	184.3
Copper	2.7	0.02	0.44	1.5	0.5	5.2
Minerals (includes IOC)	2.3	0.5	0.3	4.0	18.9	26.0
Other (includes shipping and corporate functions)	1.7	–	0.03	0.6	–	2.3

Data includes some rounding and approximations when apportioning between product groups.

Transport and logistics combined round up to 8.8Mt in the overall inventory but round down to 8.7Mt when split in these subcategories. This is why the overall emissions are 0.1Mt different to the total of the group reported emissions.

Independent Reasonable and Limited Assurance Report

KPMG (KPMG Australia) to the Directors of Rio Tinto plc and Rio Tinto Limited

CONCLUSION

a) Scope 1 and 2 GHG Emissions – Reasonable assurance

In our opinion, in all material respects, Rio Tinto's total Scope 1 and 2 Greenhouse Gas (GHG) emissions (equity basis) of 30.3 MtCO2-e (Scope 1 and 2 GHG Emissions) presented in the Scope 1, 2 and 3 Emissions Calculation Methodology 2022 for the year ended 31 December 2022, has been prepared by Rio Tinto plc and Rio Tinto Limited (together, "Rio Tinto") in accordance with the Reporting Criteria.

b) Scope 3 GHG Emissions – Limited assurance

Based on the evidence we obtained from the procedures performed, we are not aware of any material misstatements in the Scope 3 GHG emissions (equity basis) of 583.9 MtCO2-e (Scope 3 GHG Emissions) presented in the Scope 1, 2 and 3 Emissions Calculation Methodology 2022 for the year ended 31 December 2022, which has been prepared by Rio Tinto in accordance with the Reporting Criteria.

Information Subject to Assurance

The Information Subject to Assurance comprised the following data for the year ended 31 December 2022:

- Total Scope 1 and 2 GHG Emissions (equity basis) 30.3 MtCO2e
- Total Scope 3 GHG Emissions (equity basis) 583.9 MtCO2e

in the Scope 1, 2 and 3 Emissions Calculation Methodology 2022 available on Rio Tinto's website at https://www.riotinto.com/en/sustainability/climate-change.

Reporting Criteria

The Reporting Criteria used as the basis for reporting are:

- For the Scope 1 and 2 GHG Emissions, the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD)'s *GHG Protocol: A Corporate Accounting and Reporting Standard (Revised Edition) (2015)*, and the Basis of Preparation as described and presented within the Scope 1, 2 and 3 Emissions Calculation Methodology 2022; and
- For the Scope 3 GHG Emissions, the WRI and WBSCD's *GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (2013)* and *Technical Guidance for Calculating Scope 3 Emissions (version 1.0)* and the Basis of Preparation as described and presented within the Scope 1, 2 and 3 Emissions Calculation Methodology 2022.

Basis for Conclusion

We conducted our work in accordance with International Standard on Assurance Engagements ISAE 3000 and International Standard on Assurance Engagements ISAE 3410 (Standards). In accordance with the Standards, we have:

- Used our professional judgement to assess the risk of material misstatement and plan and perform the engagement to obtain reasonable assurance that the Scope 1 and 2 GHG Emissions are free from material misstatement, whether due to fraud or error;
- Used our professional judgement to plan and perform the engagement to obtain limited assurance that we are not aware of any material misstatements in the Scope 3 GHG Emissions, whether due to fraud or error;
- Considered relevant internal controls when designing our assurance procedures, however we do not express a conclusion on their effectiveness; and
- Ensured that the engagement team possess the appropriate knowledge, skills and professional competencies.

Summary of Procedures Performed

In gathering evidence for our conclusions, our assurance procedures comprised:

- Enquiries with relevant Rio Tinto personnel to understand and evaluate the design and implementation of the key systems, processes and internal controls to capture, collate, calculate and report the Information Subject to Assurance;
- Assessment of the suitability and application of the Reporting Criteria in respect of the Information Subject to Assurance;
- Analytical procedures over the Information Subject to Assurance;
- Substantively tested the Scope 1 and 2 GHG Emissions, on a sample basis at corporate and operational level, which included testing a selection of 15 operations being Weipa, Winu, Gladstone Power Station, Pilbara Rail Operations, Brockman, Yandicoogina, Marandoo, Boyne Smelters Limited, Tomago, Alouette, IOC Processing Plant, Queensland Alumina Limited, RTFT Smelting, Yarwun and Sohar;
- Interviews and walkthroughs with site personnel at each of the 15 operations listed above to assess the key systems, processes and internal controls to capture, collate, calculate and report Scope 1 and 2 GHG Emissions at an operational level, and how this information is reported and captured at corporate level;
- Testing the Scope 3 GHG Emissions to source documentation on a sample basis;
- Testing the mathematical accuracy of a sample of calculations underlying the Scope 1, 2 and 3 GHG Emissions;
- Assessing the appropriateness of a sample of emissions factors applied in calculating the Scope 1, 2 and 3 GHG Emissions;
- Reviewing the Scope 1, 2 and 3 Emissions Calculation Methodology 2022 in its entirety to ensure it is consistent with our overall knowledge of Rio Tinto and our observation of its operations.

Independent Reasonable and Limited Assurance Report

KPMG (KPMG Australia) to the Directors of Rio Tinto plc and Rio Tinto Limited

How the Standard Defines Reasonable Assurance, Limited Assurance and Material Misstatement

The procedures performed in a limited assurance engagement vary in nature and timing from, and are less in extent than for a reasonable assurance engagement. Consequently, the level of assurance obtained in a limited assurance engagement is substantially lower than the assurance that would have been obtained had a reasonable assurance engagement been performed.

Reasonable assurance is a high level of assurance, but is not a guarantee that it will always detect a material misstatement when it exists.

Misstatements, including omissions, are considered material if, individually or in the aggregate, they could reasonably be expected to influence relevant decisions of the Directors of Rio Tinto.

Use of this Assurance Report

This report has been prepared for the Directors of Rio Tinto for the purpose of providing assurance conclusions on the Information Subject to Assurance and may not be suitable for another purpose. We disclaim any assumption of responsibility for any reliance on this report, to any person other than the Directors of Rio Tinto, or for any other purpose than that for which it was prepared.

Management's responsibility

Management are responsible for:

- Determining that the Reporting Criteria is appropriate to meet their needs;
- Preparing and presenting the Information Subject to Assurance in accordance with the Reporting Criteria;
- Establishing internal controls that enable the preparation and presentation of the Information Subject to Assurance that is free from material misstatement, whether due to fraud or error;
- Ensuring the Basis of Preparation in accordance with which the Information Subject to Assurance has been determined and compiled is clearly and unambiguously set out in the Scope 1, 2 and 3 Emissions Calculation Methodology 2022;
- Telling us of any known and/or contentious issues relating to the Information Subject to Assurance; and
- Maintaining integrity of the website.

Our Responsibility

Our responsibility is to perform a reasonable assurance engagement in relation to the Scope 1 and Scope 2 GHG Emissions and a limited assurance engagement in relation to the Scope 3 GHG Emissions for the year ended 31 December 2022, and to issue an assurance report that includes our conclusions.

Our Independence and Quality Control

We have complied with our independence and other relevant ethical requirements of the *Code of Ethics for Professional Accountants (including Independence Standards)* issued by the IFAC Ethical Standards Board, and complied with the applicable requirements of International Standard on Quality Control 1 to maintain a comprehensive system of quality control.

KPMG

KPMG

22 February 2023

Adrian V. King

Adrian King

Partner
Melbourne, Australia

RioTinto

Rio Tinto plc
6 St James's Square
London SW1Y 4AD
United Kingdom

Rio Tinto Limited
Level 43, 120 Collins Street
Melbourne VIC 3000
Australia