Rio Tinto

Finding better ways

Decarbonising our minerals processing

2023

In contrast to many of our peers, approximately 80% of Rio Tinto's Scope 1 and 2 emissions come from the processing of metals and minerals. Processing generally requires high temperatures which increases energy requirements and are some of the harder-to-abate emissions.

Rio Tinto's second-largest source of process emissions, after alumina and aluminium, are generated from processing titanium dioxide (TiO_2) in Canada and South Africa. Around 9%, or approximately 2.8 million tonnes, of Rio Tinto's total 30.3 million tonnes of Scope 1 and 2 emissions in 2022 came from the processing of these minerals. Finding new and innovative technologies to support the decarbonisation of these facilities represents both a challenge and an opportunity for Rio Tinto's transition to net zero.

While some carbon abatement can be achieved through switching from fossil fuel to renewable sources of energy for heating and running processing facilities, new technologies and changes to traditional processing flow sheets are also required.

Each year, Rio Tinto produces approximately 1.2 million tonnes of TiO_2 feedstocks at our operations in Quebec, Canada and South Africa. This represents around 15% of the global TiO_2 market and produces primary products including chloride and sulphate slags, Upgraded Slag (UGS), rutile and co-products including zircon and metallics. Approximately 46% of the market for TiO_2 is produced in China using fossil fuel sources.

Titanium dioxide is a very white, opaque compound that absorbs ultraviolet rays and reflects 96% of light. It has been a primary ingredient in products such as sunscreen, toothpaste, paint and cosmetics for over a century. These same properties lend it to new applications such as heat-reflective paint used on buildings to reduce energy consumption from air conditioning, as well as battery and solar technology.

50% reduction by 2030

net zero by 2050

Figure 1: Rio Tinto's Scope 1 and 2 emissions targets.

About Rio Tinto Iron and Titanium (RTIT)

Rio Tinto Iron and Titanium Quebec Operations has been operating for more than 70 years. Ilmenite ore is mined at Rio Tinto's Havre-Saint-Pierre site, in northeast Quebec, or shipped from QIT Madagascar Minerals and then processed through hydro-powered smelters at its Sorel-Tracy metallurgical complex.

The site is vast, comprising of 6 interrelated plants across an area equivalent to 100 football fields, and plays a strategic role in bringing providing these products to the market.

We are partnering with the governments of Canada and Quebec to support technological innovations to decarbonise our operations by up to 70% and strengthen the critical minerals and metals value chains through the production of titanium metal, scandium and lithium. The BlueSmelting™ demonstration plant, which commenced in April 2023, takes world-first technology developed by Rio Tinto, to reduce emissions from RTIT.

If successful, the technology could be applied to our Richards Bay Minerals operations in South Africa which uses the same smelting process. There are also other potential applications for BlueSmelting™ technology in decarbonising steelmaking.

How titanium dioxide is made

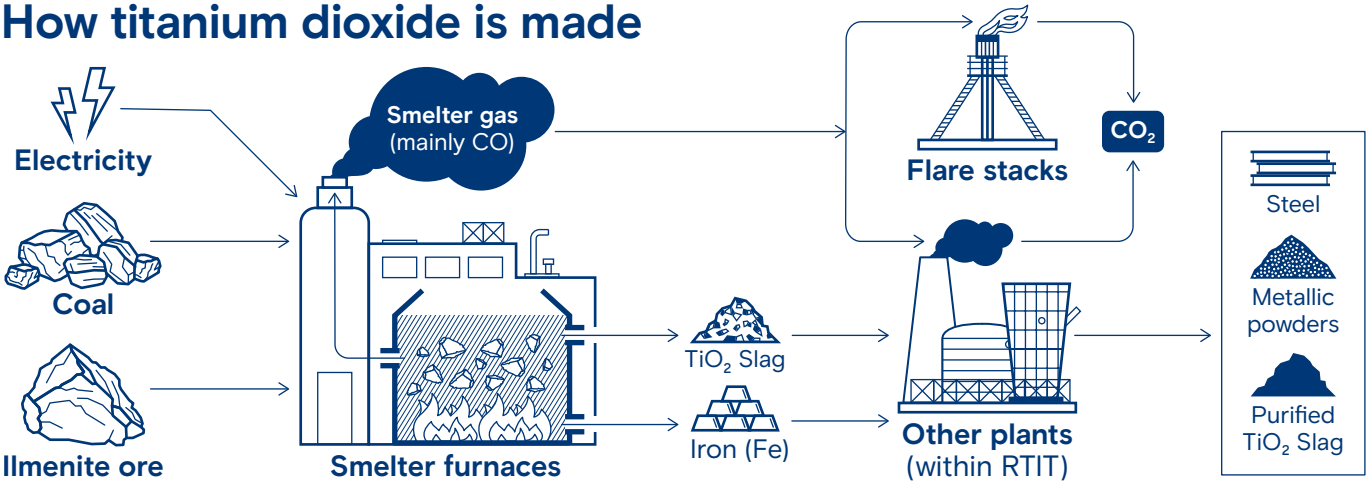

Figure 2: Overview of the titanium dioxide making process.

The traditional smelting process takes ilmenite ore containing both TiO_2 and iron oxide, and uses coal and electricity to heat the ore to approximately 1,700 degrees Celsius. During the smelting process, the carbon in the coal reacts with the ore, transferring the oxygen from the ore to the carbon, generating CO and separating a heavier iron unit which sinks to the bottom of the smelter, while the lighter TiO_2 floats.

A significant amount of energy is required to produce this reaction, known as reduction, which results in the generation of smelter gas.

At RTIT Quebec Operations, around 80% of this gas is diverted and used for process heat in other plants within the complex however, the remaining gas is emitted directly to the atmosphere. There is an opportunity to reduce emissions by reducing the amount of process heat required in the reduction process, which represents around 50% of the total energy required. The BlueSmelting™ process being piloted at RTIT Quebec Operations is a world-first developed in-house which combines mature technology used in other processes on-site, with new technologies, to develop an additional step preceding the traditional smelting process.

BlueSmelting™ (stage 1)

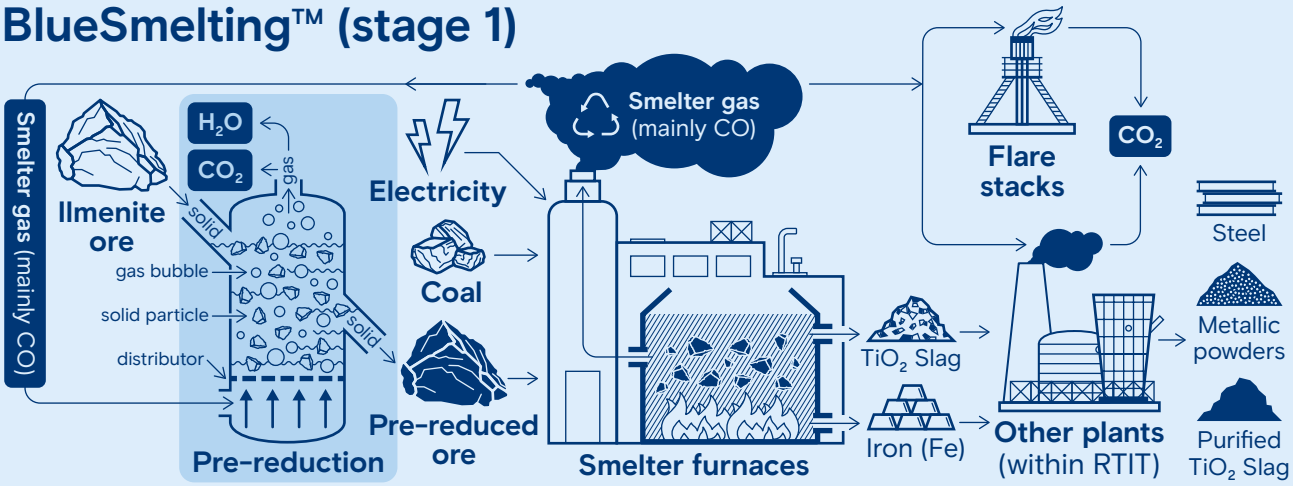

Figure 3: Overview of BlueSmelting™ process.

The additional (pre-reduction) step in the BlueSmelting™ process reduces the coal required for the traditional smelting process, meaning less coal and electricity are used to complete the ore reduction. This is the first stage of the BlueSmelting™ pilot project which could reduce emissions by approximately 30%.

BlueSmelting™ (future stages)

Further pilots will investigate a combination of using smelter gas and green hydrogen, and then green hydrogen as standalone input. This is an innovative, breakthrough technology so information gathered throughout the trials will determine effectiveness of alternative energy sources in pre-reduction while managing process safety risk. In parallel, options for the use of sustainable biomass, as an alternative to coal, are being investigated. Emissions could be reduced by up to 95% if all stages of the BlueSmelting™ process are implemented.

Project timeline

The founding of the RTIT Critical Minerals and Technology Centre in 1967 was essential to the development of BlueSmelting™ and other innovative projects. In recent years, the centre has successfully developed new products and ways of recovering minerals like scandium from waste, and advancing decarbonisation breakthroughs.

2012
Research on pre-reduction begins

2015
Ilmenite reduction studies using different reducing agents

End of 2021
Engineering studies on BlueSmelting™ process

January 2022
BlueSmelting™ pilot project approval

October 2022
Partnership with Government of Canada to decarbonise Quebec Operations

March 2022
Start of the demonstration plant construction

April 2023
BlueSmelting™ demonstration plant starts with reduction process CO gas

Ongoing
Preparation for testing to use green hydrogen as a reducing agent

This groundbreaking technology project was delivered safely, from concept to start-up,

in 14 months

Policy backdrop

While business has a vital role in managing the risks and uncertainties of climate change, governments can support the challenge by providing enabling frameworks, including policies and programs, which increase momentum toward shared net zero goals.

A range of such measures are necessary to support early movers to innovate and deploy low-carbon technology in hard-to-abate sectors. Incentives, investment from and partnerships with government and research partners are key to supporting industrial transitions and maintaining competitive manufacturing.

Transformative, leading-edge research and development is complex and trials of low emissions technology are expensive.

The Canadian federal and provincial governments have a number of programs that provide funding for projects that promote clean growth, long-term competitiveness and technological advantages. This is aligned with Rio Tinto's strategy to accelerate the decarbonisation of our operations and prioritise growth in materials that enable the energy transition.

The Government of Canada's Strategic Innovation Fund has committed to invest up to C$222 million over the next 8 years to support decarbonising our operations while supporting both Rio Tinto and Canada to supply the critical minerals essential to the energy transition in the North American market. Additional funding of C$10 million has been committed by Quebec's Technoclimat program which supports technology demonstration projects in the areas of energy and greenhouse gas emissions reduction.

This kind of support from governments at the national and sub-national level is vital to ensuring the future of RTIT Quebec Operations, promoting growth and employment and transitioning this 70-year-old facility to support the energy transition.

In addition to supporting specific projects, continued access to funding programs, including tax credits to encourage through-the-cycle investment in research and development, enables businesses to explore how existing technologies or processes can be applied in new ways, and to develop new breakthrough technologies.

Research and development incentives should reflect the pace required to address the energy transition by minimising compliance and bureaucratic processes and application approval periods.

Scaling up BlueSmelting™ to commercial scale requires increased renewable energy. Access to hydroelectric power in Quebec requires support from the government-owned provider to allocate additional units. In an extremely tight market, access to this supply could be limited and the negotiation period can be time-consuming. Support to streamline discussions and consideration of supply of additional renewable energy to hard-to-abate Canadian industries, where it can have the greatest impact, could underpin further investment in breakthrough technologies.

Alternatively, consideration and access to alternative renewable energy sources, including wind and solar, would support replace traditional fossil fuel sources used by industrial process.

Transitioning to a low-carbon future requires diverse skills and expertise. Key to meeting this demand will be investing in these skills early through educational and vocational programs and allowing flexibility for gaps to be filled internationally through efficient skills-based migration programs.

Including traceability requirements for titanium dioxide or titanium products that are government funded or purchased could support stable market demand and enhance customer relationships. Recognition of the additional cost of low carbon production should be reflected in commercial negotiations.

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