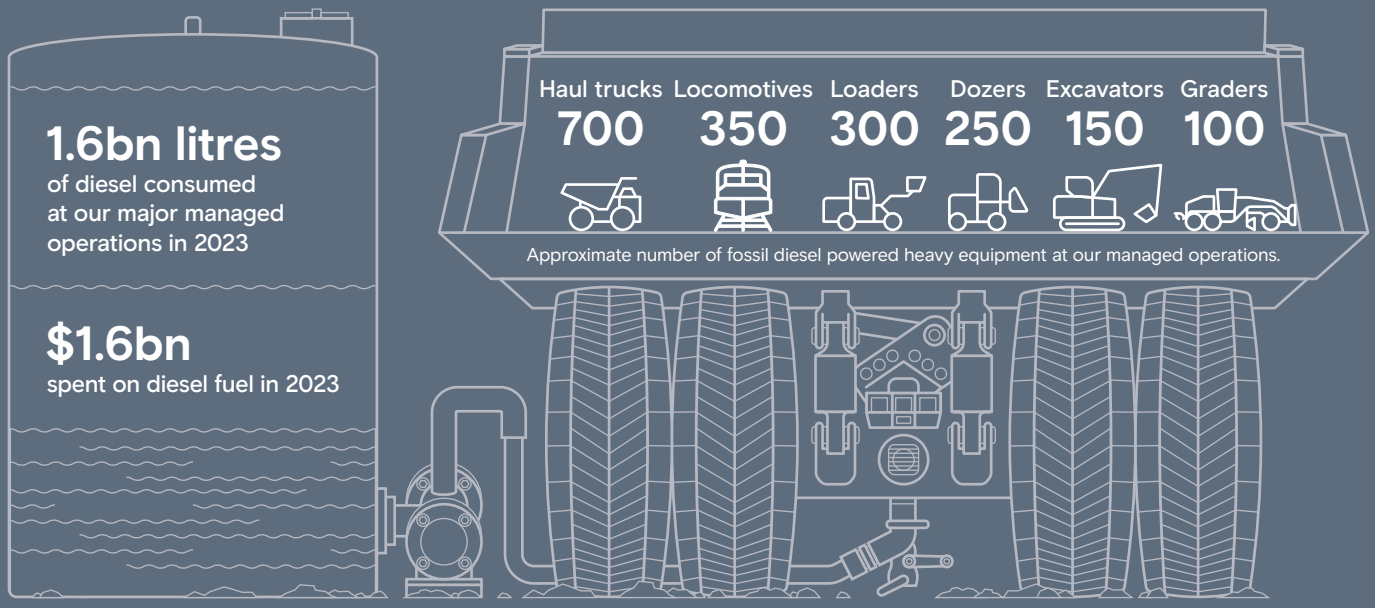
Rio Tinto

Finding better ways

Transitioning our diesel fleet

2024

Emissions from the use of diesel in our mining operations accounted for 12% or approximately 3.9mt of Rio Tinto's Scope 1 and 2 emissions in 2023. These are the emissions mainly associated with running our mobile equipment, including trucks, diggers, loaders and excavators on our sites and transporting ore on rail powered by fossil diesel fuel. Our modelling of energy sources and systems indicate that the long term-solution to reduce fossil diesel use in mining fleet and equipment is electrification.



Challenges of electrification

The electric vehicles required to support meaningful emissions reductions for the mining industry are unique from those currently being deployed in the transportation/logistics sectors or consumer vehicles with fixed routes and operating conditions. Mining solutions must be adaptable to changing mine plans and therefore supported by flexible charging locations and powerful enough to support intense work cycles with high operating hours and loads. Most importantly, they need to be safe, reliable and have sufficient battery capacity and life between charging cycles to operate in harsh environments, both hot and cold, 24 hours a day, 365 days a year.

The fleet itself is only one part of the infrastructure required to support the large-scale transition to an electric mining fleet. Charging infrastructure must be dynamic and flexible enough to support constantly evolving mine plans and equipment routes which may mean that charging stations cannot remain permanently in one location or must be complemented by mobile solutions. The charging network must also be underpinned by access to renewable energy sources and systems to operate these.

The pace of electric vehicle rollout and breakthroughs in mining fleet development assure us that this challenge can be met through innovation and collaboration, however current technology has not yet delivered the energy density required for large mining vehicles.

> Rio Tinto is committed to working with suppliers and other stakeholders to develop solutions to remove emissions from fossil fuel mining equipment from our operations.

We are exploring options with suppliers to reduce emissions from larger trucks including the development of 220 tonne zero emissions haul trucks. Trials will commence in the Pilbara with Caterpillar in late 2024, with Komatsu to follow, but we are not expecting mass deployment of battery electric haul trucks throughout our operations, and subsequent significant reduction in haul truck emissions, before 2030.

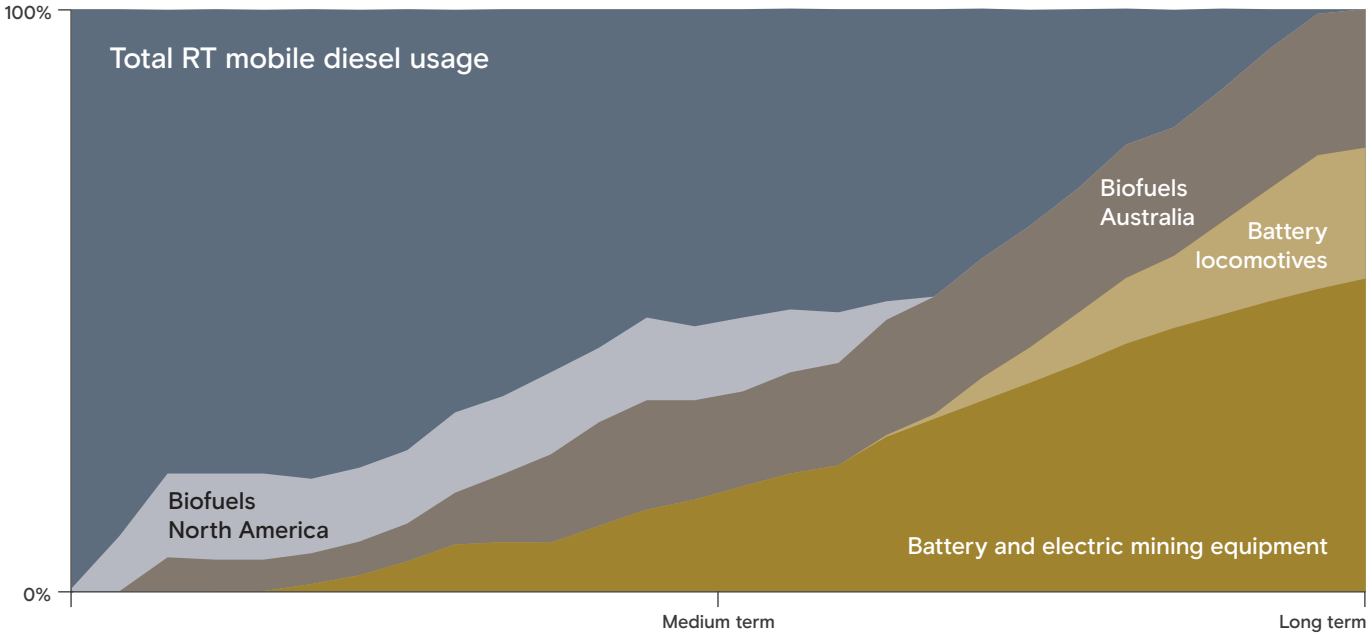
The challenges and timeframes involved with full deployment mean that the electrification pathway will not result in meaningful emissions reduction in the short term. We have developed complementary pathways to more immediately reduce diesel-sourced emissions, including improved fuel efficiency and commercial solutions, while we continue to invest in R&D projects to support electrification.

Our strategic pathway

We will prioritise projects that can meaningfully reduce diesel use before 2030, while supporting the development of electrification solutions with longer lead times.

Medium to long term transition of diesel usage

(mobile sources)



1 Improve fuel efficiency and rapidly deploy partial abatement solutions with shorter timeframes

There are alternative solutions or equipment which could reduce the number of heavy haul vehicles required or the amount of diesel fuel consumed at some of our operations. These projects could achieve partial abatement using technology that is commercially available today. For example, we are investigating the viability of trolley assist options which could reduce the fuel use of haul trucks, and other alternatives including conveyors, lower fuel-burn dig units and cable electric shovels.

2 Use alternative fuel sources including renewable diesel

Alternative, low-emissions fuels can reduce emissions from fossil diesel use in the short to medium term while we continue to work towards commercial readiness of longer-term technical solutions.

Renewable diesel is a technically feasible drop-in replacement. However, the sustainable supply of feedstock is a critical constraint to accelerated industry-wide use. This is reflected in the high price of renewable diesel in some regions.

We are developing a sourcing strategy which includes both commercial and Rio Tinto-developed supply options. The establishment of a large-scale biofuels system requires direct participation and partnerships across a complex supply chain to build a portfolio of competitive renewable diesel supply.

Developing a sustainable supply of renewable diesel in Australia is key to accelerating use in our iron ore business, which accounts for the majority of Rio Tinto's fossil diesel use. We are developing our understanding of a range of sustainable Australian-based feedstocks including carinata, pongamia and camelina.

3 Plan for battery electrification to deliver at-scale benefits after 2030

We're partnering with suppliers, original equipment manufacturers (OEMs) and our mining industry peers to accelerate the development of battery-electric haulage and charging solutions, which we believe will be operationally available after 2030 and will contribute to our 2050 emissions reduction target.

Biofuels, including renewable diesel, represent fossil fuel alternatives sourced from biomass, including vegetable oil and other organic waste materials. It is important to consider the carbon emissions associated with the full life cycle when assessing the sustainability of biofuels. This can vary depending on how the biomass feedstock is produced or sourced. Rio Tinto will continue to prioritise the use of biofuels derived from feedstocks with low life-cycle emissions, where there is a low risk of induced land-use change, and where sustainable farming practices and biodiversity are supported.

What we've done so far – a case study on trucks

There's a long-held view in mining that 'bigger is better', resulting in the use of enormous haul trucks that provide economies of scale, allowing operations to move more material, more quickly. We need to challenge our thinking on size. Larger trucks, some of which have been automated and optimised for efficiency, consume more energy than today's electric vehicle power sources can generate.

In 2022, we established a long-term research and development agreement with Scania where the Channar mine, in the Pilbara, Western Australia, would become the first active partner site for Scania's autonomous mining solutions. We are trialling the use of smaller, 40-tonne payload autonomous vehicles to test the performance of the battery truck in operations. Importantly, the trial considers the trucks' suitability for high temperature environments, and includes testing of the performance and charging rates and electrical isolation methods for the safe operation of these vehicles.

Scania autonomous electric trucks in the Pilbara, Western Australia

45,000t

Per year reduction of CO_2e emissions at our Boron operation in California by switching to renewable diesel

Refuelling with renewable diesel at our U.S. Borax operations, California.

By re-visiting optimum truck sizes, we can assess the role of trucks of various sizes as one way to reduce our emissions, as we pursue fit-for-purpose solutions to the decarbonisation challenge for diesel vehicles. There may also be added benefits of improving mining practices and reducing costs, given that smaller trucks can operate on narrower and steeper roads, therefore reducing vegetation disturbance.

Transitioning to renewable diesel

In May 2023, our Boron operation in California in the US was the first open pit mine in the world to complete the full transition of its heavy machinery to renewable diesel. The renewable diesel used at Boron is a hydrotreated vegetable oil made entirely from raw materials like used cooking oil and animal fat from the food industry. The trial showed trucks running on renewable diesel were as consistently reliable and efficient as those running on fossil diesel, without the need to modify existing diesel engines. Replacing diesel fuel with renewable diesel at Boron is expected to reduce CO_2e emissions by 45,000 tonnes per year, equivalent to the annual emissions of 9,600 cars.[1]

We expanded the trial to our Kennecott copper operation in Utah, where emissions from the use of diesel fuel account for the majority of the site's Scope 1 and 2 emissions. Rio Tinto will replace the entire fossil diesel consumption at Kennecott with renewable diesel from 2024, including 90 haul trucks and heavy machinery, as well as the concentrator, smelter and refinery.

The transition will reduce Kennecott's Scope 1 emissions by approximately 495,000 tonnes of CO_2e per annum, comparable to eliminating the annual emissions of more than 107,000 passenger cars. Combined, these these 2 initiatives at Boron and Kennecott will replace replace 11% of Rio Tinto's global diesel consumption with renewable diesel.

1. Source: United States Environment Protection Agency Greenhouse Gas Equivalencies Calculator. 45,000 tonnes CO_2e is equivalent to greenhouse gas emissions from 9,696 gasoline-powered passenger vehicles driven for one year.

Working with others

We are working with mobile equipment suppliers and mining sector peers to accelerate the commercialisation of lower emissions solutions for large haul trucks.

1 The Charge On innovation challenge

Launched by Rio Tinto, BHP and Vale in 2021, this initiative invited global technology innovators and vendors to develop new concepts for large-scale haul truck electrification systems, to accelerate commercialisation of effective solutions for charging large electric haul trucks.

2 The International Council of Mining and Metals' Innovation for Cleaner Safe Vehicles initiative

This initiative builds on our collaborative industry partnerships to solve challenges related to interoperability and large electric truck charging – promoting accelerated development of new and standardised electrification technologies.

Truck at Yandicoogina MEM workshop.

Role of government and policy

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

Investment in research and development

A range of 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 institutions are key to supporting industrial transitions and maintaining business competitiveness.

Transformative, leading-edge research and development is complex, and trials of low emissions technology are expensive. Government policies, including tax credits and incentives, which increasingly support development of new electric solutions or research to determine applicability of existing technologies in novel ways to meet this challenge are key. Government systems and regulations, including application approval periods, need to be streamlined and efficient, nimble enough to support the quantum of investment in R&D commensurate with the challenge and pace at which solutions are required to support the energy transition.

Developing alternative fuel markets

In parallel, given the potential timeframes and challenges associated with large scale development and deployment of battery vehicles in some industries, policies must support market development and competitiveness of alternative fuels.

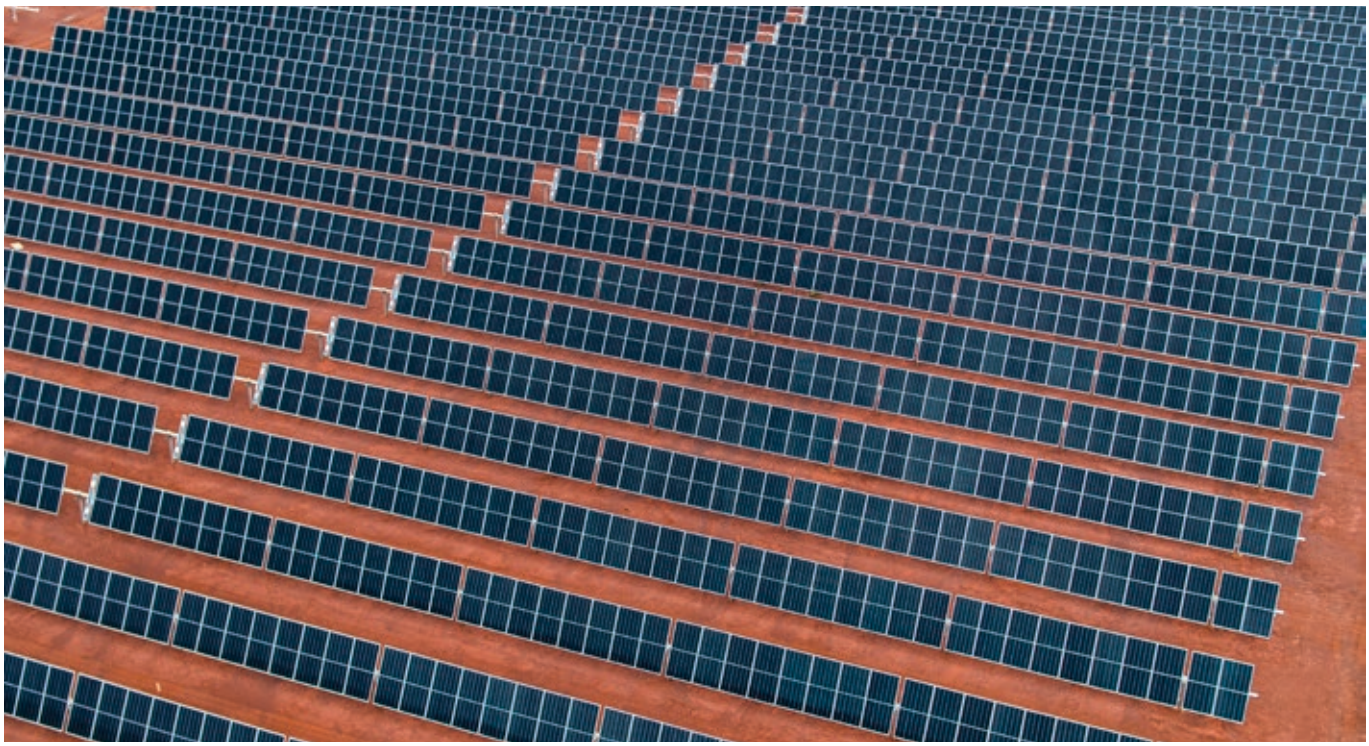
The critical role of biofuels, including renewable diesel, in Australia's energy transition was acknowledged in the previous Federal Government's 2021 Long-Term Emissions Reduction Plan. Despite this, policies addressing the physical, commercial, and economic barriers to the widespread use of diesel alternatives are yet to be developed. These must be considered and addressed as part of the development of the Government's resources and transport sectoral decarbonisation plans.

The lack of a liquid market is a key constraint to wide-spread and accelerated use of alternatives to diesel fuels, both physically and economically. Studies and projects undertaken so far which sought commercial or externally provided sources of renewable diesel were only economically viable in conjunction with government subsidies, for example those provided by the State of California.

Support is required to incentivise the production and use of biofuels, at volume, to grow this industry in Australia. Incentives could include support for R&D and pilot programs and incentives to landowners to develop advanced biofuel feedstock crops in suitable areas.

Supporting the economics of developing renewable diesel farming projects by creating pathways for these to be recognised under the Australian Carbon Credit Units (ACCU) Scheme could incentivise growth. This could serve the dual purpose of supporting development of Australia's biofuels industry, while expanding ACCU supply to help meet expected demand from facilities under the Safeguard Mechanism framework as structural decarbonisation solutions are developed and implemented.

There are broader benefits to Australian society and the economy through supporting the development of a local biofuels industry that could play an important role in the energy transition. Establishing a biofuels ecosystem, including establishing plantations, sourcing second-generation feedstocks, and processing and refining will generate multiple opportunities for creation of economic value and new partnerships, as well as supporting communities and industry in regional areas.



Solar panels at Gudai-Darri mine site's 34 megawatt capacity solar farm.

Supporting renewable energy development

Decarbonising mining fleets will require a robust renewable energy system that can meet this incremental demand reliably and at competitive prices. New large-scale renewable electricity and significant upgrades to electrical infrastructure, particularly in remote locations, will be required.

For remote locations, including the Pilbara, we anticipate this energy would be provided by Rio Tinto renewable energy projects/systems rather than through externally owned grid sources. To successfully deploy large-scale renewable projects, we will require streamlined and fit-for-purpose permitting frameworks, access to skilled labour and supportive supply chain import policies.[2]

Other policies

In Australia, all major users of diesel for business purposes – mining, manufacturing, tourism, and agriculture – have diesel fuel tax refunded.

Rio Tinto remains committed to transitioning away from traditional fossil fuels in order to achieve climate targets. There is currently a lack of technical alternatives for heavy mobile diesel fuel-based equipment and fleet and maturation of technology solutions will reduce fossil diesel use from mining equipment and fleet over time. We expect that the amount of diesel fuel tax credit that Rio Tinto receives will decline in line with the reduction of diesel use as we execute our decarbonisation programs to address emissions from these sources.

Government and government-funded businesses and industry can continue to support private industries by using their significant procurement and spending power to encourage suppliers to fast track investment in development of electric alternatives to diesel equipment.

2. The policy framework for Rio Tinto's transition to renewable energy will be the subject of a subsequent paper.

Rio Tinto