



CLIMATE ENERGY FINANCE

A Critical Minerals Value-Adding Superpower

Mapping Australia's 'once in a century' opportunity to lead the world in new economy minerals mining and renewables-powered onshore refining and manufacturing pre-export

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with a Foreword by Dr Alan Finkel

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About Climate Energy Finance

[Climate Energy Finance](#) (CEF) is an Australian based, Australian funded think tank established at the start of 2022 that works pro-bono in the public interest on mobilising capital at the scale needed to accelerate decarbonisation and the energy transition consistent with the climate science.

We conduct research and analyses on global financial issues related to the global energy transition from fossil fuels to clean energy, as well as the implications for the Australian economy, with a key focus on the threats and opportunities for Australian investments and exports. Beyond Australia, CEF's geographic focus is the greater Asian region as the priority destination for Australian exports. CEF also examines convergence of technology trends in power, transport, mining and industry in accelerating decarbonisation.

CEF is independent, non-partisan, works with partners in the corporate and finance sector, NGOs, government, and progressive social and climate movement organisations in Australia, and is philanthropically funded.

About the Authors

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Tim Buckley, CEF's founder and director, has 35 years of financial market experience in Australian, Asian and global equity markets from both a buy and sell side perspective. Before founding CEF as a public interest think tank in 2022, Tim founded the Australia and Asian arms of the global **Institute for Energy Economics and Financial Analysis** in 2013 and worked as the Australasian Director on the global energy transition for eight years.

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Tim started his career as a lecturer in Finance and Market Regulation at the University of Technology, Sydney (UTS) before moving to Macquarie Group in 1988 to work in equity research. Tim has a Bachelor of Business majoring in Accounting and Finance from UTS (1985-87) and has received the US SEC Series 7 (General Securities Representative Qualification Examination) and Series 24 (General Securities Principal Qualification Examination) qualifications.

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Foreword – Dr Alan Finkel

19 February 2023

Australia is well positioned to establish itself as a renewable energy superpower in the global shift from petrostates to electrostates. Electrostates will be those countries that supply energy transition materials such as critical minerals or supply renewable energy. Australia can be both.

The climate science is unequivocal: if we are to retain a liveable planet, the world must decarbonise. As the world's second largest exporter of coal¹ and fifth largest exporter of gas², this imperative has dramatic economic and moral implications for Australia. The Russian war against Ukraine has brought the impetus for accelerated energy transition and energy independence into even sharper focus.

The transition is happening faster than predicted. The Chinese government's target published in 2021 was for electric vehicle sales in China to reach 20% market share in 2025; this target was resoundingly beaten by sales of nearly 28% in 2022.³ The International Energy Agency's forecast in 2020 was for worldwide solar installations to reach 150 gigawatts in 2022;⁴ this target, too, was emphatically beaten by installations that exceeded 260 gigawatts.⁵

This rapid transition is fuelling the already booming demand for critical minerals. With clear direction and heightened ambition from the new government, Australia can be a leading supplier of critical minerals and decarbonised products as the world undertakes its epochal shift to the zero emissions future.

We already lead the world in the production of unrefined lithium and we are among the top exporters globally of other key energy transition materials including cobalt, copper, nickel and rare earth elements.

Currently, our resources industry is *dig-and-ship*. Nearly all our unrefined mineral resources are sent to China where they are refined, both for domestic use and to be sold to the rest of the world.

Now, two global factors are combining to facilitate Australia becoming a *value-adding superpower* that refines its critical minerals into high grade chemicals and metals before export. The first factor is that importing countries are determined to minimise their supply chain risk by diversifying their sources of supply. The second is that those same countries are increasingly looking for the refining

¹ Statista, [Leading Coal Exporting Countries Worldwide in 2021](#)

² Statista, [Leading Gas Exporting Countries in 2021 by Export Type](#)

³ People's Republic of China State Council, [14th Five Year Plan](#), 24 January 2022 (English from Google Translate)

⁴ CarbonBrief, [Exceptional New Normal: IEA Raises Growth Forecast for Wind and Solar by Another 25%](#), 11 May 2021

⁵ PV Magazine, [Global Solar Capacity Additions hit 268GW in 2022 says BNEF](#), 23 December 2022

process to be powered by low emissions energy, such as the abundant solar and wind energy in Australia.

We also have significant potential to ship sunshine as hydrogen and ammonia, and to produce decarbonised commodities such as green iron, green fertiliser, green aluminium and green aviation fuel. With appropriate policy support and private sector initiative, we could also build electrolyser and battery manufacturing industries.

The opportunity is immense, with annual global investment in clean technologies having raced past the US\$1 trillion mark. The word *billion* is inadequate to gauge the level of interest; *trillion* is the new black.

This report by Climate Energy Finance comprehensively maps, in a high degree of detail, critical minerals mining and refining and manufacturing opportunities in Australia.

It forensically examines the global new energy landscape that provides the context, including China's current dominance in decarbonisation. It reviews the policy, regulatory and public-private co-investment backdrop in Australia, and, internationally, the game-changing US Inflation Reduction Act and related initiatives.

It is a must-read for federal and state governments and agencies developing the regulatory, policy and investment architecture that will catalyse our global leadership in this sector, and for key stakeholders such as energy and resources players, investors, peak business groups and NGOs.

The race is on. We need to act strategically and with urgency and ambition, to get ahead of the game and accelerate investment. If we do, Australia will be a world-class electrostate, helping to lead the transition from the Industrial Age to the Electric Age.

This report helps us envision the shape and scale of that once-in-a-century opportunity.

As Australia's Chief Scientist and Strategic Adviser to the Australian Government, Dr Alan Finkel led the National Electricity Market Review, the National Hydrogen Strategy, the Low Emissions Technology Roadmap and the Sydney Energy Forum. His new book, "Powering Up: Unleashing the Clean Energy Supply Chain" will be published by Black Inc Books in June 2023.

Key Findings

Australia is at the start of a globally significant ‘once in a century’ clean energy-led investment boom.

The growing global focus on energy transition plays to Australia’s competitive advantages in firmed renewables and value-added critical minerals at global scale.

With urgent action on targeted, ambitious policy incentives and strategic co-investment, Australia is positioned to emerge in the new world economy as a value-added critical minerals superpower, leveraging the global energy system decarbonisation trend that accelerated dramatically in 2022.

Our economic, trade, employment, and geostrategic opportunity to take a leadership role in the zero-emissions world is unprecedented, and the opportunity cost of failing to act is untenable.

It is critical that this transformative shift is co-managed with First Nations and regional communities, and guided by a “nature positive” approach to reindustrialisation that avoids the mistakes of the past.

1. The global energy transition is a US\$1.1 trillion annual business, but to reach net zero and avert catastrophic climate change, annual investment needs to more than triple by 2030.

Global investors are voting with their money: we are seeing world #1 asset manager BlackRock’s prediction of “a seismic reallocation of capital” play out with likely upwards of US\$100 trillion of new investments in energy transition globally by 2050. However, a dramatic escalation of investment this decade is critical.

2. Accelerated recently by Russia’s invasion of Ukraine, the world is undergoing a rapid multi-decade pivot away from historically fossil fuel-dependent economies.

Russia’s war on Ukraine is a wake-up call on the importance of ending fossil fuel dependence, and on the need for energy supply chain diversification, sovereignty and security.

Globally, new investment is surging into renewable energy, grid modernisation, electrified mobility – and into critical minerals and energy transition materials mining, refining and manufacturing underpinning global decarbonisation. Global critical minerals demand is expected to grow 5 to 10x this decade.

3. China leads the world on decarbonisation by a significant margin, and controls much of the global energy transition manufacturing supply chain, presenting risks but also massive opportunities for Australia.

China globally dominates almost all emerging zero emissions and cleantech industries including processing and manufacture of critical minerals, batteries, EVs, aluminium, steel, nickel, polysilicon, graphite, solar modules and wind turbines. For example, the two Chinese leaders in battery manufacturing now produce over 50% of global supply.

This has raised significant global awareness of the risks associated with centralised supply chains, but is also a massive opportunity for Australia as an alternative supplier for countries looking to diversify their over-exposure to Chinese-dominated supply, and for Australia-China partnerships.

For example, China's Tianqi Lithium Corporation owns a stake in Greenbushes lithium mine, the world's largest, and in Australia's first onshore lithium hydroxide refinery, both in Western Australia. This key strategic partnership represents a change in the traditional zero value-add dig-and-ship model of BHP, Rio Tinto, Woodside et al. It is a win-win, attracting investment, export revenue and jobs, ameliorating trade tensions of the past, and preventing future supply chain bottlenecks.

4. Major momentum in decarbonisation policy architecture around the world is spurring massive energy transition co-investment, e.g., the US Inflation Reduction Act, a potential model for Australia.

REPowerEU is driving European decarbonisation investment, India is leading the developing world on renewables investment, Japan has announced its GX Green Transformation Roadmap and the US is now emphatically back in the global technology race.

The \$369 billion Inflation Reduction Act (IRA), \$394 billion Department of Energy loan program, \$2.8 billion Bipartisan Infrastructure Law, and Investment Tax Credit for wind, solar and battery projects, have driven >\$1 trillion of new US solar and wind investments this decade; incentivised 6.5 gigawatts (GW) per annum of new solar manufacturing; and catalysed massive investment in critical minerals mining and refining, and battery and EV manufacturing.

The Australian government should consider a comparable initiative to accelerate the domestic energy transition at the scale and pace needed to both tackle the climate and energy crisis, and position us as a global zero-emissions investment and trade leader.

5. Australia has a multi-hundred-billion-dollar investment and export opportunity to diversify our reliance on fossil fuel exports by leveraging our critical minerals wealth – but we need to value-add onshore.

Australia has the global competitive advantage of abundant geological reserves of critical minerals; we are the world's leading producer of unprocessed lithium (46% in 2021), and we produce 79% of the world's hard rock lithium, with exports forecast to reach \$16 billion in 2023, up 15x in two years. We are the world's third largest cobalt exporter, and the fourth largest exporter of mined copper, nickel and rare earths. We have significant opportunity in green ammonia, green aluminium and green hydrogen, and in manufacturing of cleantech such as electrolyzers and batteries.

However, we are failing to extract the value of our geostrategic resources here: almost 100% of Australia's critical mineral exports are sent

to China for refining to supply its dominant battery and EV manufacturing industries.

It is imperative that Australia value-add our commodities to:

- secure our economic prosperity – CEF estimates the domestic value-added energy transition materials sector is a multi-hundred-billion-dollar investment and export opportunity.
- avert a serious market contraction as fossil fuel exports terminally decline
- maximise employment opportunity, especially regionally
- ensure our energy and supply chain security, sovereignty and independence, and permanently reduce energy prices
- provide supply chain diversity to the global clean energy market.

6. Australia’s abundant firmed renewables potential should be deployed as a priority to power value-adding onshore with low-cost, 100% clean energy.

Australia’s abundant wind and solar resources and extensive land area mean we have the potential to install ~25,000 GW of renewables capacity, sufficient to generate over 86,000 terawatt hours (TWh) of energy annually, positioning us a global clean energy superpower.

This competitive advantage provides a critical opportunity to decarbonise value-adding onshore, and aid our key trade partners in abating value chain emissions by using low-cost zero-emissions firmed renewables to power mining, refining and manufacture.

We have one of the largest bulk minerals mining industries in the world. Mining majors extracting value from Australia’s resources should lead investment in renewable energy capacity expansion, decarbonising their operations and value chains. Equally, it is key that governments co-invest in and fast-track approvals for renewables capacity development at scale.

7. Australia’s pipeline of value-added critical minerals and related projects is growing, and capital inflows are accelerating, but there is a need for more ambition.

This report identifies over \$10 billion of investment proposals in resource value-adding in Australia and New Zealand including in lithium, nickel, cobalt, vanadium, rare earths, hydrogen electrolysers, green ammonia, and value-added downstream battery developments, both by Australian mining majors strategically pivoting to future-facing commodities, and new entrants to the sector.

In 2022, capital flows and value-adding significantly accelerated. For example, Australia has now produced its first commercial battery-grade refined lithium hydroxide, the precursor for battery cathodes.

Australia must now rapidly scale-up its processing of new economy minerals and metals for the economic, strategic and global decarbonisation reasons detailed here.

8. It is critical that the federal government enhance its strategic public-private investment focus to maximise co-investment in energy transition, including updating Future Fund, Clean Energy Finance Corporation (CEFC) and Australian Renewable Energy Agency (ARENA) mandates.

Public-private co-investment is a fundamental tool to secure and de-risk global clean energy supply chains, including in critical minerals. Strategic public investment by Australian capital entities and initiatives – e.g., ARENA, CEFC, the Future Fund, Northern Australia Infrastructure Facility (NAIF), Export Finance Australia (EFA), the Modern Manufacturing Initiative (MMI) etc. – reduce the financial risks of new proposals, provides a clear signal to investors to accelerate and “crowd in” private capital.

The Future Fund’s investment mandate should be updated to prioritise strategic, patient public equity investment in energy transition including value-adding critical minerals, with a national interest objective relating to Australian ownership of key assets; the CEFC’s mandate should include critical minerals refining and a requirement to work with our key regional Asia-Pacific neighbours on decarbonisation; and the same should apply for ARENA, which should help lead on renewable solutions for ASEAN and the Pacific.

9. Key strategic partnerships with global decarbonisation leaders and our trade partners are essential to value-adding our resources pre-export.

As Australia begins to value-add upstream and downstream in the global race to secure new supply chains, it is starting to build geographical diversity in foreign partnerships.

Further prioritising and scaling trade relations with the US, Japan, South Korea, India, Singapore and the EU will provide a pathway into new joint-ventured development projects.

Onshoring further down the critical mineral and manufacturing value chain is the most efficient and economic way for Australia to mitigate Scope 3 emissions globally in partnership with our key trade partners. Strategic partnerships and long-term supply agreements with global majors also provide the opportunity to leverage our mining and refining expertise with foreign R&D to scale-up the sector here.

10. There are significant employment opportunities for Australia in energy transition materials processing and manufacturing, with estimates of ~35,000 jobs by 2030.

The Australian Resources and Energy Employer Association estimates critical mineral projects currently in development will create over 6,500 jobs by 2025. If Australia diversifies and invests its mining strength into developing onshore materials processing, energy storage system manufacturing and integration, Australia can expand its workforce by 34,700 by 2030. A 2021 Accenture report estimates 30,000 new direct jobs by 2040 in critical mineral mining and refining, with a further 79,000 in associated supply chain.

Section 1. The New Energy Landscape

Today, the global energy transition is a US\$1.1 trillion per annum business. To reach global net zero emission targets, annual investment needs to triple by 2030. Russia's invasion of Ukraine was a wake-up call on the importance of global diversification of critical mineral supply and security of energy supply chains and independence. The imperative to decarbonise has never been greater, particularly with China enjoying global dominance in almost all emerging zero emission industries of the future, driven by coordinated intergenerationally focussed policy support for large-scale renewable energy, and a transition from subsidy- to market-oriented deployment. Strategically ahead of the world, China's total dominance of manufacturing in renewables, batteries, EVs and critical minerals refining is raising strategic supply chain security risks but is also a massive opportunity for Australia.

The energy transition is driving a fundamental reshaping of the global landscape.

Climate Energy Finance (CEF) forecasts cumulative investment in the global energy sector to be upwards of US\$100 trillion through to 2050⁶, creating significant global financial implications and opportunities.

The global energy crisis, crystallised in Putin's invasion of Ukraine and subsequent sanctions against Russia, has seen massive fossil fuel profiteering and energy supply shortages. However, it has also catalysed incredible global momentum in renewable energy capacity expansion and the shoring up of energy security, electrifying industry and governments alike. This provides a mammoth opportunity for Australia, with the unprecedented ability to become a global leader in critical mineral and new energy metal value-adding and exports fundamental to clean energy technology.

The scale of the clean energy investment pipeline is monumental.

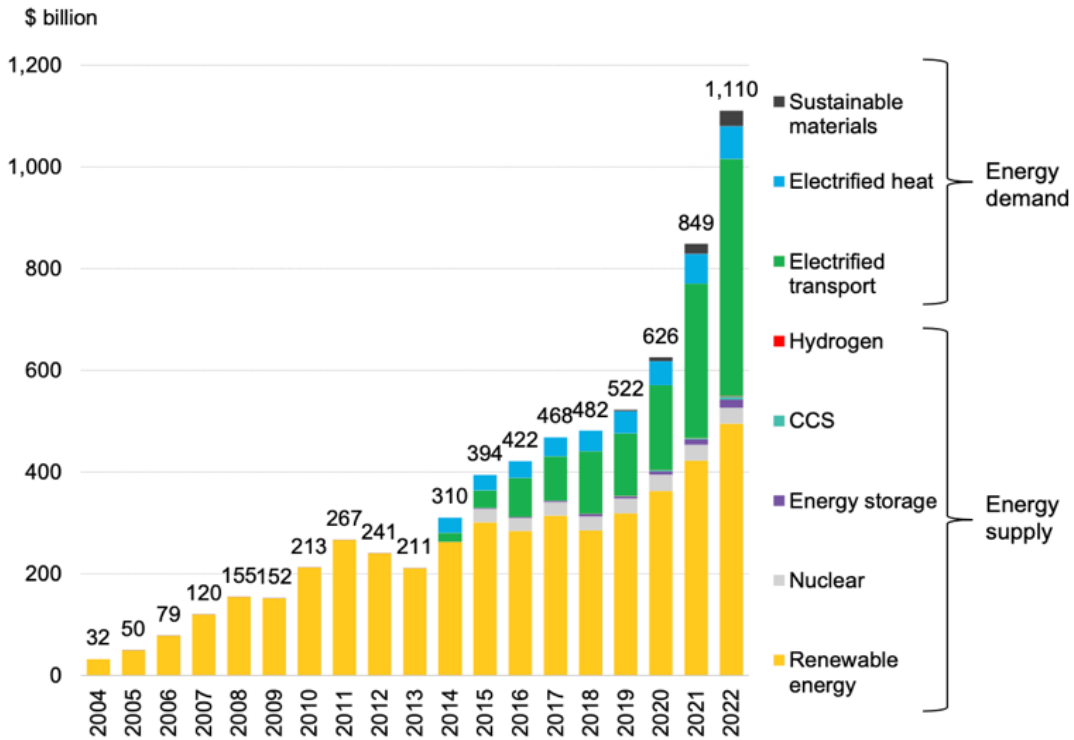
The International Energy Agency (IEA) estimated clean energy investments at US\$1.3 trillion in 2021.⁷ Bloomberg New Energy Finance (BloombergNEF) estimates energy transition investment in calendar year (CY) 2022 surged 31% year-on-year (yoy) to US\$1.11 trillion, showing the accelerating global momentum.⁸ Both the IEA and BloombergNEF forecast that to reach global net zero emission targets, investment needs to more than triple by 2030.

⁶ IEA, [World Energy Investment 2022, Overview and key findings](#), 2022

⁷ IEA, [World Energy Investment Report](#), 2022

⁸ BloombergNEF, [Energy Transition Investment Trends](#), January 2023

Figure 1: Global Clean Energy Investment Surged to a Record US\$1.1 trillion in 2022 ⁹



Source: BloombergNEF, Energy Transition Investment Trends¹⁰, January 2023

⁹ IEA, [Energy Investment in 2022](#), 26 October 2022

¹⁰ BNEF, [Global Low-Carbon Energy Technology Investment Surges Past \\$1 Trillion for the First Time](#), 26 January 2023

1.1 A Price on Carbon Emissions

The rapid deployment of renewable energy is being propelled by increasingly ambitious government targets and coordinated policy incentives for global energy security, along with progressively higher and explicit carbon emission pricing across a significant share of the global economy.

European Union

The European Union Emissions Trading System (EU ETS) pricing has just hit a historic milestone of €105/tonne having risen tenfold over the last five years. Additionally, the EU is advancing its Carbon Border Adjustment Mechanism (CBAM) to protect its domestic industries from regions failing to adequately address carbon emissions pricing. (See Figure 2)

China

The Chinese national emissions trading scheme (ETS) has been operating for over 18 months at four times the size of the sectors covered in the EU. China has announced plans to expand the scheme beyond the power sector to incorporate up to eight major emitting sectors by 2025.¹¹

United States

The United States (US) has also moved significantly on emission pricing with the Inflation Reduction Act of 2022 (refer Section 6.1) establishing a US\$1,500/tonne (t) price on methane emissions, as well as subsidies of US\$85/t for carbon capture and storage (CCS) and US\$180/t for direct air capture (DAC).

Japan

Japan announced its Basic Policy to Implement a Green Transformation (GX) roadmap in December 2022, which includes the intent to phase in a national ETS from 2026.

Australia

Australia's proposed Safeguard Mechanism advanced materially in January 2023 with Energy Minister Chris Bowen's proposal to cap carbon emission prices at A\$75/t (indexed at inflation +2% pa, so rising to ~A\$100/t by 2030) in addition to the excellent consideration of an Australian Carbon Border Adjustment Mechanism (CBAM) in support of the EU.^{12 13}

¹¹ China Dialogue, [Beijing city preparing businesses for carbon market expansion](#), 10 November 2022

¹² Climate Energy Finance, [Safeguard Mechanism submission](#), 24 January 2023

¹³ AFR, [Carbon tariffs backed by union to protect jobs](#), 11 January 2023

Figure 2: EU ETS Pricing Over the Last Five Years

Source: [Trading Economics](#), accessed 22 February 2023

1.2 Building Global Supply Chain Security Concerns

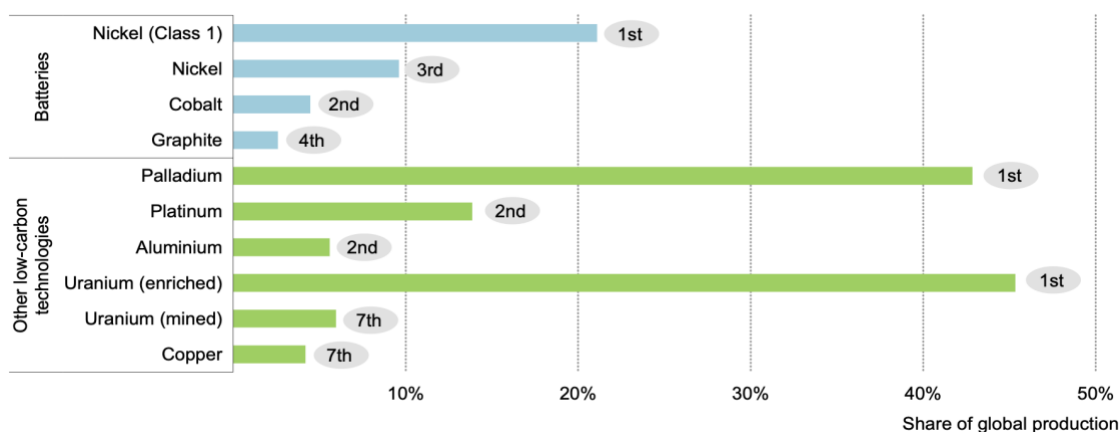
In addition to pricing in carbon emissions, minerals and metal supply critical to the clean energy transition also has dramatic geopolitical implications, many of which have been highlighted by Putin's invasion of Ukraine.

The sanctions and associated disruptions of oil, methane gas and coal supply from the world's second largest fossil-fuel exporter rippled through Europe and South Asia with significant energy price hyperinflation. The Australian Industry Energy Transitions Initiative (ETI)'s latest report, 'Pathways to Industrial Decarbonisation', illustrated the rapid increase in volume and pricing of methane gas exports from Australia to the Asia-Pacific region. For Australia's domestic market, AEMO reported average wholesale gas prices on the East coast sky-rocketed from \$8.20/GJ in 2Q2021 to \$28.4/GJ in 2Q2022. Given Australia's heavy industry predominantly operates on long-term contracts, the price inflation went directly to the households and people of Australia.¹⁴

Russia is also a major producer of the constituent minerals vital to the clean energy transition, placing further supply-pressures on the already squeezed battery market (Figure 3). For instance:

- Russia is the global #1 producer of Class 1 Nickel (high-purity, battery-grade nickel), accounting for over 20% of global supply in 2020.
- Russia is the #2 producer of cobalt, a key component to the NMC (nickel, manganese, cobalt) and NCA (nickel, cobalt, aluminium) batteries that dominate the EV industry.
- Russia is the #4 graphite producer globally, the key component of battery anodes.

Figure 3: Russia's Share of Global Production and Rank in 2020 ¹⁵



Source: IEA 2022

¹⁴ AIETI, [Pathways to Industrial Decarbonisation](#), 20 February 2023

¹⁵ IEA, [Energy Investment in 2022](#), 26 October 2022

Russia's invasion was a wake-up call on the importance of global diversification of critical mineral supply and security of energy supply chains and independence. The imperative to decarbonise has never been greater.

Energy security is enhanced by domestic energy procurement for any country with significant wind and solar resources. Decarbonisation gives a significant balance of payment economic boost as well as dramatically enhanced energy security, a lesson Germany and the EU learnt at massive economic and financial cost in 2022.¹⁶

¹⁶ CNBC, 'Crunch time': EU members in last-minute push to compromise on gas price cap, 19 December 2022

1.3 China Leads in EVs and Clean Energy

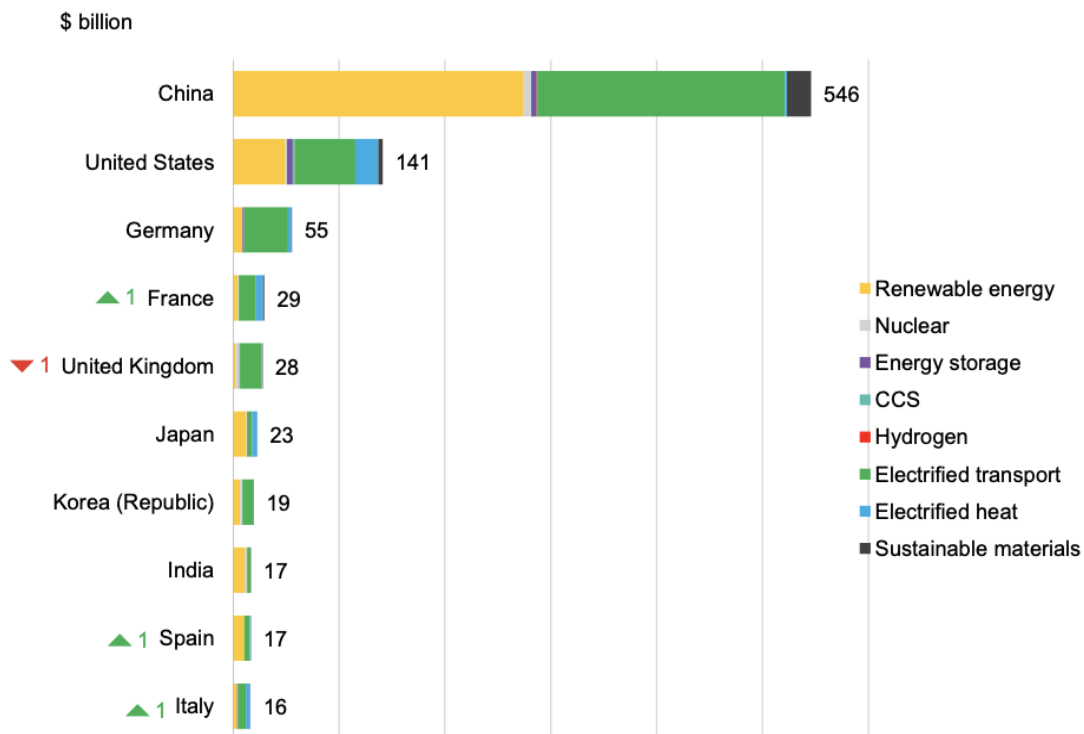
Any analysis of the enormous opportunities for Australia in the rapid growth of cleantech investing, particularly in renewable energy, electric vehicles (EVs), batteries and the associated sustained growth in critical minerals, requires a clear understanding of China's current dominance.

China has spent the last decade building out global leadership in R&DD (research, development and demonstration), investment, export positioning, refining of critical minerals, upstream manufacturing capacity as well as domestic installations at rates multiples of any competitor globally.

We would note China maintains global dominance in almost all emerging zero emission industries of the future, both within China and increasingly abroad. This includes hydroelectricity, nuclear power, grid transmission, smart meters, wind and solar installations as well as the upstream supply chains involved, batteries, EVs, green hydrogen electrolyzers and critical minerals processing.

While the US Inflation Reduction Act is a very strong and necessary move by President Biden to bring the US back into the technology race, Figure 4 highlights how significant China's annual investment lead is, most starkly in renewable energy installs and EVs.

Figure 4: China's 2022 Investment in Energy Transition Leads the World



Source: BloombergNEF, [Energy Transition Investment Trends](#), January 2023

Renewables Build-out

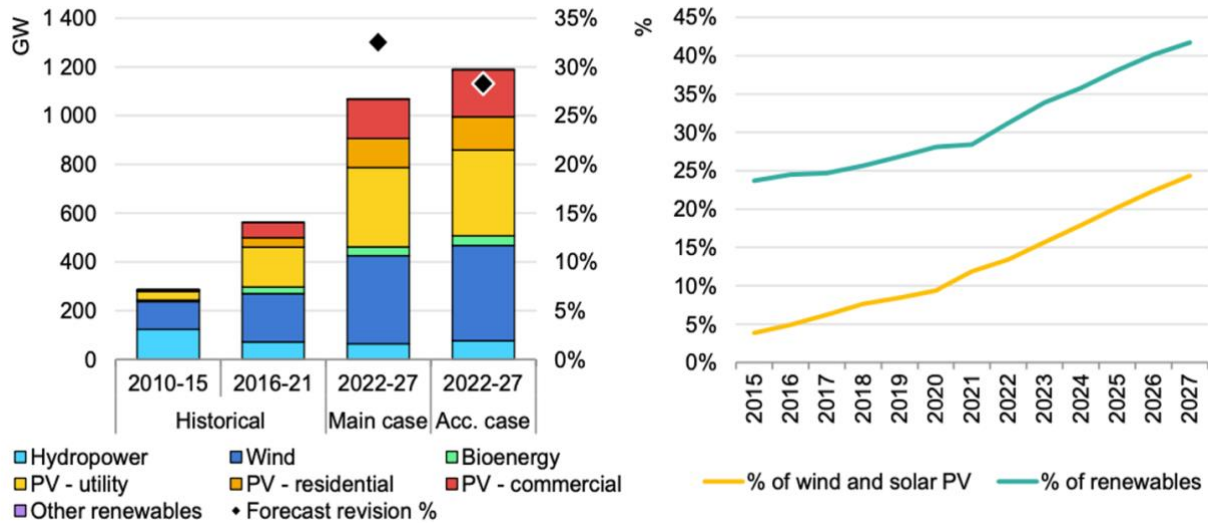
Renewables are positioned to account for over 90% of global electricity capacity expansion over the next five years, according to the IEA’s latest Renewables 2022 report.¹⁷ On a global scale, renewable energy capacity is expected to grow by ~ 2,499 gigawatts (GW) over 2022-27, equivalent to the total installed power capacity of China in 2022.

Wind and solar PV (photovoltaic) will be the key drivers of global renewable expansion, with solar PV growing by an estimated 1,500GW and 570GW of onshore wind expected to become operational by 2027. In 2021, China accounted for 35% of global energy generation from wind, and 32% from solar (the share of US and EU combined).¹⁸ China’s 2022 solar installs grew 60% yoy to 87GW.¹⁹

China’s newest Five-Year Plan (The 14th Five-Year Plan of the People’s Republic of China—Fostering High-Quality Development) marked a historic pivot in renewable capacity ambitions, shifting focus from absolute renewable deployment to a share of total electricity generation from renewable energy sources.

China’s cumulative renewable capacity is expected to double over the next 5 years, deploying over 1,000GW of renewables with ~90% from solar and wind (Figure 5).

Figure 5: China Renewable Capacity Additions and Share of Renewable ²⁰



Source: IEA 2022

¹⁷ IEA, [Renewables 2022 Report](#), December 2022

¹⁸ Reuters, [China’s Fast-Growing Renewables Limit Coal Generation](#), 18 November 2022

¹⁹ PV-Magazine, [China added 87.41 GW of solar in 2022](#), 18 January 2023

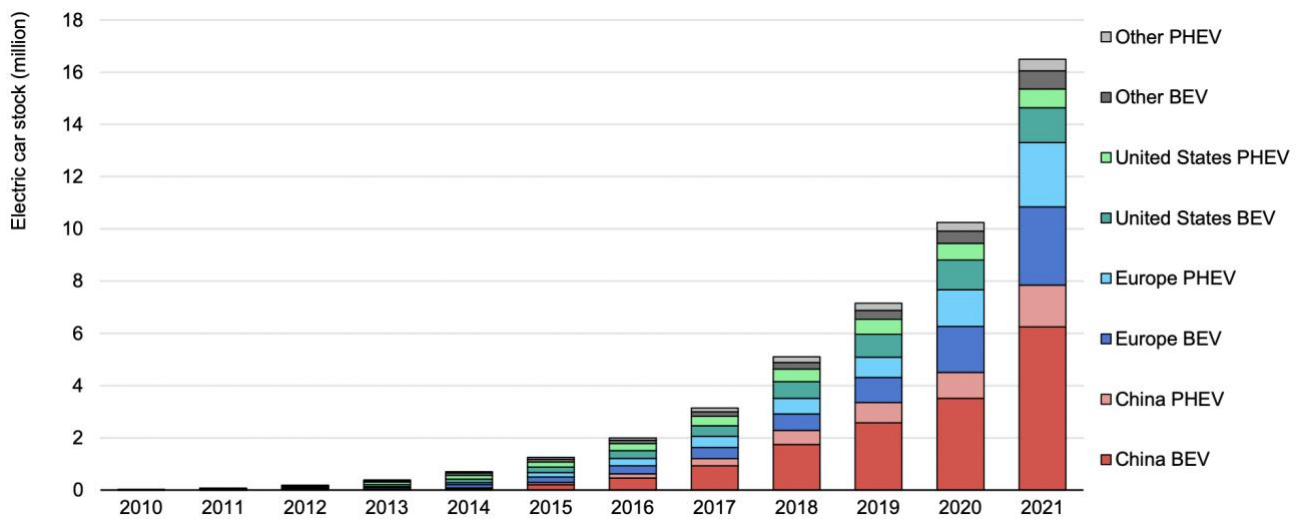
²⁰ IEA, [Renewables 2022 Report](#), December 2022

China will reach its 2030 target of 1,200GW cumulative energy generation from wind and solar PV by 2025, five years early. China’s ambitious growth is driven by coordinated, clear policy support for large-scale renewable energy, and a focussed transition from subsidy-oriented to market-oriented deployment.

New Energy Vehicles

In addition to the supercharged distribution of solar and wind technology in China, the economy also dominates electrified mobility. In 2021, New Energy Vehicle (NEV) sales more than doubled, reaching a record 6.6 million globally.²¹ China dominates the EV market, with 2021 domestic sales tripling (relative to 2020) to 3.3 million.

Figure 6: Global NEV Stock Growth ²²



Source: IEA 2022

In 2022, China NEV sales reached 6.5 million sales, up 96.3% from 2021. NEV’s accounted for an all-time high of 27.6% of all domestic auto sales, almost double that of 2021. China’s target of 20% share of vehicle sales from NEVs was expected by 2025, but it was met in 2022. The China Association of Automobile Manufacturers (CAAM) estimates NEVs to account for 30-40% of vehicle sales by 2025.²³

²¹ IEA, [EV Outlook 2022](#)

²² IEA, [EV Outlook 2022](#)

²³ Nikkei, [China NEV Sales Jump in 2022, with Some Makers Far Out in Front](#), 16 January 2023

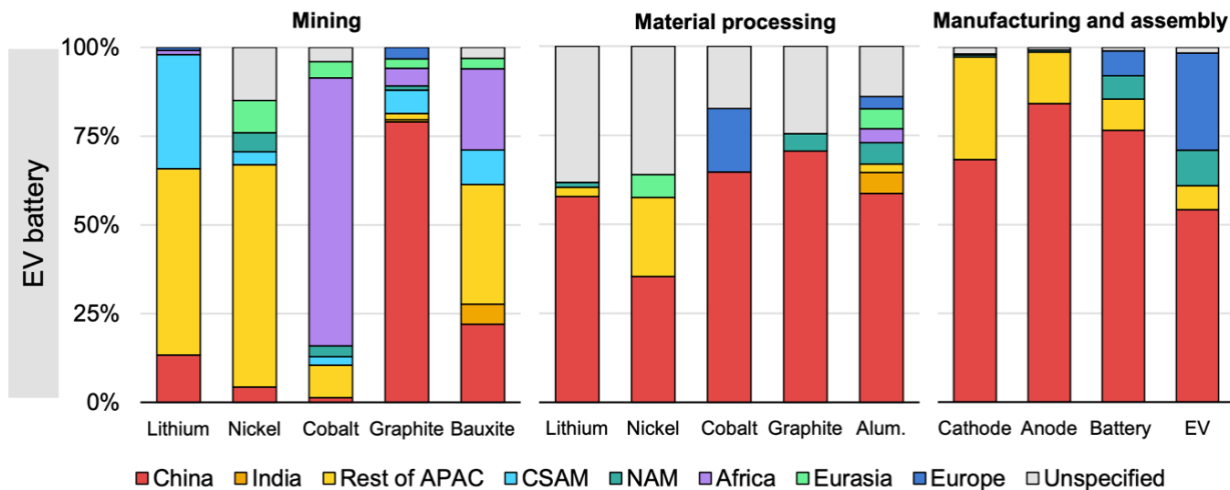
Other Clean Energy Technologies

In addition to leading the global downstream market for clean energy technologies, China is also the world leader in battery manufacturing, the key value-component of EVs.

In 2022, 60% of the top battery makers globally were Chinese, with the remainder from South Korea and Japan. China’s largest battery producer, CATL, installed over 165GWh of battery cells from January to November in 2022, up 101.8% from 2021. China’s second-largest supplier, and the global leader for EV production, BYD, installed over 60GWh of cells, expanding over 168% from the year prior. The two Chinese leaders of battery manufacturing now produce over 50% of global supply.²⁴

China dominates (Figure 7) the processing of critical minerals, aluminium, steel, nickel, polysilicon, graphite, batteries, EVs, solar modules and wind turbines. For the EV supply chain, China’s technology, investment, employment, and export power is clear.

Figure 7: Geographic Concentration of EV Technologies by Supply Chain 2021 ²⁵



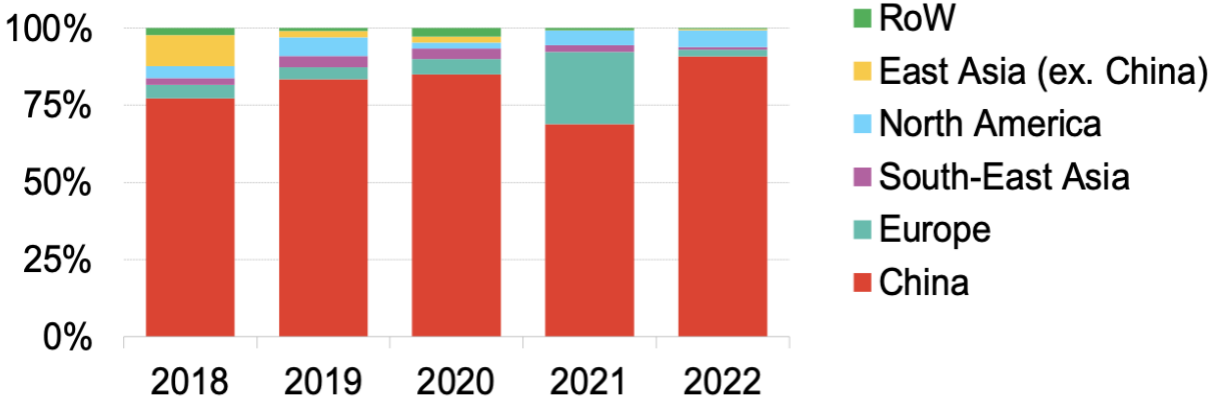
Source: IEA 2022

BloombergNEF’s January 2023 report on energy transition investing detailed a new area in their extensive coverage, that being global investment in factory manufacturing capacity. Global investment grew 44% yoy to a record US\$78.7bn across wind, solar, batteries and electrolyzers. Figure 8 shows China’s total dominance of global investment in these manufacturing supply chains.

²⁴ SCMP, *Who Powers the World’s EVs?*, 6 January 2023

²⁵ IEA, *Securing Clean Energy Technology Supply Chains*, July 2022

Figure 8: China's 2022 Investment in Energy Transition Leads the World



Source: BloombergNEF, [Energy Transition Investment Trends](#), January 2023

1.4 China's Evolving Global Clean Energy Investment Strategy

China's true dominance and global position in width and depth across fully integrated value chains has received little global attention²⁶, notwithstanding that the US military briefed Congress over a decade ago in terms of the growing strategic energy and supply chain risks, at the time most evident in rare earths.²⁷

The subsequent private market investment of US\$1.5bn in recommissioning the Mountain Pass Rare Earth Mine and Processing Facility in California by American mining corporation Molycorp²⁸ was an abject lesson in the failure of US Congress to follow through with clear strategic intent or support, with the ultimate irony being the facility was allowed to fail²⁹, then allowed by then President Trump to be acquired out of bankruptcy by a US-led consortium with a minority Chinese investor for 1c on the dollar.³⁰

Strategically ahead of the world, China's total dominance of manufacturing in renewables, batteries, EVs and critical minerals refining is raising strategic supply chain security risks, compounded by the Russian invasion of Ukraine (refer Section 1.2). This has seen an escalation of US-China trade tensions, with the US imposing significant tariff and investment imposts on Chinese firms, particularly in solar modules.

In order to build its own domestic manufacturing base in the solar supply chain, India has followed suit with solar cell and module tariffs of 25% and 40% respectively specifically targeting Chinese firms (often state-owned enterprises with all the resources of the government behind them).

Germany has overtly prohibited Chinese acquisitions of size in strategic areas, including the November 2022 blocking of Chinese proposed acquisitions by China's Sai Microelectronics of semiconductor manufacturing facility and in limiting the purchase of a strategic stake by China's COSCO of a container terminal in Hamburg.³¹

China's Belt and Road Initiative (BRI) of the last decade was all about China going global, investing in developing countries from Africa, South-East and South Asia, and the Far East through to South America. This was led by state capital underpinning landmark projects, including ports, railways, grids, and hydro and thermal power plants, and in the process, both gaining access and control over

²⁶ CGTN, [How China is leading in global energy transition](#), 17 August 2022

²⁷ Congressional Research Service, [Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress](#), 23 December 2013

²⁸ Mining Technology, [Mountain Pass Rare Earth Mine Modernisation Project, California](#), 19 June 2014

²⁹ Defensenews.com, [The collapse of American rare earth mining — and lessons learned](#), 13 November 2019

³⁰ Mining.com, [Mountain Pass sells for \\$20.5 million](#), 16 June 2017

³¹ White & Case, [Germany prohibits sale of two companies to Chinese investors – FDI scrutiny in full swing](#), 16 November 2022

mineral and fossil fuel resources in developing countries, and building an alternative geopolitical sphere of influence to counter the long-held US supremacy since the end of the Cold War with Russia. COVID and internal economic issues in China have resulted in an ongoing series of setbacks in the BRI projects.

China's Recent Cleantech Investment

Recent investments suggest a possible evolving pivot in China's global cleantech strategy.

One clear absence in the BRI was any effort to overtly invest overseas in zero emission industries of the future at any scale, putting aside the hydro and grid sectors. This changed in April 2019 with President Xi's clear pivot showing China's intent to undertake a greening of the BRI.³²

Another key event was the surprise announcement by President Xi Jinping in September 2021 (in his address at the United Nations General Assembly) that China would not build any new coal-fired power projects abroad, building on China's pledge to reach peak emissions by 2030 on the path to net zero emissions by 2060.³³

Three days later the Bank of China pledged to stop financing new coal mining abroad with immediate effect.³⁴ Over the previous five years, China, along with Japan and South Korea, were by far the largest providers of government subsidised Export Credit Agency (ECA) finance for coal mine and coal-fired power plants in the emerging world. These two pledges have been largely enforced with immediate effect (beyond existing commitments underway at the time).³⁵

China-Australia Partnerships

As noted in Section 3, while Australia is the world's leading producer of unprocessed lithium with a 46% share in 2021, China takes almost 100% of Australia's exports for refining onshore to supply their dominant downstream battery and EV manufacturing industries.

China's Tianqi Lithium Corporation owns a controlling 51% stake in Tianqi Lithium Energy Australia (TLEA), a joint venture that in turn owns a 51% controlling stake in the Greenbushes lithium mine in Western Australia (WA), the largest lithium mine in the world. Tianqi also owns a controlling 51% stake in Australia's first onshore refinery of lithium hydroxide (LHM) being built at Kwinana, WA. China in turn gets control of its global supply chain.

This is a key strategic partnership for Australia, demonstrating that we can add value to our resources pre-export, gaining the investment, regional employment and export revenues that result. It

³² Reuters, [China's Xi says Belt and Road must be green, sustainable](#), 25 April 2019

³³ Reuters, [In climate pledge, Xi says China will not build new coal-fired power projects abroad](#), 21 September 2021

³⁴ Reuters, [Bank of China to stop financing new coal mining, power projects overseas from Q4](#), 24 September 2021

³⁵ Boston University, Global Development Policy Center, "Small is Beautiful": A New Era in China's Overseas Development Finance? 19 January 2023

represents a change in the traditional zero value-add 'dig-and-ship' model of BHP, Rio Tinto, Exxon and Shell, a win-win for Australia and China that should encourage cooperation³⁶, and a move away from the trade tensions of the past few years that resulted under the antagonistic stance against China by Australia's previous Federal LNP government. Sabre-rattling against Australia's largest trade partner was never going to end well for Australia.

We also note that Australia is currently building two additional LHM refineries in WA: one in Kemerton via an 85:15 joint venture between US Albemarle and ASX-listed Mineral Resources, with the partnership favouring Albemarle; and another at Kwinana, a 50:50 joint venture between ASX-listed Wesfarmers and SQM of Chile. What appears to be a nice example of Australia welcoming investment from all countries carefully ignores that in 2018 China's Tianqi acquired a 24% strategic stake in SQM for US\$4bn.³⁷

Lithium Resource Development Driving EV Growth

The strategic implications for Australia of the announcement³⁸ by the Government of Bolivia to partner with a Chinese consortium that includes China's mining firm CMOC and China's CATL (the world's largest battery manufacturer) for a US\$1bn development of Bolivia's lithium brine resources need to be better understood. Bolivia's salt flats are home to the world's largest lithium resources at 21 million tonnes (Mt) according to the U.S. Geological Survey, but the country has almost no industrial production. We are likely to see a major new world scale competitor to Australia emerge at speed to increase global supply, which in turn might curb rampantly high lithium prices in the medium term.

Chinese battery manufacturers are rapidly expanding their footprint in clean energy technology globally. CATL invested offshore for the first time in 2019, announcing a €1.8bn 14GWh battery cell production plant in Germany, creating over 2,000 local jobs. The plant commenced cell production in December 2022.³⁹ CATL also announced an expansion into Hungary with a massive €7.34bn investment to develop a 100GW battery cell plant to supply primary European automakers.⁴⁰

In EV manufacturing and domestic sales, China leads the world, with a global EV share approaching 60% in 2022 after sales nearly doubled yoy. But China is rapidly moving to become the world's largest automobile exporter. According to CAAM data, China surpassed Germany to become the world's second-largest automobile exporter, shipping 3.11 million vehicles in 2022, up 54.4% from 2021. In 2022, Germany exported 2.61 million. China is rapidly closing in on the global export leader, Japan,

³⁶ AFR, [Xi says China-Australia ties heading in 'right direction'](#), 26 January 2023

³⁷ Nikkei Asia, [China's Tianqi buys stake in lithium miner SQM from Nutrien for \\$4.1bn](#), 4 December 2018

³⁸ Reuters, [Bolivia Taps Chinese Battery Giant CATL To Help Develop Lithium Riches](#), 20 January 2023

³⁹ CATL, [CATL's German plant receives approval for battery cell production](#), 6 April 2022

⁴⁰ CATL, [CATL Announces Second European Battery Plant in Hungary](#), 12 August 2022

exporting 3.2 million from January to November 2022. Mainland China manufacturers are expected to produce 3,000GWh of EVs in 2025, three times the anticipated domestic demand for EV capacity.⁴¹

In December 2022, China's BYD, the largest global EV manufacturer, also set its target on capturing Japan's domestic EV market. BYD announced it would enter Japan's domestic car market for the first time in January 2023, establishing 22 distribution and sales locations across the country.

Japan has the third-largest vehicle market globally, with ~4-5m units sold annually, and less than 1% New Energy Vehicles.⁴² BYD plans to disrupt the current EV producers - Nissan and Tesla - with BYD undercutting both of their entry-models in price with their Atto 3. BYD also holds a 70% market share of the domestic EV bus fleet in Japan. On 31 January 2023, BYD debuted into the Japanese market with deliveries ready to hit the market by March 2023.⁴³

Table 1: China New Energy Vehicle Domestic and Export Summary 2022 ⁴⁴

	2022 Production	YoY Growth	Market Share	2022 Sales	YoY Growth	Market Share
Total Domestic Vehicles	27,021,000	3.4%		26,864,000	2.1%	
Passenger Vehicles	23,836,000	11.2%	88.2%	23,563,000	9.5%	87.7%
of which New Energy Vehicles	6,716,000	97.8%	28.2%	6,548,000	94.3%	27.8%
BEV	5,132,000	83.4%	76.4%	5,033,000	81.7%	76.9%
PHEV	1,584,000	165.0%	23.6%	1,515,000	152.4%	23.1%
Commercial Vehicles	3,185,000	-31.9%	11.8%	3,300,000	-31.2%	12.3%
of which New Energy Vehicles	342,000	81.5%	10.7%	338,000	78.9%	10.2%
BEV	335,000	82.7%	98.0%	331,000	79.9%	97.9%
PHEV*	4,000	10.5%	1.2%	4,000	10.5%	1.2%
Total Vehicle Exports	3,111,000	54.4%				
of which New Energy Vehicles	679,000	120.2%	21.8%			

* BEV + PHEV does not account for full NEV Production and Sales in Commercial New Energy Vehicles

Source: China Association of Automobile Manufacturers

In January 2023, BYD announced its target to capture 40% of India's EV market by 2030, the fourth-largest auto market in the world, and the fastest growing major two-, three- and four-wheeler auto

⁴¹ SCMP, [China Closes Gap with Japan after 2022 Car Exports Surpass Germany](#), 15 January 2023

⁴² Nikkei, [China's BYD Plans to beat Nissan and Tesla on EV Price in Japan](#), 5 December 2022

⁴³ Nikkei, [China's BYD Starts EV Sales in Japan as it Chases Tesla](#), 31 January 2023

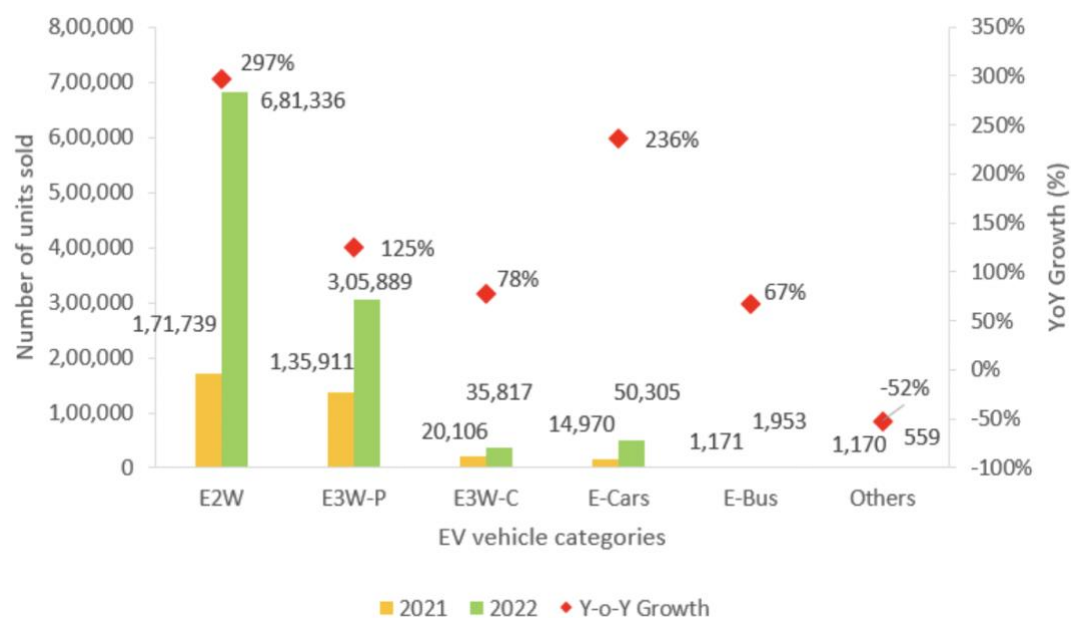
⁴⁴ CAAM, [Automotive Statistics, 2022](#)

market. Looking to access India's lagging EV market relative to other dominant economies, BYD is aggressively driving capital flows to position itself as a global technological powerhouse.⁴⁵

In 2022, India's annual EV sales reached over one million for the first time, with aggregate electrified mobility sales growing over 212% from 2021.⁴⁶ JMK Research attributed the rapid growth to increased availability within the market supported by state subsidies and incentives under the Faster Adoption and Manufacturing of Electric Vehicles – Phase 2 plan (FAME-II), with sales also fuelled by rising prices for petrol, diesel and CNG (compressed natural gas). FAME-II includes a number of improved policies and incentives for electric adoption, namely the Production Linked Incentive (PLI) scheme for the scaling of domestic manufacturing and cell production onshore. The PLI has instilled confidence in original equipment manufacturers (OEMs), both domestically with Tata Motors and Mahindra, and internationally with BYD and Hyundai, so that India will become a hub for EV component manufacturing and reduce import dependency pressures that have inflated EV prices globally.

Whilst 2-wheelers and 3-wheelers dominated India's auto-market, JMK have revealed electric passenger vehicles are the second-fastest growing subset, with 236% growth yoy in 2022.

Figure 9: EV Sales and Growth in India by Submarket 2022⁴⁷



Source: Vahan Dashboard; Telangana Open Data 2022

⁴⁵ Bloomberg, [China's BYD Plans Push into India Burgeoning EV Market](#), 12 January 2023

⁴⁶ JMK India, [India Braced Itself for a Spectacular EV Show in 2022 with 212% yoy Growth](#)

⁴⁷ JMK India, [India Braced Itself for a Spectacular EV Show in 2022 with 212% yoy Growth](#)

Tata Motors remain the dominant domestic OEM, growing its production volumes 307% yoy in 2022 to hold an 84% market share of all electric passenger vehicle sales.

Globally, BYD is already the world's second largest battery manufacturer and in 2022 became the world's largest EV manufacturer by volume, overtaking Tesla. BYD is also the world's largest EV bus manufacturer.⁴⁸ China's domestic market accounts for ~95% of the world's EV bus sales. BYD built an EV bus factory in California in 2014 and has recently done the same in Chile, South America.⁴⁹

January 2023 saw reports that BYD is looking to reverse the trend of German auto manufacturers investing in China, with a possible move to purchase Ford's Saarlouis plant in Germany so that BYD can make EVs there.⁵⁰

Recommendation

Australia is strategically well positioned both as a strong emerging supply chain partner to China in value-added critical minerals, but also as an alternative supplier for countries looking to diversify their over-exposure to Chinese-dominated supply chain risks.

Climate Energy Finance recommends that the Australian government not just set strategic policy agendas, but crowd-in private capital, both patient domestic super and strategic foreign investors (like POSCO). In doing so, strategic public grants, equity, infrastructure, venture capital (VC), export credit and debt capital can fund due diligence and endorse proposals of strategic national interest.

Diversification of industry and R&D partnerships across expanding markets, including the US, India, EU, Japan and Korea provides Australia with strategic value, whilst immediately de-risking and fast-tracking new project developments by securing long term offtake revenue clarity and endorsement.

Over the long-term, Australia can amplify mutual capabilities to leapfrog next-generation technologies and build out domestic downstream value chains, furthering Australia's position as a region for global supply chain centralisation risk mitigation. This will also help ensure adoption of our national interests are accommodated by mandating ESG best practice, and will ensure majority domestic ownership is maintained.

Additionally, given the growing decarbonisation objective of the Albanese government, patient public capital can also help ensure domestic value-adding of our critical minerals is undertaken pre-export, leveraging our world scale renewable energy resources so that we are also helping our trade partners decarbonise their economies (e.g. processing our world leading \$130bn pa of iron ore exports into green iron pre-export to help China, India, Japan and Korea move onto a path to steel sector decarbonisation).

⁴⁸ Chargedevs, [BYD delivers over 70,000 electric buses—almost all in China](#), 24 January 2022

⁴⁹ BYD press release, [BYD helps to launch Latin America's first 100% electric bus corridor](#), 15 October 2022

⁵⁰ The Driven, [China turns tables on German car industry as BYD plans to buy Ford factory to make EVs](#), 25 January 2023

Section 2. Australia's Critical Mineral Opportunity

Australia's competitive advantage is enormous as global critical minerals demand surges five to tenfold this decade, underpinned by the accelerating energy transition. Australia is currently the world's third largest cobalt exporter, and the fourth largest in mined copper, nickel and rare earths. It has nearly 80% of the world's share of hard rock lithium (spodumene concentrate), with the Office of the Chief Economist forecasting exports to hit \$16bn in FY2023, a fifteenfold increase in value terms in just two years, providing tidy earnings opportunities to commodity majors belatedly pivoting in, such as Rio Tinto. Nickel exports are forecast to nearly double to \$5.1bn while copper exports are up 5% in two years to a forecast \$12bn, leveraging BHP's world leading resource position here.

With China's clear dominance and shortages across the global supply chain, Australia can diversify its reliance on iron ore and fossil fuel exports by bolstering critical minerals with onshore refining and manufacturing powered by our growing renewable capacity, expanding investment and employment locally. These future facing commodities give Australia a global competitive advantage and could potentially divert the country from a serious market contraction as our fossil fuel exports – coal and LNG - terminally decline.

The European Commission's Mission-Oriented Policy framework design in 2017-20 highlights policy should shift from merely incentivising private firms with public capital, to clearly directing investments into targets, objectives and national strategic interests through close interaction with public-private partnerships. Establishing clear mission-oriented policy in Australia for clean energy exports and renewable energy capacity will tilt the patient long-term strategic financing required for high-risk and capital-intensive projects, bringing economic value and growth to Renewable Energy Zones and mining / refining projects that encompass regional communities.

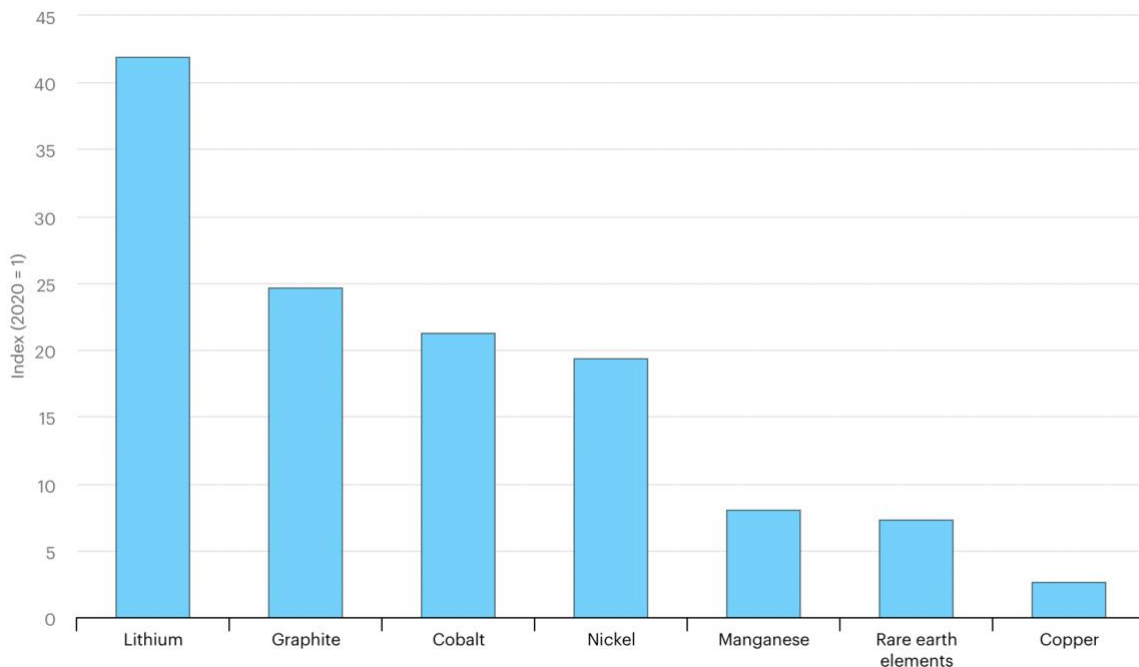
Global critical minerals demand is expected to surge five to tenfold this decade, underpinned by the accelerating energy transition. The IEA forecasts global demand for lithium could grow 42 times by 2040 (relative to 2020 demand) under its Paris-aligned Sustainable Development Scenario. Other key components to battery technology, including graphite, cobalt, and nickel, could grow by 19-25 times over the same period.⁵¹

Global supply shortages are already evident, driving many key commodity prices to record highs. This has been compounded by sanctions against Russia after its invasion of Ukraine, China's world leadership of almost all zero emission industries of the future and the rapid ongoing expansion in the domestic Chinese economy to help drive global scale and learning-by-doing, most starkly illustrated by the near doubling of Chinese EV sales in 2022.

⁵¹ IEA, [The Role of Critical Minerals in Clean Energy Transitions](#), 26 October 2022

Supply chain security concerns have been exacerbated by a growing awareness of the world’s over-reliance on Chinese and Russian suppliers. For Australia, combined with our world-leading renewable energy resources, this creates a ‘once in a century’ opportunity that is economically transformative, and on a scale that surpasses even our existing dominance in other commodities. Australia is the world’s largest exporter of iron ore (55% global seaborne share), equal largest in both LNG (20%) and coal (30%), and the country can now add lithium spodumene (79%) to this key list.

Figure 10: Mineral Demand Growth from Clean Energy Technologies 2020-2040 ⁵²



Source: IEA 2022

Key Supporters of Change for Australia

Australia’s Chief Scientist, Professor Cathy Foley, has written about the booming demand for critical minerals, Australia’s abundance of deposits, and the opportunity for highly skilled regional jobs in value-adding, describing it as an “excellent economic opportunity to cement Australia into the global supply chain for low-emissions technologies”.⁵³ Ex-Chief Scientist and key government technology and energy advisor Dr Alan Finkel likewise notes the imperative to change Australia’s ‘dig and ship’ economy has intensified.⁵⁴ And in September 2022, Australian-born Tesla Chair Robyn Denholm

⁵² IEA, [The Role of Critical Minerals in Clean Energy Transitions](#), 26 October 2022

⁵³ The Australian, [Critical minerals offer us a new kind of mining boom](#), 31 August 2022

⁵⁴ Canberra Times, [Aust tipped to be powerful 'electro state'](#), 14 September 2022

highlighted how Australia is to-date missing out on the “value-add” from its mineral resources, urging investment to establish the infrastructure to refine and manufacture battery cells and EVs.⁵⁵

These views reflect BlackRock’s CEO Larry Fink’s referencing of the “accelerating tectonic shift” in global capital markets toward clean energy.

Australia needs to remain nimble and strategic to ride this global wave without delay, particularly after the inertia, climate science denialism, and intransigence of the previous Federal government, and the huge opportunity cost that its epic policy failure and fossil fuel sector capture entailed. All Australians are paying the price for this lost decade. The immense opportunities of the transition are now ours for the taking.

Experts like Professor Ross Garnaut and Alan Finkel have long argued that Australia will be a Renewable Energy Superpower.⁵⁶

The global challenge of decarbonisation means that Australia is also perfectly positioned to be a critical minerals mining and refining powerhouse, leveraging our world-leading wind and solar resources, our huge, relatively sparsely populated continent, and our financial market depth at a potential scale unrivalled by any other nation (except China, which already leads the world).

Australia has a unique opportunity to transition elegantly from dirty to clean energy exports and energy generation, with the capability to drive spillover economic benefits to regional and First Nations communities.

The European Commission’s Mission-Oriented Policy framework design in 2017-20 highlights that policy should shift from merely incentivising private firms with public capital, to clearly directing investments into targets, objectives and national strategic interests through close interaction with public-private partnerships.⁵⁷

Establishing clear mission-oriented policy in Australia for clean energy exports and renewable energy capacity will tilt the patient long-term strategic financing required for high-risk and capital-intensive projects, bringing economic value and growth to Renewable Energy Zones and mining / refining projects that encompass regional communities.

CEF views the investment, regional employment, technology, and value-added export potential of the global energy transition as a ‘once in a century’ opportunity for Australia. Competing with the largely state-owned, world leading energy giants of China is largely beyond the financial capacity of private markets alone. Strategic policy settings that catalyse industry development and co-investment by the Australian government will be key to Australia maximising its potential.

⁵⁵ AFR, [Australia is missing out’ on battery revolution: Tesla chairman](#), 14 September 2022

⁵⁶ Ross Garnaut, [Energy: Superpower: Australia’s low carbon opportunity, 2019](#)

⁵⁷ European Commission, [Towards a Mission-Oriented Research and Innovation Policy in the EU](#), 7 April 2018

2.1 Australia’s Mining Majors’ Strategic Pivot

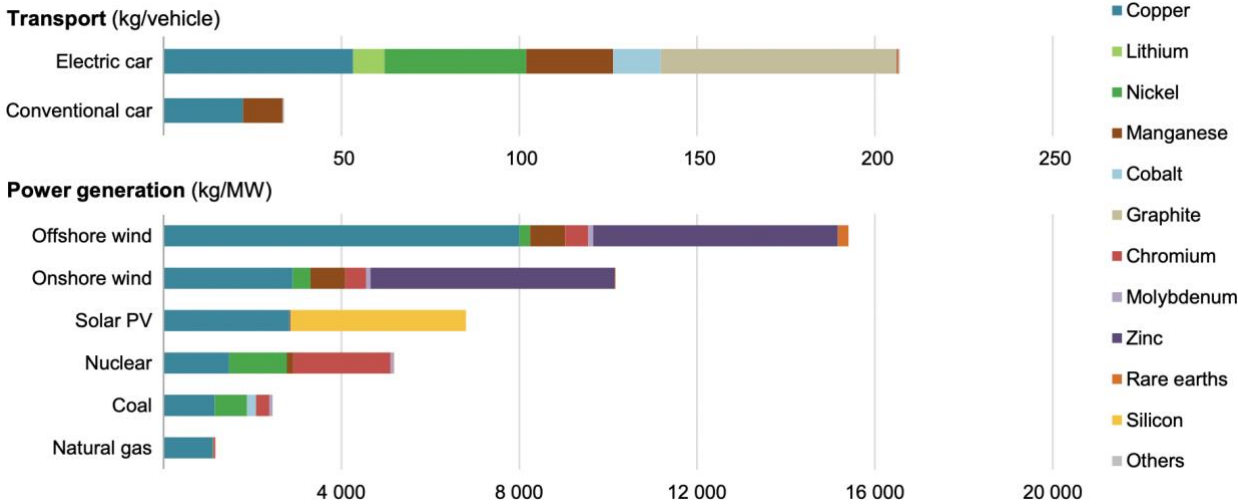
While the global economic development of the past few decades has been massively reliant on steel, cement and fossil fuels, the energy transition now underway will lower the absolute dependence on bulk commodity mining and change the composition of mining radically.

The energy transition’s reliance on critical minerals (or future facing commodities, to use BHP’s parlance) will rise dramatically. The IEA schematic below (Figure 11) shows the mineral intensity required for energy generation technologies, but we note in analysing Australia’s threats and opportunity, it fails to showcase the massive intensity of use of coking coal, thermal coal, or methane gas mining in the current global energy.

For Australia, this is the key issue. As the world’s largest LNG and coal exporter, Australia is exceptionally exposed to the world’s collective efforts to address climate science at the scale and speed needed. Australia needs to understand and invest in preparation for this change, and Australia’s world-leading mining industry and workforce combines with our world-leading resources wealth to prove a massive opportunity.

We can potentially entirely offset the inevitable long-term contraction as our fossil fuel exports if we invest in onshore refining powered by renewables to drive decarbonisation.

Figure 11: Mineral Intensity of Clean and Fossil-Based Energy Technology ⁵⁸



Source: IEA 2021

⁵⁸ IEA, *The Role of Critical Minerals in Clean Energy Transitions*, May 2021

Australia has long been a key quarry to the world. And once again, the country is blessed as the ‘lucky country’, being a top five supplier of a number of critical minerals. In lithium, our current global supply dominance exceeds that of iron ore, with a 79% global share of hard rock lithium – spodumene concentrate. South America dominates the less well-developed supply of lithium carbonate from brine. Australia is likewise a significant exporter of mined copper (#4 in the world, with a 4% global share), nickel (#4 in the world, 5% share (but 25% of the world’s resources))⁵⁹, rare earths (#4 in the world, 9% share), and cobalt (#3 in the world (but 19% of the world’s resources))⁶⁰.

Today, Australia exports the majority of its commodities straight from the mine, with very limited refining value-adding. Aluminium is one of the few exceptions at scale, as the country still powers its mainland aluminium refineries predominantly with high carbon emission-intensive fossil fuels, leaving this industry heavily at risk should the EU CBAM come into force and be replicated by any of Australia’s key trade partners across greater Asia.

⁵⁹ Australian Government, [Resources and Energy Quarterly: June 2022](#), 4 July 2022

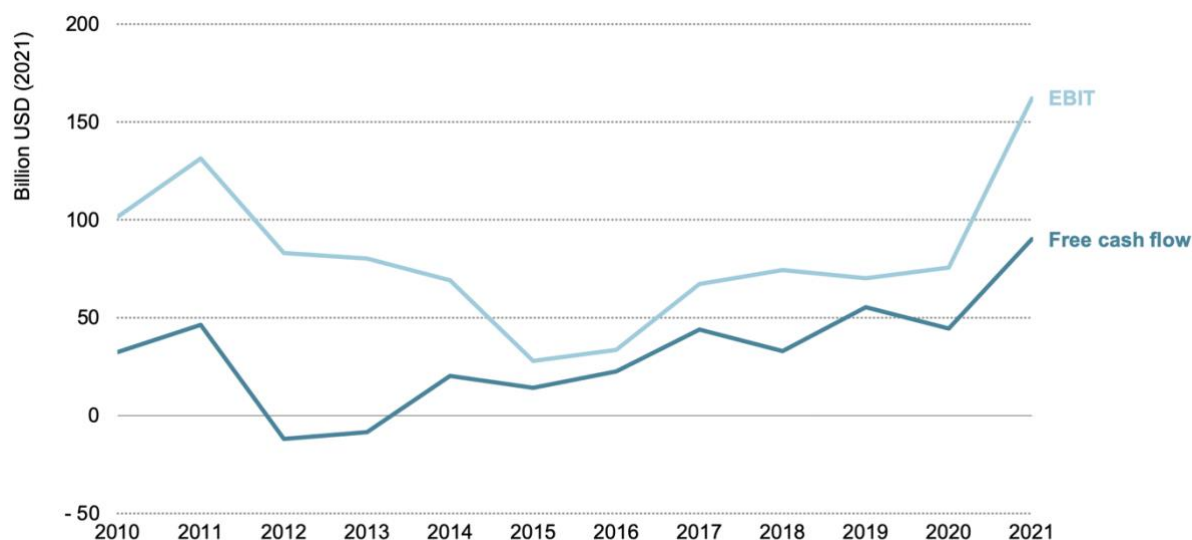
⁶⁰ West Australian Government, [A Global Battery and Critical Minerals Hub](#), June 2022

Diversification Away from Fossil Fuels

Australia is starting to diversify away from its mining export reliance on iron ore and fossil fuels. In December 2022, the Office of the Chief Economist (OCE) forecast lithium exports to hit \$16.1bn in 2023, up fifteenfold in value terms in just two years. Nickel exports are forecast to nearly double to \$5.1bn while copper exports are up just 5% in two years to a forecast \$12bn after the copper price correction seen in 2022.⁶¹

The rapid growth in profitability and cash flow positions of global commodity majors from the energy transition, including Australian giants Rio Tinto, BHP and Mineral Resources, is driving capital flows into exploration and expansion. The EBIT (Earnings before Interest and Tax) for lithium specialists increased by over 50% in 2021, driving expenditure into widening portfolios and vertical integration across critical mineral value chains.⁶²

Figure 12: Operating Profits and Free Cash Flow of Top 18 Global Mining Companies ⁶³



Source: IEA 2022

⁶¹ Australian Government, Office of the Chief Economist, [Resources & Energy Quarterly Report](#), Dec 2022

⁶² IEA, [Energy Investment in 2022](#), 26 October 2022

⁶³ IEA, [Energy Investment in 2022](#), 26 October 2022

Australia's Major Mining Houses Are Well Underway in Strategic Repositioning

Underlying divestment of its petroleum business to Woodside, BHP has progressively pivoted its corporate strategy to “secure further growth opportunities in future facing commodities” essential to the energy transition and economic growth, with CEO Mike Henry noting that “the world will need more copper and nickel for electrification, renewable power and electric vehicles.”⁶⁴ This follows the significant de-weighting of coal in BHP's portfolio with the South32 spin-off back in 2017. The BHP 2022 book value of assets split is an impressive 50% copper/nickel, 31% iron ore, 14% coal and 7% potash (although the gross profit split is 52% iron ore weighted, reflective of this division's exceptional profitability).⁶⁵

Meanwhile, Rio Tinto is following a similar path. Having fully divested from coal back in 2018⁶⁶, Rio is now looking to dramatically ramp up its copper exposure via development of the Oyu Tolgoi mine in Mongolia⁶⁷ and the Rincon lithium brine deposit in Argentina.⁶⁸

Wesfarmers completed its exit from coal in 2018⁶⁹ and then in 2019 pivoted aggressively into lithium mining at Mt Holland and lithium refining at Kwinana, WA.⁷⁰

Meanwhile, with most of the global mining and fossil fuel majors too heavily focussed on sunset commodities (with BP really trying to be the exception here), a whole raft of new Australian mining majors are coming through, showing strategic foresight and leadership, led by Pilbara Minerals, Mineral Developments and IGO, with market capitalisations over \$12bn each (refer Appendix 1), and delivering massive sustained outperformance for their shareholders (up 200-400% each in the last five years alone).

The return on investment will be evident as Australia establishes itself as a value-added critical minerals sector leader, with the concomitant benefits for energy independence, supply chain security, and critical geostrategic considerations in our increasingly volatile and warming world.

⁶⁴ BHP, [Growing value and positioning for the future](#), 18 August 2021

⁶⁵ BHP [2022 financial results and operational reviews](#), 16 August 2022

⁶⁶ Renew Economy, [Rio Tinto's restructuring signals global industry move away from coal](#), 5 March 2015

⁶⁷ AFR, [The global war for copper is just getting started](#), 12 September 2022

⁶⁸ Rio Tinto, [Rio Tinto completes acquisition of Rincon lithium project](#), 29 March 2022

⁶⁹ Reuters, [Australia's Wesfarmers quits coal with \\$635 million mine sale](#), 7 August 2018

⁷⁰ AFR, [Wesfarmers says lithium play part of taking carbon out of economy](#), 2 May 2019

Section 3. Australia's Lithium Outlook

Australia leads the world in lithium mining. We have benefited significantly in the last two years from unprecedented growth in lithium export volume and value driven by surging demand from refiners and battery manufacturers and the global race for clean energy supply chain security. The top five pure lithium ASX-listed companies now having a combined market capitalisation exceeding A\$56bn, up eight-fold over the last seven years.

Capturing the value of minerals processing pre-export is imperative to Australia's economic growth. Australia is necessarily beginning to value-add upstream and downstream in the global race to secure new supply chains, and is starting to build geographical diversification in foreign partnerships. Further prioritising and scaling trade relations with the US, Japan, South Korea, India, and the EU provides a pathway into new joint-ventured development projects to help global battery and EV leaders secure their supply chains. Onshoring further down the critical mineral and precursor manufacturing value chain is the best deal for mitigating Scope 3 emissions globally in partnership with our key trade partners. The inclusion of strategic partnerships and long-term supply agreements with global majors provides the opportunity to leverage our mining and refining expertise with foreign R&D to scale out precursor and battery manufacturing onshore. Australia can leapfrog commercialisation and innovation and become a global leader in decarbonised heavy industry and sustainable mining practices.

Australia is at the start of a globally significant 'once in a century' clean energy-led investment boom.

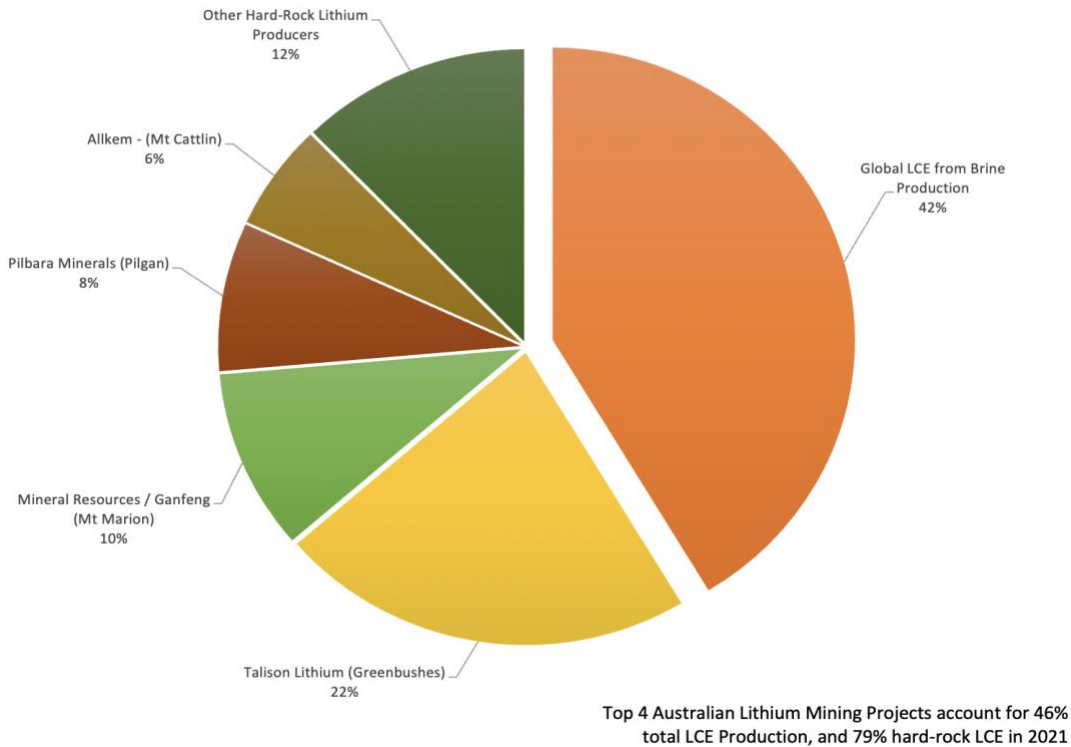
Australia is already the largest exporter of spodumene concentrate (lithium contained in hard rock), with a 2021 global mining share of 79% of global spodumene concentrate production (i.e., excluding non-battery grade lithium brines, produced in South America) and 46% of lithium carbonate equivalent (LCE).

Drivers of Earning Growth

The rapid growth in earnings is driven by the aforementioned unparalleled deployment of clean energy technology and electrified mobility in China. In 2021, 85% of Australia's lithium exports were to China. In 2022, China's share of Australia's lithium exports continued to grow, accounting for over 94%, with over \$1.1bn of spodumene concentrate shipped to China in June alone. (See Figure 14)

This exponential value growth is a consequence of the growing supply gap to meet demand from rechargeable batteries, the industry that accounts for 80% of lithium use. Lithium refiners and battery manufacturers are shoring up inventory, concerned by an even-more pressurised global supply chain.

Figure 13: Global Lithium Carbonate Equivalent Production 2021 ⁷¹



Source: Wood Mackenzie 2022

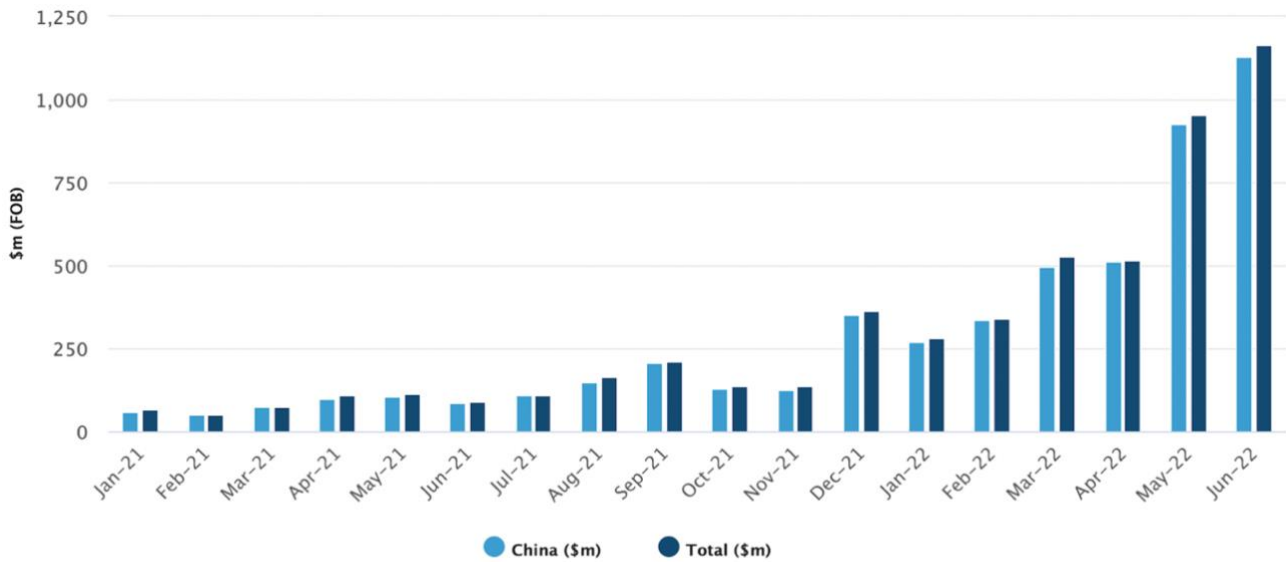
This trend is also clear in the capital raisings of new ASX listings and the surge in exploration spending, with mineral exploration by all companies in Australia in the June 2022 quarter hitting a record \$1.04bn even as petroleum exploration fell 21% to \$245m. Lithium exploration hit a record \$600m or 60% of all Australian mineral's exploration.⁷²

Australia's top 5 pure lithium companies⁷³ now have a combined market capitalisation exceeding A\$50bn, up eight-fold over the last 7 years.

⁷¹ Tianqi, [Appendix IV, Tianqi Lithium Global Prospectus 2022](#)

⁷² AFR, [Mining exploration spend of \\$1b hits record levels](#), 2 September 2022

⁷³ Pilbara Minerals, IGO Ltd, Liontown Resources, Mineral Resources and Allkem Ltd; excluding Wesfarmers (50% owner of Covalent Lithium) as a conglomerate.

Figure 14: Australian Lithium Concentrate Exports to China as Share of Total Exports ⁷⁴

(a) FOB = Free on Board (excludes freight and insurance costs)

Source: Australian Bureau of Statistics 2022

Lithium Refining

The refined lithium mineral used as precursor material to Li-ion battery manufacturers, lithium hydroxide (LHM), experienced similar value growth in 2022 to its upstream form. In 2021, LHM prices were US\$17,370/t. In 2022, prices rose upwards of US\$39,850/t, with an anticipated rise to over US\$60,000/t in 2023, rising over 260% in 2 years.⁷⁵

In 2021, Australia was the world's largest exporter of iron ore, coal, LNG and critically, lithium, making it the 'quarry to the world' with zero value-adding being undertaken. Capturing the value of minerals processing pre-export is imperative to Australia's economic growth.

The OCE forecasts Australia will account for 10% of global LHM production by 2024, rising to 20% by 2027. China currently processes 60% of the world's LHM, almost all sourced from Australian lithium spodumene mines, highlighting the strategic opportunity for Australia to value-add pre-export.

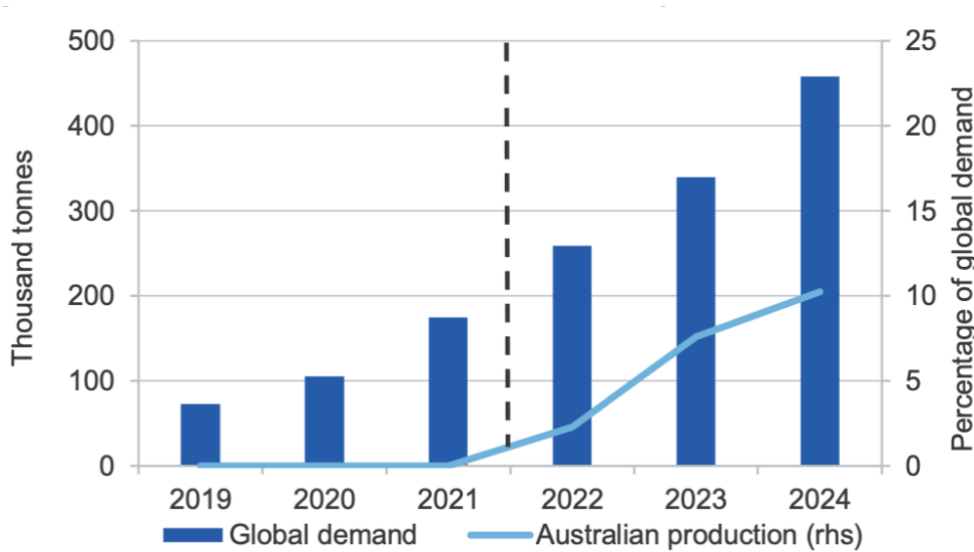
The Australian Bureau of Statistics reported a 22% increase in mineral exploration spending in 2021-22, reaching \$3.9bn.⁷⁶ Australia has two major spodumene-focused projects currently in the developmental pipeline, both set to supply majors across the mineral refining and battery landscape.

⁷⁴ ABS, [Insights into Australian Exports of Lithium](#), 4 August 2022

⁷⁵ OCE, [Resources and Energy Quarterly](#), December 2022

⁷⁶ Australian Critical Minerals Prospectus 2022

Figure 15: World and Australian Lithium Hydroxide Monohydrate Output ⁷⁷



Source: Bloomberg NEF, Office of the Chief Economist June Quarter 2022

Liontown Resources (Australia)

ASX-listed Liontown Resources (market cap. \$3.4bn) is developing the WA Kathleen Valley Lithium Project, designed to initially feed 2.5Mtpa, producing 500,000tpa of spodumene concentrate.

The plant is expected to begin production in the first quarter of CY2024 with an expansionary investment planned to increase ore processing from 2.5Mtpa to 4Mtpa, producing ~ 700,000tpa.

The initial capital investment and expansion was expected to be \$545m. However, in January 2023 Liontown announced an improved initial capacity of 3Mtpa ore throughput, but also significant cost inflation in its capex estimates to \$895m.⁷⁸ Liontown looks to still have sufficient liquidity to complete the project on schedule.

Kathleen Valley had over 90% of its projected output secured in long-term contracts before it started construction. Liontown Resources signed agreements with global battery value chain majors Tesla, LG Energy Solutions and Ford Motor Company, each securing ~ 150,000tpa.

Liontown has commenced open pit operations which will provide material for Run-of-mine pad and Tailings Storage Facility, with Liontown also open to Direct Shipped Ore (DSO) sales whilst stockpiling to facilitate commission and ramp up of concentrator plant.⁷⁹

⁷⁷ Australian Government, [Resources and Energy Quarterly: June 2022](#), 4 July 2022

⁷⁸ Liontown Resources, [Kathleen Valley Project Update](#), 20 January 2023

⁷⁹ Liontown Resources, [Open Pit Mining Operations Commence at Kathleen Valley](#), 3 February 2023

The rapid development of Kathleen Valley was due to the speed of financial close, driven purely by market forces. A key component of its Final Investment Decision (FID) was the injection of a \$300m debt facility from its foundational customer, Ford Motor Company. The debt facility demonstrates the sector's growing bargaining power, with automakers fundamentally poor stakeholders in mining firms given the competing interest in product pricing. The debt facility also has a comparatively low interest rate of 1.5% above the bank bill swap rate.⁸⁰

In November 2021, Liontown announced a Downstream Scoping Study to develop a 3-train lithium hydroxide facility to value-add its Kathleen Valley operations. The proposed 86.4ktpa facility (28.8ktpa per train) would be the 3rd-largest LHM producer globally, and the largest outside of China. The scoping study estimates capital cost of ~ \$1.5bn.⁸¹

Core Lithium (Australia)

ASX-listed Core Lithium (market capitalisation \$2.1bn) commissioned its Northern Territory Finniss Lithium Project in October 2022, with the capacity to supply up to 197,000tpa.⁸² Finniss is the first lithium project outside of WA, further cementing Australia's dominant position as the world's largest lithium exporter. The pre-production capital expenditure was calculated at \$89m.⁸³

The Finniss project has off-take agreements with Chinese refining major Yahua Industrial Group, a key supplier to EV powerhouse Tesla. The Finniss project is strategically located to supply spodumene to Asia, given its proximity to Darwin Port and substantial infrastructure in place for grid connectivity and haulage. On 5 January 2023, Core Lithium shipped its first product, 15kt of spodumene to its Chinese customer base, discharged at US\$951/t.⁸⁴ Core Lithium is also exploring the possible addition of a downstream value-added plant to produce lithium hydroxide. Core Lithium was awarded a \$6m Modern Manufacturing Initiative (MMI) grant to move into feasibility studies for the Darwin proposal.

Allkem (Australia)

ASX-listed Allkem (market capitalisation \$8.9bn) is one the largest established lithium majors globally, operating in four continents in 2022. Allkem recommenced the Mt Cattlin spodumene operation in 2016, producing ~ 194,000tpa. Mt Cattlin obtained long term off-take contracts for its entire production to Chinese refiners, Yahua Lithium and Chengtun Lithium.⁸⁵

⁸⁰ Bloomberg, [EV Makers Partner with Miners to Secure Key Metals](#), 3 October 2022

⁸¹ Liontown Resources, [DFS and Updated DSS](#), November 2021

⁸² Core Lithium, [Finniss Lithium mine official opening](#), 10 October 2022

⁸³ Core Lithium, [DFS and Scoping Studies Investor Presentation](#), 26 July 2021

⁸⁴ Core Lithium, [First Finniss Lithium Shipment Sails](#), 5 January 2023

⁸⁵ Mining Technology, [Mt Cattlin Spodumene Project](#), 21 June 2021

Pilbara Minerals (Australia)

ASX-listed Pilbara Minerals (market capitalisation \$15.3bn) is one of Australia's largest lithium mining firms, exporting 8% of the global lithium supply in 2021 through its 100% owned Pilgangoora lithium mine in WA, which produces 580ktpa of lithium spodumene concentrate.

Pilbara Minerals is investing in expansionary projects in both refining and exploration. The P680 Project includes an upgraded Primary Rejection facility and refined crushing and ore sorting package that will increase Pilgangoora's output by 100ktpa.⁸⁶

In December 2022, the capital cost was revised to \$404m, a capital inflation of 36% from its FID capex estimate as recently as June 2022.⁸⁷ Completion is expected by December 2023 with ramp-up scheduled for March 2024. The new facility will bring Pilgan operation processing up to 5Mtpa.

Pilbara is also investing long-term with its P1000 project, an expansionary investment to bring output up to 1Mtpa of spodumene product, up from 680ktpa on completion of the P680 expansion. In December 2022, Pilbara said FID is expected in March quarter 2023.⁸⁸

Pilbara Minerals has expanded its footprint in the downstream lithium industry, entering into an 18:82 JV with South Korea's POSCO to develop a 43ktpa lithium hydroxide facility in Gwangyang, South Korea.⁸⁹ The total funding of the project was estimated at US\$750-800m, with commissioning expected in September 2023. Pilbara Minerals' strategic cooperation with POSCO strengthens Western Australia's and South Korea's battery industry connection, a globally significant market with ~ 37% of global battery output in 2022. POSCO's investment and funding support for Pilbara Minerals' development of its lithium business supports its commitment to invest US\$40bn with local partners in Australia by 2040 in clean energy supply chains, announced in December 2022.⁹⁰ This demonstrates the positive economic growth and enhanced competitiveness of Australia's critical mineral exports from diversified foreign direct investment, and Australian firms expanding their global position.

May 2022 saw a 55:45 JV of Pilbara Minerals and ASX-listed Calix awarded a \$20m grant from the Australian Government under the MMI⁹¹ to progress a world-first small demonstration scale chemicals facility at the Pilgangoora Project. The aim is to produce high value-add lithium salts for global distribution via an innovative midstream value-added refining process to dramatically reduce shipping of the ~94% waste mixed in with the 6% lithium ore.⁹² This builds on the Pilbara-Calix memorandum of understanding (MoU) for a scoping study executed in May 2021. The MMI grant has been re-endorsed by the new Federal government (albeit with grant documentation still to be executed), and FID is due in the first half of CY2023.

⁸⁶ Pilbara Minerals, [FID To Increase Pilgangoora Production Capacity](#), 29 June 2022

⁸⁷ Pilbara Minerals, [Offtake Pricing and Project Expansion Update](#), 21 December 2022

⁸⁸ Pilbara Minerals, [December 2022 Quarterly Activities Report](#), 19 January 2023

⁸⁹ Pilbara Minerals, [Diggers and Dealers Conference 2022 Presentation](#), 3 August 2022

⁹⁰ Korea Times, [POSCO Chief, Australia PM discuss \\$40bn in Eco-Friendly Projects](#), 1 December 2022

⁹¹ AFR, [Coalition's modern manufacturing grants used as election announcements](#), 26 August 2022

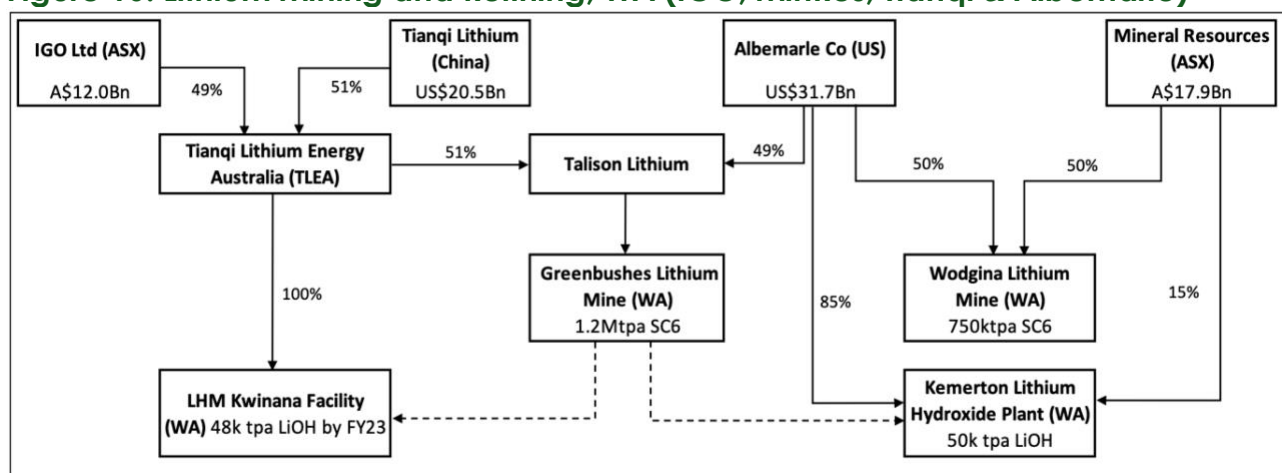
⁹² Pilbara Minerals & Calix press release, [\\$20m Australian Government MMI grant awarded](#), 17 May 2022

Mineral Resources and Albemarle (US)

ASX-listed Mineral Resources (MinRes) (market capitalisation \$17.9bn) is a key example of foreign investors partnering in Australia as a strategy to scale their exposure in critical minerals. MinRes has a 50% stake in the Mt Marion lithium mine in WA, alongside China's Ganfeng Lithium, the largest lithium hydroxide producer globally.⁹³ Mt Marion was the fourth-largest hard-rock lithium mine in the world in 2021, with partners rapidly expanding its capacity. The Stage 1 expansion to 600ktpa (up from 450ktpa) reached FID in April 2022 with a planned Stage 2 of capacity to 900ktpa.⁹⁴ The Stage 2 capacity expansion is expected to commence in April 2023 and ramp-up to a full run-rate from July 2023, with capital costs remaining at \$120m.⁹⁵

In 2019, MinRes sold a strategic stake in its 100%-owned Wodgina lithium project in WA to US-firm, Albemarle (market capitalisation \$31.7bn). MinRes recognised the growth of the lithium industry and understood the urgency to invest in downstream refining, gaining a US\$820m cash payment from Albemarle, and more importantly, a then 40% interest in the proposed Kemerton Lithium Hydroxide Facility in WA, under the MARBL Lithium JV.⁹⁶ The Kemerton interest has shifted to an 85:15 stake favouring Albemarle, with MinRes still holding its share of Wodgina.

Figure 16: Lithium Mining and Refining, WA (IGO, MinRes, Tianqi & Albemarle)



Source: Company Accounts, Climate Energy Finance calculations

The Kemerton LHM Facility is an II-Train (25ktpa each) operation, with Train I commissioned in July 2022. The first product from Train II is expected in the second quarter of FY2023, taking the capacity to 50ktpa. The initial capital required was estimated at US\$1.2bn (funded by Albemarle).⁹⁷ However, in September 2022, the Australian Financial Review (AFR) reported the capital costs had blown out

⁹³ Mineral Resources, [Mt Marion Mineral Resource Update](#), 31 October 2018

⁹⁴ Mineral Resources, [Lithium Business Update](#), 5 April 2022

⁹⁵ MinRes, [Quarterly Exploration and Mining Activities Report](#), 25 January 2023

⁹⁶ Mineral Resources, [MinRes and Albemarle complete Wodgina Lithium Project Transaction](#), 1 November 2019

⁹⁷ Mineral Resources, [MinRes and Albemarle complete Wodgina Lithium Project Transaction](#), 1 November 2019

significantly due to labour shortages and WA's hard-line border closure policy during COVID-19.⁹⁸ Albemarle have declined to reveal the final price tag.

Mentioned in the IGO summary (Figure 16), TLEA owns 51% of the Greenbushes mine, with the remaining 49% owned by Albemarle. Albemarle's share of off-take is used as feedstock for the Kemerton LHM Facility.

MinRes has demonstrated the effectiveness of strategic partnerships from global lithium majors up- and downstream the critical mineral value chain. Ganfeng Lithium has been a vital component in scaling MinRes' Mt Marion mine, and Albemarle has provided capital support and exposure to MinRes in the fastest growing commodity market. Albemarle also provided a pathway to a US\$1.25bn bond raising for MinRes in the US debt markets.⁹⁹

The restructure to 85:15 for MARBL's Kemerton also increased MinRes' share of Wodgina to 50% and established a 50:50 partnership to jointly fund a proposed 50ktpa LHM refinery to value-add its Wodgina operations.¹⁰⁰ The proposal has been designed by MinRes' Chinese partners with an estimated \$1.3bn price tag if built at Wodgina.¹⁰¹ A Ganfeng Lithium refinery of equal capacity in China is reportedly estimated to cost US\$230m, whereas Albemarle's equal capacity plant in Chengdu cost US\$600m.

IGO Ltd and Tianqi Lithium (China)

ASX-listed IGO (market capitalisation \$12.0bn) is the second-largest shareholder in the world's largest lithium mine, Greenbushes WA, which exported over 22% of the global lithium supply in 2021. In 2020, IGO strategically invested \$1.9bn to acquire a 49% non-controlling stake in Tianqi Lithium Energy Australia (TLEA) (Tianqi Lithium market capitalisation US\$20.5bn), which also brought with it a 51% interest in Greenbushes.

Greenbushes produced 1.135Mtpa of spodumene in FY2022, with its latest available information reporting a record quarter in September 2022, producing over 360kt, up 7% yoy. TLEA continues to expand its operations in WA, with a \$507m investment into constructing its third chemical grade processing facility (CGP3), the grade used in advanced lithium-ion batteries (each CGP produces ~ 500-600ktpa).¹⁰² TLEA is also accelerating the timeline for a proposed fourth CGP for \$537m, with potential commission in 2027.

TLEA is strategically investing further into Australia's lithium landscape, acquiring ASX-listed Essential Metals Ltd for \$136m in January 2023.¹⁰³ The acquisition adds the Pioneer Dome Lithium proposal in

⁹⁸ AFR, [Albemarle interested in potential \\$10b lithium spin-off](#), 19 September 2022

⁹⁹ Mineral Resources, [Mineral Resources Completes US\\$1.25bn Senior Uncensored Notes Offering](#), 3 May 2022

¹⁰⁰ Mineral Resources, [Investor Tour](#), 9 October 2022

¹⁰¹ AFR, [MinRes puts \\$1.3b price tag on Pilbara lithium hydroxide plant](#), 11 October 2022

¹⁰² IGO, [Greenbushes Lithium Operation Site Visit Presentation](#), 29 July 2022

¹⁰³ IGO, [Lithium JV to Acquire Essential Metals Ltd](#), 9 January 2023

WA to its portfolio. The buy-out has, critically, provided TLEA access to the lithium ore reserve in close proximity to the Mt Marion deposit of its key competitor, Mineral Resources. The transaction is expected to be completed in May 2023.

TLEA has constructed the first downstream value-added lithium refinery in Australia, commissioning the Kwinana Lithium Hydroxide (LHM) Facility in May 2022. TLEA's refinery is a critical investment to vertically integrate and value-add Australia's lithium supply chain, catalysing other global mining majors to investment onshore.

TLEA has a long-term plan to expand Kwinana into a four-train operation which will lift production to 96ktpa LHM (each train 24ktpa). With Train I commissioned in May 2022, TLEA announced commercial production for Train I effective 30 November 2022.¹⁰⁴ Train II is currently under construction and is due to commission in 2024, with further planned investments into Train III and Train IV.¹⁰⁵ IGO announced it has increased its FY2023 growth capex guidance to \$550-600m.¹⁰⁶ Spodumene concentrate feedstock is sourced from TLEA's share of Greenbushes production, as well as continuing to supply its key off-take partners.

Wesfarmers and SQM (Chile)

Australian-based Wesfarmers (market capitalisation \$56.0bn) struck a partnership with Chilean lithium major, Sociedad Química y Minera de Chile S.A. (SQM) (market capitalisation US\$26.4bn) for the joint development and operation of the Mount Holland lithium project and its downstream value-added LHM facility in Kwinana, WA.¹⁰⁷ In May 2019, Wesfarmers completed the strategic acquisition of Kidman Resources to gain a 50% stake in the project.

Under the JV Covalent Lithium, the Kwinana LHM Facility is a 50ktpa operation due to be commissioned at Kwinana by the end of 2024. The Kwinana refinery had fundamental off-take partnerships years before the venture reached FID in February 2021.¹⁰⁸ In 2018, the venture had partnerships ready for Mitsui, LG Energy Solution and EV giant, Tesla.¹⁰⁹

Wesfarmers expects to allocate ~ \$400m of developmental capital towards the Mt Holland Project in FY2023, and has raised its total capex share to \$1.2-1.3bn in nominal terms, a 10-20% increase from prior guidance.¹¹⁰

Wesfarmers have confirmed first earnings are expected in 1HCY2024, with the company stockpiling its first ore in December 2022. Discussions are ongoing with global parties for lithium Direct Shipped

¹⁰⁴ IGO, [Commercial Production from Kwinana Refinery](#), 5 December 2022

¹⁰⁵ S&P Global, [IGO, Tianqi successfully produce first LHM at Australia's Kwinana refinery](#), 23 August 2022

¹⁰⁶ IGO, [2Q23 and 1H23 Results Presentation](#), 31 January 2023

¹⁰⁷ SQM, [Mt Holland Technical Report Summary](#), 25 April 2022

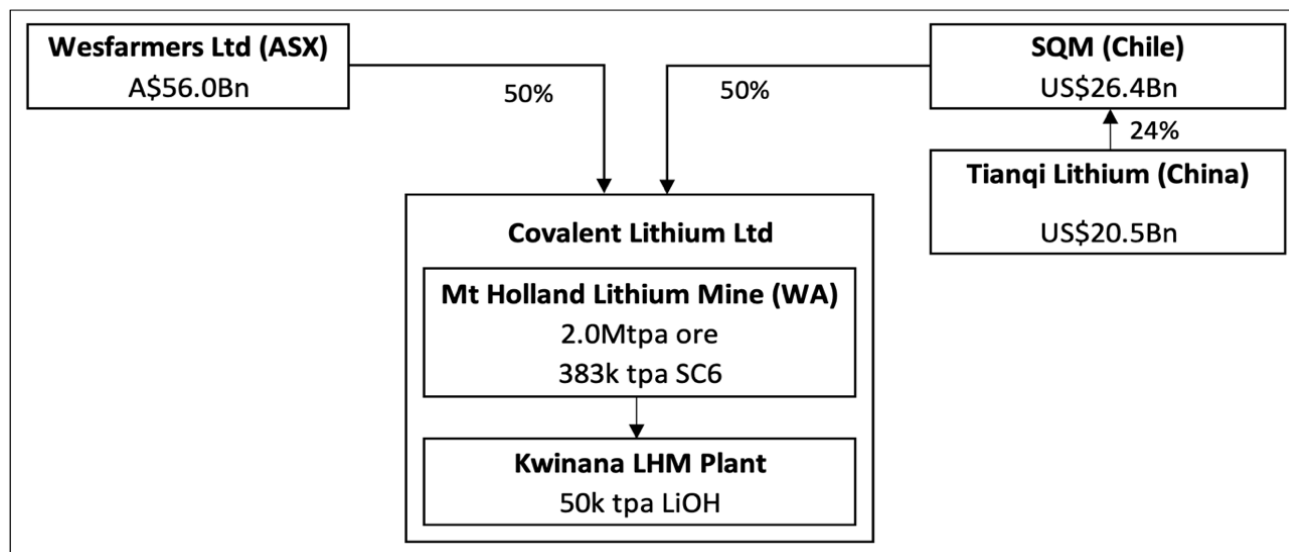
¹⁰⁸ Wesfarmers, [Mt Holland lithium project – final investment decision](#), 17 February 2021

¹⁰⁹ Kidman Resources, [Annual Report](#), 2018

¹¹⁰ Wesfarmers, [2023 Half-Year Results Briefing Presentation](#), 15 February 2023

Ore (DSO) agreements in the meantime. First production of lithium hydroxide from the Kwinana LHM Facility is now expected 1H CY2025.¹¹¹

Figure 17: Lithium Mining and Refining, Western Australia (Wesfarmers & SQM)



Source: Company Accounts, Climate Energy Finance calculations

Going Forward

Reaching net zero is the north star driving the new energy transition, and is thus creating unprecedented global refined mineral and metal demand.

As Australia builds its global competitive advantage in embedding decarbonisation in value-added expansions onshore, reducing the currently huge share of waste rock exported to offshore refineries is a key component to reducing global Scope 3 value chain emissions.

Despite the reported initial pre-production capital disparity between scaling out new capacity in Australia and China, value-adding lithium pre-export not only provides a massive economic opportunity for our nation, but provides an opportunity to export decarbonisation to our key trade partners. The combination of low cost firm renewable energy supply at world scale, multiplied by the reduced transport of waste, is the fastest way to reach Australia's decarbonisation targets, as well as support our key trading partners in reaching theirs.

¹¹¹ Wesfarmers, [2023 Half-Year Results News Release](#), 15 February 2023

Section 4. Australia's Critical Mineral Pipeline

Australia critically needs to see a strategic public-private focus on the value-adding of our world leading renewable energy and critical mineral resources so as to maximise the investment, regional employment and export value-adding opportunities as the country embraces the enormous opportunities of the global energy transition.

The regional employment and investment opportunities for Australia can be doubled by undertaking refining pre-export, particularly with any weakening of the A\$/US\$. And given commodity refining and processing is very energy intensive, this can also leverage our global competitive advantage in zero emissions, low-cost world scale renewable energy.

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The regional employment and investment opportunities for Australia can be doubled by undertaking refining pre-export, particularly with any weakening of the A\$/US\$. And given commodity refining and processing is very energy intensive, this can also leverage our global competitive advantage in zero emission, low-cost world scale renewable energy.

The growing global focus on decarbonisation plays to Australia's competitive advantage. With strategic investment, Australia is perfectly positioned to be a globally reliable renewable energy-powered critical minerals value-adding source, leveraging the booming EV and energy system decarbonisation trends that accelerated in 2022 in response to the hyper-inflation of all things fossil fuel.

The investment and mining sectors are full of discussion about the commodity shift from burning fossil fuels to the 'New World Metals' needed for decarbonisation and electrification.¹¹² In September 2022, BNEF forecast global copper use will increase more than 50% by 2040 even as copper ore grades decline.¹¹³

Demand for critical minerals is booming, and the global diversification from China's refining dominance is key to Australia's opportunity.¹¹⁴ Australia is the world's largest lithium mining country, but it is imperative the country does more than 'dig and ship'. Australia must value-add onshore using renewables.¹¹⁵

¹¹² The Australian, [New World Metals conference opens roadshow as metals demand spikes](#), 9 September 2022

¹¹³ Bloomberg, [Surging Copper Demand Will Complicate the Clean Energy Boom](#), 1 September 2022

¹¹⁴ Centre for Geopolitics, [The Geopolitics of Critical Metals and the Green Revolution](#), 22 June 2022

¹¹⁵ WA Today, [Irrelevant to Global Decarbonisation? No, Australia's Crucial to It](#), 4 October 2022

In 2022, capital flows accelerated. Australia has now produced its first commercial battery-grade refined lithium hydroxide (LHM), the precursor for battery cathodes.¹¹⁶ It has identified over \$10bn of investment proposals in resource value-adding across Australia and New Zealand, with several in production already, and a number having moved beyond FID to ‘under construction’ across rare earths, hydrogen electrolyzers and green ammonia, vanadium, nickel and cobalt, as well as value-added downstream battery developments.

Australia must now scale up the value chain through onshore processing of minerals including nickel, manganese, cobalt, lithium, aluminium and iron ore for economic, strategic and global decarbonisation reasons, and leverage our global competitive advantages by powering minerals processing with clean energy. There is huge potential for Australia to undertake refining and processing of our mineral resources before export.

There is also considerable debate about the role of green hydrogen in the global energy system. We note that absent a firm high price on carbon emissions implemented by our key trade partners and / or significant ongoing financial support by governments, the commercial viability of green hydrogen will remain extremely challenged this decade. This is even more so for export markets, given there is no ability to ship hydrogen. Green ammonia has significant safety challenges of its own, but is a clear interim solution that is commercially and technically able to be shipped internationally, as grey hydrogen is shipped at scale today. Targeting domestic applications for green hydrogen and green ammonia first is a logical strategic option, particularly onsite / inhouse like Fortescue Future Industries (FFI) is proposing. There is also the interesting proposal to examine developing green biofuels / methanol, given the need to decarbonise agriculture and aviation.

We review a range of leading breakthrough projects across Australasia below.

Lynas Rare Earths (Australia)

ASX-listed Lynas Rare Earths (market capitalisation \$8.1bn) is the world’s only significant producer of separated rare earths outside of China, and is planning significant mine capacity expansions.

May 2022 saw Lynas start construction of a new rare earths processing facility in Kalgoorlie to value-add onshore its’ Mount Weld mine, with a project cost of \$500m (including associated upgrades at the Lynas Malaysia plant). Once operational, mixed rare earths carbonate will be shipped directly from Kalgoorlie to the Lynas plant in Malaysia for further processing, or to Lynas’ proposed US Rare Earths Separation Facility.

However, pressure is mounting on a ruling from the Malaysian Government on whether to extend Lynas’ license to operate following a decade of controversy and community opposition to low-level radioactive waste generated at the Lynas plant.¹¹⁷ Previous deadlines were set to halt ore imports by

¹¹⁶ IGO, [Commercial Production from Kwinana Refinery](#), 5 December 2022

¹¹⁷ AFR, [Decision on Lynas’ Malaysia Operations Imminent](#), 26 January 2023

Lynas by 2 March 2023, and to halt cracking and leaching operations mid-year. The Prime Minister of Malaysia has recognised the value of Lynas’ foreign investment and local job promotion, drawing in manufacturing giants like Intel to the region. However, the government will have to U-turn on its decisions to halt the importing and processing licenses for the Malaysian plant to remain operational. Malaysia’s loss is likely to be Australia’s gain in terms of value-adding our resources pre-export, with all the investment and regional jobs that come with that.

On 30 January 2023, the AFR reported Lynas has acknowledged it may have to shut down processing operations imposed by Malaysian authorities as it races the clock to commission and ramp-up the Kalgoorlie plant.¹¹⁸ As the only global supplier of refined rare earths outside of China, western economies have recognised the importance of keeping Lynas operational. Discussed in Section 8, the US Government is heavily subsidising separation facilities onshore in Texas as it looks to diversify and mitigate centralised supply chain risks.

Lynas is a key example of the global financial support behind Australian miners onshoring the value-add of critical minerals to reduce the global dependence on the refining might of China.

The Kalgoorlie plant has been designed to facilitate processing of third-party rare earths concentrate from other Australian projects as they come online, and will create 209 positions during construction and 128 new ongoing jobs.^{119 120}

Iluka Resources (Australia)

In April 2022, Iluka (market capitalisation A\$4.7bn) announced its FID for the development of phase 3 of Australia’s first fully integrated rare earths refinery at Eneabba in WA’s mid-west at a capital cost of A\$1.2bn.¹²¹ The Australian Government has proposed a \$1.25bn non-recourse Export Finance Australia loan of 16 years’ duration to construct and commission the refinery¹²², and this is strongly supported by Iluka’s net cash position of \$600m.

The Eneabba project is a multi-staged, value-added, rare earths refining project that captures the value of by-products in Iluka’s existing zircon operations, with a 2025 commissioning target. Rare earths are found within the mineral sands, monazite and xenotime, both of which are extracted as by-products from Iluka’s zircon processing. The Eneabba refinery would have a feed rate of 55ktpa, producing 17.5ktpa of REO (Rare Earth Oxides). This will be refined to produce 4ktpa of NdPr (neodymium and praseodymium) products.¹²³

¹¹⁸ AFR, [Lynas Races the Clock as it Lobbies Malaysia on Partial Plant Closure](#), 30 January 2023

¹¹⁹ Lynas, [Lynas announces A\\$500m Mt Weld Expansion](#), 3 August 2022

¹²⁰ Lynas, [Kalgoorlie RE Processing Facility Project Fact Sheet](#).

¹²¹ Iluka Resources, [Eneabba Rare Earths Refinery FID](#), 3 April 2022

¹²² WA Government, [A Global Battery and Critical Minerals Hub](#), June 2022

¹²³ Iluka Resources, [Eneabba Rare Earths Refinery FID Presentation](#), 4 April 2022

The Eneabba Project is designed to also process third-party feedstock. In October 2022, Iluka signed an 8-year supply agreement with Northern Minerals' Northern Browns Range Project. Iluka will support the development of the mine, providing \$20m to accelerate the DFS and FID timeline over the next year.¹²⁴

Hastings Technology Metals (Australia)

Hastings Technology Metals' (market capitalisation A\$465m) Yangibana project in WA will develop a mine and processing (beneficiation and hydrometallurgy) plant, capable of processing 1Mtpa of ore, producing up to 15ktpa Mixed Rare Earths Carbonate (MREC).¹²⁵ The ore reserve is derived from multiple deposits across Bald Hill, Frasers, Yangibana West, Yangibana and Auer. All deposits are wholly owned by Hastings. Importantly, neodymium (Nd) and praseodymium (Pr) account for ~ 85% of rare earth oxides within the ore reserve, making the project one of the highest rare earth basket values in the world.

The pre-production capital requirement was revised in February 2022 to \$658m (including contingency).¹²⁶ The June 2022 WA Government battery report put the capex at \$650m for production capacity of 3,400tpa NdPr.¹²⁷ Hastings was approved for a A\$140m loan facility from the Northern Australia Infrastructure Fund (NAIF) in February 2022 and a \$100m equity placement in October 2022, both critical components for the development of Yangibana Rare Earths Project at Onslow, WA.¹²⁸ The NAIF funding was increased to \$220m in January 2023.¹²⁹ Employment post the 2024 completion is estimated at 250, with a construction workforce of up to 500.

Australian Vanadium (Australia)

ASX-listed Australian Vanadium's (market capitalisation A\$131m) Bankable Feasibility Study (BFS)¹³⁰ confirms the Australian Vanadium Project in WA as a potentially globally significant high-grade, long-life vanadium mine targeting critical minerals primarily for steel strengthening, but also energy storage (vanadium redox flow batteries).

A processing plant and concentrator near Geraldton, but separate from the mine site (supplied by road train), would allow access to competitively priced gas, a local workforce, and access to the Geraldton Port. A separate vanadium electrolyte plant is proposed to be built in the Kwinana industrial area, south of Perth.

¹²⁴ Iluka, [Strategic Partnership with Northern Minerals Rare Earths Concentrate Supply](#), 26 October 2022

¹²⁵ Hastings, [Investor Briefing: Begin the Future](#), 6 September 2022

¹²⁶ Hastings, [Yangibana Project NPV Increases 84% to A\\$1Bn](#), 21 February 2022

¹²⁷ WA Government, [A Global Battery and Critical Minerals Hub](#), June 2022

¹²⁸ Hastings, [NAIF Approves A\\$140m Loan for Yangibana Rare Earths Project](#), 2 February 2022

¹²⁹ Hastings, [NAIF Increases Financial Support for Yangibana Rare Earths Project](#), 17 January 2023

¹³⁰ Australian Vanadium, [Bankable Feasibility Study for the Australian Vanadium Project](#), 6 April 2022

The proposal has a \$604m capex cost, and in March 2022 received a \$49m award from the Australian Government's MMI grant program.¹³¹ FID was due late last year, but has been deferred into 2023. In January 2023, Australian Vanadium signed a Term Sheet for the opportunity to purchase and process additional vanadium generated from Neometals' Barrambie Project and to share processing plant infrastructure. The partnership provides the opportunity to unlock the full potential of WA's vanadium resources and reduce the barrier into refining that has limited many small-market cap projects in the past.¹³²

This critical mineral proposal provides supply chain diversification from the current vanadium supply dominance of China and Russia.

BHP (Australia)

At the end of 2021, BHP (market capitalisation \$350bn) finished a \$60m 100,000tpa nickel sulphate refinery at Kwinana, WA as an Australian-first.¹³³ BHP reports every EV battery requires 40kg of nickel and that 90% of its nickel goes into the global battery market. It expects demand for nickel in batteries to increase by 500% in the next decade. BHP's Nickel West employs over 2,500 people and its operations include a fully integrated mine-to-metal business.

Three mines at Mt Keith, Leinster and Kambalda have concentrator plants to process ore. The three streams feed into the Kalgoorlie nickel smelter, which uses a flash furnace to convert the nickel into nickel metal in the form of powder and briquettes, and then to a high purity battery-grade nickel sulphate plant, also in Kwinana. The nickel sulphate plant created 80 new direct jobs, plus 200 jobs during the construction phase.¹³⁴

In December 2022, BHP made a second A\$9.6bn agreed bid for Oz Minerals which now moves to an Oz Minerals shareholder vote in April 2023.¹³⁵ The key assets are copper and nickel mines and resources in SA, providing synergies with BHP's copper-gold-silver-uranium operations around Olympic Dam, and the optimisation of the existing copper smelter and refinery. BHP is looking to leverage scale of the combined mine-to-refinery business, underpinning new potential initiatives of building a desalination plant and a \$500m, 320MW renewable energy power purchasing agreement (PPA) signed in October 2021 with Iberdrola to reduce the mine emissions from electricity consumption by 50% by 2025, creating 200 construction jobs.¹³⁶

Oz Minerals brings significant new mine capacity potential, including the newly approved \$1.7bn copper-nickel West Musgrave mine in remote WA, bringing 1,500 new construction jobs.¹³⁷

¹³¹ Australian Vanadium, [AVL Awarded \\$49m Federal Government Manufacturing Collaboration Grant](#), 16 March 2022

¹³² AVL, [Critical Minerals Collaboration Signed with Neometals](#), 25 January 2023

¹³³ West Australia, [A Global Battery and Critical Minerals Hub](#), June 2022

¹³⁴ BHP, [BHP delivers first crystals from Kwinana nickel sulphate plant](#), 1 October 2021

¹³⁵ AFR, [BHP, OZ Minerals agree scheme deed in \\$9.6b deal](#), 22 December 2022

¹³⁶ Iberdrola, [Iberdrola will supply green energy to the BHP Olympic Dam mine project in SA](#), 14 October 2021

¹³⁷ AFR, [OZ Minerals gives green light to \\$1.7b copper-nickel mine](#), 23 September 2022

Sun Metals Green Zinc (Korea/Australia)

Korea Zinc's Sun Metals in Townsville, Qld is well on track to be one of the world's first fully green zinc refineries.

Employing 350 staff, the company has committed to running this refinery on 100% renewable energy by 2025 as part of a global corporate goal of 80% renewables by 2030.

In 2018, it invested \$200m to build an adjacent 143MW solar farm that provides 25% of its electricity needs. Sun Metals has subsequently taken a one-third equity stake in the \$2bn 1,026MW Macintyre wind precinct being built by Acciona Energia and supported by Queensland's CleanCo.¹³⁸ This windfarm will provide another 64% of Sun Metals' electricity needs. Sun Metals' Ark Energy CEO Daniel Kim says Macintyre will help decarbonise the zinc refinery, enabling it to become one of the first major refineries in the world to produce 'green zinc'.¹³⁹

September 2022 saw Daniel Kim announce that strategic partnerships would be essential to building a 3GW of renewables plan as part of its proposed new green ammonia supply chain from Australia to Korea.¹⁴⁰

Sunrise Energy Metals (Australia)

ASX-listed Sunrise Energy Metals (market capitalisation \$180m) is developing a nickel, scandium and cobalt fully integrated, renewable energy-powered mine-to-battery-grade chemical production proposal west of Parkes in central NSW. Sunrise is co-chaired by Robert Friedland who was the driving force behind Rio Tinto's Oyu Tolgoi copper-gold-silver mine in southern Mongolia.

During FY2022, a letter of conditional support was received from Export Finance Australia for up to A\$400m of debt funding under the Australian Government's \$2bn Critical Minerals Facility.¹⁴¹ The total proposal has a capex estimate of \$2.6bn, making this one of the largest non-coal mining value-add development proposals in NSW.

The Sunrise project would create 1,800 direct jobs during the construction phase, with an estimated 400 sustained full-time jobs from operation.¹⁴²

¹³⁸ AFR, [Queensland wind to power Telstra under Korea Zinc deal](#), 4 October 2022

¹³⁹ Renew Economy, [First concrete foundation poured in Australia's first gigawatt scale wind project](#), 14 September 2022

¹⁴⁰ Renew Economy, [Korea Zinc plans 3GW renewable hub in huge Queensland GH2 play](#), 21 September 2022

¹⁴¹ [Export Finance Australia Issues Letter of Support for the Sunrise Project](#), 17 January 2022

¹⁴² Sunrise Energy Metals, [Innovation in Battery Metals presentation](#), May 2022

Fortescue Metals Group (FMG) (Australia)

ASX-listed Fortescue Metals Group (market capitalisation A\$69.2bn) is looking to commission in March 2023 stage 2 of its US\$3.7bn (A\$5bn) Iron Bridge magnetite mine-and-processing project 145km south of Port Hedland in the Pilbara, WA.¹⁴³ Approved back in 2019¹⁴⁴, the project has experienced some COVID delays.

The vast majority of Australia's \$100bn annual export of iron ore is haematite of 50-63% iron content. In contrast, the 22Mtpa Iron Bridge targets a 67% iron content, which is the equal highest premium product of all major mines globally, a critical prerequisite to higher efficiency steelmaking.

Fortescue has been very vocal about the enormous investment opportunities in decarbonisation and has committed to a US\$6.2bn investment program this decade to build out wind and solar infrastructure, and the associated battery firming capacity.¹⁴⁵ This also includes heavy equipment fleet electrification to remove the current reliance on imported diesel, along with the Pilbara Energy Connect, a US\$700m grid transmission project to provide electricity links to a number of key Fortescue facilities in the Pilbara.

Climate Energy Finance sees value-adding Australian resources pre-export as a massive opportunity to leverage our world-leading renewable energy potential and assist global decarbonisation, given much of the world's future-facing minerals are currently processed in China by its coal-heavy electricity grid.

While Fortescue's existing iron ore exports are lower quality 50-60% iron content haematite mines (average FY2022 pricing was just 72% of the 62% CFR index), Fortescue has undertaken a significant US\$3.7bn investment in value-adding at well-above-index price expectations for Iron Bridge.

Adding zero emission electricity capacity is an obvious next stage of value-adding / decarbonisation of this new mine, as part of the electrification of the entire Fortescue mining equipment fleet.

Fortescue Future Industries (FFI) (Australia)

Fortescue has committed to investing US\$6.2bn this decade into FFI to drive towards Fortescue's "real zero" emissions by 2030 target (scope 1&2).^{146 147}

The most advanced FFI major project is a \$114m, 2GW electrolyser manufacturing facility at Gladstone, Qld, which was to be a 50:50 joint venture with Plug Power US¹⁴⁸, but this suffered a

¹⁴³ FMG Investor Presentation – Pilbara Operations Site Tour, October 2022

¹⁴⁴ FMG Press Release, [US\\$2.6 billion Iron Bridge Magnetite Project approved](#), 2 April 2019

¹⁴⁵ The Brisbane Times, [Forrest 'locked and loaded' for net-zero but does Fortescue have the calibre?](#), 2 October 2022

¹⁴⁶ Renew Economy, ["We literally smoke fossil fuels:" Forrest on why FFI might already be worth \\$US20bn](#), 29 August 2022

¹⁴⁷ Financial Times, [Australian mining major Fortescue to invest \\$6.2bn in net zero push](#), 20 September 2022

¹⁴⁸ FFI, [Construction commences on world-leading electrolyser facility in Gladstone, Queensland](#), 27 February 2022

serious setback in January 2023 when Plug Power pulled out of the proposal.¹⁴⁹ The facility is under construction, creating over 100 construction jobs and an anticipated 50 permanent jobs.

If commissioned in 2023 at the 2GW scale proposed, this will be one of the largest electrolyser manufacturing facilities in the world (Germany's thyssenkrupp nucera currently has the largest (outside of China), a 1GW facility, with plans to expand to 5GW by 2025¹⁵⁰).

The scaling up of manufacturing to drive down the production cost of electrolysers is one of the major factors driving the rapid projected cost deflation for green hydrogen. The IEA forecasts global electrolyser manufacturing capacity will expand more than tenfold this decade to reach 65GW pa.¹⁵¹

FFI is evaluating numerous investment proposals, with January 2023 reports suggesting the group expects to reach FID on five clean energy projects in 2023, including a Front-End Engineering Design (FEED) for a 500MW electrolyser to produce up to 400,000tpa of green ammonia conversion of Incitec Pivot's Gibson Island fertilizer manufacturing facility in Brisbane, with FID due by June 2023.¹⁵²

Other projects

While this review is largely focussed on value-adding critical minerals for decarbonisation, Australia also has world-leading renewable energy resources which cannot be directly exported (until / if the Sun Cable venture is realised¹⁵³).

Using renewables to power critical mineral refining is one way Australia can play a globally significant role in driving decarbonisation. A second way is the replacement of imported fossil fuels like diesel and ammonia (produced from methane) with domestic powered EVs and green hydrogen, as well as the export of green ammonia.

Yara Fertilizers (Norway/Australia/France)

The Norwegian fertilizer giant Yara (revenues US\$16bn pa) has proposed to build the Yuri Renewable Hydrogen plant in collaboration with ENGIE of France to provide feedstock into the adjacent Yara ammonia operations near Karratha in WA, following the September 2022 FID on the project. This is likely to be the first operational facility in WA to receive green hydrogen to produce clean ammonia.

The project has been strategically supported by a \$47.5m grant through ARENA's Renewable Hydrogen Deployment Funding Round. The WA State Government has also supported Yuri with a \$2m grant contribution from the State's Renewable Hydrogen Fund.

¹⁴⁹ AFR, 'Bring it on,' says Fortescue boss as hydrogen partner pulls plug, 27 January 2023

¹⁵⁰ Capital Markets Day: thyssenkrupp Uhde Chlorine Engineers changes name and brand to thyssenkrupp nucera, 13 January 2022

¹⁵¹ IEA, *Global Hydrogen Review 2022*, September 2022

¹⁵² Fortescue, *Fortescue Future Industries and Incitec Pivot progress green conversion of Gibson Island ammonia facility*, 7 October 2022

¹⁵³ Sun Cable, Powering Singapore with the world's largest solar farm, battery and undersea cable

The Yuri project Phase I includes a 10MW electrolyser, 18MW of solar PV, and battery storage. Once completed, the project will be one of Australia's largest electrolysers, capable of producing up to 640tpa of green hydrogen.

A consortium of Technip Energies and Monford Group has been awarded the Engineering, Procurement, Construction and Commissioning (EPCC) contract for the hydrogen plant. The green hydrogen production is scheduled to commence and be supplied to the ammonia plant in 2024.¹⁵⁴

Yara has outlined an ambitious plan for stage II and then stage III expansions to potentially build the world's largest green ammonia facility.

The development of Project Yuri has also paved the way for the Yara Pilbara Fertilizers ammonia plant to be recognized under the Smart Energy Council's Zero Carbon Certification Scheme. The plant has been given pre-certification as result of the commitment to produce renewable ammonia from energy produced by on-site solar PV. The Yara plant is the first green ammonia project to receive the Council's certification.

Calix (Germany/Australia)

In January 2023, ASX-listed Calix (market capitalisation \$959m) announced the HyGATE Solar Methanol Project proposal in Port Augusta, SA had received \$19.5m ARENA grant funding and €13.2m from Germany's Federal Ministry of Education and Research to develop a world-first green methanol demonstration plant.¹⁵⁵

Meridian Energy Green Ammonia (New Zealand)

We have cheated a bit by including in our Australian list of newly proposed value-add projects one exciting world-leading proposal from New Zealand, the Southern Green Hydrogen based in Southland.¹⁵⁶ This green ammonia facility will value-add renewable energy (hydro and wind) by electrolysis of water for export, not critical minerals.

While yet to reach FID, this 600MW green ammonia export proposal is well advanced. November 2022 saw the lead proponent Meridian Energy enter a strategic partnership with Woodside Energy and Mitsui & Co.¹⁵⁷ The 600MW scale proposal is thirty times the largest 20MW green hydrogen facility operating in the world (outside of China, which has a 150MW operational green hydrogen facility¹⁵⁸).

¹⁵⁴ Yara, [Yara at the forefront of clean ammonia in Australia](#), 15 September 2022

¹⁵⁵ Calix, [Press Release](#), 30 January 2023

¹⁵⁶ Meridian, [Southern Green Hydrogen](#)

¹⁵⁷ Meridian, [Meridian's Southern Green Hydrogen Project selects Woodside Energy as preferred partner](#), 29 November 2022

¹⁵⁸ FuelCellsWorks, [The World's Largest Green Hydrogen Project With a 150MW Electrolyser Comes Online in China](#), 3 February, 2022

Southern Green Hydrogen aims to also provide a critically valuable demand response management tool to turn off the facility to help manage the dry year impact of NZ's dependence on hydro, complementing the value-add of a 90-95% average utilisation rate for the electrolyser in a normal year.

This proposal would deliver a first-of-kind, step-change in the scale of green hydrogen exports (using ammonia as the carrier) moving from newly commissioned 10-20MW pilots to under-construction 100MW facilities across Europe to 600MW proposed facilities in NZ, to prove up the path to commercialisation of gigawatt-scale proposals.

4.1 Integrating Further Downstream into Battery Components

Climate Energy Finance sees enormous economic, trade, employment and strategic geopolitical opportunities for Australia to lead on global decarbonisation efforts. Australia should be a renewable energy and value-added critical minerals superpower. Australia needs to think strategically, leverage its strengths, and localise its supply chains. Australia has one of the largest bulk minerals mining industries in the world, led by global giants BHP and Rio Tinto, with significant Australian operations. Many of these projects are energy intensive, providing a further opportunity to accelerate global decarbonisation by leveraging our vast, largely untapped, low-cost renewable energy resources. This will require concerted public-private initiatives, including the safeguard mechanism's price on carbon and declining emissions profile, but also leveraging strategic public interest financial support, albeit administered under the new Federal government with integrity, transparency, and financial support.

Beyond refining resources pre-export, there is a growing debate about how significant a global player Australia can be in the battery manufacturing sector.

Australia's lack of proximity to EV manufacturing and key end consumer markets is often cited as a reason for caution for Australia. There has been a raft of world-scale new battery manufacturing facility announcements, all located close to EV manufacturing e.g., CATL's 100GWh US\$7.6bn investment proposal for Hungary.¹⁵⁹ But there are two significant counters to this. Firstly, the growing global supply chain security threats means battery and EV firms globally are all moving to reduce their resource security risks. Secondly, if Australia can build out its world-scale renewable energy resources at low cost and sufficiently firm, there is a key potential to mitigate the heavy energy intensity of battery manufacturing.¹⁶⁰

Several recent small scale battery manufacturing facilities are testing this assertion:¹⁶¹

- University of Sydney spinout **Gelion** has opened a pilot 2MWh pa battery manufacturing facility in Fairfield, NSW in September 2022 to produce a gel-based zinc bromide battery.¹⁶²

¹⁵⁹ CATL, [CATL Announces its Second European Battery Plant in Hungary](#), 12 August 2022

¹⁶⁰ AuManufacturing, [Power Australia, power the world](#), 7 October 2022

¹⁶¹ We would add a cautionary note that it is hard to externally evaluate the substance and financial support for these ambitious proposals. CEF is wary given the number of cleantech press releases (by start-ups through to mining leaders like FMG) showing aspirations often well ahead of clear evidence in the public domain of financial, regulatory approvals and/or operating capacity to deliver. This warning comes after the dramatic spending binge at BritishVolt on the back of promises to build a £3.8bn English gigafactory only for administrators to be appointed in January 2023, cutting staff by 90% from the peak of 300.

¹⁶² Stockhead, [Gelion just opened a zinc-bromide battery plant in NSW – here's why that's a big deal](#), 30 September 2022

- September 2022 saw **Energy Renaissance** reported as planning a \$28m investment to commission a lithium battery assembly plant in Newcastle, NSW to significantly expand its newly established 48MWh pa pilot.¹⁶³
- Since 2018, **Sonnen** of Germany (now owned by Shell) has operated a home battery assembly factory of 30-50MWh pa of capacity in SA.¹⁶⁴
- **EcoGraf Limited** has proposed a 5,000tpa Australian Battery Anode Material Facility in the Rockingham-Kwinana Strategic Industrial Area in WA.¹⁶⁵
- **Pure Battery Technologies** is planning a Kalgoorlie, WA \$460m 50,000tpa cathode active materials and precursors (pCAM) refinery hub in JV with **Poseidon Nickel**.¹⁶⁶
- **Recharge Industries** has been reported to be evaluating a new battery manufacturing proposal at Geelong, Victoria.¹⁶⁷
- **InfraNomics Technologies** and UK battery manufacturer **AMTE Power** announced in October 2021 a proposed joint venture, Bardan Cells, to evaluate a Kwinana WA proposal.¹⁶⁸ The latest investor briefing reports AMTE reported a net loss of £6m on FY2022 revenues of just £2m, showing this start-up doesn't not have the financial capacity to deliver on its announcements as it currently stands.
- Queensland's **Energy Storage Industries - Asia Pacific** has started preliminary construction of a \$70m iron-flow battery plant in Maryborough, Queensland, in partnership with US company **ESS Inc.**¹⁶⁹
- Queensland also has the Australian owned start-up **RedEarth Energy Storage** with an established factory in Brisbane producing customised systems for residential, commercial and industrial use.¹⁷⁰

¹⁶³ Energy Renaissance, [AMGC announces completion of advanced manufacturing pilot in Tomago](#), 1 September 2022

¹⁶⁴ [sonnen - Intelligent Australian Made energy storage systems](#), 3 June 2020

¹⁶⁵ EcoGraf, [HFfree Battery Anode Material Facility](#)

¹⁶⁶ AuManufacturing, [Pure Battery Technologies progresses battery materials hub](#), 28 July 2022

¹⁶⁷ PV-Magazine, [Lithium-ion battery cell gigafactory coming to Geelong as US-Australia ties deepen](#), 17 January 2023

¹⁶⁸ AMTE Power press release, [AMTE partners InfraNomics to build battery cell production line](#), 4 October 2021

¹⁶⁹ PV-Magazine, [Iron-flow battery arrives at Queensland testing centre ahead of major 'perfectly suited' manufacturing play](#), 14 December 2023

¹⁷⁰ [RedEarth Energy](#), RedEarth Energy Storage is an Australian-owned and operated manufacturer of energy storage systems, accessed 28 January 2023

Other Projects

Founded in 2001, Brisbane’s **Tritium** fast chargers are also illustrative of how Australia’s ingenuity and resourcefulness can lead the world, even absent any government support, and even if the result is the company moves to the US as it continues to expand its global footprint. Tritium has sold more than 10,000 fast chargers in 45 countries and in January 2023 reported orders growth of 38% yoy to US\$195m in CY2022.¹⁷¹

Renewable Metals is trialling a critical new development in battery recycling in Perth WA. For batteries and EVs to be really sustainable, we need a circular economy and to avoid our use and dump consumer economic history.¹⁷² It is critical for Australia that these innovating new business start-ups are supported by patient public capital i.e., private equity funds like Virescent, rather than buried in grant processes that take forever and leave proponents in limbo.

Australia has also started on the journey proposed by Energy Minister Chris Bowen¹⁷³ (potentially leveraging the Federal Government’s National Reconstruction Fund), with a huge opportunity to rebuild domestic vehicle manufacturing. Australia’s last internal combustion engine (ICE) manufacturer closed in 2017. CEF notes that introducing some vehicle emissions standards could be an excellent place to start. Australia already has several EV start-ups targeting particular niches already underway including Janus Electric¹⁷⁴, SEA Electric¹⁷⁵, Varley Electric Vehicles¹⁷⁶, Zoomo¹⁷⁷ and ACE¹⁷⁸.

Going Forward

It has been pointed out by some foreign lithium and battery firms that Australia is too small a passenger vehicle market, and that battery manufacturing need to be located in proximity to EV manufacturers, that in turn need to be near end consumers.¹⁷⁹ CEF disagrees.

Australia needs to think strategically, leverage our strengths, and localise our supply chains. Australia has one of the largest bulk minerals mining industries in the world, led by global giants BHP and Rio Tinto, with significant Australian operations by Fortescue, Hancock, Yancoal, Anglo-American, Peabody and Glencore et al. As Australia competes with the world, local cooperation would require a completely different mindset, but in developing “world-firsts”, the size of the opportunity is huge.

¹⁷¹ Tritium press release, [Tritium Announces Largest Customer Order in Company History and Releases Preliminary Results for CY2022 with Record Sales, Revenue, and Backlog](#), 17 January 2023

¹⁷² Renewable Metals, [Rethinking Lithium Battery Recycling](#)

¹⁷³ The Driven, [Bowen hints Australia could kickstart local EV manufacturing](#), 23 September 2022

¹⁷⁴ AFR, [US demand for electric trucks turbocharges Australian business](#), 27 January 2023

¹⁷⁵ SEA Electric press release, [Australian EV Truck Manufacturer Doubles Assembly Capacity](#), 26 September 2022

¹⁷⁶ Goauto, [Varley launches Aussie super-EV](#), 19 December 2021

¹⁷⁷ Techcrunch, [Last-mile delivery e-bike supplier Zoomo tacks on \\$20M to Series B](#), 22 February 2022

¹⁷⁸ CleanTechnica, [ACE EV On The Road — More Than Meets The Eye](#), 26 January 2023

¹⁷⁹ AFR, [Australia ‘too far behind’ to make EV batteries: lithium giant](#), 19 September 2022

For instance, Australia is a huge consumer of long-distance haulage trucks, trains, ships, diggers and dirt moving equipment. Australia has been giving the mining sector a \$4-5bn annual subsidy in the form of the imported diesel fuel rebate – a tax everyone else in Australia pays (farmers rightly exempted). This subsidy has been around for 60 years, and incentivises high emission expensive imported diesel at a time the Federal Government is committing Australia to a long-overdue accelerated decarbonisation strategy. This perversely challenges the mining groups' net zero emissions targets, and undermines the market signal to make the switch to EVs. Dr Andrew Forrest has campaigned to have the diesel fuel rebate phased out for the mining sector.¹⁸⁰ CEF entirely agrees.¹⁸¹

Climate Energy Finance sees enormous economic, trade, employment and strategic opportunities for Australia to lead on global decarbonisation efforts. Australia should be a renewable energy and value-added critical minerals superpower. Many of these projects are energy intensive, providing a further opportunity to accelerate global decarbonisation by leveraging our vast, largely untapped, low-cost renewable energy resources. This will require concerted public-private initiatives¹⁸², including leveraging strategic public interest financial support, as we detail in Section 5, albeit administered under the new Federal government with integrity, transparency, and financial support.¹⁸³

¹⁸⁰ AFR, [Forrest says diesel rebate should go after 2025](#), 23 November 2021

¹⁸¹ Climate Energy Finance, [REPORT | Windfall profits: Time to fix loopholes & subsidies to serve Australians better](#), 17 August 2022

¹⁸² Financial Times, [The new rules for business in a post-neoliberal world](#), 9 October 2022

¹⁸³ InnovationAUS, ['Value-add here': PM wants new approach to next resources boom](#), 29 August 2022

Section 5. Australia's Federal and State Support Landscape

Australia can leverage the enormous opportunity to build clean energy industry economies of scale by positioning minerals processing and manufacturing downstream of its mining operations, providing geographic diversity to the concentration of global processing in China to-date. With Australia's abundant geological reserves and renewables potential, there is a mammoth opportunity to bring early and mid-stage downstream mineral processing back onshore. Given the nature of the global technology race, public-private partnerships are an increasingly fundamental tool to support global clean energy supply chains, enabling key actors to secure and de-risk the supply of critical minerals. De-risking projects and crowding-in access to private global debt and equity finance is critical for our resource value-adding manufacturers and refineries to reach full-scale production. Public policies which enhance the investment environment and reduce the financial risks of new proposals, providing a signal to investors and crowd-in private capital, thereby accelerating investment.

The rapid acceleration of public and private convergence around energy economy investments in North America, and the efficacy of China's state-backed clean energy initiatives, have demonstrated the growing use of federal support in accelerating private capital inflows to scale and diversify their supply chains.

The strategic investments by Australia's federal and state governments is key to catalysing private capital engagement.

New Commitments from the Australian Government

Australia's Federal Budget 2022-23 brought forth a number of significant new programs and funds to accelerate the transition to clean energy technology, as well as confirming expenditures on commitments made pre-election.

- A \$1.9bn **Powering the Regions Fund** will support industry decarbonisation and development of new clean energy.¹⁸⁴
- A new **Driving the Nation Fund** earmarks \$275m over six years to invest in electric and hydrogen vehicle infrastructure for cheaper and cleaner transport. The fund will work in association with ARENA to deliver charging infrastructure for regional Australia.¹⁸⁵

¹⁸⁴ Australian Government, [Creating Jobs and Spurring Investment in New Energy Industries](#), 25 October 2022

¹⁸⁵ Australian Government, [Reducing Emissions and Addressing Climate Change](#), 25 October 2022

- And there was confirmation of the government’s flagship \$20bn commitment to critical transmission infrastructure under the **Rewiring the Nation** plan to enable the acceleration of firmed renewables into the grid.¹⁸⁶
- The Albanese Government is accelerating the growth in value-adding Australia’s critical minerals industry with the new **National Critical Minerals Strategy** announced 21 October 2022, establishing a clear vision to unlock Australia’s critical minerals and renewable energy potential.¹⁸⁷
- Operating alongside the \$2bn Critical Minerals Facility (announced in 2021), the new strategy includes a \$1bn **Value Adding in Resources Fund** and \$50m to establish the Australian Critical Minerals Research and Development Hub.
- And the \$15bn **National Reconstruction Fund**, confirmed in the Budget, includes a commitment to expand our regional industrial base in critical minerals, so that, in the words of the Treasurer, “we can be a country that makes things again, so we can add value to the things we sell to the world, and so that every part of the country can have a stake in our Australian-made future.”¹⁸⁸

Complementing the **National Battery, Battery Recycling**¹⁸⁹ and the **Electric Vehicle**¹⁹⁰ strategies, these Federal Government initiatives will ensure the creation and support of regional jobs, position Australia at an advantage in the diversification of global supply chains, and improve our export resilience.

In announcing the National Critical Minerals Strategy, Prime Minister Anthony Albanese said: “Australia’s natural resources have powered our nation and we are committed to supporting the critical minerals sector and new clean technologies to reach our target of net zero, and make our nation an economic powerhouse with a clean energy future. Today’s new initiatives will ensure we can create and support local jobs, diversify global supply chains and meet the growing demand for batteries, EV and clean energy technology. These minerals will be critical to Australia achieving net zero emissions, and to helping the rest of the world make that transition as well.”¹⁹¹

And Resources Minister Madeleine King said: “This package of measures demonstrates our commitment to net zero and the important role the resource sector can play in our energy transition. We are investing in science and R&D collaborations. We are backing projects that are early to mid-stage, as well as helping fast-track financing for projects.”

¹⁸⁶ Australian Government, [Landmark rewiring the nation deal to fast-track clean energy jobs and security in NSW](#), 21 December 2022

¹⁸⁷ Australian Government, [Support for Critical Minerals Breakthroughs](#), 21 October 2022

¹⁸⁸ Australian Government, [Budget Speech 2022–23](#), 25 October 2022

¹⁸⁹ Australian Government, [Battery Stewardship Council](#), 2022

¹⁹⁰ Australian Government, [National Electric Vehicle Strategy: consultation paper](#), September 2022

¹⁹¹ Australian Government, [Support for Critical Minerals Breakthroughs](#), 21 October 2022

In 2021-22, the WA government committed \$1.6bn to establish midstream critical mineral projects.¹⁹²

These investment commitments reflect the key themes of Prime Minister Anthony Albanese's headland speech to the National Press Club in August, where he set out his policy vision after 100 days in office: *"We have everything that goes into a battery. We have lithium, we have copper, we have all of those minerals that will increasingly be in demand. We should be value-adding here"*. He argued for a "different approach" to our historical "dig and ship" economy.¹⁹³

Given the nature of the global technology race and supply chain security, particularly post Putin's Ukraine invasion, public-private partnerships are an increasingly fundamental tool to support global clean energy supply chains, enabling key actors to secure and de-risk the supply of critical minerals.

De-risking projects and crowding-in access to private global debt and equity finance is critical for our resource value-adding manufacturers and refineries to reach full-scale production. Public policies which enhance the investment environment and reduce the financial risks of new proposals will signal to investors and crowd-in private capital, thereby accelerating investment.¹⁹⁴

Australia can leverage this enormous opportunity to build clean energy industry economies of scale by positioning minerals processing and manufacturing downstream of its mining operations, providing geographic diversity to the concentration of global processing in China to-date. With Australia's abundant geological reserves and renewables potential, there is a mammoth opportunity to bring early and mid-stage downstream mineral processing back onshore.

¹⁹² WA Government, [A Global Battery and Critical Minerals Hub](#), June 2022

¹⁹³ InnovationAUS, ['Value-add Here': PM Wants New Approach to Next Resources Boom](#), 29 August 2022

¹⁹⁴ Australian Government, [Resources Technology and Critical Minerals Processing \(archived\)](#)

Figure 18: West Australian Refining Opportunities ¹⁹⁵

Western Australia's key midstream investments

- Operating/committed
- Planned – with government funding in place

Lithium

- **Tianqi Lithium Australia**
Production capacity: 48,000 tpa of lithium hydroxide
Capex: \$700 million

Lithium

- **Covalent Lithium**
Production capacity: 45,000 tpa of lithium hydroxide
Capex: \$1.9 billion*

Nickel

- **BHP Nickel West**
Production capacity: 100,000 tpa of nickel sulphate
Capex: \$60 million

Graphite

- **Ecograf**
Production capacity: 20,000 tpa of spherical graphite
Capex: \$100 million

Rare earths

- **Hastings Technology Metals**
Production capacity: 3,400 tpa NdPr[^]
Capex: \$650 million

Vanadium

- Australian Vanadium**
Production capacity: 11,200 tpa of vanadium
Capex: \$600 million

Rare earths

- **Iluka Resources**
Production capacity: 17,500 tpa of rare earth oxides
Capex: \$1.2 billion

Rare earths

- Lynas Rare Earths**
Production capacity: 10,500 tpa NdPr[^]
Capex: \$500 million^{^^}

P-CAM

- **Pure Battery Technologies**
Production capacity: 50,000 tpa precursor cathode active material (P-CAM)
Capex: \$460 million

Lithium

- **Albemarle Lithium**
Production capacity: 50,000 tpa of lithium hydroxide^{**}
Capex: \$1 billion

tpa = tonnes per annum

*inclusive of mine and concentrator

** 100,000 tpa once fully operational

[^] Neodymium and Praseodymium, produced as a rare earth carbonate

^{^^} Figure inclusive of Malaysian plant upgrades

Production capacity and capex figures are provided as estimates only. Actual production and costs may vary

Source: WA Government

¹⁹⁵ WA Government, [Battery and Critical Minerals Prospectus](#), June 2022

5.1 Key Federal and State Financial Institutions and Commitments

Government support catalyses private capital. Public-private partnerships will accelerate capital deployment in value-adding projects up- and downstream, and ensure Australia helps drive global decarbonisation. Current investment initiatives by the Australian Government are welcomed, however our Future Fund should be aligned towards the development of national interest projects and ensuring majority Australian ownership of strategic new projects, and in doing so, providing a clear endorsement and due diligence to accelerate private capital crowding in, and even working constructively to highlight which projects should be prioritised and fast-tracked for EPBC reviews.

In this section we review Australian public Federal and State financial capital entities and initiatives, and their expanding role in accelerating the development of Australia's critical mineral supply chain value-adding projects working strategically in the national interest, and crowding in private debt, infrastructure, and equity in the process. There are a range of existing, established public institutions with strong independent boards and oversight covering the full financial spectrum of:

- grant funding (ARENA)
- debt (CEFC)
- private equity (Virescent Ventures)
- infrastructure (NAIF)
- equity (Future Fund)
- export financing (EFA).

There are also state-based financial entities (CleanCo in Queensland, Net Zero Industry and Innovation Investment Plan in NSW, and the State Electricity Commission in Victoria).

The previous Government's Modern Manufacturing Initiative (MMI) (reconfirmed in August 2022) provided some piecemeal capital grants to certain project proposals of strategic national interest consistent with the wider strategy we are proposing here. These examples show how Australian firms can see the benefits of crowding-in finance, where government investment catalyses private capital inflow, amplifying market signals for the strategic support of the critical minerals industry.

Australia is perfectly positioned to be a renewable energy-powered critical minerals superpower, value-adding before export to maximise the investment and employment opportunities as the world accelerates the energy transition and reduces our crippling reliance on fossil fuels. Public-private partnerships will accelerate capital deployment as Australia helps drive global decarbonisation.¹⁹⁶

¹⁹⁶ Led by the Smart Energy Council, the [Climate Capital Forum discussion paper](#) was launched in January 2023 with the aim to accelerate the transition, drive investment and 'Make Australia Make Again'. This analysis shows Australia's supply chain vulnerabilities impeding national security.

Australian Renewable Energy Agency (ARENA)

ARENA is a mechanism for accelerating RD&D in renewables, supporting projects across industries including large-scale solar, EVs, large-scale battery and energy storage, and renewable hydrogen. In FY21, ARENA committed \$1.77bn to Australian renewable energy projects.¹⁹⁷

October 2022 saw ARENA provide a \$14m award to part-fund the \$38m front-end engineering and design (FEED) study of a 500MW green ammonia project at Brisbane's Gibson Island by FFI.¹⁹⁸

Clean Energy Finance Corporation (CEFC)

CEFC is an integral vehicle for crowding-in private investment into Australia's low-emission future, kick-starting projects across large-scale solar, wind, energy storage and green hydrogen industries. With \$10.76bn committed across 265 large-scale transactions, CEFC has catalysed \$37bn in investments into Australia's economy.¹⁹⁹

October 2022 saw the CEFC provide low-cost debt facilities for the Marinus Link between Tasmania, Victoria and the NSW-Victoria Interconnector. This involves building out REZ, including offshore wind to drive decarbonisation at speed and scale for Victoria's industry including the key electricity user in the state, the Portland aluminium refinery, enabling the creation of green aluminium for export.²⁰⁰

CEFC also provided \$12.5m to Sun Metals' Ark Energy Corporation to support the development of the SunHQ hydrogen hub in Townsville, further enabling Sun Metals to become the first to produce green zinc in the world. The finance package is for a 1MW pilot plant to test 5 purpose-built zero emission trucks as part of their Townsville decarbonisation mission.²⁰¹

Virescent Ventures

February 2022 saw the CEFC launch Virescent Ventures, a specialist fund manager focused on investing in ambitious cleantech founders, technologies and businesses that can help achieve net zero emissions. CEFC is working in partnership with Virescent Ventures' founders, former senior executives with the Clean Energy Innovation Fund.²⁰²

¹⁹⁷ ARENA, [Annual Report 2020-2021](#)

¹⁹⁸ ARENA, [World's biggest hydrogen plant could power Australia's first fully decarbonised ammonia facility in Brisbane](#), 7 October 2022

¹⁹⁹ CEFC, [CEFC Marks 10 years as Trailblazing Investor](#)

²⁰⁰ Prime Minister of Australia, [Rewiring the Nation to Supercharge Victorian Renewables](#), 19 October 2022

²⁰¹ CEFC, [Ark Energy Hydrogen Trucks Support Green Zinc](#), 8 November 2021

²⁰² CEFC, [Virescent Ventures supercharges the cleantech ecosystem](#), accessed 26 January 2023

Recommendation

We would recommend CEFC's mandate be expanded to include critical minerals refining, in addition to a mandate to work in alignment with Australia's key regional Asian and Pacific neighbours on energy transition and decarbonisation. This would help rebuild our national aid profile abroad, but in a way that leverages and develops Australia's technology and innovation. The same applies for ARENA, where Australia should lead the world on microgrid VPPS and off grid firmed renewables solutions for remote islands across ASEAN and the Pacific, for example.

Northern Australia Infrastructure Facility (NAIF)

NAIF is a development financier to projects across the Northern Territory plus northern Queensland and WA with a primary focus on driving public benefit and economic growth. Through its financing infrastructure, NAIF has committed \$3.5bn to Australian projects.²⁰³

Hastings Technology Metals was approved for a \$140m loan facility from NAIF in February 2022, a critical component for the development of its proposed Yangibana Rare Earths Project.²⁰⁴ In January 2023, Hastings announced NAIF had increased financial support for Yangibana to \$220m, representing more than half of the total debt financing required to complete the project.²⁰⁵ Speaking on the updated financing package, Executive Chairman Charles Lew said: "the increased NAIF loan and financial support from Wyloo Metals via the \$150m Exchangeable Note reinforces Hastings continued progress to have Yangibana fully funded in conjunction with its strategy to develop an integrated mine to magnet supply chain aligned with the critical minerals strategies of Australia and the EU."

Hastings has significant government financial support with funding from NAIF, KfW IPEX-Bank (German State bank), and Finnvera Oyj (Finland Export Credit Agency) for a senior debt facility totalling \$400m. Hastings' Yangibana Rare Earths refining operation has a pre-production capex of \$658m (including contingency), and is capable of producing up to 15ktpa MREC.²⁰⁶ Following the NAIF award, Hastings received firm commitments for a \$110m two-tranche Placement to accelerate the project's development. The introduction of these institutions, with support from current long-term shareholders, has boosted Hastings' position to commission the facility in mid-2024.²⁰⁷

²⁰³ NAIF, [Corporate Plan 2022-2026](#)

²⁰⁴ Hastings, [NAIF Approves A\\$140m Loan for Yangibana Rare Earths Project](#), 2 February 2022

²⁰⁵ Hastings, [NAIF Increases Financial Support for Yangibana Rare Earths Project](#), 17 January 2023

²⁰⁶ Hastings, [Yangibana Project NPV Increases 84% to A\\$1Bn](#), 21 February 2022

²⁰⁷ Hastings, [A\\$110m Two-Tranche Placement to Accelerate Development of the Yangibana Project](#), 7 September 2022

Future Fund

Labelled Australia’s sovereign wealth fund (SWF), the Future Fund established in 2006 is responsible for investing for the benefit of future generations of Australians across six funds with combined assets under management (AuM) of A\$240bn as of September 2022.²⁰⁸

Recommendation

As a public interest fund, CEF would argue that the Future Fund’s mandate should be updated by the Federal Government to have a strategic national interest object relating to retaining and increasing Australia’s ownership of key Australian assets. This can include ensuring new projects of national significance in the mining and refining of critical minerals in Australia leverage firmed renewable energy and are majority Australian owned. Taking an enabling patient equity stake after full due diligence can be strategically deployed to ensure appropriate accelerated new proposals development, whilst mandating the highest level of environmental, social and governance (ESG) standards are deployed at the project’s inception. This would also mean Australian taxpayers and future generations can share in the equity upside of these projects, and can balance financial returns with the wider objectives we articulate in this report. This strategic national interest focus would allow the Future Fund to de-risk and hence accelerate developments and in doing so, crowd-in private Australians superannuation funds that have the key restriction of the sole purpose test of maximising risk-adjusted returns, with no overt ESG framing unless the asset managers accept the (still mixed) evidence that taking ESG into financial decision-making improves the long-term risk-return outcomes.

Australia’s enormous resources wealth massively out-weighs that of Norway. It would be strategically sensible to address the multi-decade failure of Australia to replicate the success of the US\$1.36bn Norwegian SWF. Rather than starting an entirely new public policy debate from scratch, the Federal Government could enhance the Future Fund’s mandate to include this strategic equity investment objective. To give this proposal greater longevity, new Future Fund funding could be subsequently tied to mining royalties and the petroleum rent resources tax (PRRT), particularly if the PRRT was reviewed to actually work as originally contemplated, and/or if royalty rates were made progressive, and even deferred on new critical mineral proposals where there was a binding domestic value-adding commitment.

This is not a new idea. The A\$130bn iron ore export bonanza shared mostly by BHP, Rio Tinto, FMG and Hancock Prospecting were originally tied to commitments for BHP and Rio to explore domestic iron ore processing onshore, but both proposals failed spectacularly, leaving BHP in particular as a firm that “digs and ships” Australian resources with next to no domestic value-adding.

²⁰⁸ Future Fund, [About Us](#)

Export Finance Australia (EFA)

EFA provides financial support for Australian exporters and overseas infrastructure developments that deliver value to Australia. EFA is pivoting and will start adding a vital component to Australia's international trade and investment.²⁰⁹

In November 2022, **Pilbara Minerals** was awarded a \$125m long-term debt facility from EFA to support the construction of the P680 Expansion Project at Pilgangoora, WA. The Pilgangoora Project was built from initial financing support from the Clean Energy Finance Corporation (CEFC) committing US\$36.7m alongside US\$73.3m from BNP Paribas as a 5-year debt facility with an average 5% interest rate in 2020.²¹⁰ Pilbara Minerals is also awaiting an investment decision from the board of NAIF for a further \$125m. Pilbara Minerals has recognised the critical role of Australian Government funding for its Pilgangoora Operation, and in the expansion of Australia's critical mineral supply.²¹¹

Iluka Resources secured a \$1.25bn non-recourse loan from the Government's Critical Mineral Facility for the development of the Eneabba Rare Earth's Refinery, administered by EFA.²¹² With a capex of \$1-1.2bn for its Phase 3 expansion, WA's Eneabba Rare Earths Project is Australia's first fully integrated rare earth refining operation, emerging as a critical actor in onshoring the global supply and value of downstream rare earth projects.

Sunrise Energy Metals' NSW Sunrise Battery Materials Proposal is strongly positioned to compete as one of the largest and lowest-cost suppliers of nickel and cobalt for the battery industry. Sunrise was offered a \$400m debt funding from EFA.²¹³ With a pre-production capex of US\$1.66bn, EFA's debt facility is likely to prove a critical injection to get the proposal to FID. Creating 1,800 jobs through its construction phase and 400 sustained, the project would produce high-quality nickel for the production of one million EVs annually.²¹⁴ Sunrise has repeatedly articulated the importance of higher degrees of vertical integration across the value chain from automakers in order to execute their all-electric strategies. Ownership of assets that continue to generate positive operating cash flows through investment cycles provide the most effective form of metal price hedging for automakers, whilst securing new supply.²¹⁵

²⁰⁹ EFA, [Annual Report 2020-21](#)

²¹⁰ CEFC, [Pilbara Minerals Sets Sights on Growing Lithium Demand as CEFC Lifts Investment](#), 30 July 2020

²¹¹ Pilbara Minerals, [\\$250m Aus Gov Financing to Support Expansion at Pilgangoora](#), 11 November 2022

²¹² Iluka Resources, [Eneabba Rare Earths Refinery FID](#), 4 April 2022

²¹³ Sunrise Energy Metals, [Annual Report, 2022](#)

²¹⁴ Sunrise Energy Metals, [Battery Materials Project Execution Plan](#), 28 September 2020

²¹⁵ Sunrise Energy Metals, [Annual Report, 2022](#)

CleanCo, Queensland

CleanCo is a state-owned energy generator and developer which aims to capture Australia's abundant natural resources to deliver stable, globally competitive low-emission energy solutions.²¹⁶

Sun Metals is targeting 100% renewable energy for its Townsville zinc refinery, including capacity at the 1GW Macintyre wind farm, part secured by a 10-year PPA from CleanCo.²¹⁷

Net Zero Industry and Innovation Investment Plan, NSW

Established in October 2022, NSW's Net Zero Industry and Innovation Investment Plan aims to invest \$360m as the state's first industrial emission reduction initiative. Delivering the plan, NSW Treasurer and Energy Minister Matt Kean stated that it will *"help the deployment of clean manufacturing precincts in the Hunter and Illawarra and accelerate decarbonisation opportunities for NSW's highest emitting industrial sectors. These investment priorities will stimulate private sector investment to further drive the decarbonisation of NSW industry."* A total of \$200m will be dedicated to the deployment of opportunities to reduce industrial emissions, \$105m to accelerate strategic abatement opportunities, and \$55m to develop low-carbon infrastructure and industrial precincts.²¹⁸

December 2022 saw the NSW Government make a leading commitment to an economy wide 70% decarbonisation by 2035 target²¹⁹, showing how ambition on decarbonisation is snowballing across Australia, as it is globally.

State Electricity Commission, Victoria

Victoria's state election in 2022 was in part a referendum on the speed of decarbonisation of the Victorian economy. The re-election of the Daniel Andrews government has confirmed the commitment to the 95% renewable energy by 2035 target, a Gas Substitution Roadmap, and the reestablishment of the State Electricity Commission to build, own and operate new firm renewable energy assets in Victoria, crowding in private patient Australian pension capital, starting with a plan for \$1bn of new investments to build out 4.5GW of renewables ahead of Victoria's accelerating lignite-fired power plant closures.²²⁰

²¹⁶ CleanCo, [Annual Report FY22](#)

²¹⁷ AFR, [Queensland wind to power Telstra under Korea Zinc deal](#), 4 October 2022

²¹⁸ NSW Government, [Investing in a Low Carbon Future for NSW Industry](#), 25 October 2022

²¹⁹ The Guardian, [Matt Kean announces NSW target to cut carbon emissions by 70% by 2035](#), 23 December 2022

²²⁰ The Guardian, [Victoria set to re-enter electricity market after setting 95% renewable energy target](#), 20 October 2022

Government Support Catalyses Private Capital

Modern Manufacturing Initiative (MMI)

In October 2020, the previous federal government announced a \$1.5bn investment into the Modern Manufacturing Strategy to aid Australian manufacturers to be more competitive, resilient, and build scale in global markets. The fund was established to transform the critical minerals and processing sector by developing high-value, reputable and dynamic manufacturing.²²¹ The MMI acts as a crucial first-loss capital vehicle for Australia's emerging rare earths, vanadium, cobalt, and nickel suppliers, de-risking and crowding-in private capital. Figure 19 illustrates the projects currently supported under the modern manufacturing strategy.

Figure 19: Australian Critical Mineral Projects Selected under MMI ²²²



Source: Australian Government

²²¹ Australian Government, [Resources Technology and Critical Minerals Processing \(archived\)](#)

²²² Australian Government, [Resources Technology and Critical Minerals Processing \(archived\)](#)

The Minister for Industry and Science Ed Husic awarded the following MMI grants in August 2022:²²³

- **Australian Vanadium** was awarded a \$49m grant under the MMI Collaboration Stream to support its Vanadium Project²²⁴. The project has an estimated capex of \$604m and the potential to be a globally significant producer of high-quality vanadium pentoxide (V2O5) for the critical minerals, steel, and energy storage industry. The strategic integration of downstream refining onshore captures the value of the rapidly expanding market for Vanadium. In June 2022, Australian Vanadium successfully issued a Share Purchase Plan and Institutional Placement, raising \$20m to support the finalising of debt finance for FID.²²⁵
- **Lynas Rare Earths** was awarded a \$15m grant under the MMI Translation Stream to accelerate the commercialisation of its Kalgoorlie Rare Earths Processing Facility.²²⁶ With a capex of \$500m, the Kalgoorlie Processing Facility would onshore downstream refining from its Malaysian Plant, producing Mixed Rare Earth Concentrate (MREC), creating 209 jobs during construction, with 128 sustained. Lynas successfully completed a Retail Entitlement Offer, raising \$425m to finance the onshoring of its MREC operations.²²⁷
- **Pilbara Minerals** was awarded a \$20m grant under the MMI for the development of a mid-stream Lithium Salts project with ASX-listed **Calix**. Utilising spodumene concentrate from Pilbara's Pilgangoora operations (the third largest hard-rock lithium operation globally in 2021), a lithium calcination process enables a pathway to decarbonising supply of lithium via reduced waste movement across transport and logistic supply chains.²²⁸ The MMI grant will enable a Scoping Study for the project, furthering Pilbara's lithium expansion. Calix subsequently completed a \$60m institutional equity raise (plus SPP) to fund RD&D.²²⁹

²²³ Australian Government, [Examination of Modern Manufacturing Initiative Grant Concludes](#), 26 August 2022

²²⁴ Australian Vanadium, [Bankable Feasibility Study for the Australian Vanadium Project](#), 6 April 2022

²²⁵ Australian Vanadium, [Share Purchase Plan Results](#), 22 June 2022

²²⁶ Lynas, [Awarded \\$14.8m Australian Government Grant](#), 22 July 2021

²²⁷ Lynas, [Equity Raising Presentation](#), 17 August 2022

²²⁸ Pilbara Minerals, [Aus Govt. Modern Manufacturing Initiative Grant Awarded](#), 17 May 2022

²²⁹ AFR, [Calix gets Heidelberg agreement, raising \\$60m](#), 19 October 2022

Section 6. The Global Investment, Policy and Subsidy Race

Significant global momentum in the development of new policies aimed at accelerating investment in decarbonisation and zero emissions deployments occurred over the last year. With China leading the world in EVs and renewable energy installs, REPowerEU driving massively accelerated European decarbonisation investment, and India likewise leading the developing world on investment in renewables, the US Inflation Reduction Act puts the US back in this key global technology race. The Inflation Reduction Act (IRA) has demonstrated that government regulation is necessary to drive massive crowding in of private investments and manufacturing.

With US\$369bn of subsidies and incentives – including US\$500m into critical minerals processing and requiring at least 40% of the monetary value of critical minerals for batteries to be supplied by the nation or a US free-trade partner to qualify for EV tax credits - and the revival of the Department of Energy (DoE) loan program leveraging US\$394bn in low interest loans for clean-tech funding, the IRA includes over US\$60bn for onshore clean energy manufacturing to mitigate future price shocks, bring down the cost of clean energy, and debottleneck supply chains. The US\$2.8bn for battery manufacturing and value chain projects has already spurred US\$6.25bn of private capital investment.

Further, the Bipartisan Infrastructure Law battery manufacturing initiative has created over 6,000 new jobs. In turn, new infrastructure has provided security and diversification of risk across the supply network of precursor materials vital to onshoring manufacturing of clean energy technologies and minerals.

The IRA has reduced the cost of US manufactured green hydrogen by up to 75% and introduced a \$1,500/t tax on methane emissions. In combination with the continuation of the Investment Tax Credit (ITC) for wind, solar and battery projects, the IRA has spurred multi-billion dollar investments into US renewable energy developers and has made renewable energy more competitive, likely driving over \$1 trillion of new US rooftop and utility solar plus on- and offshore wind investments this decade, whilst incentivising 6.5GW pa of new domestic solar manufacturing, spurring massive investment in new critical minerals mining and refining, battery manufacturing and recycling, plus EV factories.

The IRA plan to electrify everything, making a wide array of distributed energy resources (DERs) eligible for new incentives—including renewables, energy efficiency, and other advanced energy systems installed in homes and businesses, with many of the programs specifically addressing lower income, disadvantaged and tribal households to ease upfront costs as they transition to clean energy – tops off this game-changing package of reforms.

There has been significant global momentum in the development of new policies aimed at accelerating investment in decarbonisation and zero emissions deployments over the last year. Much of this has been expedited in response to the hyperinflation of all fossil fuel commodities on the back of sanctions against Russia in response to its ongoing invasion of Ukraine.

Major strategic policy shifts include the US Inflation Reduction Act²³⁰, REPowerEU²³¹, China's 14th Five Year Plan²³², India's Production-Linked Incentives (PLI) scheme²³³, and most recently, Japan's GX Roadmap²³⁴.

Given the global significance of the US Inflation Reduction Act (IRA), and the importance for US free trade agreement partners like Australia, we have reviewed some of the key financial parameters in Section 6.1.

We also note the US IRA has provoked a significant response from the EU, and is likely to provoke an even greater level of public support for EU investments in clean energy manufacturing supply chains²³⁵, with the proposed EU Net-Zero Industry Act emerging in January 2023.²³⁶

Discussions at the World Economic Forum Annual Meeting in Davos in January 2023 included debate over the issue of green trade wars, concern investment was being lured from Europe to the US, and the risks of discrimination against European businesses due to the lack of a Free Trade Agreement. German Chancellor Olaf Scholz highlighted that the IRA's local content requirements "must not result in discrimination against European businesses" and that "protectionism hinders competition and innovation and is detrimental to climate change mitigation."²³⁷

²³⁰ Whitehouse, [Biden-Harris Administration Releases Inflation Reduction Act Guidebook for Clean Energy and Climate Programs](#), 15 December 2022

²³¹ European Commission, [REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition](#), 18 May 2022

²³² IEA, [An energy sector roadmap to carbon neutrality in China Country report](#), September 2021

²³³ The New Indian, [Role of PLI scheme in India's quest for clean & affordable energy](#), 20 January 2023

²³⁴ Japan 2 Earth, [GX: Nuclear Power To Play a Key Role in New Green Transformation Roadmap](#), 10 January 2023

²³⁵ FT, [How Biden's climate law is charging US green spending and provoking Europe](#), 26 January 2023

²³⁶ CNBC, [EU announces new green proposals to rival Biden's Inflation Reduction Act](#), 17 January 2023

²³⁷ FT, [Talk of green trade war overshadows Davos optimism](#), 22 January 2023

6.1 The Inflation Reduction Act

Critical minerals, and the subsets of lithium and rare earths in particular, are becoming an increasingly large and crucial part of the global economy's clean energy transition, and particularly the renewable industry with its heavy reliance on wind turbines, EVs, and batteries.

President Joe Biden's Inflation Reduction Act (IRA), signed into law in August 2022²³⁸, is the single largest action ever taken to mitigate the impacts of climate change in the US.

The IRA involves US\$369bn of subsidies and incentives, and revives the Department of Energy (DoE) loan program leveraging as much as US\$394bn for clean-tech funding.²³⁹

The IRA includes over US\$60bn to onshore clean energy manufacturing with the aim to mitigate risks of future price shocks, bring down the cost of clean energy, and debottleneck supply chains, including:²⁴⁰

- US\$30bn of production tax credits to accelerate US manufacturing of solar panels, wind turbines, batteries, and critical minerals processing
- US\$10bn investment tax credits to build clean manufacturing infrastructure for EVs, wind turbines, and solar panels
- US\$500m into critical minerals processing in the Defence Production Act
- US\$2bn to retool existing auto-manufacturing facilities to transition into clean vehicles, and
- Up to US\$20bn in loans to build new EV manufacturing facilities.

This has made renewable energy more competitive, likely driving over \$1 trillion of new US rooftop and utility solar, plus on- and offshore wind investments this decade, whilst incentivising 6.5GW pa of new domestic solar manufacturing. It has in turn seen Brookfield, ENGIE and RWE make over \$10bn of US renewable developer acquisitions since the IRA was launched (refer below).

The IRA provides a subsidy of up to \$7,500 for EVs if built in the US using US or allied critical minerals, spurring massive investment in new critical minerals mining and refining, battery manufacturing and recycling, plus EV factories. The IRA also reduces the cost of US manufactured green hydrogen by up to 75% and embeds Dr Saul Griffith's Electrify Everything strategy²⁴¹ by massively incentivising distributed energy resources (DER).

²³⁸ CNBC, [Schumer-Manchin Reconciliation Bill has \\$369bn to Fight Climate Change](#), 28 July 2022

²³⁹ Bloomberg, [Biden's Green Energy Bank Races to Leverage \\$394bn to Scale Cleantech](#), 18 January 2023

²⁴⁰ [Summary of Energy Security and Climate Change Investments in IRA 2022](#)

²⁴¹ Saul Griffiths, [Electrify, 2021](#)

There has been a massive crowding in of private investments and manufacturing into the US as a result of the IRA. While the US is still far behind China on all “things” decarbonisation related²⁴², this certainly puts the US back in this key global technology race.

The IRA introduces a US\$85/t²⁴³ subsidy for Carbon Capture and Storage (CCS)²⁴⁴, US\$60/t for Carbon Capture Utilisation & Storage (CCUS), and US\$180/t for Direct Air Capture (DAC). On the positive side of the climate ledger, it also included a transformative US\$1,500/t tax on methane emissions.²⁴⁵

The Energy Infrastructure Reinvestment Program (Section 1706 of Inflation Reduction Act) enables the DoE Loan Program Office to create an additional US\$250bn in low-interest loans to transform the nation’s energy infrastructure landscape. The loan program expires at the end of 2026.²⁴⁶ By January 2023, the total capacity of the DoE Loan Program was reported as US\$394bn.²⁴⁷

This builds on the December 2021 executive orders by President Biden to make the US Federal Government zero emissions by 2050²⁴⁸, with an interim target of a 65% reduction by 2030. Biden’s plan broadly encompasses the 300,000 buildings, 600,000 cars and trucks and \$650bn in purchases that are part of the federal government’s operations. The order sets multiple goals across those operations, including 100% EV acquisitions by 2035 and a net-zero emissions building portfolio by 2045, including a 50% emissions reduction by 2032.

EV Production

The IRA offers subsidies of up to \$7,500-a-car for EV makers but only if those cars are assembled in North America and local content requirements are met. Minerals must be extracted from or processed in countries the US has a free trade agreement with, and a large percentage of battery components need to be manufactured or assembled in the US.

In August 2022, the Canadian Government sealed agreements with **Volkswagen AG** and **Mercedes-Benz Group AG** for the security of nickel, cobalt, and lithium supply across their North American manufacturing networks.²⁴⁹ The agreement was a result of the deepening connection and cooperation in North American sustainable battery manufacturing and critical mineral supply chains. Supporting the IRA, the Canadian Government released the 2030 Emissions Reduction Plan, targeting a 40% reduction in emissions relative to 2005 levels by 2030 and net-zero by 2050.²⁵⁰ The Plan includes C\$3.8bn to develop Canada’s first Critical Minerals Strategy.²⁵¹

²⁴² CEF, [China’s global energy transition leadership](#), 25 August 2022

²⁴³ Grist, [Will the Inflation Reduction Act Jumpstart Carbon Capture?](#), 22 August 2022

²⁴⁴ CRS, [Carbon Capture and Sequestration \(CCS\) in the United States](#), 5 October 2022

²⁴⁵ NPR, [Biden Tightens Methane Emissions Rules, Even as the US Pushes for More Oil Drilling](#), 11 November 2022

²⁴⁶ Canary Media, [How will DoE Loan out \\$250bn to Make Dirty Energy Systems Clean](#), 3 November 2022

²⁴⁷ Bloomberg, [Biden’s Green Energy Bank Races to Leverage \\$394bn to Scale Cleantech](#), 18 January 2023

²⁴⁸ REGlobal, [Executive Order Pushes Government Operations Towards Renewable Energy](#), 24 January 2022

²⁴⁹ Bloomberg, [Volkswagen Lines Up Tariff-Friendly Battery Supplies in Deal with Canada](#), 22 August 2022

²⁵⁰ Government of Canada, [2030 Emissions Reduction Plan: Clean Air, Strong Economy](#), 12 July 2022

²⁵¹ Government of Canada, [Canada Strikes Historic Partnerships with Leading German Automakers](#), 23 August 2022

August 2022 saw **Panasonic** expanding their planned investments in the US, with discussions for an additional US\$4bn battery facility in Oklahoma²⁵² in addition to their US\$4bn Kansas battery plant announced the month prior. In October, Panasonic announced the commencement of construction of the Kansas facility²⁵³ with a planned capacity of 30GWh of 2170 batteries, the key component of Tesla's Model 3. The Model 3 represented over 27% of US EV sales in 2022.²⁵⁴

Panasonic also signed supply agreements with **Redwood Materials**²⁵⁵ in November 2022 to secure a domestic sustainable supply of critical minerals and precursor materials for Panasonic's Kansas and proposed Oklahoma battery facility. Redwood announced a US\$3.5bn investment to develop a 100GWh cathode facility to support the company's anode and copper foil pipeline in South Carolina.²⁵⁶ The supply agreement marks the first gigafactory-scale cathode manufacturing operation in North America, a critical milestone for the objectives of the IRA. A key differentiation for Redwood Materials is to have the highest recycled lithium, cobalt, and nickel content available.

Redwood Materials had formed a partnership with **Volkswagen America**²⁵⁷ in July 2022 to recycle end-of-life batteries as supply for the company's cathode and anode pipeline. Redwood recovers 95% of metals including nickel, copper, cobalt, and lithium from batteries and injects back into the domestic supply chain, rather than exporting. Redwood's initiative is imperative to the targets of the IRA in onshoring supply, creating a robust, circular domestic battery manufacturing value chain.

In October 2022, **LG Energy Solution** and **Honda** committed a joint US\$3.5bn investment²⁵⁸ for a new 40GWh battery plant in Columbus, Ohio. Creating 2,200 new manufacturing jobs, the plant is expected online by the end of 2024, supplying Honda's growing EV ecosystem. LG Energy Solution raised their 2022 sales outlook by 14% in October²⁵⁹, with LG stressing the critical importance that the North American markets had on the company's performance and growth plan. The South Korean company also updated its targets for North American growth, with internal compounded annual growth forecasts in the US to outperform European and Chinese markets.²⁶⁰

LG Chem announced in November 2022 the investment of US\$3bn to develop the nation's largest cathode manufacturing facility in Tennessee²⁶¹ with a target of 120ktpa by 2027. LG will provide domestically produced battery materials to automakers. The facility will be 100% powered by renewable energy, sourced from solar and hydro plants.

²⁵² Reuters, [Tesla Supplier Panasonic Plans Additional \\$4bn US EV Battery Plant](#), 27 August 2022

²⁵³ Panasonic, [Construction of Manufacturing Facility of Automotive Li-Ion Batteries in US](#), 31 October 2022

²⁵⁴ Electrek, [Here's How US EV Sales by Maker and EV Model Compare](#), 18 October 2022

²⁵⁵ Redwood Materials, [Panasonic to source high-nickel cathode from Redwood](#), 15 November 2022

²⁵⁶ Redwood Materials, [Redwood Chooses Charleston, South Carolina Region for New Battery Materials Campus](#), 15 December 2022

²⁵⁷ Redwood Materials, [Redwood Materials and Volkswagen Group of America announce partnership](#), 13 July 2022

²⁵⁸ LG Energy Solution, [Honda and LG Energy Solution Announce Ohio as Home to Joint Venture EV Battery Plant](#), 12 October 2022

²⁵⁹ Bloomberg, [LG Energy Pins Hopes on America Growth as EV Battery Sales Climb](#), 26 October 2022

²⁶⁰ LGES, [LGES to Triple Revenue, Achieve Double-Digit Operating Profit Margin in 5-Years](#), 27 July 2022

²⁶¹ LG Chem, [LG Chem to Establish Largest Cathode Plant in US for EV Batteries](#), 22 November 2022

To support the development of LG's capacity expansion in North America, LGES has signed a number of raw material supply contracts to diversify its supply chain risks. LGES has agreements with Compass Minerals, Avalon Advanced Materials and Snow Lake Resources for the supply of lithium carbonate and hydroxide. LGES has also formed partnerships with Sigma Lithium for spodumene and Electra Battery Materials Corporation for cobalt sulfate supply. Most recently, LG partnered with ASX-listed Syrah Resources to off-take natural graphite from its future Louisiana operations (discussed in Section 8), currently the only non-Chinese supplier of the key component to anodes.²⁶²

September 2022 saw **Hyundai Motor Group** of Korea²⁶³ announce the possible acceleration of construction timeline for its US\$5.5bn EV factory near Savannah, Georgia²⁶⁴. Hyundai and South Korean officials expressed public concern over the new regulations in the IRA to receive the tax incentives, and its disproportionate effect on automakers. The Savannah Economic Development Authority announced Hyundai began construction of the facility in October 2022.²⁶⁵ A significant component of Hyundai's decision was the State incentive package valued at over US\$1.8bn for Hyundai to commit to the facility. The announcement marked a historic moment for Georgia, creating over 8,100 new manufacturing and supply jobs.

Hyundai Mobis, the South Korean automakers electrification component division, announced a further US\$1.3bn for the construction of an EV components factory²⁶⁶ to support Hyundai and Kia's local operations to qualify for domestic production credits.

October 2022 saw **BMW** announce a US\$1bn retooling of its South Carolina EV plant as well as a proposal to support China's Envision (this the former battery unit of Nissan Motor Co. of Japan, that was acquired by Envision Group of China in 2018) to build a nearby US\$700m 30GWh battery assembly factory.²⁶⁷ Envision had in March 2022 announced a strategic intent to build a US battery cell facility to supply Mercedes' US\$1bn battery and EV assembly operations in Alabama.²⁶⁸

November 2022 saw **Hyundai Motor Group** sign an agreement with battery supplier, **SK On**, for a proposed US\$1.9bn 20GWh²⁶⁹ to supply Hyundai's first US EV-dedicated facilities. The JV will strengthen the connection between the South Korean giants, with the partnership already supplying the successful Hyundai IONIQ5, IONIQ6, and Kia EV6.

In support of the partnership, SK On announced a lithium hydroxide supply agreement from **SQM**, to strengthen security of supply for its expanding US operations.²⁷⁰ The supply of 57ktpa lithium

²⁶² LGES, [LGES Partners with Syrah to Expand Critical Minerals Portfolio in North America](#), 20 October 2022

²⁶³ Bloomberg, [Hyundai Considers Speeding Up Building New US Factory for Electric Cars](#), 30 September 2022

²⁶⁴ The Atlanta Journal-Constitution, [Hyundai sets date to break ground on \\$5.5B EV factory in Georgia](#), 13 October 2022

²⁶⁵ The Atlanta Journal-Constitution, [Hyundai Factory Ground-breaking Highlights EV Promise and Challenges](#), 29 October 2022

²⁶⁶ The Atlanta Journal-Constitution, [Hyundai EV parts supplier announces plans for \\$1.3B factory in U.S.](#), 7 October 2022

²⁶⁷ Bloomberg, [BMW Invests \\$1.7 Billion to Expand South Carolina EV Plant](#), 20 October 2022

²⁶⁸ Bloomberg, [Mercedes Opens Battery Plant for Alabama-Made Electric SUVs](#), 15 March 2022

²⁶⁹ Electrek, [Hyundai, SK On investing \\$4-5B in US battery factory, creating 3,500 jobs](#), 25 November 2022

²⁷⁰ SK On, [SK On Signs LHM Supply Deal with World's Leading Producer SQM](#), 7 November 2022

hydroxide from 2023 will be sufficient to power 1.2 million EVs. The agreement is in response to the critical mineral requirements for EV value chains under the IRA, with the supply from SQM's Chilean operations, a free-trade partner of the US.

November 2022 saw Norway's **FREYR** announce a US\$1.7bn 34GWh lithium-ion battery manufacturing facility in Georgia. FREYR plans to use the SemiSolid battery production technology developed by 24M Technologies, a spinout from the Massachusetts Institute of Technology (MIT) in Cambridge, Mass. The 24M process claims to have simplified lithium-ion battery production with a design that requires up to 80% less of the inactive materials, such as copper and aluminium, and a claimed benefit of lowering manufacturing costs by up to 40%. Time will tell.²⁷¹

In December 2022, Siemens announced it will open a second US manufacturing hub for EV chargers in Carrollton, Texas. Siemens will retrofit the Carrollton plant to manufacture their VersiCharge Blue charger, their specifically designed US-market charger designed to be installed in workspaces, hospitals, airports, campuses, and parking structures. The new manufacturing hub will create a further 100 jobs at the facility, with full operations expected mid-2023.²⁷²

Battery Material Supply Chain

The IRA requires at least 40% of the monetary value of critical minerals for batteries to be supplied by the nation, or a US free-trade partner, to qualify for EV tax credits. The threshold will increase to 80% in 2027.²⁷³

The US DoE Loan Program awarded US\$2.8bn in grants to battery materials processing, manufacturing, and recycling projects under the Bipartisan Infrastructure Law (BIL)²⁷⁴. The federal grants provided significant support to 20 firms critical to securing the domestic value of the energy transition and onshoring of supply chains.

Other projects, including from Australian-listed companies, have also benefited:

Albemarle announced the development of a lithium concentration facility²⁷⁵ to produce spodumene concentrate after being awarded a US\$150m grant from the DoE. The spodumene would provide feedstock for Albemarle's previously announced mega-flex lithium conversion facility, originally proposed to process concentrate from various sources, producing 100ktpa of LHM.²⁷⁶ The

²⁷¹ PV Magazine USA, [FREYR plans the Giga America lithium-ion battery manufacturing facility in Georgia](#), 11 November 2022

²⁷² Electrek, [Siemens is Opening an EV Charger Factory in Texas](#), 13 December 2022

²⁷³ White & Case, [New US Climate Bill Seeks to Bolster Domestic Critical Minerals Supply Chain](#), 2 August 2022

²⁷⁴ US Department of Energy, [Biden-Harris Administration Awards \\$2.8 Billion to Supercharge U.S. Manufacturing of Batteries for Electric Vehicles and Electric Grid](#), 19 October 2022

²⁷⁵ Albemarle, [Albemarle Secures DOE Grant For U.S.-Based Lithium Facility To Support Domestic EV Supply Chain](#), 19 October 2022

²⁷⁶ Albemarle, [Albemarle Secures DOE Grant for US-Based Lithium Facility to Support Domestic EV Supply Chain](#), 19 October 2022

concentration facility would provide domestic supply of hard-rock concentrate to support the manufacture of 1.6 million EVs pa.

ASX-listed **Piedmont Lithium**'s US\$600m lithium project in Tennessee²⁷⁷ will provide 30ktpa of LHM to the US battery value chain. The proposed facility was spurred by a US\$142m grant under the BIL to accelerate the project's timeline. The support from the IRA is a critical injection for Piedmont to enable the engineering and construction of the plant, with operations expected to commence in 2025.

ASX-listed **Syrah Resources** received a US\$220m BIL grant for the expansion of its Vidalia Active Anode Material facility²⁷⁸. CEF previously discussed the global significance of the Vidalia natural graphite processing facility as the only large-scale supplier outside of China.²⁷⁹ The BIL grant supports Syrah's progression into its Phase 3 expansion, which will provide 45ktpa of domestic anode material to Tesla, SK On and LG Energy Solutions²⁸⁰.

The US\$2.8bn in federal support for battery manufacturing²⁸¹ and value chain projects supported under the IRA has spurred US\$6.25bn of private capital investment. The BIL battery manufacturing initiative has catalysed the creation of over 6,000 new jobs in the US. In turn, the new infrastructure has provided security and diversification of risk across the supply network of precursor materials vital to onshoring the manufacture of cathodes, anodes, separators, drivetrains, wind turbines, and solar.

Solar Manufacturing

November 2022 saw **First Solar US** confirm²⁸² it will build a US\$1.1bn 3.5GW annual capacity US solar module manufacturing operation in Alabama²⁸³. With an expected commissioning by 2025, the facility will create 700 new direct manufacturing jobs. August 2022 saw First Solar announce an US\$185m upgrade²⁸⁴ of its existing three factories in Ohio by 0.6GW to 3.6GW pa of capacity for Series 6 thin film solar modules, including upgrading one facility to produce world-leading Series 7 modules, scheduled to come online in the first half of 2023. In October 2022 First Solar announced

²⁷⁷ Piedmont Lithium, [Piedmont Lithium selected for \\$141.7 million grant by US Department of Energy for Tennessee Lithium Project](#), 20 October 2022

²⁷⁸ Syrah Resources, [Syrah selected for US Department of Energy grant of up to US\\$220m for Vidalia expansion](#), 20 October 2022

²⁷⁹ CEF, [Globalisation: The Expansion of Future Facing Mineral Companies beyond Australia](#), 15 November 2022

²⁸⁰ LG Energy Solution, [LG Energy Solution Partners with Syrah To Expand Critical Mineral Portfolio in North America](#), 20 October 2022

²⁸¹ US Department of Energy, [Biden-Harris Administration Awards \\$2.8 Billion to Supercharge U.S. Manufacturing of Batteries for Electric Vehicles and Electric Grid](#), 19 October 2022

²⁸² First Solar US, [First Solar Selects Alabama for Fourth American Manufacturing Facility](#), 16 November 2022

²⁸³ Bloomberg, [US Solar Installs to Get 40% Boost on Climate Law, Industry Says](#), 8 September 2022

²⁸⁴ First Solar US, [First Solar to Invest up to \\$1.2 Billion in Scaling Production of American-Made Responsible Solar by 4.4 GW](#), 30 August 2022

that it plans to invest \$270m in a dedicated R&D innovation centre²⁸⁵ in Perrysburg, Ohio, creating 100 R&D jobs.

November 2022 saw **ENEL** of Italy²⁸⁶ announce it will replicate its under-construction 3GW pa solar module manufacturing facility in Sicily by building an annual capacity 3GW high-performance bifacial PV modules and cells manufacturing plant in the US²⁸⁷, generating 1,500 jobs. Enel has plans to then double to 6GW pa in Phase 2.

Solar Capacity

Clean-energy developers are forecast to install 215GW of solar during the next five years, according to the Solar Energy Industries Association, 40% more than expected prior to the IRA, reaching almost 50GW pa by 2027. Additionally, BNEF forecasts residential rooftop solar installations²⁸⁸ will increase by 25% yoy to 5.6GW in 2022 (7.5GW including commercial & industrial).

Wind Capacity

In September 2022 President Biden set a goal of deploying 30GW of offshore wind by 2030, an investment of US\$100bn (and 110GW by 2050²⁸⁹). Additionally, the Floating Offshore Wind Shot²⁹⁰ targets 15GW by 2035 and aims to reduce the costs of floating technologies by 70% to \$45/MWh. Additionally, California announced a goal to deploy 25GW of floating offshore wind by 2045²⁹¹.

October 2022 saw **Hitachi Energy** announce²⁹² a \$37m investment to expand its power transformer factory in South Boston, Virginia to the benefit of the US power grid.

The US is expected to install over 50GW of onshore wind²⁹³ over 2022-2026, a US\$75bn investment. December 2022 saw the announced tender winners of the first California offshore wind energy auction by the Bureau of Ocean Energy Management (BOEM). Raising deposits of US\$757m, BOEM's lease sale offered five lease areas covering 373,268 acres off California with the combined potential to produce 6GW of offshore wind energy.²⁹⁴ ²⁹⁵ Winning bids were from **RWE** of Germany, **Equinor** of Norway, **Invenergy** of the US, **Central California Offshore Wind LLC**, associated with **EDPR** of Spain

²⁸⁵ First Solar US, [First Solar to Accelerate American Thin Film PV Innovation with \\$270 Million Investment in Dedicated R&D Innovation Center](#), 27 October 2022

²⁸⁶ PV Magazine, [Enel Green Power confirms plans to build 3 GW solar module factory in US](#), 21 November 2022

²⁸⁷ ET Energyworld, [Italy's Enel to build solar PV cell & panel factory in US](#), 18 November 2022

²⁸⁸ Bloomberg, [US Homes Add Rooftop Solar at a Record Clip to Cut Power Bills](#), 29 August 2022

²⁸⁹ REGlobal, [US Offshore Wind: Poised for rapid expansion to meet climate goals](#), 9 November 2022

²⁹⁰ White House, [FACT SHEET: Biden-Harris Administration Announces New Actions to Expand U.S. Offshore Wind Energy](#), 15 September 2022

²⁹¹ Electrek, [US offshore wind sets a record with 58% growth in long-term targets in Q3](#), 13 October 2022

²⁹² Electrek, [Hitachi Energy will expand its Virginia power transformer factory to meet soaring US demand](#), 12 October 2022

²⁹³ US Department of Energy, [Land-Based Wind Market Report: 2022 Edition](#), August 2022

²⁹⁴ US Department of the Interior, [Biden-Harris Administration Announces Winners of California Offshore Wind Energy Auction](#), 7 December 2022

²⁹⁵ UtilityDrive.com, ['Proceed with caution': Key takeaways from California's first offshore wind energy auction](#), 19 December 2022.

and **ENGIE** of France, and **California North Floating LLC**, a subsidiary of **Copenhagen Infrastructure Partners** (CIP) and RWE.

Mergers and Acquisitions

The IRA, in combination with the continuation of the Investment Tax Credit (ITC) for wind, solar and battery projects, has spurred multi-billion-dollar investments into US renewable energy developers.

September 2022 saw **Brookfield Renewables**²⁹⁶ invest up to US\$2bn in US renewables, including US\$1bn to acquire Scout Clean Energy's portfolio which included 1.2GW of operating wind assets, 400MW of which is managed on behalf of third parties, and a pipeline of 22GW of wind, solar and storage projects across 24 states, including 2.5GW of under construction and advanced-stage projects. Brookfield also announced the acquisition of Standard Solar for consideration of US\$540m, which owns 500MW of operating and "under construction" contracted assets and a development pipeline of 2.0GW. This builds on the Brookfield acquisition in January 2022 of Urban Grid²⁹⁷ for \$650m, a leading solar and battery storage developer with a development pipeline of 13GW of utility-scale solar and 7GW of energy storage projects across key markets in the US.

October 2022 saw **RWE**²⁹⁸ of Germany acquire Con Edison Clean Energy Businesses for US\$6.8bn (implying an enterprise value multiple of 11x). Con Edison CEB operates and develops renewable energy plants around the US, with 3GW of operational capacity and solar projects accounting for 90% of the total. This acquisition nearly doubles RWE's commissioned US renewables infrastructure portfolio to 7GW.

In October 2022 **ENGIE** of France acquired 6GW of solar and battery projects²⁹⁹ from Belltown Power U.S., significantly strengthening its renewable development pipeline. The acquisition includes 33 projects comprising 2.7GW of solar with 0.7GW of paired storage and 2.6GW of stand-alone battery storage. This significantly enhances ENGIE's existing 3.9GW of installed US renewables projects.

Distributed Energy

The IRA put in place a plan to electrify everything³⁰⁰, making a wide array of distributed energy resources (DERs)³⁰¹ eligible for new incentives—including renewables, energy efficiency, and other advanced energy systems installed in homes and businesses. Many of these programs specifically

²⁹⁶ Brookfield Renewable Partners, [Brookfield to invest up to \\$2 billion in Scout Clean Energy and Standard Solar](#), 29 September 2022

²⁹⁷ Brookfield Renewable Partners, [Brookfield Renewable Acquires Premier Renewable Developer Urban Grid, Adding Approximately 20,000 Megawatts of Solar and Energy Storage Projects in the U.S.](#), 26 January 2022

²⁹⁸ REGlobal, [RWE to acquire Con Edison CEB for \\$6.8 billion](#), 3 October 2022

²⁹⁹ ENGIE, [ENGIE acquires 6 GW of solar and battery storage capacity projects from Belltown Power U.S. and significantly strengthens its renewable development pipeline](#), 27 October 2022

³⁰⁰ Saul Griffiths, [Electrify: An Optimist's Playbook for Our Clean Energy Future](#), 2021

³⁰¹ REGlobal, [What's in the Inflation Reduction Act for utilities?](#) 18 November 2022

address lower income, disadvantaged and tribal households and aim to ease their upfront costs as they transition to clean energy.

The IRA gives \$2,000 to homeowners who install efficient heat pumps, heat pump water heaters or biomass stoves, and boilers. It refreshes the tax credit for energy efficient home building, increasing the maximum credit to \$5,000 per home. It creates a \$1bn fund for the Department of Housing and Urban Development for distribution to affordable housing providers for energy efficiency projects, distributed generation, electrification, or other sustainability projects. The IRA has also directed the DoE to distribute \$4.3bn to states for home energy retrofit rebates, up to \$4,000 per household. It has allocated \$200m to the DoE to support states in developing and implementing programs to train and educate contractors on energy efficiency and electrification. It has also launched a \$27bn grant program for states, local and tribal governments, and non-profits to enable greenhouse gas (GHG) reduction projects including energy efficiency and distributed generation.

With China leading the world in EVs and renewable energy installs, REPowerEU³⁰² driving massively accelerated European decarbonisation investment, and India³⁰³ likewise leading the developing world on investment in renewables, the IRA puts the US back in this key global technology race. With the climate crisis being a clear, present and growing danger, global momentum is building.

Green Hydrogen

The IRA is a game changer for US green hydrogen manufacturing. Tax credits of US\$3/kg for 10 years reduce the cost of manufacturing by up to 75% and make green hydrogen immediately cost competitive against hydrogen produced from fossil fuels, particularly given renewable energy projects also get a 30% Investment Tax Credit as well. This will make the use of green hydrogen in steel manufacturing cost competitive, spurring decarbonisation investments.

³⁰² European Commission, [REPowerEU: affordable, secure and sustainable energy for Europe](#), May 2022

³⁰³ CEF, [India-China investment analysis in Electricity as COP27 Progresses](#), 8 November 2022

Section 7. Conversion To Clean Energy use in Critical Minerals, Mining and Manufacturing Value Chains

To reach Australia's targeted renewables share, variable renewable energy capacity additions will be needed at speed and scale to overtake soon-to-be-retired fossil-fuel based generation. A primary driver will be coordinated public and private financing, accelerating investments into Renewable Energy Zones. Australia must support the expansion of value-adding industries onshore to realise the global competitive advantage and become a world-leader in driving decarbonisation in mining, metals, heavy industry, and production and manufacturing across the board. This will counter the extreme market price fluctuations and instability of traditional fossil fuel energy sources.

Government support is key to fast-track approvals that incorporate the world's best decarbonisation objectives, and to crowd in private capital by deploying patient, national-interest equity, infrastructure, debt, export credit and grant finance. Large-scale, world-leading miners extracting value from Australia's resources must also lead capital-intensive renewable energy capacity expansion.

An accelerated pathway to decarbonisation using low-cost variable renewable energy (VRE) with battery storage, pumped hydro, enhanced grid interconnection, dynamic pricing, EV-to-grid and demand response management firming, is the solution to the climate crisis, and firming up energy security and grid stability, here and globally.

For Australia, it is also paramount to support the expansion of Australia's value-adding industries onshore. While methane gas, diesel, and coal currently dominate Australia's powering of value-added operations in mining and metal production, we need to realise our opportunity and our global competitive advantage to become a world-leader in driving decarbonisation in mining, metals, heavy industry, and production and manufacturing across the board. This will counter the extreme market price fluctuations and instability of traditional fossil fuel energy sources.

The recent outage from Chevron's Wheatstone gas plant, the third gas plant breakdown this summer in WA, is a case in point.³⁰⁴ Wheatstone provides ~17% of WA's gas production. Its failure triggered an energy crisis with an immediate impact on major alumina and ammonia nitrate operations, including South32, Wesfarmers and Alcoa, with Alcoa shutting down operations in a refining unit and resorting to emergency diesel generation.

Currently, Australia's mining sector derives its energy requirements from diesel (41%), gas (33%), grid electricity (22%), and other fuel sources aggregating to form the remainder. The mining sector accounts for ~10% of Australia's total energy demand, with energy consumption rising 6% over the

³⁰⁴ AFR, [Chevron Struggles to Fix WA Gas Plant as Alcoa Boots Up Diesel](#), 8 January 2023

last year.³⁰⁵ The use of electricity in alumina and aluminium refining doubles this mining share nationally. The expansion of Australia’s critical minerals industry, as well as decarbonisation of aluminium refining, will intensify the demand on the country’s electrical grid and increase the needed investment in grid-firming.

Australia’s Climate Change Act 2022 aims to reduce the nation’s greenhouse gas emissions by 43% by 2030 (relative to 2005 levels).³⁰⁶ To achieve the Federal Government’s emissions target, the \$20bn Rewiring the Nation Plan aims to support the Australian Energy Market Operator’s (AEMO) Integrated System Plan (ISP) to achieve 82% renewable energy share of the National Electricity Market (NEM) by the end of the decade.³⁰⁷

To reach the targeted renewables share, variable renewable energy (VRE) capacity additions will be needed at speed and scale to overtake soon-to-be-retired fossil-fuel based generation. AEMO’s ISP projects that 48GW of new utility-scale wind and solar VRE in Queensland will be required by 2050 to replace retiring coal-fired generation capacity, with 40GW for NSW, 15.5GW in SA, and 22.7GW in Victoria.³⁰⁸

The Australian Industry ETI estimates by 2050, 84GW of wind and 87GW of large-scale solar PV, coupled with 79GW of rooftop solar generation will be required to power Australia’s heavy industries in their ‘Coordinated Action Scenario’.³⁰⁹ A unified approach to national decarbonisation with substantial government incentive and policy frameworks coupled with industry leadership driving emission abatement across all sectors. As the mineral, aluminium, iron and steel industries in Australia further their export focus, feeding global energy transition supply chains, the renewable energy scale could reach 232GW of wind, 243GW of large-scale solar and 79GW of rooftop solar with ETI’s export sensitivity analyses. The Coordinated Action Scenario’s scale would require as much as \$440bn of cumulative investment into Australia’s energy system, primarily into generation and transmission infrastructure.

The IEA expects Australia to deploy 40GW of new renewable energy capacity by 2027 - up 30% from the Agency’s 2021 estimate - driven by corporate PPA activity to meet private sector decarbonisation targets and new projects facilitated by Renewable Energy Zones (REZs).³¹⁰

The nation’s massive VRE comparative advantage provides a “once in a century” opportunity for Australia to become a global leader in decarbonised heavy industry across the board. Australia’s abundant resources of wind, sun, and most importantly, extensive land area provide a critical opportunity to decarbonise onshore and aid our key trade partners in abating value chain emissions.

³⁰⁵ ARENA, [Renewable Energy in the Australian Mining Sector](#), 21 July 2020

³⁰⁶ Federal Register of Legislation, [Climate Change Act 2022](#), 14 September 2022

³⁰⁷ AOFM, [Aus Government Climate Change Commitments, Policies and Programs](#), November 2022

³⁰⁸ AEMO, [2022 Integrated System Plan Appendix 3. Renewable Energy Zones](#), June 2022

³⁰⁹ AIETI, [Pathways to Industrial Decarbonisation](#), 20 February 2023

³¹⁰ IEA, [Renewables 2022 Report](#), December 2022

Australia has the capacity to install ~ 25,000GW of renewable energy given our resources, sufficient to generate over 86,000TWh of energy annually.³¹¹ The shift is taking place in the context of a dramatic escalation of climate policy ambition and public and private investment into renewables globally.

A primary driver of emissions reductions and renewable capacity and concomitant emissions reductions domestically will be co-ordinated public and private financing, accelerating investments into REZs.

Australia's Critical Minerals Decarbonisation Opportunity

It is imperative that Australia captures the value of surging global critical minerals demand generated by the clean energy transition. As critical mineral mining and refining expands here, the country has an opportunity to embed decarbonisation in new projects across the value chain, harnessing Australia's low-cost, reliable VRE and building onshore supply chains at global scale.

The Australian Government's 2022 Critical Minerals Prospectus summarises the key future projects across all metals and minerals required for the energy transition.³¹² A key example is **Liontown Resources'** Kathleen Valley lithium project, under development in WA. **Zenith Energy** has partnered with Liontown Resources to develop one of the largest off-grid wind, solar and BESS (battery energy storage system) facilities to power a significant component of Liontown's Kathleen Valley lithium mine, a key development project for Tesla, Ford, and LG Energy Solutions. The facility will involve a 30MW Wind and 16MW Solar Farm with a 17MW battery firming solution.³¹³ It is noted the Hybrid Power Station will include 27MW of gas generation for thermal power and 5MW of diesel standby capacity.³¹⁴

In January 2023, Arafura Rare Earths published a Greenhouse Gas Emission Reduction Pathway for its Nolan's Rare Earth Project in Northern Territory. The pathway detailed various options the company evaluated in transitioning to zero emission technologies for their electrical, thermal and firming power requirements in order to reach net zero by 2050. Arafura have established a roadmap to scale out 30MW of solar PV and 60MW of wind by 2030 to supply 50% of the project's electrical demand by 2030. The solar and wind capacity will scale to 60MW and 90MW respectively to power the full electricity demand from Nolans. Arafura will scale Concentrated Solar Thermal (CST) and Thermal Energy Storage (TES) for their thermal generation requirements. The project, like Liontown Resources, will rely on methane gas firming for the electrical and thermal systems, before transitioning to renewable fuels.³¹⁵

³¹¹ AIETI, [Pathways to Industrial Decarbonisation](#), 20 February 2023

³¹² Austrade, Australian Critical Minerals Prospectus, 2022

³¹³ Liontown Resources, [Letter of Award for Kathleen Valley Hybrid Power Station](#), 12 September 2022

³¹⁴ Liontown Resources, [Binding Power Purchase Agreement for Kathleen Valley](#), 20 December 2022

³¹⁵ Arafura Rare Earths, [GHG Emission Reduction Pathway](#), 31 January 2023

A concurrent theme across all projects identified in the Federal Government prospectus is the companies' promises to meet their energy demand using commercial and sustainable renewable energy.

Government support is key to fast-track approvals that incorporate the world's best decarbonisation objectives, and to crowd in private capital by deploying patient, national-interest equity, infrastructure, debt, export credit and grant finance, via, for example, the Future Fund, CEFC, NAIF, EFA and ARENA, and state level funders such as Queensland's CleanCo – as discussed in Section 5.1.

A key underlying problem however is the lack of leadership from Australia's largest mining companies on rapid deployment of decarbonising technology and capital. When federal and state governments have clearer, more tangible roadmaps to decarbonising energy than some of the biggest mining firms in the world, commercial considerations mean that smaller-scale critical mineral firms will be reluctant to act. It is the responsibility of the large-scale, world-leading miners extracting value from Australia's resources to lead capital-intensive renewable energy capacity expansion.

Rio Tinto

Rio Tinto (market capitalisation \$205.0bn) is one of the leading mining companies in Australia with a dedicated climate roadmap, and Australia's #1 energy user.

Rio Tinto's decarbonisation strategy is focussed on the phase-out of coal from grid-connections with renewable power capacity additions across Queensland and WA, transitioning from gas-powered to solar micro-grids, and diesel abatement through electrified transport and hauling solutions. Post the Juukan Gorge debacle³¹⁶ which profoundly damaged its social licence, it is pleasing to see Rio demonstrate its new commitment to decarbonised supply chains as well as operational emissions in a timeframe and capital intensity that reflects the urgency of the transition, and in a manner far better than its key Australian competitors.

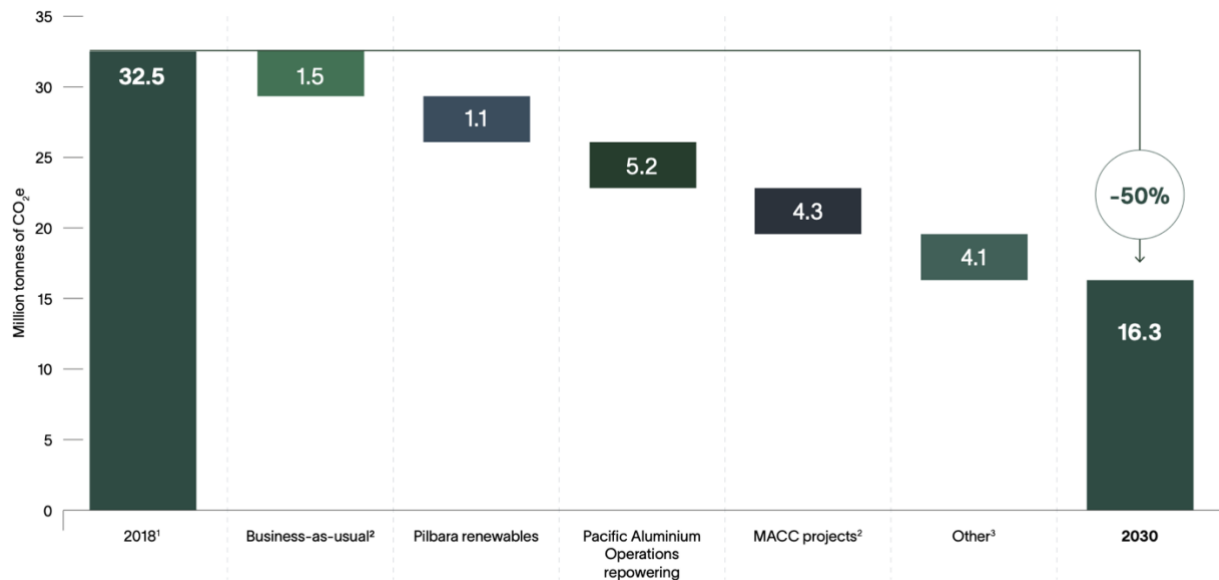
In 2021, Rio strengthened its climate commitments, with a targeted 50% reduction in Scope 1 and Scope 2 emissions by 2030 (from a 2018 baseline).³¹⁷

Figure 20: Rio Tinto Operational Emission Reduction Roadmap³¹⁸

³¹⁶ Rio Tinto, [Juukan Gorge](#)

³¹⁷ Rio Tinto, [Central Queensland Leads the Way in Clean Energy](#), 12 October 2021

³¹⁸ Rio Tinto, [Climate Change Report](#), 2021



So

Source: Rio Tinto Climate Change Report 2021

Rio plans to collaborate with state governments to capture clean energy value opportunities and transition to renewables. It will invest US\$7.5bn in decarbonising projects over the coming decade, with US\$500m annually over the next 3 years.³¹⁹

In 2021 (latest available data), Rio powered over 33% of its global energy demand from renewable sources, dominated by Canadian hydroelectricity. Through 2021, Rio Tinto's primary single-source energy was coal, powering 31.8% of all energy demand, with 13.3% and 20.1% from diesel and gas respectively.³²⁰

Over 60% of Rio's Scope 1 and 2 greenhouse gases were emitted from Australia in 2021, predominantly from its aluminium and iron ore operations. For Rio to reach its 50% reduction target by 2030, investments into reducing reliance on coal and gas in Australia are paramount.

However, we note that for all the lifting of ambition by Rio Tinto with its 2030 target, it is exceptionally disappointing to hear the excuses and calls for patience from Rio Tinto CEO Jakob Stausholm at the World Economic Forum in Davos in January 2023.³²¹ Given the exceptional profits flowing to the company from the use of Australia's public national resources, CEF would suggest it is overdue for Rio Tinto to stop waiting for government subsidies and handouts. It would be better if Stausholm listened to the comments by Fortescue's Andrew Forrest at the same forum highlighting the climate science, and the fact that the technology solutions are known and commercially viable today. The only thing lacking is leadership.

³¹⁹ Rio Tinto, [Annual Report](#), 2021

³²⁰ Rio Tinto, [Sustainability Fact Book](#), 2021

³²¹ AFR, ['We are fooling ourselves on the timeline': Rio CEO's warning on solar](#), 19 January 2023

Rio's Operational Decarbonisation

A priority focus for Rio Tinto is its Pilbara iron ore and Queensland aluminium operations.

Rio Tinto operates the world's largest integrated portfolio of iron ore assets, powered by one of the largest microgrids of gas-based power. At 480MW, the grid contributes to ~30% of the company's emissions. In April 2022, Rio established its **Pilbara Renewables Project**, a 1GW integrated network of solar and wind, 7 times larger than WA's current highest capacity operational solar farm.³²² Alongside a planned Battery Energy Storage System (BESS), this will abate ~1Mtpa of CO₂-equivalent, reducing the iron ore division's Scope 1 and 2 emissions by over 30%.

In November 2022, Rio announced a planned investment of \$600m into the Project for the development of two 100MW solar farms and 200MWh on-grid BESS by 2026.³²³ The project will decrease Rio's Scope 1 and 2 emissions by 10% and displace 30% of Rio's gas consumption in the Pilbara. Initial funding has been approved and financial close is expected in the fourth quarter of CY23.

Rio Tinto's decarbonisation of its WA operations is supported by its 34MW Gudai-Darri Solar Farm, commissioned in August 2022. Connected to Rio's microgrid via the Tom Price 45MW and 12MWh battery system, the solar farm will power a third of the average electricity demand of Rio's first iron ore greenfield expansion in over a decade.³²⁴

Decarbonising aluminium is a key opportunity. Aluminium smelting has the highest emissions intensity across the aluminium value chain, producing ~ 16 tonnes of CO₂-e per tonne of aluminium produced, with majority from Scope 2 energy supply emissions.³²⁵ Some 60% of the world's aluminium production was powered by coal in 2020, with Rio's aluminium operations, centred in Queensland, accounting for ~70% of the entity's direct and indirect emissions. Rio also plays a critical role in driving the development of competitive firm VRE and "supporting Queensland's renewable energy targets"³²⁶. Rio's aluminium assets within the Gladstone region – Boyne smelter, Yarwun alumina refinery and Queensland alumina refinery – will require 1,140MW of reliable energy supply to operate, or 4GW of wind and solar.³²⁷

In June 2022, Rio made a formal market Request for Proposal (RFP) for the development of a large-scale, grid-direct, wind and solar integrated project to power its Gladstone assets. In October 2021,

³²² Rio Tinto, [Harnessing Renewables to Decarbonise the Pilbara](#), 28 April 2022

³²³ Rio Tinto, [Rio Tinto Plans Further Investment in Renewable Energy in the Pilbara](#), 30 November 2022

³²⁴ Renew Economy, [Rio Tinto Starts Commissioning Gudai-Darri Solar Farm and Tom Price Battery](#), 22 August 2022

³²⁵ AIETI, [Pathways to Industrial Decarbonisation](#), 20 February 2023

³²⁶ PV Magazine, [Rio Tinto Targets Large-Scale Solar as Part of Shift to Renewables](#), 9 June 2022

³²⁷ Rio Tinto, [Calls for Proposals for Large-Scale Wind and Solar Power in Queensland](#), 8 June 2022

Rio Tinto signed a statement of cooperation with the Queensland Government to transition Central Queensland into an industrial and renewable energy powerhouse.³²⁸

Rio's Value Chain Decarbonisation

July 2022 saw Rio partner with Ford to develop sustainable and secure supply chains for battery and low-carbon materials for Ford's EV division. The partnership will support the decarbonisation of Rio's operations in lithium, aluminium, and copper, and enhance Rio's shift into critical minerals, with Ford a key customer of Rio's Rincon lithium proposal in Argentina, and the development of North American aluminium and battery supply chains for Ford's electric truck line-up.³²⁹

September 2022 saw Rio Tinto announce a partnership for the supply of low-carbon products to Volvo, with a focus on decarbonising Rio's diesel exposure, piloting Volvo's electrified hauling solutions.³³⁰

In October 2022, Rio partnered with the Canadian Government to invest C\$737m to decarbonise its iron ore and titanium operations in Quebec, and establish a critical minerals processing facility.³³¹

BHP

BHP's is targeting a 30% reduction in operational Scope 1 and 2 emissions by 2030, relative to FY2020.³³² It has committed US\$4bn into operational decarbonisation by that date, half its market capitalisation, and half the commitment of Rio Tinto. This will be reflected by an annual capital allocation of US\$200-600m over the next 5 years.³³³ Reducing GHG emissions is a key component of BHP's climate change strategy. However, BHP's management response to meet its 2030 emissions target is to split the coming decade into two periods, delaying real action.

FY21-25 is focussed on the conversion from fossil-fuel based purchased and self-generated electricity into renewable sources and investigating feasibility studies for diesel displacement in operated assets. FY26-30 focuses on green electricity and investing into diesel displacement for material movement, light vehicles, and stationary equipment.³³⁴ A cynic might view this as BHP promising to follow Rio Tinto and Fortescue once they have done the hard yards.

The main evidence of BHP decarbonising and scaling its renewable energy supply lies in power purchase agreements (PPA) for its Australian and Chilean operations established in FY22.

BHP's Power Purchase Agreements

³²⁸ Rio Tinto, [Central Queensland Leads the Way in Clean Energy](#), 12 October 2021

³²⁹ Rio Tinto, [Ford MOU for Battery and Low-Carbon Materials Supply](#), 21 July 2022

³³⁰ Rio Tinto, [Volvo Partner for Low-Carbon Materials Supply and Pilot Sustainable Hauling Solutions](#), 13 September 2022

³³¹ Rio Tinto, [Partners with Government of Canada to Decarbonise RTFT & Boost Critical Minerals Processing](#), 11 Oct 2022

³³² BHP, [Annual Report 2022](#),

³³³ BHP, [Annual Report 2022](#), p.43

³³⁴ BHP, [Climate Change 2022](#), p.19

In February 2021, BHP signed a PPA to supply up to 50% of its Kwinana Refinery energy demand from Risen Energy's **132MW Merredin Solar Farm**, the largest solar facility in Western Australia.³³⁵

In April 2022, BHP signed a PPA with Enel Green Power for development of the **\$200m 76MW Flat Rocks Wind Farm in WA**.³³⁶ This is expected to reduce Nickel West's Scope 2 emissions by a third relative to 2020 levels from 2024.

BHP signed a PPA with TransAlta for the development of an off-grid large-scale renewable energy project in WA. The **Northern Goldfields Solar Project** includes a 27MW solar farm at Mt Keith, a 10.7MW solar farm and 10MW BESS at Leinster, which will be integrated into TransAlta's remote power grid.³³⁷ The project is the first on-site solar farm and battery system for BHP.

The aggregate renewable energy feedstock from Merredin, Flat Rocks, and Northern Goldfields will supply 100% of the electricity needs of Nickel West's refining operations.³³⁸

In 2021, BHP announced an intended partnership with Iberdrola to supply 50% of the energy demands of its Olympic Dam operations through the **\$500m Port Augusta Renewable Energy Park** in South Australia.³³⁹ Once built, the long-term PPA would provide renewable energy from a hybrid 210MW wind and 107MW solar farm.³⁴⁰

In November 2022, signed a PPA with Neoen to supply 70MW of baseload electricity from the **203MW Goyder South Stage 1 Wind Farm**, supported by its Blyth battery system. The PPA aims to provide Olympic Dam with 50% of its electricity requirements from renewables from July 2025.³⁴¹ The Goyder South wind farm is a component of the Goyder South Renewables Zone, a hybrid energy project with a planned capacity of **1.2GW from wind and 600MW from solar**.³⁴²

An accelerated roll-out of PPAs from renewable energy is only part of the decarbonisation problem BHP will face in the coming years. Grid electricity accounted for 24.8% of BHP's energy demand in 2022. BHP's energy sourcing is dominated by diesel and gasoline, accounting for 58.5% of energy, as in Table 1.

Despite the growth from 0% to 11.5% renewable energy usage, BHP has maintained an equivalent share of energy demand from diesel and gas to power their operations across FY21-22.

Table 2: ESG Factbook Comparison of BHP, Rio Tinto, FMG and Alcoa

³³⁵ BHP, [Nickel West Kwinana Refinery to Reduce Emissions from Electricity use by up to 50%](#), 1 February 2021

³³⁶ Enel, [Enel and BHP Strike Deal for 12-year Renewable Energy PPA](#), 5 April 2022

³³⁷ Australian Mining, [Solar Project to Power BHP](#), 2 February 2022

³³⁸ Mining.com, [BHP's Nickel West to be Fully Powered by Renewables](#), 6 April 2022

³³⁹ BHP, [Olympic Dam to Partner with Iberdrola at Port Augusta Renewable Energy Park](#), 14 October 2021

³⁴⁰ Renew Economy, [Solar Powers Up at Australia's Biggest Hybrid Renewables Park](#), 11 October 2022

³⁴¹ Neoen, [Neoen and BHP sign a 70MW Renewable Energy Baseload Contract in South Australia](#), 3 November 2022

³⁴² BHP, [New Wind and Battery Project in South Australia](#), 3 November 2022

ESG Comparison	BHP (FY2022)	Rio Tinto (2021)	FMG (FY2022)	Alcoa (2021)
Market Capitalisation	\$350.0bn	\$205.0bn	\$69.2bn	\$13.0bn
Scope 1 and 2 Emission Reduction Target by 2030	30% from FY2020 levels	50% from CY2018 levels	100%	50% from FY2015 levels
Planned Capital Expenditure on Decarbonisation by 2030	US\$4bn	US\$7.5bn	US\$6.2bn	N.A.
Reported Annual Investments	US\$200-600m	US\$500m	\$620m	N.A.
Scope 1 and 2 Emissions (Mt CO ₂ -e)	12.3	31.1	2.28	21.8
Scope 3 (Supply Chain) Emissions (Mt CO ₂ -e)	364.3	553.5	254.7	47.5
Energy Usage (PJ)	149	393	30.6	184.8
Diesel and Gasoline	58.5%	13.3%	-	2.0%
Gas	14.9%	20.1%	-	55.4%
Coal and Coke	0.5%	31.8%	-	36.1%
Renewables	11.5%	33.1%	-	0.1%
Other	14.6%	1.7%	-	6.4%

Source: Company ESG Databooks

According to BHP's FY2022 ESG Factbook, renewable capacity additions are focussed on decarbonising its Chilean operations. In FY2023, 100% of Escondida and 83% of Spence's electricity demand will be sourced from renewable energy. However, in FY2023, only 5% of one PPAs electricity demand for Leinster, WA, will be powered by renewables out of four PPAs signed across Nickel West and Olympic Dam.

In CY2022, the NEM sourced 34.9% of its power from renewable energy, its highest penetration to date. South Australia's grid was powered by 67.7% VRE on average in 2022, and 22.4% in Queensland.

WA's SWIS also averaged 35% over 2022.³⁴³ BHP's grid connectivity in Australia consistently underperformed compared to the state, and national renewable penetration.

For a firm that prides itself on global leadership, in CEF's view BHP is a laggard in both value-adding Australian critical minerals and in embracing climate science through inhouse actions. It sees scaling out diesel abatement solutions is a future battle, not one to be fought today and it continues to underperform in capital involvement into renewable energy and emission reduction targets.

In contrast, Sun Metals and Fortescue Metals Group are exemplars of leading capital intensity and rapid deployment of decarbonised and renewable solutions across Australia.

Alcoa

Alcoa operates the Portland aluminium smelter, Victoria's largest electricity user, accounting for over 10% of total demand.³⁴⁴ In 2021, it sourced over 55% of its energy demand from gas, and 36% from lignite.³⁴⁵ Renewable energy accounted for only 0.1% of its energy demand.

Alcoa announced its sustainability and decarbonisation technology roadmap in 2021, with a 2030 corporate target of 50% reduction in Scope 1 and 2 emissions from a 2015 baseline, and an interim target of 30% reduction by 2025. It has placed a heavy dependence on its proposed \$4bn **1,000MW Spinifex Offshore Wind Farm** with Alinta Energy to be commissioned by 2027, with the goal to power 100% of its Portland aluminium smelter from renewable energy, supported by the Victorian and Federal governments.³⁴⁶

In October 2022, the proposal received \$1.5m from ARENA to conduct a pre-development resource assessment.³⁴⁷ The key difference between Spinifex and the 20+ proposals for offshore wind in Australia is its support from a value-adding mining major and fundamental off-taker for future renewable energy.

Alcoa can play a global leadership role in enabling renewable energy investment via their long term offtake agreement, de-risking what is potentially the first of a number of offshore wind projects leveraging A\$40bn of new investment in clean energy across Australia.

³⁴³ AEMO, [OpenNEM](#)

³⁴⁴ ARENAWire, [Offshore Wind Could Unlock Green Aluminium](#), 13 October 2022

³⁴⁵ Alcoa, [Sustainability Report](#), 2021

³⁴⁶ Spinifex, [Offshore Wind Farm Project Overview](#)

³⁴⁷ Renew Economy, [Offshore Wind Power Plans for Portland Smelter gets Federal Boost](#), 6 October 2022

Sun Metals

Sun Metals is the Australian subsidiary of Korea Zinc, the largest zinc, lead, and silver producer globally, and its Townsville Zinc Refinery is the second largest single-site consumer of electricity in Queensland. Sun Metals has committed to power its entire operations with renewable energy by 2040, with an interim target of 80% by 2030.

In 2018, Sun Metals committed \$200m for the development of its **143MW Solar Farm**, with the capacity to provide ~25% of the refinery's electricity demand, the largest integrated industrial solar project in Queensland.³⁴⁸

In 2021, **Ark Energy Corporation** was founded by Korea Zinc with the goal of decarbonising its entire energy supply, starting with Sun Metals. In December that year it acquired a 100% interest in Epuron, a leading utility-scale wind and solar developer in Australia. Through the acquisition, Ark Energy has developed 6.5GW of wind and 500MW of solar energy generation across Queensland, NSW, and Tasmania.

Sun Metals Queensland Wind Precinct

In March 2021, Ark Energy partnered with ACCIONA on the **923MW MacIntyre Wind Farm**, acquiring a 30% stake.³⁴⁹ The project, which commenced construction in June 2022, will provide ~64% of Sun Metals' zinc refinery's energy requirements.



MacIntyre Wind Precinct under construction near Karara, QLD.

³⁴⁸ ANZ, [Greening the Zinc Economy](#), 28 April 2022

³⁴⁹ QLD Government, [Work Starts on Mega Wind Farm](#), 2 June 2022

As part of the MacIntyre Precinct, Queensland Government's CleanCo allocated \$145m to develop the adjacent **103MW Karara Wind Farm**. A total \$1.96bn will be invested into the aggregated **1,026MW MacIntyre Wind Precinct**, making it one of the largest onshore wind farms globally, and one of the largest renewable energy projects in Australia. The Queensland Government allocated \$170m in enabling transmission infrastructure to connect the Wind Precinct to the NEM.³⁵⁰

In November 2022, ACCIONA announced an additional \$2bn investment into the MacIntyre Wind Precinct with the **1,000MW Herries Range Wind Farm**.³⁵¹ The Precinct will now produce a total capacity of 2GW, with an overall investment of \$4bn. At 360 turbines, the Precinct is the largest wind project in Australia, dwarfing the 511MW Stockyard Hill Wind Farm and 453MW Coopers Gap Wind Farm.³⁵²

Fortescue Metals Group (FMG)

Under Dr Andrew Forrest's leadership, FMG has a nation-leading decarbonisation roadmap targeting net zero operational emissions by 2030, and a world-leading complete value chain target of net zero emissions by 2040 (Scope 1-3). FMG has committed 10% of its after-tax profits to fund renewable energy growth through Fortescue Future Industries (FFI), with a further 10% committed to growth opportunities in other commodities. Fortescue's capital allocation link to company performance provides a consistent financial base of ~US\$620m annually to renewable energy. By 2030, FMG aims to invest US\$6.2bn into leading decarbonisation in Australia.³⁵³

Unlike its iron ore competitors in WA's Pilbara, FMG has a tangible plan and capital allocation framework to deploy 2-3GW of renewables and battery firming, transmission networks and site infrastructure via its US\$700m **Pilbara Energy Connect (PEC)**. In FY2022, stationary power generation accounted for 14% of the entity's emissions, powered by 42% diesel and 58% gas. The PEC involves a high voltage transmission network between the Solomon Hub and Iron Bridge, eliminating the need for diesel-power generation at Iron Bridge, with a 16MW and 26MW battery system at Solomon and Iron Bridge to provide renewable firming.

The Herb Elliot Port will be connected to the PEC, powered by renewable energy, aiming to eliminate most Scope 2 emissions from its operations.³⁵⁴ The PEC is powered by the FMG / Alinta Energy's 60MW Chichester Solar Gas Hybrid Hub, capable of powering 100% of Fortescue's Christmas Creek and Cloudbreak mining sites' daytime operations with renewable energy.³⁵⁵

³⁵⁰ Infrastructure Partnerships Australia, [MacIntyre Wind Precinct](#)

³⁵¹ ACCIONA, [Expand the MacIntyre Wind Precinct to 2000MW](#), 28 November 2022

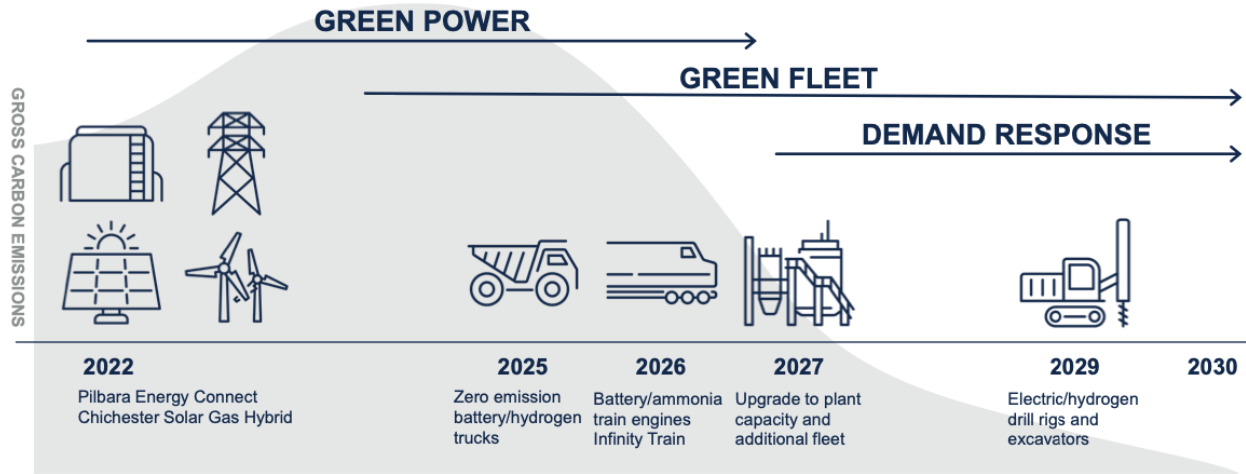
³⁵² QLD Government, [Queensland Wind Farm Precinct to Dwarf All Others](#), 28 November 2022

³⁵³ FMG, [Climate Change Report](#), 2022 p.9

³⁵⁴ FMG, [Climate Change Report](#), 2022 p.12

³⁵⁵ PV Magazine, [Alinta Switches on WA's Largest Remote Solar Farm](#), 16 December 2021

Figure 21: FMG Operational Emissions Decarbonisation Roadmap ³⁵⁶



Source: FMG Decarbonisation Execution Plan

Fortescue Future Industries (FFI)

Beyond renewable energy capacity, FMG has established a pathway to decarbonise mobility and hauling in its operations. In January 2022, FMG's FFI acquired Williams Advanced Engineering (WAE) for £164m to utilise its R&D in high-performance battery systems and electrification.³⁵⁷ March 2022 saw WAE and Fortescue announce the development of its zero-emission Infinity Train, a regenerating battery electric iron ore train that uses gravitational energy to fully recharge its battery stores without additional charging requirements for the return trip.³⁵⁸

Fortescue announced a partnership with Liebherr to supply zero-emission power systems for the joint development of renewable mining haul trucks and accelerate the commercialisation of battery systems in heavy industry.³⁵⁹ Electrification of FMG's mining haul trucks will displace over 200 million litres of diesel and reduce Scope 1 emissions by over 25%.

In November 2022, FFI announced a partnership with Windlab to develop the wind and solar **10GW Super Hub** in Northwest Queensland. Forrest's private subsidiary, Squadron Energy, acquired 75% of Windlab in June 2020. The Super Hub aims to feed into Queensland's electrical grid and FFI's planned industrial-scale Gladstone green hydrogen project.

³⁵⁶ FMG, [Execution Plan for Industry Leading Decarbonisation](#), 20 September 2022

³⁵⁷ WAE, [Global Green Renewable and Resource Co. Fortescue to Acquire WAE in Race to Net Zero](#), 23 January 2022

³⁵⁸ FMG, [WAE Settlement Powers Development of World's First Infinity Train](#), 1 March 2022

³⁵⁹ FMG, [Liebherr to Supply Green Mining Haul Trucks Incorporating Fortescue's Zero Emission Power System](#), 15 June 2022

The initial stage includes the **800MW Prairie Wind Farm** and the **1,000MW Wongalee Project**, currently in development planning, with construction to commence 2025, and power generation by 2027, leveraging North Queensland’s untapped renewable energy base, and helping drive the nation’s clean energy transition.³⁶⁰

The Hub will also accelerate the development of the Northern Queensland REZ and play a vital role in Queensland’s proposed **SuperGrid** – the Queensland Government’s Infrastructure Blueprint to enable the state’s energy supply transition and realise its goal of 50% renewables and a 30% economy-wide emission reduction by 2030.³⁶¹

³⁶⁰ Windlab, [Game Changing North Queensland Super Hub to Power Green Hydrogen with Wind and Solar](#), 14 November 2022

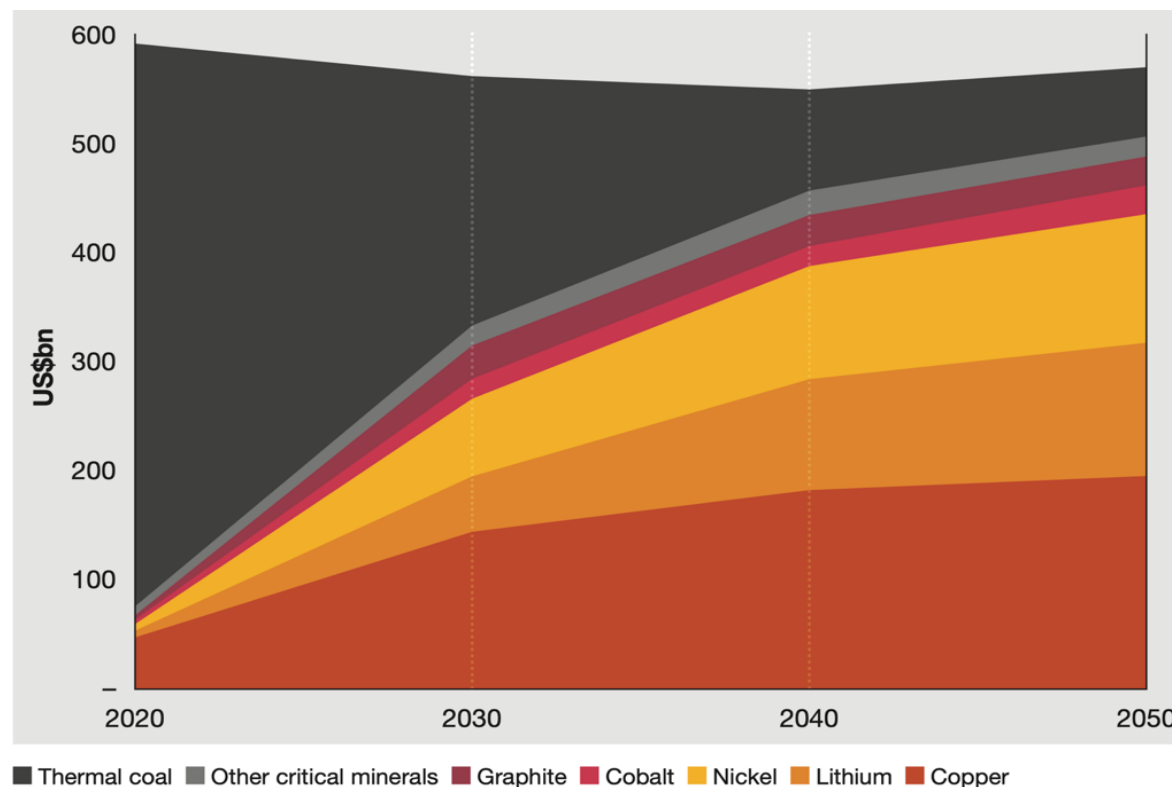
³⁶¹ Queensland Government, [Queensland SuperGrid Infrastructure Blueprint](#), September 2022

Section 8. Globalisation, The Expansion of Future Facing Mineral Companies Beyond Australia

Australian miners are increasingly expanding their involvement in both domestic value-adding and offshore critical mineral industries, maximising their position in the energy transition value chain, enhancing security and diversity of supply sources.

The global mining and energy system is undergoing a radical repositioning as the world's economy decarbonises (Figure 22). As a leading mining nation globally, Australian firms are well positioned to leverage this pivot, both in terms of value-adding domestic supplies of critical minerals using renewable energy, as well as being a trusted global supplier. The investment opportunities are huge.

Figure 22: Global Market Value for Coal vs Energy Transition Minerals ³⁶²



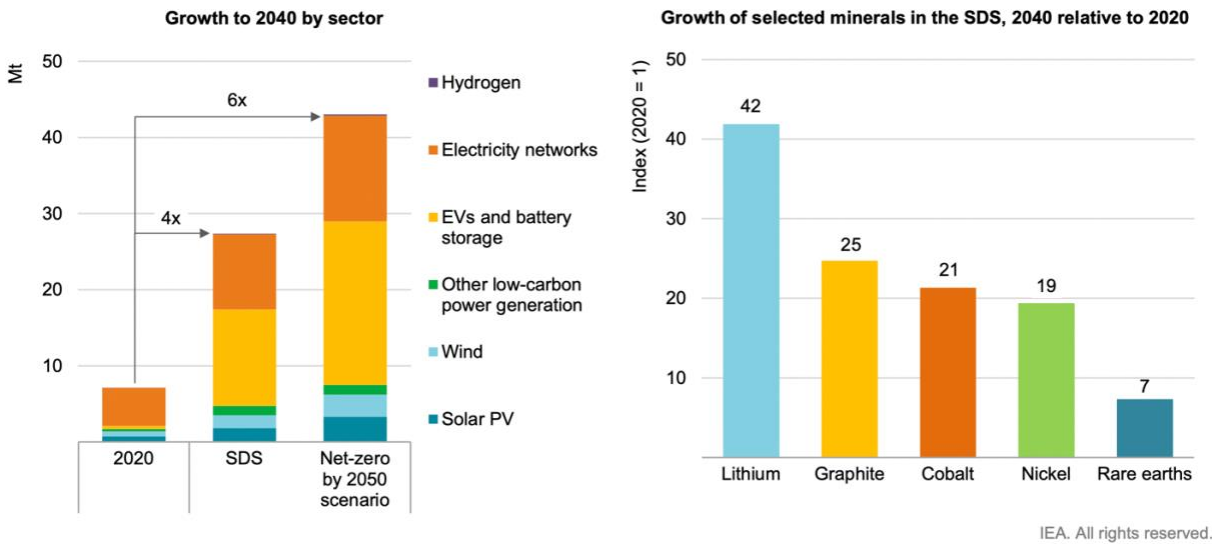
Note: Other critical minerals include rare earth elements, silicon and manganese. Estimates are of global annual market value for coal vs. critical minerals demand from energy transition end use only. Estimates do not include other industrial applications. Source: PWC, Adapted from International Energy Agency

³⁶² PWC, [Mine 2022 A Critical Transition](#), June 2022 p.11

The global energy transition will drive unprecedented growth opportunities for critical minerals. The rapid acceleration of EV uptake and deployment of battery storage systems provides an incredible opportunity for the Australian economy. With the nation’s significant critical minerals resources and mining expertise, Australia can position itself as an integral player in the global new-energy supply chain.

As outlined in Section 2, the lithium market might grow by 42x relative to 2020, with graphite, cobalt, nickel, and rare earths industries expanding by 25x, 21x, 19x, and 7x respectively to supply clean energy deployment to meet global decarbonisation targets aligned with the Paris Agreement.³⁶³

Figure 23: Mineral Demand for Clean Energy Technologies by SDS and NZS ³⁶⁴



Australia dominates global lithium production, and accounts for 25% of global lithium ore reserves. Chile is home to ~41% of the global lithium ore reserve in 2022, with Argentina holding a further ~10% of the world’s reserves. Chile likewise dominates global copper ore reserves, accounting for ~23%, compared to Australia’s 11%.³⁶⁵ As evident in Figure 24, China accounted for ~80% of the global graphite supply chain in 2022, an essential component in all high-market share battery chemistry anodes.

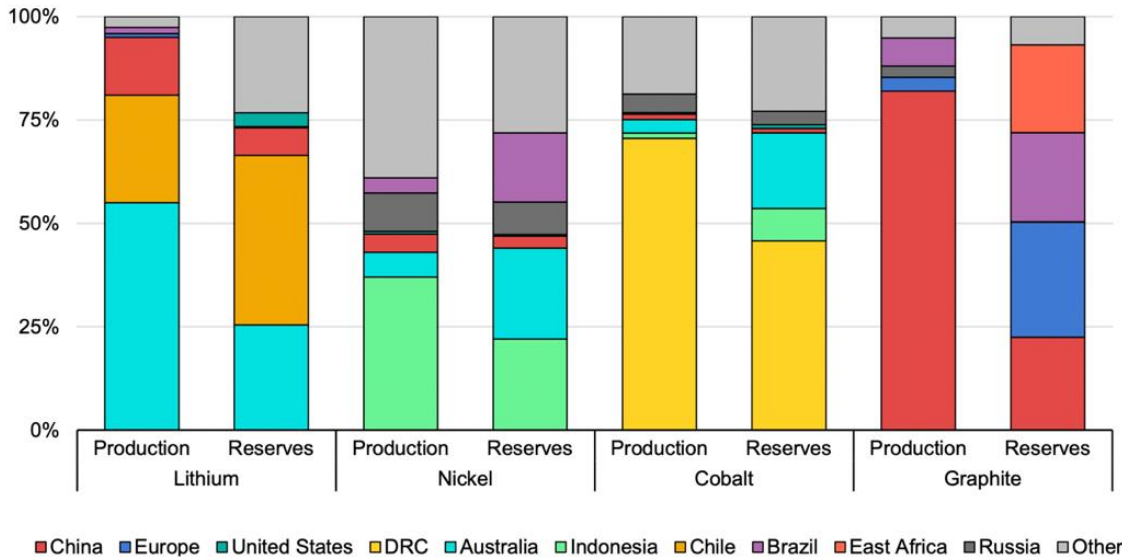
As a world leading mining country, and to maximise its position in the energy transition value chain, Australian miners are increasingly expanding their involvement across critical mineral industries offshore.

³⁶³ IEA, [The Role of Critical Minerals in Clean Energy Transitions](#), Updated 2022 Version

³⁶⁴ IEA, [The Role of Critical Minerals in Clean Energy Transitions](#), Updated 2022 Version

³⁶⁵ US Geological Survey, [Mineral Commodity Summaries 2022](#), 31 January 2022, p.55 & p.101

Figure 24: Production and Reserves of Battery Materials 2022 ³⁶⁶



Notes: Li = lithium; Ni = nickel; Co = cobalt; Gr = graphite; DRC = Democratic Republic of Congo. Reserves refer to economically extractable resource as defined and determined by the US Geological Survey.
 Sources: IEA analysis based on [US Geological Survey \(2022\)](#).

IEA. All rights reserved.

Beyond the enormous demand growth opportunity, another key theme in 2022 is supply chain security. China has invested heavily over the last decade to become one of the dominant critical minerals processing sources. But with security and diversity of supply sources being increasingly sought, this has highlighted a global opportunity for Australian firms, both in terms of domestic value-adding and offshore investment initiatives.

In August 2022, the Biden Administration issued the executive order for the government’s entire fleet to be replaced by US-made EVs.³⁶⁷ The US Inflation Reduction Act demands the onshoring of domestic and allied battery infrastructure.

ESG considerations in supply chains are now in focus, with US president Joe Biden’s November 2022 announcement of the proposed Federal Supplier Climate Risks and Resilience Rule, which will require federal contractors to report Scope 1 and 2 emissions and disclose climate-related financial risks.³⁶⁸ Federal suppliers with over US\$50m in annual contracts will also be required to set science-based emissions reduction targets.

³⁶⁶ IEA, [Global EV Supply Chains of EV Batteries Report, 2022](#)

³⁶⁷ The Whitehouse, [President Biden Announces Steps to Drive American Leadership Forward on Clean Cars and Trucks](#), 5 August 2022

³⁶⁸ ESG Today, [Biden Unveils Rule Requiring Federal Suppliers to Disclose Emissions](#), 11 November 2022

For Australia to capture the value of strategic trade alliances with North America, Asia and Europe, our companies are starting to enhance their global position, scaling beyond our borders to provide long-term expanded supply for critical minerals in the new age of energy and electric mobility.

CEF has identified key examples of foreign investment by Australian firms that are expanding their global positions upstream and downstream to become essential suppliers of lithium, copper, nickel, rare earths, and graphite.

Australian Miners Poised to Ride the Green Minerals Wave

1. BHP

BHP is a globally significant supplier of copper, producing a total of 1,574kt in FY22 across its Chilean (Escondida, Pampa Norte), Australian (Olympic Dam), and Peruvian (Antamina) operations.

BHP's wholly owned Pampa Norte copper operation consists of the Spence and Cerro Colorado mines. BHP has invested US\$2.46bn in the expansionary Spence Growth Option of Pampa Norte.³⁶⁹ This is an investment that will prolong the life of the mine by 50 years and upgrade its ore throughput to deliver an additional 185ktpa of copper. BHP plans investments of US\$100m over FY2023 to enhance Pampa Norte and fund studies for additional capacity uplifts.³⁷⁰

BHP have established a JV with Rio Tinto for their proposed Resolution Copper in Arizona, US. If progressed, the project has the potential to be the largest copper producer in North America.³⁷¹

2. Rio Tinto

To meet additional demand created by the global drive to net zero emissions, Rio is prioritising commodities needed for this transition, with an ambition to double growth capex to ~\$3bn annually from 2023.³⁷²

To capture this significant value opportunity, March 2022 saw Rio Tinto acquire the Argentinian Rincon Lithium Project for \$825m, a large undeveloped lithium brine proposal in the Salta Province.³⁷³ Rincon will provide global scale for Rio Tinto's exposure into battery materials.

Copper is another key commodity in Rio Tinto's growing global asset portfolio. Copper is essential to the transformation of energy, with EVs containing 4x the volume of copper than internal combustion engines, and solar and wind power systems consuming 3-6 tonne per megawatt installed (compared to 1 tonne thermal power).

³⁶⁹ BHP, [Annual Report](#), 2021 p.268

³⁷⁰ BHP, [Annual Report](#), 2022 p.203 & p.15

³⁷¹ BHP, [Annual Report](#), 2022 p.27

³⁷² Rio Tinto, [Strengthen Performance, Decarbonise, and Grow](#), 20 October 2021

³⁷³ Rio Tinto, [Complete Acquisition of Rincon Lithium Project](#), 29 March 2022

Oyu Tolgoi in Mongolia adds to Rio's world-class greenfield and brownfield copper project pipeline.³⁷⁴ This is a JV between Rio and Turquoise Hill Resources (TRQ). The US\$6.9bn mine is expected to become one of the largest copper mines in the world, and a major contributor to the Mongolian economy.³⁷⁵ Rio made a takeover bid of US\$3.3bn for TRQ. Minority shareholders expressed opposition and November 2022 saw the transaction placed on hold.³⁷⁶ December 2022 saw Rio Tinto complete the acquisition of Turquoise Hill Resources for US\$3.1bn, raising Rio's effective interest to 66% with the remainder held by the Government of Mongolia through Erdenes Oyu Tolgoi.³⁷⁷

Rio Tinto has a 49% non-operating interest in nickel with Canadian-listed Talon Metals. The venture is the high-grade Tamarack Nickel-Copper-Cobalt project in Minnesota, US. The proposed Advanced Domestic Battery Minerals Processing facility will process nickel ore for the US domestic manufacturing of EV batteries. In October 2022 Talon was awarded a US\$115m federal grant from the US Department of Energy (DoE), with Talon funding the remaining US\$318m of capital cost.³⁷⁸ Talon has partnered with Tesla to produce nickel, copper, cobalt, and iron from its concentrates for the EV maker's supply chain, with a supply agreement for 75,000 tonnes of concentrates.

3. Allkem

In 2021, Allkem was the 4th largest supplier of hard-rock lithium (spodumene) globally from its Mt Cattlin operations in Western Australia. Allkem accounted for 6% of global spodumene supply, but also contributed substantially to lithium brine output with its Argentinian operations.

Allkem is one of the most globally diversified lithium suppliers, with investments in critical projects across four continents in 2022. The **US\$286m James Bay Spodumene** operation in Canada is the latest addition to Allkem's dominant hard-rock lithium development pipeline. Utilising one of the largest hydroelectric systems in the world, James Bay will provide over 320ktpa of low-cost, low carbon spodumene concentrate. Targeting commissioning in late H1CY2024³⁷⁹, the strategic geographical diversification of upstream lithium production paves the way for Allkem to become a key supplier in the North American and European energy transition value chain.

With a 66.5% effective equity interest³⁸⁰, Argentinian Olaroz is Allkem's flagship lithium brine facility. Commencing production in 2015 and producing a cumulative 77kt lithium carbonate equivalent (LCE) to date, the Olaroz Stage 2 (OS2) expansion will bring total capacity to 25ktpa of technical-grade LCE. With a proposed capex of US\$425m, this positions Olaroz as one of the largest lithium evaporation pond systems globally.

³⁷⁴ Rio Tinto, [Our Approach to Climate Change](#), 2021

³⁷⁵ AFR, [Mongolian Fracas Rumbles on for Rio Tinto as Takeover Deadline Looms](#), 3 November 2022

³⁷⁶ FT, [Rio Tinto's Bid for Turquoise Hill Hits Snags](#), 11 November 2022

³⁷⁷ Rio Tinto, [Rio Tinto Completes Acquisition of Turquoise Hill](#), 16 December 2022

³⁷⁸ DOE, [Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing](#), 19 October 2022

³⁷⁹ Allkem, [September 2022 Quarterly Activities Report](#), 21 October 2022

³⁸⁰ Allkem (66.5%), Toyota Tsusho Corporation (TTC) (25%) and JEMSE (8.5%)

Allkem's secondary Argentinian brine operation, Sal De Vida (SDV), is developing a 15ktpa LCE operation with a capex of US\$271m, with commissioning expected mid CY2024. In October 2022, Allkem agreed on a proposed US\$200m financing facility from the International Finance Corporation to support the development of Stage 1 (SDV S1). The facility is expected to reach financial close by end CY2022.³⁸¹

SDV will undergo a Stage 2 (SDV S2) expansion, adding a further 30ktpa LCE of 80% battery-grade lithium, expanding SDV to a 45ktpa operation. The capex for SDVS2 is estimated at US\$524m.³⁸²

Expanding downstream, Allkem's partnership with Toyotsu Lithium Corporation (TLC) is constructing the first-of-its-kind lithium hydroxide monohydrate (LHM) facility in Naraha, Japan. The plant is expecting first production in 4QCY2022, utilising offtake of technical grade lithium carbonate from OS2, converting to 9.5ktpa battery-grade lithium hydroxide for the battery supply chain. Allkem has invested US\$67m into the project thus far.³⁸³ In November 2022, Allkem announced first production of lithium hydroxide from Naraha.³⁸⁴

4. Wyloo Metals

Andrew Forrest's private family company Wyloo Metals completed the acquisition of Canadian Noront Resources in April 2022 (having significantly overbid BHP³⁸⁵), with the commitment to transform one of the largest undeveloped, high-grade nickel sulphide deposits in the world at Eagle's Nest, Ontario.³⁸⁶ Upon acquisition, Wyloo rebranded its Canadian-based operations under 'Ring of Fire Metals'.³⁸⁷

The Province of Ontario indicated a commitment of up to C\$1bn to infrastructure, subject to Federal Government approval. This support demonstrates the economic importance of this project's development, with studies estimating a C\$9.4bn contribution to Canada's GDP and creation of 5,500 jobs annually.³⁸⁸

In August 2022 Wyloo Metals also made a cornerstone investment of \$150m into Australia's rapidly expanding rare earths developer, Hastings Technology Metals. The proceeds were used to acquire a 22% equity interest in TSX-listed Neo Performance Materials, a leading non-Chinese rare earth supplier.³⁸⁹ The investment highlights Wyloo's focus on developing Canada's critical mineral opportunity.

³⁸¹ Allkem, [US\\$200m IFC Project Finance Proposal for Sal De Vida](#), 7 October 2022

³⁸² Allkem, [Sal de Vida Increased to 45ktpa in Two Stages](#), 4 April 2022

³⁸³ Allkem, [FY22 Annual Report](#), 25 August 2022

³⁸⁴ Allkem, [First Lithium Hydroxide Successfully Produced at Naraha](#), 15 November 2022

³⁸⁵ Tattarang, [Noront Board Recommends Wyloo Metals' Superior Offer](#), 21 December 2021

³⁸⁶ Wyloo, [Wyloo Metals Completes Acquisition of Noront Resources](#), 8 April 2022

³⁸⁷ Tattarang, [Noront Resources Renamed Ring of Fire Metals as Activity Recommences](#), 3 October 2022

³⁸⁸ Tattarang, [Wyloo Metals to Purchase Cornerstone Position in Noront Resources](#), 7 December 2020

³⁸⁹ Tattarang, [Wyloo Metals Invests \\$150m in Rare Earth Materials](#), 26 August 2022

Neo is a leading producer of NdFeB (neodymium, iron, boron) magnets and rare earth materials, operating as the only commercial rare earth separator in Europe.³⁹⁰ The investment opens Wyloo Metals to an array of key Tier 1 customers in the battery and decarbonisation supply chain, including BOSCH, Samsung, Panasonic, Umicore, LG, and Johnson Matthey. The transaction with Hastings spans the value chain for battery and clean-energy technologies, with the rare earth filled permanent magnets critical inputs into EV and wind turbines.

5. Syrah Resources

ASX-listed Syrah's (market capitalisation \$1.6bn) Balama graphite mine in Mozambique is the largest natural supplier in the world and is the largest imported supplier to the Chinese anode supply chain.³⁹¹ Syrah's Vidalia downstream expansion will produce graphite-based Active Anode Material (AAM) for the lithium-ion battery supply chain. Upon commissioning, the project will be the only vertically integrated, large-scale AAM manufacturer outside of China, creating 220 jobs in the state of Louisiana.³⁹²

Syrah attracted substantial offtake agreements with Tesla and BlueOval SK (Ford and SK On's battery JV) for supply of AAM.³⁹³ In October 2022, LG Energy Solution announced a partnership with Syrah to diversify its supply chain of natural graphite and expand its critical mineral portfolio in North America.³⁹⁴ Under the agreement, Lynas will supply LGES with AAM from its Vidalia production facility in Louisiana, US.

Syrah selected Louisiana, US, as the value-add project location, receiving US\$102m as a binding loan from US DoE for the initial development of its 11.25ktpa AAM facility. Additionally, Syrah received a US\$220m federal grant from the US DoE for its expansion to 45ktpa AAM.³⁹⁵

6. Lynas Rare Earths

Lynas has confirmed the construction of a US Light Rare Earths (LRE) separation facility in Texas. The LRE plant will receive material directly from their cracking and leaching plant in Kalgoorlie, WA. The plant is designed to produce ~5ktpa of rare earth products, with ~1.25ktpa NdPr (neodymium praseodymium).³⁹⁶ With a capex of US\$60m, Lynas received a US\$30m grant from the US Department of Defence.

Lynas is jointly developing its Heavy Rare Earth (HRE) separation facility, securing the first domestic supply in the US. HRE's are essential for the development of robust supply chains for future-facing

³⁹⁰ Hastings, [Investor Presentation August 2022](#), 26 August 2022

³⁹¹ Syrah, [Diggers and Dealers Mining Forum](#), 1 August 2022

³⁹² Department of Energy, [Syrah Vidalia Loan Programs Office](#)

³⁹³ Syrah, [Syrah Enters MoU with Ford and SK On](#), 22 July 2022

³⁹⁴ LGES, [LGES Partners with Syrah to Expand Critical Minerals Portfolio in North America](#), 20 October 2022

³⁹⁵ DOE, [Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing](#), 19 October 2022

³⁹⁶ Lynas, [Lynas Contract for US LRE Separation Facility](#), 22 January 2021 & [Lynas RE USA Fact Sheet](#)

industries including EVs and wind turbines. With a total capex of US\$180m, Lynas will receive a US\$120m US Government contract to develop the commercial HRE Processing Facility.³⁹⁷

7. Novonix

ASX-listed Novonix (market capitalisation \$875m) is a synthetic graphite anode material manufacturer that will supply low-carbon intensity, high performance, large-scale anode material for US EV and energy storage supply chains. Novonix is currently constructing its first mass-production facility in Tennessee, US, with capacity of 10ktpa of synthetic graphite. The firm aims to also construct a new plant of 30ktpa capacity for the EV industry.³⁹⁸ The plants will create 1,000 jobs in the process.

Leveraging domestic raw material supply and energy-efficient processes, Novonix states it will be able to supply the US anode supply chain with a 60% reduction in carbon intensity relative to current Chinese synthetic graphite operations. Novonix was awarded a US\$150m federal grant from the DoE. Novonix will supply the remaining capex, estimated at US\$877m.³⁹⁹

8. Ioneer

ASX-listed Ioneer (market capitalisation \$977m) owns Rhyolite Ridge, an advanced lithium mine proposal in Nevada, US, processing lithium carbonate from lithium ore for the domestic battery supply chain. The facility is designed to produce 20.5ktpa LCE in its initial phase, with planned investments into downstream refining into lithium hydroxide products. The project has a capex of US\$785m, and has received a DoE Loans Office Program 10 year loan offer of US\$700m,⁴⁰⁰ conditional on getting to FID.

Ioneer have attracted key off-take agreements, including Ford Motor Co., PPES (a Toyota and Panasonic JV), and EcoPro, the second largest cathode producer globally.

9. Pilbara Minerals

Pilbara Minerals entered an 18:82 JV with POSCO for the development of a 43ktpa LHM Refinery in Gwangyang, South Korea, utilising 315ktpa spodumene concentrate feedstock from Pilbara's Pilgangoora operations.⁴⁰¹ The US\$750-800m facility is strategically located on the doorstep of South Korean cathode producers.⁴⁰²

³⁹⁷ Lynas, [Lynas Awarded US\\$120M Contract for HRE Facility](#), 14 June 2022

³⁹⁸ DOE, [Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing](#), 19 October 2022

³⁹⁹ Novonix, [Selected for US\\$150m Grant from US Department of Energy](#), 19 October 2022

⁴⁰⁰ Ioneer, [Rhyolite Ridge DFS Summary](#), April 2020

⁴⁰¹ Pilbara Minerals, [Diggers and Dealers Conference 2022 Presentation](#), 3 August 2022

⁴⁰² Pilbara Minerals, [Update on Downstream JV with POSCO](#), 11 April 2022

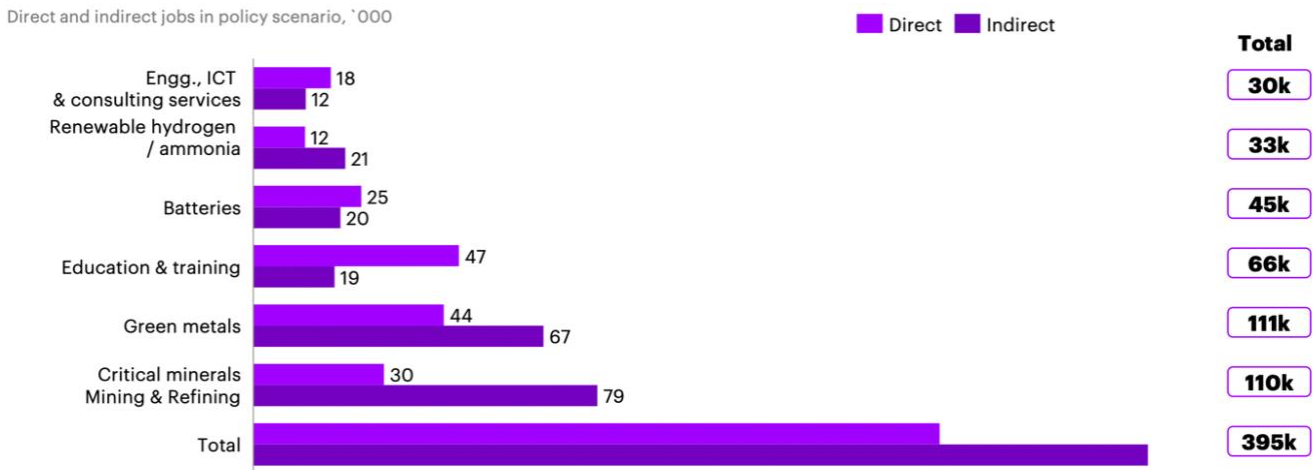
Section 9. Australia’s Critical Mineral Employment Opportunity

The Australian Resources and Energy Employer Association (AREEA) estimates the critical mineral projects currently in development will create over 6,500 jobs by 2025. If Australia remains focussed on its “dig and ship” economy, 18,700 new jobs could be created by 2030. However, if Australia diversifies and invests its mining strength into developing onshore materials processing, and prioritises energy storage system manufacturing and integration, Australia can expand its workforce by 34,700 by 2030, a 478% increase relative to battery raw material mining jobs in 2020.

In 2021, Climate Energy Finance provided expert advice into the Accenture report “Sunshot: Australia’s opportunity to create 395,000 clean export jobs”⁴⁰³. At the time, “clean exports” was a largely hypothetical exercise; the investment flows had yet to materialise, and our then-government refused to even accept the climate science, let alone the inevitability of the energy transition, including the global pivot to EVs – essentially batteries on wheels, requiring a massive upscaling in mining and refining of critical minerals.

The Accenture report estimated 30,000 new direct jobs by 2040 from critical mineral mining and refining expansion, with a further 79,000 added through its associated supply chain.

Figure 25: Jobs Enabled by Australia’s Clean Energy Export Opportunities ⁴⁰⁴



Source: Accenture 2021

⁴⁰³ Business Council of Australia, [Sunshot: Australia’s opportunity to create 395,000 clean export jobs](#), 14 October 2021

⁴⁰⁴ Business Council of Australia, [Sunshot: Australia’s opportunity to create 395,000 clean export jobs](#), 14 October 2021

In 2021, the Future Battery Industries CRC (FBICRC) collaborated with Accenture for the ‘Future Charge: Building Australia’s Battery Industries’ report, an in-depth analysis on the demand, investment, and employment opportunities Australia has from value-adding downstream. Accenture consulted with Australian industry majors including IGO, Pilbara Minerals, Wesfarmers, and Australian Government agencies including the Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation (CEFC), CSIRO and Austrade for the report.⁴⁰⁵

Table 3: Jobs Enabled by Australia’s Clean Energy Export Opportunities ⁴⁰⁶

Company	Project	Commodity	Year	Est. Workforce
EcoGraf	Battery Anode Graphite Facility	Graphite	2024	65
Element25	Butcherbird	Manganese	2024	150
Iluka Resources	Enneable Refinery	Rare Earths	2025	100
Australian Vanadium	Australian Vanadium Project	Vanadium	2023	240
Gabnintha Vanadium	Gabanintha	Vanadium	2023	120
Ardea Resources	Goongarrie Project	Nickel and Cobalt	2024	300
TLEA / Albemarle	Greenbushes CGP3	Lithium	2024	50
Alpha HPA Ltd	High Purity Alumina Refinery	HPA	2022	140
Lynas Rare Earths	Mt Weld and Kalgoorlie Refinery	Rare Earths	2023	120
FMG	Iron Bridge Project	Iron Ore (Magnetite)	2023	900
Liontown Resources	Kathleen Valley	Lithium	2024	350
Wesfarmers / SQM	Kwinana Refinery	LHM	2024	200
Macarthur Minerals	Lake Giles Magnetite Project	Iron Ore (Magnetite)	2024	258
Wesfarmers / SQM	Mt Holland	Lithium	2024	150
Greenstone Resources	Mt Thirsty	Nickel and Cobalt	2025	300
IGO	Odysseus Cosmos Project	Nickel	2022	80
Pilbara Minerals	Pilgangoora Expansion	Lithium	2025	43
Hastings Tech. Metals	Yangibana Refinery	Rare Earths	2024	250
Copper Mountain Mining	Eva Copper Project	Copper	2023	280
Australian Mines Ltd	Sconi	Nickel and Cobalt	2024	300
Cobalt Blue Holdings	Broken Hill Cobalt Project	Cobalt	2024	400
Aeris Resources	Stockman Project	Copper and Zinc	2023	250
Rex Minerals	Hillside	Copper	2023	430
Havilah Resources	Kalkaroo	Copper	2023	260
KGL Resources	Jervois	Copper	2025	260
Core Lithium	Finniss Project	Lithium	2022	130

Source: AREEA Energy and Resource Workforce Estimates

⁴⁰⁵ FBICRC, [Future Charge: Building Australia’s Battery Industries](#), June 2021

⁴⁰⁶ AREEA, [Resources and Energy Workforce Forecast 2022-27](#), July 2022

The report identified that if Australia remains focussed on its 'dig and ship' economy, global demand could create 18,700 new jobs by 2030. However, if Australia diversifies and invests its mining strength into developing onshore materials processing, and prioritises energy storage system manufacturing and integration, Australia can expand its workforce by 34,700 by 2030, a 478% increase relative to battery raw material mining jobs in 2020.

The FBI CRC also collaborated with the WA Government and TAFE WA to assess the skills gap and workforce training required to power Australia's growing battery value chain. The Vocational Skills Gap Assessment and Workforce Development Plan published in August 2021 provides a detailed and credible roadmap to equip the future workplace with the necessary training and qualifications for mining, concentrate production, refining, precursor production and battery / cell manufacturing.⁴⁰⁷

In July 2022, the Australian Resources and Energy Employer Association (AREEA) published its 5-year workforce forecast, detailing the employment opportunities from new mineral and metal projects in Australia's investment pipeline. AREEA estimates the critical mineral projects current in development will create over 6,500 jobs by 2025.⁴⁰⁸

⁴⁰⁷ FBICRC, [Vocational skills gap assessment and workforce development plan](#), August 2021

⁴⁰⁸ AREEA, [Resources and Energy Workforce Forecast 2022-27](#), July 2022

Appendix One

Table A1: Market Capitalisation of Key Mining Firms Detailed in this Report

Market Cap Listed Companies	Ticker	Location	A\$m	5Y Growth
BHP	BHP.AX	Australia	254,220	62%
Rio Tinto	RIO.AX	Australia	205,040	61%
Fortescue Metals Group	FMG.AX	Australia	69,215	341%
Wesfarmers	WES.AX	Australia	55,977	58%
Albemarle	ALB	USA	44,669	132%
SQM	SQM	Chile	37,173	62%
Tianqi Lithium	002466.SZ	China	28,801	123%
POSCO	PKX	South Korea	26,692	-32%
Mineral Resources	MIN.AX	Australia	17,877	385%
Pilbara Minerals	PLS.AX	Australia	15,320	406%
Alcoa Corporation	AA	USA	12,996	-2%
IGO Ltd	IGO.AX	Australia	12,033	210%
Allkem Ltd	AKE.AX	Australia	8,851	101%
Lynas Rare Earths	LYC.AX	Australia	8,119	329%
Iluka Resources	ILU.AX	Australia	4,662	13%
Liontown Resources	LTR.AX	Australia	3,383	3596%
Core Lithium	CXO.AX	Australia	2,070	1434%
Syrah Resources	SYR.AX	Australia	1,589	-41%
Arafura Resources	ARU.AX	Australia	1,170	414%
Ioneer	INR.AX	Australia	977	35%
Calix	CXL.AX	Australia	959	743%
Novonix	NVX.AX	Australia	875	84%
Hastings Technology Metals	HAS.AX	Australia	465	-43%
Sunrise Energy Metals	SRL.AX	Australia	180	-86%
Australian Vanadium	AVL.AX	Australia	131	-32%
EcoGraf	EGR.AX	Australia	92	-32%

Note: AUD/USD = 0.71 and USD/CNY = 6.78 as of 26 January 2023

Source: Yahoo Finance (26 January 2023)

The chart below (Figure A1) details the performance over the last decade of leading ASX-listed lithium mining firm Mineral Resources (green, +870%) relative to the All Ordinaries (purple, +65%), BHP (yellow, +43%), and Australia’s largest ASX-listed fossil fuel exporter, Woodside Energy (red, +13%).

For all the climate science denialism and claims that Australia cannot afford to move away from our excessive reliance on LNG, coking and thermal coal exports, global investors have certainly voted with their money.

The energy transition is driving a multi-decade pivot from the historically fossil fuel-powered industrial model of old to renewable energy, grid modernisation, EVs, and all the decarbonised critical mineral mining, refining and battery manufacturing required to facilitate this. This will see upwards of a US\$100 trillion of new investments globally by 2050 - a seismic reallocation of capital, as BlackRock CEO Larry Fink has said many times.⁴⁰⁹

Figure A1: Share Price Performance of Mineral Resources Relative to BHP and Woodside



Source: Yahoo Finance

⁴⁰⁹ AFR Chanticleer, [Fink sees ‘a seismic reallocation of capital’](#), 9 November 2020

Appendix Two: Responses to Federal Government’s Discussion Paper on National Critical Minerals Strategy 2023

The government’s Discussion Paper⁴¹⁰ asks for input from industry and community stakeholders, including traditional owners.

We have responded in brief to the Discussion Paper’s questions below, and provided direction for where the interested reader can learn more in the body of this report.

Creating economic opportunity

1. How can Australia capitalise on its existing advantages to create economic opportunity for all Australians – particularly regional communities and First Nations Peoples?
2. What could be done to facilitate project development and ensure benefits flow to regional communities?
3. What might be done to ensure maximum reasonable opportunity for local employment and local business participation in projects?
4. What role can Government play to help ensure the sector maximises gender equality?

Australia’s Chief Scientist, Professor Cathy Foley, has written about the booming demand for critical minerals, Australia’s abundance of deposits, and the opportunity for high skilled regional jobs in value-adding, describing it as an “excellent economic opportunity to cement Australia into the global supply chain for low-emissions technologies”.

Section 2 of this report describes how Australia is already the fifth largest supplier of key critical minerals on the world stage. Building upon our extensive home-grown renewable energy capacity, we have the opportunity to expand and value-add the critical minerals landscape to turbocharge regional employment.

This is a ‘once in a century’ opportunity for Australia. Strategic policy settings that catalyse industry development, and co-investment by the Australian government, will be key to maximising potential and creating employment opportunities.

Regional employment and investment opportunities for Australia can be doubled by refining critical minerals pre-export, particularly with any weakening of the A\$/US\$. And given commodity

⁴¹⁰ Australian Government: Department of Industry, Science and Resources, [Critical Minerals Strategy 2023: Discussion Paper](#)

refining and processing is very energy intensive, this can also leverage our global competitive advantage in zero emissions, low-cost world-scale renewable energy.

*As described in **Section 9**, Climate Energy Finance’s 2021 expert advice into Accenture’s report ‘Sunshot’ suggested Australia has the opportunity to create 395,000 clean export jobs.*

The Australian Resources and Energy Employer Association (AREEA) estimates critical mineral projects currently in development will create 6,500 jobs by 2025. If Australia remains focussed on its ‘dig and ship’ economy, 18,700 new jobs could be created by 2030. If Australia diversifies and invests its mining strength into developing onshore materials processing, and prioritises energy storage system manufacturing and integration, Australia can expand its workforce by 34,700 by 2030, a 478% increase relative to battery raw material mining jobs in 2020.

*A number of Australian companies are already value-adding their critical minerals interests and creating jobs and economic stimulus in regional Australia, as described in **Section 4**. For example:*

Lynas Rare Earth’s Kalgoorlie plant in Western Australia (WA) will create 209 jobs during construction, with 128 sustained.

Sunrise Energy Metals’ Sunrise Projects, a nickel, scandium and cobalt renewable energy-powered project west of Parkes in central NSW would create 1,800 direct jobs during construction, with an estimated 400 ongoing operational jobs.

BHP’s Nickel West employs over 2,500 people. Its Australian-first nickel sulphate plant created 80 new direct jobs, in addition to the 200 jobs during the construction phase.

BHP’s Oz Minerals’ planned \$1.7bn copper-nickel West Musgrave mine in remote WA will bring 1,500 new construction jobs.

And Fortescue Future Industries has a 2GW electrolyser manufacturing facility at Gladstone in Queensland under construction, creating 100 construction jobs and 50 permanent jobs.

Section 6.1 describes the jobs impacts of the US Inflation Reduction Act 2022.

As a result of the IRA, LG Energy Solution and Honda committed a joint US\$3.5bn investment for a new 40GWh battery plant in Ohio, creating 2,200 new manufacturing jobs. Hyundai Motor Group of Korea’s new EV factory near Savannah, Georgia, created 8,100 new manufacturing and supply jobs. And First Solar US is building a US\$1.1bn 3.5GW annual capacity US solar module manufacturing operation in Alabama creating 700 new direct manufacturing jobs. The BIL battery manufacturing initiative also catalysed the creation of over 6,000 new jobs.

*As described in **Section 8**, Andrew Forrest’s Wyloo Metals has committed to develop high-grade nickel sulphide deposits in Ontario, with government support of C\$1bn for infrastructure, and an estimated C\$9.4bn contribution to Canada’s GDP and creation of 5,500 jobs annually.*

*Government-designed initiatives in consultation with business and communities - such as the \$1.9bn Powering the Regions Fund to support industry decarbonisation and development of new clean industry, the Driving the Nation Fund, working in association with ARENA to deliver charging infrastructure for regional Australia, and the National Reconstruction Fund, which includes a commitment to expand our regional industrial base in critical minerals - highlight the necessity of policy development and subsidies to drive programs into regional Australia, as described in **Section 5**.*

Australia has a unique opportunity to transition elegantly from dirty to clean exports and energy generation, with the capability to drive spill-over economic benefits to regional and First Nations communities.

Developing new sovereign capabilities and industries

5. What are the specific opportunities Australia should seek to realise while developing downstream processing and manufacturing capabilities?
6. For key technologies and value chains, such as batteries, magnets, alloys and other clean energy technologies, what are the key obstacles to Australia moving up the value chain?
7. How can governments, industry, and researchers support Australia's critical minerals industry to move further downstream and develop new sovereign capabilities?
8. What can Australia do to better develop and retain IP and to attract IP investment from like-minded partners?

*As **Section 4.1** describes, Climate Energy Finance sees enormous economic, trade, employment, and strategic geopolitical opportunities for Australia to lead on global decarbonisation efforts. Australia should be a renewable energy and value-added critical minerals superpower, but needs to think strategically, leverage its strengths, and localise its supply chains.*

Australia has one of the largest bulk minerals mining industries in the world, led by global giants BHP and Rio Tinto. These projects are energy intensive, and provide an opportunity to tap our vast, largely untapped, low-cost renewable energy resources. This will require concerted public-private initiatives, including the Safeguard Mechanism's price on carbon and declining emissions profile, and strategic public interest financing.

*As **Section 5** describes, with Australia's abundant geological reserves and renewables potential, it can build clean energy industry economies of scale by positioning onshore minerals processing and manufacturing downstream of its mining operations, diversifying the concentration of global processing in China.*

Public-private partnerships are an increasingly fundamental tool to support global clean energy supply chains, enabling key actors to secure and de-risk the supply of critical minerals.

As described in **Section 5.1**, government support catalyses private capital. Public-private partnerships will accelerate capital deployment in value-adding projects up- and downstream, and ensure Australia helps drive global decarbonisation.

Current investment initiatives by the Australian Government are welcomed, but could be boosted and better targeted.

Recommendation: Climate Energy Finance would argue that the Future Fund’s mandate, as a public interest fund, should be updated to include a strategic national interest object relating to retaining and increasing Australia’s ownership of key Australian assets. This can include ensuring that new projects of national significance in mining and refining of critical minerals leverage firmed renewable energy and are majority Australian owned. Taking an enabling patient equity stake after full due diligence can be strategically deployed to ensure appropriate accelerated new proposals development, whilst mandating the highest level of environmental, social and governance (ESG) standards at the project’s inception.

This strategic national interest focus would also allow the Future Fund to de-risk and hence accelerate developments, and in doing so, crowd-in private Australian superannuation funds that have the key restriction of the sole purpose test of maximising risk-adjusted returns.

Australia’s enormous resources wealth massively outweighs that of Norway. It would be strategically sensible to address the multi-decade failure of Australia to replicate the success of the US\$1.36bn Norwegian Sovereign Wealth Fund (SWF) through the above reform.

Recommendation: We recommend the CEFC’s mandate also be expanded to include critical minerals refining, in addition to a mandate to work in alignment with Australia’s key regional Asian and Pacific neighbours on energy transition and decarbonisation. The same applies for the Australian Renewable Energy Agency (ARENA), where Australia should lead the world on microgrid Virtual Powerplants (VPPs) and off grid firmed renewables solutions for remote islands across ASEAN and the Pacific.

In terms of opportunities, **Section 3** describes how Australia leads the world in lithium mining. We have benefited significantly in the last two years from surging demand by refiners and battery manufacturers and the global race for clean energy supply chain security. The top five pure lithium ASX-listed companies now have a combined market capitalisation exceeding A\$56bn, up eight-fold over the last seven years. Capturing the value of minerals processing pre-export is imperative to Australia’s economic growth.

Further prioritising and scaling trade relations with the US, Japan, South Korea, India and the EU provide a pathway into new joint-venture development projects to help global battery and EV leaders secure their supply chains. The inclusion of strategic partnerships and long-term supply agreements with global majors provides the opportunity to leverage our mining and refining expertise with foreign R&D to scale precursor and battery manufacturing onshore.

Onshoring further down the critical mineral and precursor manufacturing value chain is also the most economic and efficient way of mitigating Scope 3 emissions globally in partnership with our key trade partners.

Section 3 reviews top tier Australian companies and their progress in developing value-adding up- and downstream projects. It also explores strategic partnerships with international companies, and the strategic and economic advantages to Australia.

Section 4 reviews battery manufacturing projects in operation in Australia, and other projects (e.g., fast charging) challenging assumptions that domestic projects cannot be established away from EV manufacturing and key end consumer markets.

Building reliable, competitive and diverse supply chains

9. How can government support the capability of critical minerals companies and other relevant entities to identify, engage and grow new target markets?
10. How should Australia engage with international partners to support the diversification of supply chains? What should this engagement focus on (including which countries)?
11. What actions can Australia take to ensure it leverages related investment by other countries, for example the US Inflation Reduction Act.
12. Is there more the Australian Government can do to facilitate business-to-business engagement and drive supply chains diversification?
13. How can Government and business work together to ensure private sector insights on the context and complexity of current supply chains and markets can inform policy design?

Section 2 describes Australia's competitive advantage as a world leader in critical minerals reserves and export. Global critical minerals demand is expected to surge five to tenfold this decade, underpinned by the accelerating energy transition.

Australia is currently the world's third largest cobalt exporter, and the fourth largest in mined copper, nickel and rare earths. It has nearly 80% of the world's share of hard rock lithium (spodumene concentrate), with the Office of the Chief Economist (OCE) forecasting exports to hit \$16bn in FY2023, a fifteenfold increase in value terms in just two years. Nickel exports are forecast to nearly double to \$5.1bn while copper exports are up just 5% in two years to a forecast \$12bn.

Australia is perfectly placed to diversify its reliance on iron ore and fossil fuel exports by bolstering critical minerals with onshore refining and manufacturing powered by our growing renewable capacity, expanding investment and employment locally. These future facing commodities give Australia a global competitive advantage and will help avert serious market contraction as our fossil fuel exports - coal and LNG - terminally decline over time.

As described in **Section 8**, Australian miners are increasingly expanding their involvement in both domestic value-adding and offshore critical mineral industries, maximising their position in the energy transition value chain, enhancing security and diversity of supply sources.

Section 2 describes the strategic pivot towards critical minerals and value-adding currently being undertaken by Australian key majors following their recent exit from fossil fuels in terminal decline, with Australia is already the fifth largest supplier of key critical minerals on the world stage.

Section 4 describes how Australia critically needs to see a strategic public-private focus on the value-adding of our world leading renewable energy and critical mineral resources so as to maximise investment, regional employment and export value-adding opportunities as it embraces the enormous opportunities of the global energy transition.

The European Commission's Mission-Oriented Policy framework design in 2017-20 highlights that policy should shift from merely incentivising private firms with public capital, to clearly directing investments into national strategic interests through public-private partnerships.

CEF would recommend that the Australian government set strategic policy agendas that crowd-in private capital, both patient domestic super and strategic foreign investors (like POSCO). In doing so, strategic public grants, equity, infrastructure, venture capital (VC), export credit agency (ECA) and debt capital can fund due diligence and endorse proposals of strategic national interest.

Establishing clear mission-oriented policy in Australia for clean energy exports and renewable energy capacity will tilt the patient long-term strategic financing required for high-risk and capital-intensive projects.

Given the growing decarbonisation objectives of the Albanese government, patient public capital can also help ensure domestic value-adding of our critical minerals is undertaken pre-export, leveraging our world scale renewable energy resources so that we are also helping our trade partners decarbonise their economies (e.g. processing our world-leading \$130bn pa of iron ore exports into green iron pre-export to help China, India, Japan and Korea move onto a path to steel sector decarbonisation).

As **Section 1.4** describes, diversification of industry and R&D partnerships across rapidly expanding markets, including the US, India, EU, Japan and Korea will provide Australia with strategic value, whilst immediately de-risking and fast-tracking new project developments by securing long term offtake revenue clarity and endorsement.

Over the long term, Australia can amplify mutual capabilities to leapfrog next-generation technologies and build out domestic downstream value chains, furthering Australia's position as a region for global supply chain centralisation risk mitigation. This will also help ensure our national interests are met by mandating the ESG best practice, and ensure majority domestic ownership is maintained.

Section 1 reviews China's dominance over the global supply chain in emerging and new clean energy technologies including battery manufacturing and EVs. Despite its leadership, there is room for more players to meet gaps in the global supply chain while bolstering energy security for Australia and other countries. Diversification and carefully designed strategic partnerships are key.

Strategic partnerships that Chinese companies including CATL and BDV have made with other countries, including Australia, to China's advantage, provide an example of the need for due diligence and long-term planning in securing project partnerships with public/private funding from a range of players, and determining prior to project sign-off opportunities for value-adding onshore pre-export.

Recommendation: The Australian government needs to diversify its over-exposure to Chinese-dominated supply chain risks. Australia is well positioned both as a strong emerging supply chain partner to China in value-added critical minerals, but also as an alternative supplier for countries looking to diversify their over-exposure to Chinese-dominated supply chain risks.

Section 6 describes how there has been significant recent global momentum in the development of policies aimed at accelerating investment in decarbonisation and zero emissions deployments.

With China leading the world in EVs and renewable energy installs, REPowerEU driving massively accelerated European decarbonisation investment, and India likewise leading the developing world on investment in renewables, the US Inflation Reduction Act puts the US back in this key global technology race. The IRA has demonstrated that government regulation and investment is key to drive massive crowding-in of private investment and manufacturing.

Section 6.1 reviews the US Inflation Reduction Act 2022. The IRA provides an excellent model of business working with government to create legislation that incentivises, regulates, and provides subsidies to strategic key interests to the benefit of US companies and their strategic partners.

With US\$369bn of subsidies and incentives - including US\$500m into critical minerals processing and requiring at least 40% of the monetary value of critical minerals for batteries to be supplied by the nation or a US free-trade partner to qualify for EV tax credits - and the revival of the Department of Energy (DoE) loan program leveraging US\$394bn in low interest loans for clean-tech funding, the IRA includes over US\$60bn for onshore clean energy manufacturing to mitigate future price shocks, bring down the cost of clean energy, and debottleneck supply chains.

The US\$2.8bn for battery manufacturing and value chain projects has already spurred US\$6.25bn of private capital investment. Further, the Bipartisan Infrastructure Law battery manufacturing initiative has created over 6,000 new jobs. In turn, new infrastructure has provided security and diversification of risk across the supply network of precursor materials vital to onshoring manufacturing of clean energy technologies and minerals.

The IRA has reduced the cost of US manufactured green hydrogen by up to 75% and introduced a \$1,500/t tax on methane emissions. In combination with the continuation of the Investment Tax

Credit (ITC) for wind, solar and battery projects, the IRA has spurred multi-billion dollar investments into US renewable energy developers and has made renewable energy more competitive, likely driving over \$1 trillion of new US rooftop and utility solar plus on- and offshore wind investments this decade, whilst incentivising 6.5GW pa of new domestic solar manufacturing, spurring massive investment in new critical minerals mining and refining, battery manufacturing and recycling, plus EV factories.

The IRA plan to electrify everything, making a wide array of distributed energy resources (DERs) eligible for new incentives - including renewables, energy efficiency, and other advanced energy systems installed in homes and businesses, with many of the programs specifically addressing lower income, disadvantaged and tribal households to ease upfront costs as they transition to clean energy - tops off this game-changing package of reforms.

CEF would suggest that the IRA provides a model for Australia for strategic government co-investment in accelerating the energy transition at the scale and pace required to address the climate and energy crisis, and position the country to reap the vast economic and employment benefits of decarbonisation.

Supporting clean energy technologies

14. What are the opportunities for critical minerals projects to maximise their ability to support clean energy supply chains and technologies?
15. How could the Australian Government help industry address capability barriers to supporting clean energy supply chains for critical minerals projects?
16. How can the Australian Government support the sector's integration with key clean energy supply chains, both domestic and international?

***Section 1** describes how the global energy transition is now a US\$1.1 trillion per annum business. To reach global net zero emission targets, annual investment needs to triple by 2030.*

Russia's invasion of Ukraine was a wake-up call on the importance of global diversification of critical mineral supply and security and independence of energy supply chains. The imperative to decarbonise has never been greater, particularly with China enjoying global dominance in almost all emerging zero emission industries of the future, driven by coordinated intergenerationally-focussed policy support for large-scale renewable energy, and a transition from subsidy- to market-oriented deployment. China's total dominance of manufacturing in renewables, batteries, EVs and critical minerals refining is raising strategic supply chain security risks, but also a massive opportunity for Australia.

*As described in **Section 7**, to reach Australia's targeted renewables share, variable renewable energy capacity additions will be needed at speed and scale to overtake soon-to-be-retired fossil-*

fuel based generation. A primary driver will be coordinated public and private financing, accelerating investments into Renewable Energy Zones.

Australia must support the expansion of value-adding industries onshore to realise the global competitive advantage and become a world-leader in driving decarbonisation in mining, metals, heavy industry, and production and manufacturing across the board. This will counter the extreme market price fluctuations and instability of traditional fossil fuel energy sources.

Government support is key to fast-track approvals that incorporate the world's best decarbonisation objectives, and to crowd in private capital by deploying patient, national-interest equity, infrastructure, debt, export credit and grant finance.

Large-scale, world-leading miners extracting value from Australia's resources must also lead capital-intensive renewable energy capacity expansion.

Supporting sustainable critical minerals development

17. What more can Australia do to ensure we are the international best practise jurisdiction for ESG?
18. What role can Government play in supporting the critical minerals sector ensure workplaces are safe and inclusive, and can attract and retain underrepresented cohorts, such as women?
19. How can Government and industry create meaningful engagement with First Nations Peoples and ensure critical minerals projects benefit their communities?
20. What are the opportunities to further strengthen the ESG credentials of the sector? For example, helping industry showcase their high ESG projects or support enabling capabilities such as the adoption of mineral traceability measures.
21. What are the opportunities for Australia in increasing recycling and circular economy practices in the critical minerals sector?

*See **Section 1.4**. Australia is exceptionally well positioned both as a strong emerging supply chain partner to China in value-added critical minerals, but also as an alternative supplier for countries looking to diversify their over-exposure to Chinese-dominated supply chain risks.*

*For batteries and EVs to be really sustainable (see **Section 4**), we need a circular economy that avoids our 'use and dump' consumer economic history.*

***Section 4.1** describes a number of initiatives being undertaken by Australian companies, including Renewable Metals which is trialling a critical new development in battery recycling in Perth WA.*

The current Federal Government has developed a number of strategies to complement the Battery Recycling strategy. These Federal Government initiatives will ensure the creation and support of

regional jobs, position Australia at an advantage in the diversification of global supply chains, and improve our export resilience.

*The US Inflation Reduction Act and US DoE Loan Program (see **Section 6.1**) has shown the imperative of embedding recycling into the system. Alongside their key role in catalysing an unprecedented upsurge in renewables, minerals and manufacturing investment, they have also spurred massive investment in recycling, including battery recycling.*

22. Are there any other factors or issues the Government should consider in developing the new Critical Minerals Strategy?

Australia has built up an excessive debt burden over the last decade, compounded by COVID. This report makes a number of financial recommendations that will come at some budget income and capital impost to Australian taxpayers. Even with a patient strategic objective, there has to be a financial return to the government, and hence taxpayers and voters, to ensure the Critical Minerals Strategy is endorsed as prudent and balanced.

We would recommend an analysis of the cost-benefit of royalty holidays in the near to medium term, balanced against a longer term high and progressive royalty system, so investors have a carrot to invest in now, but with clarity on the longer term social and financial obligations this entails. These critical mineral proposals use finite scarce public resources for private gain, and that needs to be harnessed fairly in the public interest. A progressive royalty system that sees the public benefit when prices and hence returns are well above average is only fair (just as currently it is unfair that thermal coal prices are disproportionately delivering war-profiteering gains to private firms).

We acknowledge sovereign risks arise if regulations and laws are changed retrospectively after investments are made, but circumstances change, and governments have a fiduciary duty to evolve with that.

If East Australian governments had had the strategic foresight to prioritise domestic energy security and allow multinationals to export only the surplus as the WA government did, we would not have the hyperinflation of domestic fossil fuel energy prices we have today, along with the energy poverty this has unfairly inflicted on the people of Australia. Treasury should model a fair progressive royalty scheme that delivers clarity in the national interest longer term, whilst crowding-in capital near to medium term, particularly given the urgency and size of this 'once in a century' opportunity.

Important Information

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