



Critical Minerals

AN INDUSTRY PERSPECTIVE

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State of Play was initiated in 2014 to create a platform to support industry discussion of innovation and performance at a strategic level, macro-level insights into the industry ecosystem, and more effective strategy execution and business design for competitive advantage.

State of Play has undertaken 4 global surveys – 2015, 2017, 2019, and 2021. We have also undertaken drill-down research work into specific themes including Electrification in 2020, Cybersecurity in 2019 and the specific mining industries of South Africa and India in 2017.

State of Play is now a leading voice for industry leaders and decision-makers. Our research is the basis for strategic decision-making and investment analysis globally, across operators, suppliers, investors, and government. Our work directly impacts on-the-ground innovation efforts such as the Electric Mine Consortium and countless in-house innovation acceleration programs.

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METS Ignited works with Australian suppliers to the mining industry, global miners, research organisations and capital providers to improve the competitiveness and productivity of the Australian METS sector. Its five areas of strategic focus to help strengthen the global competitiveness of the Australian METS sector are: a shared vision; strengthening collaboration in the mining innovation system; addressing gaps in the ecosystem; raising your profile; and promoting world class clusters.

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The Minerals Research Institute of Western Australia

With the global shift towards decarbonisation, the need for mineral resources to support the energy transition places Western Australia at the forefront of a significant economic opportunity.

The Minerals Research Institute of Western Australia (MRIWA), a WA State Government statutory body, fosters and promotes minerals research for the benefit of WA. Through its focus on critical minerals and its research on processing technologies, MRIWA is working to help develop critical minerals for use in the future.

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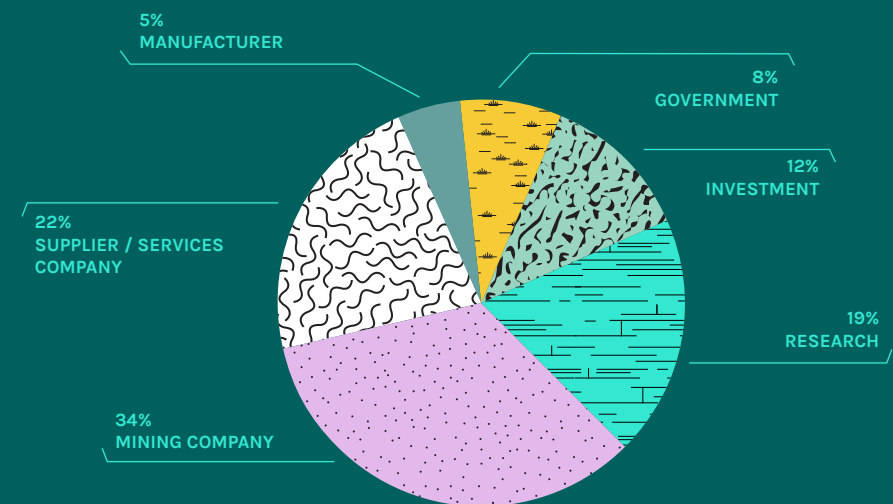
The method

In 2022, State of Play partnered with METS Ignited, the Minerals Research Institute of Western Australia and CSIRO to undertake a series of research activities on the strategic opportunities presented by the increased demand for critical minerals.

The research aims to understand how Australia can rapidly increase the global supply of critical minerals and become a significant player in downstream processing markets. The research consisted of:

- ✓ 110 individual surveys with a combination of miners, suppliers, government, financiers, researchers, and manufacturers involved in critical mineral markets. The survey was open from June – August 2022, and targeted Australian respondents
- ✓ 20 interviews with critical mineral industry experts
- ✓ 5 topic based collaborative workshops (financing, economic development, technology, and process based) with select industry representatives
- ✓ Desktop research and analysis

The research process delivered an understanding of how members of industry, across all aspects of the value chain, perceive critical mineral markets to be developing and how they can be best accelerated. The breakdown of survey participants is below:



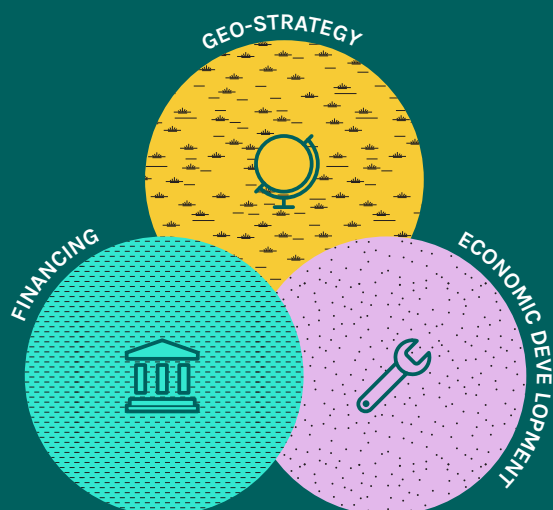
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Executive Summary

The confluence of geo-political uncertainty and a shift to a zero-carbon world has created an extraordinary demand for certain raw materials. Countries around the world have released their own lists of 'critical minerals', defined as either necessary to produce new energy technology, central to national security, at risk of supply chain disruption, or a combination of the three.

The Oxford dictionary defines 'critical' as a situation or problem having the potential to become disastrous, or at a point of crisis. For our research, the crisis in question relates to the structural supply deficit that will materialise if more critical minerals are not produced, faster.

"A critical mineral should be anything which we need to make sure that we have access to long term, without dependence on convoluted and complex value chains" – Mining Company CEO



When this research project began in early 2022, one of the initial focusing questions was around *when* the impending supply crisis would reach an inflection point. This question was soon rendered obsolete, as we quickly realised the market signals suggested the crisis was already underway.

For the first time in decades, the scarcity of raw materials is threatening the pace, cost, and efficiency of technological advancement and the transition to a low-emission economy. The price of a battery cell is expected to increase by 22% through to 2026 on the back of insufficient supply availability¹. As a result, the focus of the research shifted from *when will the crisis hit*, to *how to respond*?

Other researchers followed a similar path of realisation. Prior to this year, considerable work was being conducted to forecast the likely demand profiles and scenarios out to 2050, so all members in the value chain can respond accordingly. In a similar vein, this research emphasis quickly shifted from what demand may look like, to how it can be met.

The following report therefore aims to outline *how Australia can rapidly increase the global supply of critical minerals*. The recommendations are provided through three different, but highly interrelated lenses: Geo-strategy, financing, and economic development.

The confluence of these three factors suggests there is a significant role for national and sub-national governments to play in developing critical minerals markets, industries, and supply. The immaturity and risk profiles of critical minerals markets, the increasingly complex geo-political landscape for foreign investment, and the potential for a downstream critical minerals processing industry places government at the crux of the opportunity.

Such sentiment conflicts with the results of prior research conducted by State of Play, whereby industry perceived government's role in mining to be peripheral, predominantly focused on research, collaboration, and regulation². In establishing the need for sovereign intervention, the question then becomes focused on how governments could intervene, and through what mechanisms?

As alluded to earlier, the landscape for critical minerals is changing rapidly. Supply scarcity is creating a global competition for minerals. Downstream end-users are formulating strategic partnerships with upstream suppliers in an attempt to secure raw materials. Cooperative agreements and financing arrangements between countries are being negotiated to strengthen alliances and build resilient supply chains. Everyone is competing for capital and talent.

The industry recognises critical minerals present a once in a generation opportunity to re-strategise global supply chains. There is a collective demand from countries around the world to democratise the production, transmission, and consumption of energy, which is altering international alliances and creating new opportunities for collaboration and value creation.

From the feedback received, the following recommendations have been identified with the intent to ensure Australia remains a globally renown and competitive location for critical minerals investment, and an integral supplier of critical minerals to global markets. Furthermore, these recommendations are targeted at ensuring Australia captures the full value of its ore, by fostering a downstream processing industry that will provide and diversify the nation's economic prosperity for decades to come.

Summary table of recommendations

Recommendation	Rationale
Promote Australia as a low-risk critical mineral supplier through government and business-led engagement	Engagement from Australian businesses, senior government officials, trade delegations and NGOs with foreign investors to consistently and positively promote the opportunities that are present in the critical minerals industry in Australia is essential to mobilise public and private capital from overseas investors.
Improve direct flight accessibility to Western Australia	The ability of C-suite investors to gain direct access to the Western Australian economy is crucial to further growth. The lack of direct flights from Asia, particularly Seoul, into the resource capital of Australia, Perth, should be addressed.
Pursue cooperative arrangements with foreign investors	The creation of alliances, forging of cooperative arrangements or trade agreements should be pursued with those foreign investors considered impactful in accelerating the critical minerals industry in Australia.
Streamline the Foreign Investment Review Board (FIRB) process for critical minerals investment proposals	As it is currently (part of the Treasury), the FIRB is subject to the same 'red tape' as any government department, significantly slowing the review process. There is currently a large backlog of applications. Reform targeted at streamlining the critical mineral investment review processes and increasing the flexibility of investment thresholds should be considered.
Provide direct project finance	Continue and increase the provision of government-backed grants, incentives, and debt facilities to catalyse private co-investment, reduce investment risk for the broader market, and form a significant proportion of capital required for the recipient companies to go into production. This is particularly applicable for the niche critical minerals.
Initiate government-backed offtake arrangements	Provision of minimum revenue offtakes on a 5, 10 or 20-year basis gives greater certainty around the revenue model, removes some of the downside risk from the investment decision and improves customer understanding in the early stages of market development.
Improve policy driven risk settings for Australian banks	Address the Australian banks lack of involvement in critical minerals by encouraging the banks to finance critical minerals through reform of policy driven risk settings.
Establish waste processing hubs	Support the construction of centralised waste processing facilities or 'hubs', where existing waste, whether it be from tailings, fly ash, or other streams can be sent for processing to extract critical minerals and reduce pressure on primary supply.

Recommendation	Rationale
Improve international competitiveness through taxation incentives	<ul style="list-style-type: none"> ✓ Delaying royalties payments until after a few years of production to assist with early cash flow struggles and improve payback periods. ✓ Capping the quantum of royalty payments after a certain number of years to encourage full value extraction as deposits begin to deplete. ✓ Enhancing the applicability of the research and development tax offset for the demonstration and application of the unique processing technologies required for novel blends and specifications.
Educate the general public on role of critical minerals in global energy transition and national security	Improve the public perception of the mining industry through education campaigns targeted at highlighting the role mining plays in the transition to a low-emission, advanced technology future.
Streamline approval process through proactive preparation	Complete and approve aspects of the pre-assessment phases (e.g., heritage listing, environmental assessments, water resource analysis, etc.) of industrial development to ensure investment opportunities are prepared, simplified and ready for investment.
Invest in 'Strategic Industrial Areas'	<p>Initiating an ecosystem for manufacturing to promote flow on effects for value-creation through:</p> <ul style="list-style-type: none"> ✓ Investing in identifying and constructing heavy industrial areas or hubs where industrial activity can be co-located. ✓ Building critically important infrastructure to improve and connect these hubs to global markets (e.g., energy, water, waste facilities, rail, road, and ports)
Become a cornerstone investor in shared industrial facilities	Play a leading role in constructing the partnerships and commercial arrangements between local resource companies and international technology suppliers to overcome the "first mover" hurdles, and kick start Australia's downstream processing industry.

Whilst many of these recommendations are being considered or partially addressed already, the pace and extent of the effort needs to be accelerated in order to fully-capture the economic opportunity.

The geo-strategic backdrop

To fully evaluate the critical minerals industry in Australia, it is necessary to analyse the geo-strategic backdrop. Many opportunities and challenges exist for the critical minerals sector, yet before seeking to capitalise or problem solve, executives and investors should reflect on the ever-evolving international context in which they operate.

The vast and all-encompassing phase of globalisation that occurred over the past thirty years has transformed how businesses operate. Technological advances have made extensive cross-continental supply chains and remote work an efficient reality, resulting in the rise of new economic superpowers.

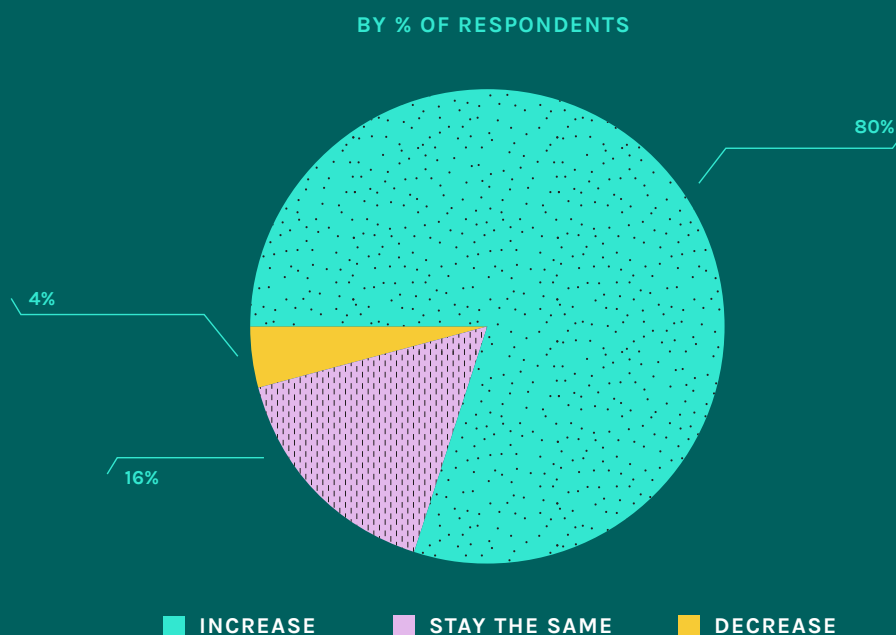
The COVID-19 pandemic has had an enormous impact on international business. The lack of resilience in global supply chains was painfully evident for all to see. Among other factors, the pandemic illustrated the implications of an over-reliance many countries,

Australia included, have on China for key inputs in their value chain. In the post-COVID era, particularly in Australia's region – the Indo-Pacific – international political motivations, alliances, and tensions are changing the way executives think about international cooperation.

Other geo-political phenomena continue to challenge Australia, with the most significant being the build-up of tensions between the US and China. Industries that rely on substantial foreign investment, and largely export their produce are particularly affected.

It is unlikely, at least in the medium term, that there will be a panacea for the turbulent international society we are part of today. 80% of our survey respondents expected global political tensions to increase over the next 5 years. Less than 5% thought they would subside.

WE ASKED: HOW DO YOU EXPECT GLOBAL POLITICAL TENSIONS TO SHIFT OVER THE NEXT 5 YEARS?



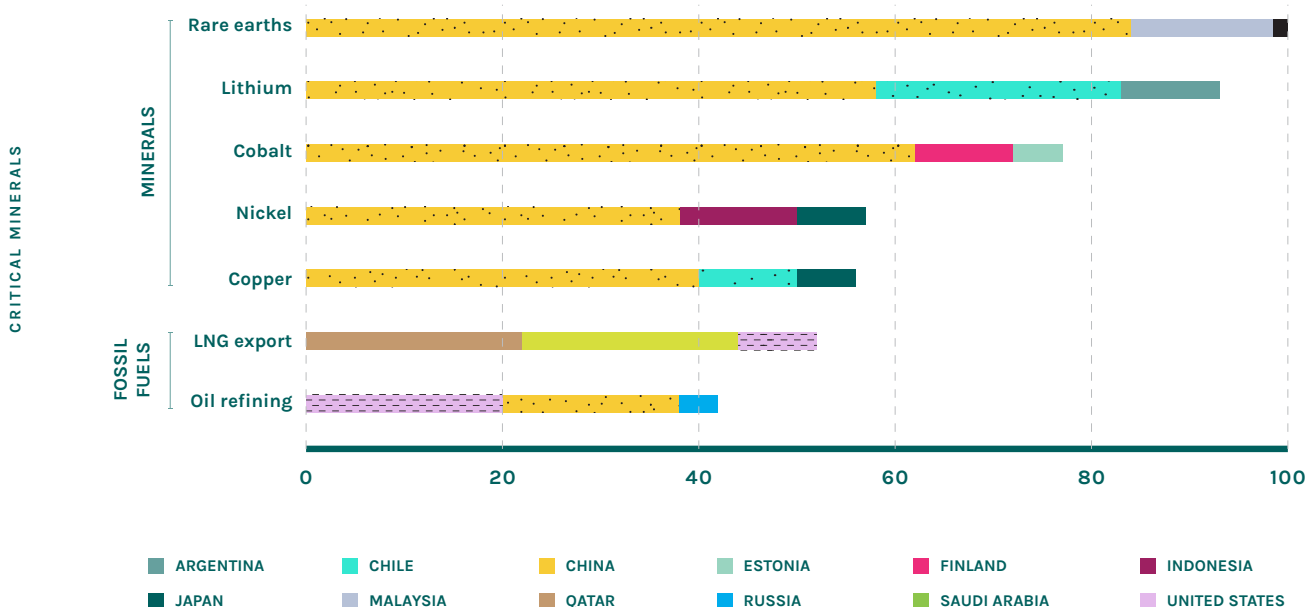
Domestication of supply chains

The War in Ukraine and the ensuing economic sanctions are reducing global supply of several critical minerals (incl. nickel, titanium, palladium, scandium, and vanadium), whilst also causing energy prices to increase across the globe. As critical minerals are energy intensive to process, the relative impact this has on the industry is intensified. While tremendously significant, Russia's invasion of Ukraine is only one complication.

China is estimated to possess up to 90% of the refining and processing of the globe's critical minerals, with a specific dominance in rare earth elements (REEs)³.

In 1990, the Chinese Government declared REEs as a strategic mineral, and invested heavily in the R&D of its processing technologies. The implementation of protectionist measures from foreign investment and other initiatives including unified pricing mechanisms, production quotas and export duties, quickly resulted in the monopolisation of the REE market, and two decades of dependence on China for supply⁴. In 2021, China supplied 98% of the European Unions (EU) processed REEs⁵.

SHARE OF TOP 3 COUNTRIES IN GLOBAL PROCESSING



Since 2009, the US and the EU in particular, have been cognizant of the risks surrounding their reliance on any dominant foreign source for strategic minerals. Action is being taken, as evidenced through multiple complaints to the World Trade Organisation, the development of National Defence Stockpiles, the release of critical mineral lists and strategies, and most recently the announcement of considerable allocations of funds to catalyse the development of domestic critical mineral industries.

Both the pandemic and the invasion of Ukraine have reignited the sentiment to diversify global supply chains in the public consciousness. In the process of increasing the resilience of supply chains, it is highly likely countries will look to reduce their reliance on Chinese inputs. As a result, the role Australia plays in the supply of critical minerals may become more geo-strategic.

³ International Energy Agency

⁴ CSIS

⁵ European Commission

To address this opportunity, it is important to consider: What role can Australia play in supplying an increasingly divided global market, and how can Australia leverage its international trading partners to accelerate the development of critical minerals projects locally?

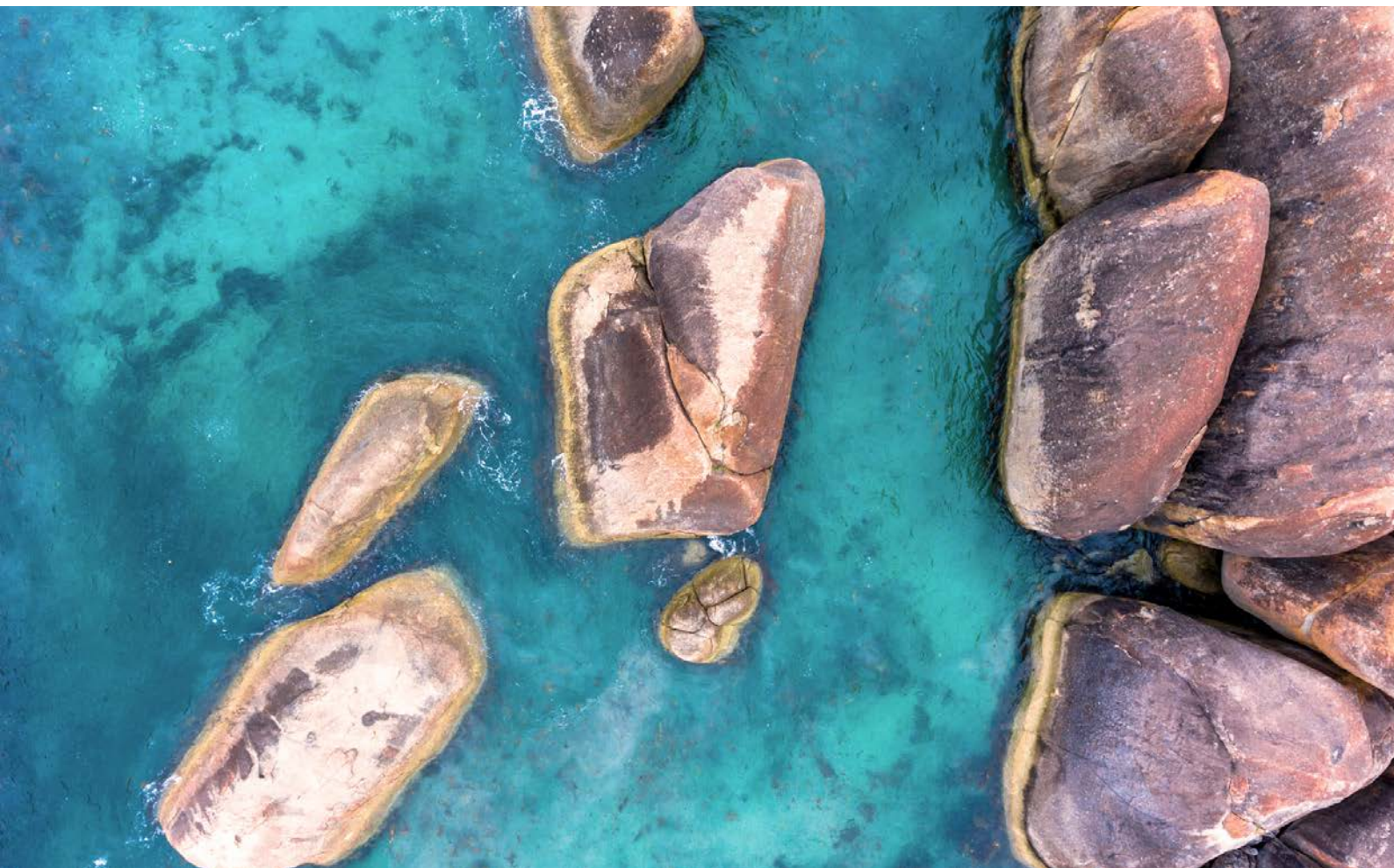
"If I had \$40 billion at my disposal, I would actually go out and diversify supply of these commodities, with some loss leading, and it would be the greatest gift I could give to my children and their grandchildren" - Mining CEO

Cooperative opportunities for investment

Australia is viewed as a robust and stable democracy with low jurisdictional risk and is a largely attractive place for foreign investment. When analysing Australia's opportunities for global cooperation in the critical minerals industry it is important to identify and understand the partners who are most likely to have the biggest impact on domestic growth.

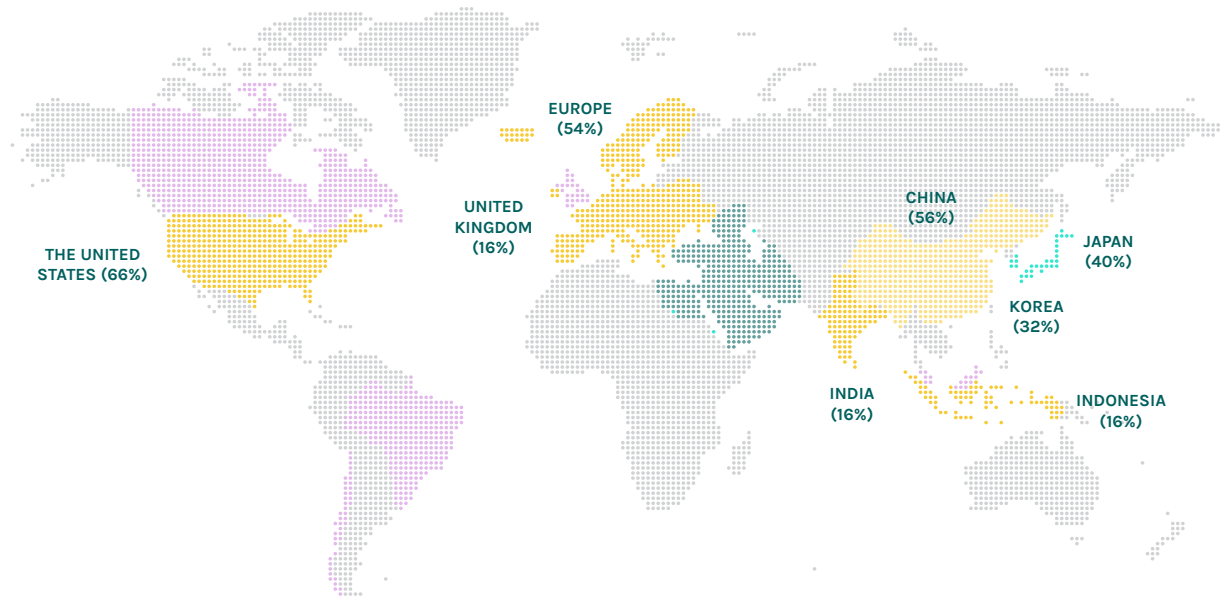
Survey respondents showed that the top 5 most impactful investors driving an increase in the supply of critical minerals in Australia are believed to be the United States (US), China, Europe, Japan, and Korea. These results are logical, given that the US, China, Europe, and Japan are the world's four largest economies by GDP.

The United Kingdom, India and Indonesia were ranked lower in importance. Despite these nations currently placing significant emphasis on consolidating their domestic critical mineral industries, we expect the three countries will be important players for Australia in the medium term.

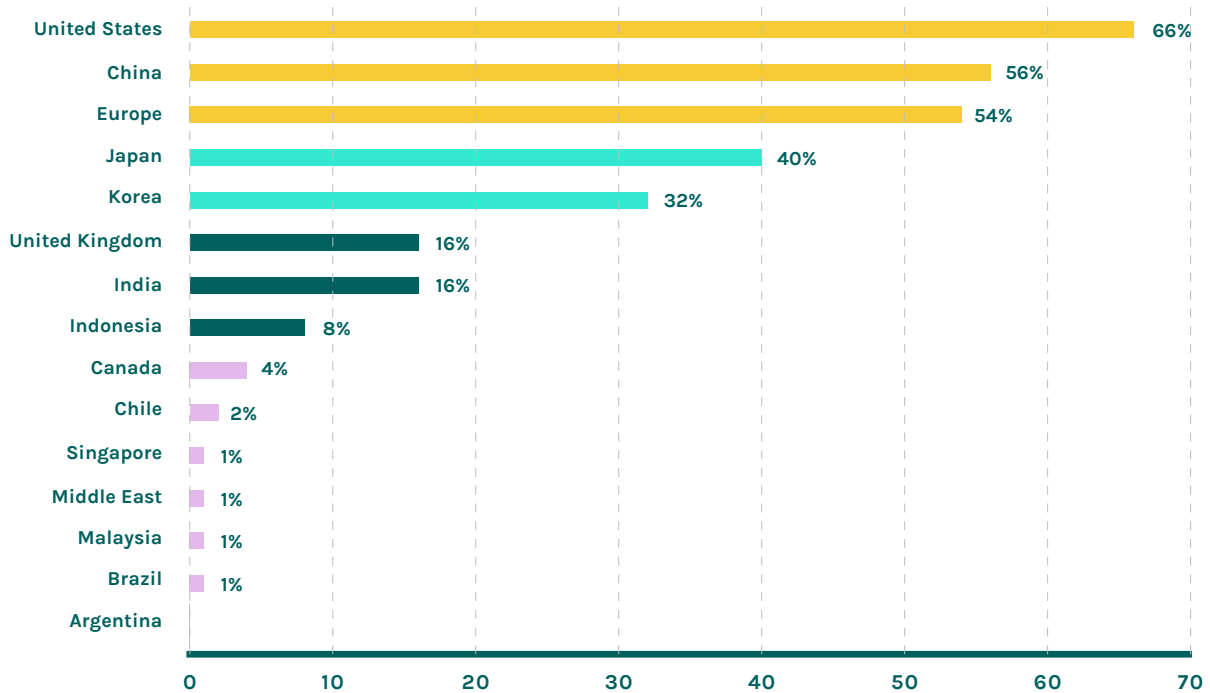


Based on these perceptions, overviews of the eight nations mentioned are outlined below:

WE ASKED: WHO ARE THE MOST IMPORTANT INVESTORS IN THE DEVELOPMENT OF AUSTRALIA'S CRITICAL MINERALS INDUSTRY?



BY % RESPONDENTS GIVEN THREE OPTIONS



United States

In the past two years political ties, particularly in defence, have highlighted this trend; the Australia-United Kingdom-United States partnership (AUKUS), the Australia, New Zealand and United States Security Treaty (ANZUS), and the Quadrilateral Security Dialogue (QUAD) stand as high-profile examples. Such political links are also reinforced by economic links.

The US is Australia's largest two-way investment partner, with two-way investment at the end of 2020 tipping A\$1.8 trillion⁶. Australia is seen as a stable destination for large US firms to hold assets and in many cases, invest. More specifically, the *US Defence Production Act* has been invoked, naming Australia as a country eligible for free trade and project funding on the same basis as domestic US projects.

Already, Australian-backed companies, including *Novonix*, *Syrah Resources* and *Talon Metals*, are among recipients of the Biden Administrations US\$2.8b worth of grants aimed at accelerating US production of critical minerals⁷.

China

China's domination of critical minerals – particularly rare earth elements – is indisputable. Despite other nations looking to reduce their reliance on China, they will likely continue to grow as an economic superpower, with Chinese GDP forecasted to overtake the US by 2030⁸.

Australia and China have enjoyed a profitable relationship in mining over the last decade and a half, driven predominantly by iron ore and coal trade. In recent years, this relationship has become increasingly tense. Chinese investment in Australia, particularly mining, has reduced significantly since 2016 from \$16.5b to just \$1.1b in 2020⁹. Australia's Foreign Investment Review Board (FIRB) may have played a role in the declining number of deals executed, as lines between foreign policy and economic incentives have become blurrier.

"It's always been American money that's really done everything in Australia" - Mining CEO

Europe and North Asia's efforts to diversify their supply chains away from China has positioned them as viable alternatives for trading partners with Australia. Australian firms may benefit from the requirement of more diverse and globally resilient supply chains; however, this may undermine the relationship between China and Australia.

Whilst Australia remains a favoured trading partner for iron ore and coal, it is still unclear as to whether bilateral engagement between the two nations will follow the same trajectory in critical and strategic minerals.

Europe

Europe stands as an important engagement partner for Australia. In addition to being the world's second largest market for Electric Vehicles (EVs)¹⁰, the European Union has instituted the *European Raw Materials Fund*, providing unprecedented financing aimed at developing resilient supply chains¹¹. In addition, the Carbon Border Adjustment Mechanism (CBAM) policy that has been passed is creating a requirement for low-carbon critical minerals, something which Australia can leverage to their advantage via the use of renewable energy and mine site electrification.

Like the US, European companies have been attempting to de-risk their supply chains from Chinese inputs, however Russia's War in Ukraine has made the strategic situation increasingly tenuous. European firms will need to be mobile and responsive.

"There's no graphite anode that goes into any instrument anywhere at scale, that's manufactured excluding China. So that means there's not a battery on the planet at a commercial scale that's manufactured outside of China exclusively" – Mining CEO

⁶ AusTrade

⁷ Australian Financial Review

⁸ CEBR

⁹ Australian National University

¹⁰ World Economic Forum

¹¹ ERMA

Many EU firms have signed agreements with proximal partners including Canada and several countries in Africa,¹² however not yet with Australia. The EU's ties with Australia were tested in 2021 after the free trade agreement was put on hold following the sudden termination of the French Submarine contract. Despite this, an agreement is set to be made, as supported by comments from members of the EU delegation in Australia.

With a strong domestic resource of critical minerals and a secure supply line, Australian firms can pitch themselves as reliable alternatives to Russia and China, as well as align with the EU's low-carbon raw material requirements.

Korea

Korea, the world's 12th largest economy, garnered significant interest for Australia in both our interviews and surveys. Despite its size and distance, Korea has always been an outsized investor and partner in the Australian minerals industry.

In December 2021, while marking the 60th year of diplomatic relations, Australia and Korea signed a Comprehensive Strategic Partnership (CSP). Among other things, the CSP builds on the flourishing bilateral economic ties between the two countries. Korea is Australia's fourth-largest trading partner, worth A\$35 billion in two-way trade¹³.

Korea are aggressively pursuing the development of a world-leading battery industry, of which their strategy will see the government invest over US\$35 billion by 2030¹⁴. Australia currently supplies Korea with 40% of their critical mineral imports¹⁵, and with giants POSCO seeking to firm up ties with Australian firms¹⁶, it is likely that collaboration will continue.

Japan

Japan is a strategic ally and economic link who has proved core to Australia's international interests in recent times. Currently the world's most advanced country in complex manufacturing¹⁷, Japan is Australia's third-largest trading partner, valued at ~A\$67 billion.

Decarbonisation of the global economy has reinvigorated Australian and Japanese bilateral engagement, with more and more Australian companies and investors flocking to Japan. Japan's *Green Growth Strategy* provides Australia with a high quality and reliable destination for critical minerals. Amid rising global geopolitical tensions, Japanese investors may perceive Australia as a trusted and attractive long-term investment destination.

United Kingdom

As a Commonwealth nation, Australia's relationship with the United Kingdom (UK) on many fronts, including foreign policy, defence and trade, has been highly cooperative. The UK is the second largest source of foreign investment in Australia and is the country's 8th largest two-way trading partner¹⁸. Historical free trade agreements have been further strengthened by the recent AUKUS agreement.

Whilst not currently a significant producer or customer of critical minerals relative to other nations, the function of the UK in mining is underpinned by its role as one of the three major mining finance centres in the world, others being Perth and Toronto. Many mining companies have headquarters in London, particularly those with projects in the northern hemisphere and central Asia. The UK therefore plays a large financing role for mining projects in Australia. This is set to continue, as the UK invests to ramp-up its domestic critical mineral's capability.

¹² European Commission

¹³ Department of Foreign Affairs and Trade

¹⁴ Perth USAsia Centre

¹⁵ S&P Global Market Intelligence

¹⁶ POSCO

¹⁷ Harvard Business School's Economic Complexity Index

¹⁸ DFAT



India

The world's largest democracy, India, is Australia's sixth largest export market¹⁹, having grown on average ~9% each year over the last 25 years. The relationship has strengthened in several areas in recent years, particularly in that of critical minerals, as evidenced by the recent Australia-India Economic Cooperation and Trade Agreement (AI-ECTA).

Notably, for such a vast country, India possesses small amounts of economically viable critical mineral deposits²⁰, leaving them vulnerable to disruptions in supply. With strong ambitions to increase their energy security and become a producer of batteries to serve their growing domestic market, Australia is well positioned as a partner for India in securing supply.

Australian and Indian companies have an opportunity to cooperate in creating critical mineral supply chains. India can benefit from Australia's vast mineral endowment, meanwhile Australia can benefit from the human resource power and industrial capability India offers in moving further downstream to battery manufacturing. The AI-ECTA will support this notion through the reduction of export duties as well as the facilitation of direct investment into Australian projects.

Indonesia

By far the largest and most influential member of ASEAN, an integral regional grouping and relationship for Australia, Indonesia is a rapidly transforming economic force driven by a youthful population of more than 270 million. The country holds the ambition and potential to become the world's fifth-largest economy by 2030 and the fourth largest soon after.

Australia and Indonesia share a series of mutual interests; both nations boast an abundance of critical minerals and complementary competitive advantages that align with each other's priorities. Ties with Indonesia have long sought to be strengthened and deepened by leaders of both countries. Whilst volatile at times, the business-first approach and prioritisation of FDI led by President Joko Widodo has led to a renewed period of partnership between Australia and Indonesia.

With an emerging economic superpower and influential security partner positioned right on Australia's doorstep, integration between Australia and Indonesia's critical mineral markets offer significant opportunity.

"We can't, and shouldn't try and do everything, but at least maybe try and localise and regionalise the capabilities with allied, or the right countries" – Services company CEO

¹⁹ DFAT

²⁰ JSTOR

Facilitating foreign investment

Role of the Foreign Investment Review Board

In facilitating the flow of foreign investment into Australia, the role of the Federal government's Foreign Investment Review Board (FIRB) must be explored. 65% of survey respondents believe the investment community have the most impact of all stakeholders in accelerating critical mineral supply.

Reform of the FIRB was raised by some industry respondents. The suggestion was made that Australia should establish a full-time, impartial review board with the relevant capacity to advise parliament directly on issues of foreign investment; streamline review processes; and increase the flexibility of investment thresholds.

As it is currently (part of the Treasury), the FIRB is subject to the same 'red tape' as any government department, significantly slowing the review process. Amplifying the problem, during the pandemic, the threshold for investment review went to \$0 and has contributed to a large backlog of applications which are currently being overcome.

Whilst Australia holds the view foreign investment is beneficial and plays an enormous role in stimulating the economy, there is evidence to suggest foreign investment into critical minerals is a sensitive issue. Impartiality of a reformed review board may help in delineating the line between political pressure, national security interests and economic incentives.

In 2020, the FIRB rejected Northern Minerals', a holder of rare earth minerals deposits, proposed transaction with a Chinese State-Owned Enterprise (SOE). AVZ Minerals were forced to reduce the investment figure by \$3 billion from Yibin Tianyi, a Chinese company seeking to support AVZ's lithium development projects, despite the deposits being in the Democratic Republic of Congo. US company Austroid Corporation has had to re-apply for approval to take over the Bald Hills lithium mine, due to uncertainty around backing from a Chinese company. In a positive example, in 2022, Korean based POSCO gained approval to take over ASX-listed Senex Energy.

The geo-strategic and geo-economic aspects of all critical mineral investment proposals have led to increased scrutiny in recent years. Whilst this may be necessary, there are still opportunities for reform, particularly around the timeliness of review.

Promoting Australia

Opportunistic Australian companies should leverage the sentiment of European and North Asian countries to shift away from Chinese supply by positioning themselves as a stable and resilient source of critical minerals, who provide a transparent investor experience.

In the process of presenting Australia as a low-risk supply alternative, the ability of C-suite investors to gain direct access to the Western Australian economy is crucial to further growth. Survey respondents and interviewees continually referenced the lack of direct flights from Asia, particularly Seoul, into the resource capital of Australia, Perth.

Domestically attractive, internationally collaborative

In times of continued geo-political uncertainty, opportunities exist to both strengthen existing alliances and forge new ones - quickly. Promoting the opportunities that are present in the critical minerals industry in Australia at all levels is essential to mobilise public and private capital.

In addition to ministerial-level engagement, there is also an important role to be played by Australian businesses, senior government officials, trade delegations, and NGOs. Success requires nuanced and creative ways of engaging neighbours, our likeminded allies, and those – such as Indonesia - who present opportunities for the industry.

Australian business executives also have a role to play in engaging foreign interest. Earlier this year hundreds of executives travelled to India, Japan, and South Korea to promote Australia as a preferential investment location, and secure strategic deals to support industry growth.

In October 2022, Prime Minister Anthony Albanese welcomed Japanese Prime Minister Mr Kishida Fumio to Western Australia. Following this, Australia and Japan signed a new partnership on critical minerals to help build secure supply chains. In July 2022, Australia welcomed a ministerial-level delegation from India which ultimately formed the Australia-India Critical Minerals Investment Partnership. Similarly, a delegation led by the Trade, Tourism and Investment Minister visited the US in April, meeting with potential investors into the cobalt industry. These, plus other ministerial visits illustrate the increased prominence the industry is enjoying overseas yet should be seen as just a start of more government-led engagement.

The Australian industry requires businesses from a range of countries, both within Asia and outside, to invest. If governments and businesses continue to pursue cooperative arrangements with likeminded countries, in addition to providing emerging economies within the region a reason to invest, the industry will be positioned sustainably to thrive in the future.

Fund or fail

Without access to efficient forms of financing, many critical minerals projects will struggle to reach production. The reliance on atypical sources of funding has slowed development significantly, and if left to the free markets, critical mineral supply deficits will continue to hold back the global energy transition. Over US\$400 billion needs to be invested in the supply of critical minerals this decade to achieve the Paris Climate goals²¹. To accelerate critical mineral supply, national and sub-national governments will need to play a larger financing role than what historically has been required.

Not only do these minerals play an essential role in the global energy transition, but they also present a large economic development opportunity through downstream industrial development, with secure supply necessary for national security. Therefore, the case for increased government intervention is strong, and has the capacity to underpin, influence, or co-opt wider participation from other investors.

The mining industry has a rich history of entrepreneurialism. Supported by the capital markets we have witnessed time and time again mining companies grow from one-or-two-person teams to major global players. However, with some exceptions, the current entrepreneurial mechanisms have failed to deliver critical minerals at the pace and scale required. This section of the report will consider why that is the case, and propose alternative mechanisms for efficient financing.

Whilst different countries have listed different types of minerals as 'critical', the definition of criticality is generally well aligned. Either they are essential for the energy transition, national security, are at risk of supply chain disruption, or some combination of the three. To discuss in detail the nuances of project financing, the term 'critical minerals' has been segmented into three sub-categories, characterised predominantly by risk and maturity.

The first category of critical minerals is those with **mature**, established, and large primary markets with well understood technical and processing requirements. Minerals such as nickel, zinc, alumina, and copper would fall into this category.



STATEOFPALAY.ORG

"The capital markets go to places where they can make money at a reasonable risk. And the risk in critical minerals is high, because there's not a lot of transparency around price. There's no liquidity, there's no derivative market, there's no track record" – Mining CEO

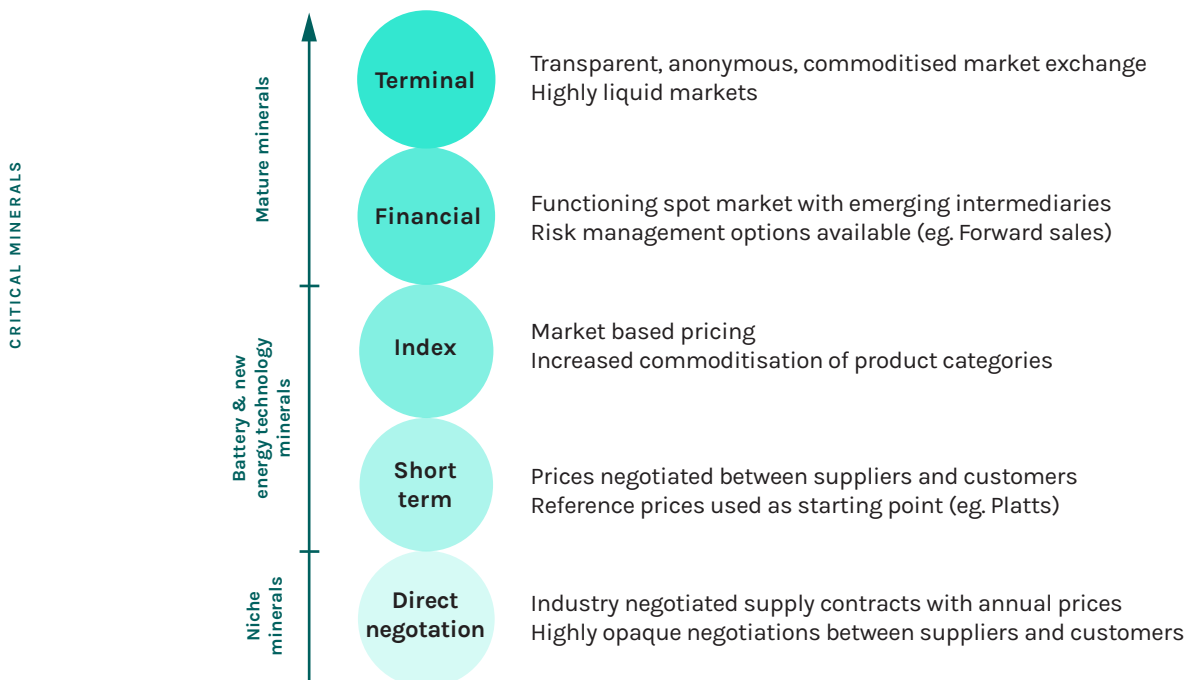
The second category comprise of minerals which primarily serve the **battery and new energy technology market**. Whilst relatively immature and still faced with technical complexities, the amount of public and private funding going into battery development globally is substantial. The supply chain is relatively well-understood and there is a large and diverse customer base for miners to engage with. Whilst a positive, the extreme growth in demand is placing pressures on supply chains to deliver minerals at speed and scale, uncovering bottlenecks and structural

inefficiencies that need to be overcome. This would include minerals such as lithium, graphite, cobalt, vanadium, platinum etc.

Finally, those remaining are the more **niche** critical minerals. Characterised by small volumes, price opacity, technical complexities, and an uncertain customer base, these tend to be the riskiest, and therefore most difficult to fund. Rare earth elements (REEs), including neodymium, praseodymium, lanthanum, cerium, and scandium are some examples of niche critical minerals.

STAGES OF MARKET PRICING EVOLUTION

Pricing mechanisms go through several stages of evolution before becoming fully liquid markets



Mining is already an inherently risky industry, typified by its capital intensity, long payback periods, price volatility, geological uncertainty, and in select locations, heightened sovereign risk. Whilst critical minerals are subject to the same features, there are several more layers of complexity that exacerbate the risk equation even further.

Before making any recommendations on how to mitigate risks and propose more efficient funding models, it is prudent to examine the unique complexities and barriers to investment associated with critical mineral projects in more detail.

"Critical minerals are a hellscape, essentially of everything and anything that risks a project" – Investment Executive



Barriers to investment

1. Low volumes

In the niche critical mineral markets, the actual volume required to meet demand, even under optimistic forecasts, is quite small. Fast depletion of ore resources risks achieving capital payback. Furthermore, a large increase in the volume of materials could materially impact price assumptions and market dynamics. For example, Iluka, Hastings, and Arafura Resources rare earth projects coming online by 2025 will increase Australian REEs supply by 238%, and global supply by 80%²². Bringing projects on at the rate necessary to meet capital payback targets may flood global markets, completely undermining value modelling assumptions made by investors.

2. Processing complexities

Many of the niche and battery critical minerals require unique chemistry configurations in the refining and processing stages that are not yet well understood. Refineries are therefore built to handle particular blends of ore. There is no 'off the shelf' processing kit available like there is for many other minerals (e.g., gold). Further pilot work is therefore required to build and test the technology and ensure the saleable product is optimized to a suitable specification. Pilot work is often very expensive and time consuming, and even successful outcomes in pilot- and trial- stage processing is no guarantee of success in large-scale plants.

3. By-products and waste reprocessing

It is well known that many critical materials are currently mined as by-products and exist in waste facilities and tailings dams at volumes that could supply global markets. For example, it is estimated that BHP's Olympic Dam project could supply up to 40% of the world's rare earth elements through its waste streams if it chooses to recover them²³. Current projects could choose to refine and sell minerals they once considered by-products in response to heightened demand, introducing supply to market at rates that may impact market dynamics (refer to 'low volumes' barrier discussion). For those minerals that are already in waste facilities, there may be opportunities for reprocessing. Whilst not without its own risks and reliant on further technological development, the geological uncertainty and capital costs associated with a new asset cannot compete with the costs of reprocessing waste.

4. Customer discovery

Due to the unique blends and chemistry sets required to process and refine some critical materials into saleable products, there is substantial complexity around understanding who is going to buy the product, under what conditions they will buy, and for what price. Particularly for the niche minerals, mining ore and expecting a customer and pricing transparency to eventuate straightaway is not a viable approach. Considerable work is required in discovering the customer, understanding the specification they demand, achieving product certification and proving they are credit worthy before securing project finance.

²² State of Play Analysis

²³ Monash University

5. Market transparency

84% of survey respondents believe market transparency of price and supply is an issue in developing critical minerals projects. For many of the niche and battery critical minerals, markets are extremely immature, with no spot price and therefore no derivative markets. Products are often sold through offtake agreements, with opacity around the commercial arrangement and uncertainty surrounding who the offtake partners are and their creditworthiness. Coupled with high levels of volatility, the lack of transparency in the supply chain creates a reluctance from investors to get involved.

6. Competition for capital

The global macro-economic environment is currently challenging equity markets. Even established minerals development projects which are very well understood in terms of processing, market and price transparency are finding it difficult to raise capital in such markets. Critical mineral projects, especially those in the niche category, are having to compete for capital in an already tightened market, against commodities with much lower risk and in many cases, better return profiles. The low volumes and complex processing associated with critical minerals reduces the overall margins, despite a forecasted increase in pricing.

"These points tend to compound on each other... you're not just dealing with one of them, you are dealing with a bunch of them at the same time. And that exacerbates the situation" – Investment Executive

Overcoming the barriers

Critical minerals projects are riddled with investment complexities. If these are overcome, nations, companies and investors will reap the rewards either economically, or through accessing strategic materials. Depending on the category of critical mineral, different strategies will be required to increase the efficiency of project financing.

For the **mature** critical minerals, the outcome should be focused on reaping economic benefits, with little intervention required from government. The investment barriers are less applicable to this segment, meaning current capital market solutions are efficient in supporting their acceleration, as they have done for decades. As a result, the recommendations in this report are less applicable to this segment.

Battery and new energy technology minerals are at a slightly different stage in accessing finance to both the mature and niche critical minerals. Two-years ago, the recommendations to improve project financing for this segment would be very different. It is only in the last 12-months that many of the investment barriers have begun to be addressed, driven by a global focus on reducing carbon intensity and the resulting change in consumer behaviour. The adoption of electric vehicles has created a hefty and continually growing demand for battery minerals, helping it transition from a small to a large market base. Furthermore, initiatives such as Pilbara Minerals 'Battery Minerals Exchange', a digital auction platform for lithium, has accelerated price transparency and helped investors gain a greater understanding of the market.

As a result, the Australian banks have finally come to the table and have shown an interest in financing some of these projects – prior to 2021, battery minerals developers relied on novel sources of finance from overseas markets for debt. Today, sizeable amounts of public money is being offered to battery minerals projects from governments around the world who wish to benefit from the economic opportunity the energy transition presents. Whilst there is still much work to be done, the progress this segment of the industry has made is extremely promising and appears not to be slowing down.

Therefore, the focus of the recommendations in this report are most applicable to the **niche** critical minerals, which are likely a decade behind in their market development than the battery minerals, and which are still faced with overcoming almost all the investment barriers stated earlier.

Many of the niche critical minerals, whilst playing a role in the energy transition, are predominantly listed as critical for their strategic role in advanced technology or defence – things such as semi-conductors, alloys, magnets, or weapons. Their supply chains may have shifted in recent decades to countries where environmental and labour practices impute lower costs, but now also strategic vulnerabilities. Relocating such supply chains for strategic reasons imputes increased costs and investment risks. As a result, the capacity for consumer markets to drive investment and an increase in the market base may be smaller than that of what occurred with battery minerals.

For some of these materials, a major consumer, at least in the short-term, is likely government. Therefore, this segment of critical minerals requires greater government-led intervention if supply is to be accelerated in the coming years, with the outcome being focused on access to strategic materials, rather than immediate economic benefit.

Types of intervention

Creating favourable conditions for investment into critical minerals projects through government intervention can come through either incentivising the supply side (the producers) or the demand side (the consumers). The following government-led interventions are focused on supporting the supply side.

1. Direct funding

The direct funding provided by the government to date has not gone unnoticed. Funds released from the \$2b Critical Minerals Facility, the \$1.3b Modern Manufacturing Grant Initiative and the \$7b Northern Australian Infrastructure Fund, in addition to other grant and incentives programs have kickstarted a wave of private co-investment and form a significant proportion of capital required for the recipient companies to go into production. Furthermore, government backing sends a message to the broader market a due diligence process has occurred, reducing the investment risk. Whilst this relies on government prioritising projects or 'picking winners', there is a clear need for this direct funding to continue, as evidenced through survey results, whereby respondents ranked it as the second most impactful policy change for accelerating investment.

2. Government-backed offtake arrangements

Driven by the sovereign demand to secure access to strategic minerals, the federal government alone, or in partnership with aligned corporate or sovereign entities could put in place offtake agreements that include minimum pricing guarantees. Provision of minimum revenue offtakes on a 5, 10 or 20-year basis gives greater certainty around the revenue model and removes some of the downside risk from the investment decision. In contrast to the above recommendation, this approach may not rely on the government prioritising certain projects and allows the market to pick winners. Particularly for the niche critical minerals, this mechanism could also address investment barriers associated with market transparency of price and customer understanding in the early stages of market development.



3. Australian banking system

As mentioned earlier, the Australian banks have remained reticent to invest in critical minerals projects. Throughout the research, resources sector respondents were not complimentary of the role the banks play in accelerating the industry. Their lack of involvement is driven by the operational and risk settings of the banks not aligning with the risk profiles of critical mineral projects. The banks are also hampered by a lack of technical capability required to finance resources projects. Due in part to the poor perception of mining's role in decarbonisation and the poor credit appetite for resources risk, the banks have not maintained their specialist resources project finance capabilities. "The Australian banks are heavily influenced by government policy. The Australian government should therefore play a role in encouraging the banks to finance critical minerals through reform of policy driven risk settings.

"As a resources nation, critical minerals should be an area of fundamental Australian competitive advantage for the banks" – Investment Executive

4. Waste processing hubs

Whilst the abundance of critical minerals found in waste streams may be considered to reduce the attractiveness of investment into new projects, it also presents an opportunity to fill short-medium-term supply gaps. The government could support the construction of centralised waste processing facility or 'hubs', where existing waste, whether it be from tailings, fly ash, or other streams, can be sent for processing to extract critical minerals. Doing this all at centralised facilities through a 'hub and spoke' model, would help address the economic issues of low volumes at individual mine sites, and would catalyse interest from companies who otherwise may not have viewed their waste as a viable business opportunity. In increasing supply, particularly of niche critical minerals, the government is also accelerating the cleaning up of environmental hazards. As a result, such a program would have a great probability of achieving bipartisan political support as well as broad public support.

Tax incentives

There are a range of different taxation mechanisms governments can leverage to improve international competitiveness and encourage investment. Options raised throughout the research included:

- ✓ Delaying royalties payments until a few years after production to assist with early cash flow struggles and improve payback periods. The royalties could be paid back at a later stage.
- ✓ Capping the quantum of royalty payments after a certain number of years to encourage full value extraction as deposits begin to deplete.
- ✓ Enhancing the applicability of the research and development tax offset for the demonstration and application of the unique processing technologies required for novel blends and specifications.

5. Broader educational efforts

There is substantial work required to improve the perception of the mining industry to be seen as pivotal to the clean energy transition, and to demonstrate it as part of the solution to climate change. Educating the public on the role critical minerals play in powering the future was reiterated throughout several interviews. The historical funding of coal projects and environmental catastrophes are still front of mind for a lot of the public. Whilst this is the case, there may be a perception government intervention in the form of incentives are giving funding or tax breaks to large, polluting multi-nationals, which will make gaining bipartisan support for critical mineral development harder.

The above examples are likely most applicable to the niche critical minerals, which infers the role of government in the project financing of the mature and battery and new energy technology minerals is less warranted. The exception to this interpretation is in the downstream processing – all the critical minerals segments will benefit significantly from government policy aimed at promoting investment into downstream refining, processing, or manufacturing. Detailed recommendations on this will be discussed in the following chapter.

Vested interests: Upstream financing

In the early stages of critical mineral project development, commercial offtake agreements are commonly executed to assist the project in moving through to construction. The critical minerals supply deficit is causing downstream customers to question whether these offtake agreements are the most secure form of procuring supply, as the global market for materials becomes more competitive. As a result, downstream customers are becoming more integrated with their upstream suppliers, which may fundamentally alter the industry's approach to project finance.

The extent to which full vertical integration may happen remains unknown. However, if it does become commonplace at scale, there is no doubt many of the project financing challenges currently facing the critical minerals industry will become moot.

Demand for key components such as lithium, nickel and cobalt are expected to grow by 30%, 11% and 9% year-on-year up to 2030²⁴. It is estimated that over 336 new mines, in addition to those already in the pipeline, are needed to produce enough minerals for the battery market by 2035²⁵. The numbers are intimidating, especially when the 8-10 years it takes to get a mine from initial feasibility to production is taken into account.

Given this, it is understandable why car manufacturers, battery manufacturers and other players down the value chain are concerned they may not be able access sufficient raw material supply to support their product and growth plans. For many years, customers have not needed to pay much attention to their upstream supply base and as a result, have remained relatively removed from the mining industry. Critical minerals are dramatically changing this relationship.

For many years, procurement for critical minerals has been through long-term contracts or offtake agreements with major players, with 66% of survey respondents seeing it as the best commercial structure to enhance project viability. More of these agreements are being signed with smaller, junior, or developing mining companies. For example, LG Energy, Ford, Stellantis, BMW, Mercedes-Benz and Tesla have all signed offtake agreements with several mining companies not yet in production, with some not likely to be producing until after 2026²⁶.

Many industry participants are labelling this as the signing of "virtual supply agreements", and believe it indicates an angst amongst manufacturers to communicate to market that supply has been 'secured'. Whether non-binding offtake agreements will prove to be sufficient in confirming access to supply in an extraordinarily competitive market remains a curious question.

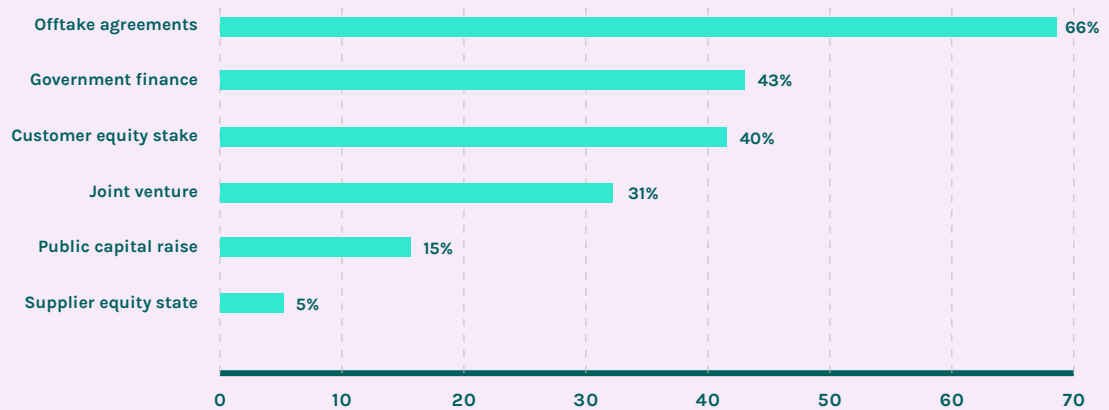
²⁴ IEA

²⁵ Benchmark Mineral Intelligence

²⁶ Reuters

WE ASKED: WHICH COMMERCIAL STRUCTURES BEST ENHANCE THE VIABILITY OF CRITICAL MINERAL PROJECTS?

BY % OF RESPONDENTS GIVEN TWO OPTIONS



For greater assurance, raw material customers are looking to forge different strategic relationships with mining companies to compete for minerals, with customer equity stakes (40%) and joint ventures (31%) considered as viable options. SQM Lithium, one of the 'big four' battery chemical producers, has publicly stated that manufacturers "are going to have to start buying 25% of these mines if they want to guarantee supply".

Downstream customers are already acting on such sentiment. US automotive company Ford has agreed to provide Australian company Lontown Resources with a \$300 million debt facility to supplement their project development, and ensure they are a recipient of future offtake²⁷. General Motors will invest up to \$69m and take an equity stake in Queensland Pacific Minerals, an Australian producer of nickel and cobalt. Volkswagen has publicly stated they are considering becoming a shareholder in mining companies to ensure they are first in line for supply. Whilst the feasibility is questioned, Tesla has acquired the rights to lithium rich clay deposits in Nevada in a step towards one day supplying their own lithium.

The above demonstrates a clear shift in strategy. Whilst these companies aren't yet moving (convincingly) upstream, they are investing significant amounts of money to secure supply, something which they have never had to do before. After not paying attention to the raw materials supply base for years, car and battery manufacturers are now playing a pivotal role in the financing of critical minerals projects.

"I think you'll see more and more end users looking to fund back into the mine level in order to make sure they secure the supply" – Mining Company CEO

The full value of Australian resources

Australia's mineral endowment has been the cornerstone of its economic development as a country for the 170 years since the 1850's gold rush, underpinning a population that is now the wealthiest per capita globally²⁸. The sector is highly responsive and mature, evidenced by its ability to create a \$7b lithium export industry from next to nothing in a mere 2-years²⁹.

Historically, Australia's mining industry has focussed on 'digging and shipping', whereby minimal processing is done locally before selling to overseas markets. To fully capture the value of Australia's resources and the growth in critical mineral demand, Australia must take the step beyond just mining and build a large, sophisticated, downstream industry. In occupying more of the critical mineral value chain, Australia can set up its people for another 30 years of economic prosperity.

Despite supplying 60% of the world's lithium, analysis suggests Australia currently earns only 0.5% of the ultimate value of its exported ore³⁰. If Australia was to move a step downstream to lithium hydroxide production (which has already begun), it could double the value realised. Another step further to chemical precursor production, and the value realised would increase by a total of 20x³¹. If the global market for battery cells reaches the forecasted \$360b by 2030³², without moving downstream Australia would be foregoing billions of dollars of economic opportunity.

The opportunity is not exclusive to Australia, with other nations around the globe investing public money and formulating incentives to encourage foreign investment in their own jurisdictions. Australia will be competing for capital and talent. There is an estimated \$10 billion worth of investment proposals in resource value-adding projects across Australia currently³³, (incl. lithium, REEs, nickel, zinc). However there is a clear need for this to accelerate to keep up with the rest of the world. Fast-paced and substantial investment will develop local capability and promote Australia as an attractive and ready-made location for foreign investors.

"If you want to capitalise on creating a position in the market, you must have done that within the next five to 10 years, otherwise, you'll have missed it. The rest of the world will have picked up whatever market is created." – Mining Company CEO

In this section of the report, the advantages of establishing a downstream critical mineral industry in Australia are considered, and how the country can position itself as a globally competitive destination for foreign investment in industrial development is discussed.

²⁸ Credit Suisse

²⁹ Renew Economy

³⁰ Future Smart Strategies (2020)

³¹ Australian Trade and Investment Commission

³² McKinsey

³³ Renew Economy

The Australian advantage

Australia slipped five places from 86th to 91st in the Harvard Business School's Economic Complexity Index this year. The analysis indicated the largest contribution to our export growth currently comes from low and moderate complexity products³⁴. In 2021, Australia was the largest exporter of lithium, iron ore, coal, and LNG, however little value-added processing was undertaken for any of these commodities. Critical minerals offer a real opportunity to counter this trend and increase our nation's productive knowledge.

"We are in the mid 70s in terms of our economic diversity and complexity, as a nation we need to be doing much, much smarter stuff" – Services company CEO

Location, location, location

Australia's geographic location, small population and lack of available capital have slowed industrial development in the past. Historically, the economics have proven better when value-adding closer to large end-use markets, using labour that is cheaper and lower skilled.

Advancements in technology, including energy, automation, and analytics, coupled with growing expectations surrounding ESG are rapidly changing the perception that cheaper and lower skilled labour enhances the business case.

Despite relative consumption of critical minerals in Australia being small, only 23% of survey respondents saw customer location as a major barrier in establishing a downstream manufacturing industry. In the last 30 years, Australia's proximity from global economic activity has reduced, as the global centre of economic gravity has substantially shifted to Asia. By 2030, China is expected to be the world's largest economy³⁵, India the 3rd and Indonesia the 5th largest³⁶.

³⁴ Harvard Business School

³⁵ Centre for Economics and Business Research

³⁶ McKinsey Global Institute



"With the progression of both renewable energy and automation, some of those previous drivers to go offshore have the opportunity to change" – Services company CEO

Whilst Australia does not have a huge automotive industry to service, there is a significant opportunity to service the growing Asian market, of which our proximity and geo-strategic relations should be used as a competitive advantage. It must also be noted Australia's expanding domestic market for batteries, particularly in rooftop solar, should not be underestimated. Growth in residential energy storage systems is forecast to make Australia the third largest market for battery installations in the world by 2030³⁷.

Monetising Australia's ESG credentials

Australia's most obvious comparative advantage lies in our ability to co-locate raw material extraction, processing, and manufacturing. Having the up, mid, and downstream in the same region reduces operating costs through process optimisation (i.e., reduced transport, energy, re-handling costs...) and radically reduces scope 3 emissions. How long will it make sense to export our hard-rock lithium as 6% spodumene, 94% waste? The case for upgrading the product where it was extracted presents a much stronger environmental and economic argument.

Few countries match Australia's potential to generate renewable energy, with the highest solar radiation per square metre of any continent in the world³⁸. Australia's ability to power both its mines and processing facilities with renewable energy not only has the capacity to reduce operating costs by up to 30%³⁹, but it will allow Australia to become a preferential supplier in the delivery of low-carbon raw materials to global markets.

Mining currently accounts for roughly half of the carbon footprint of a battery cell⁴⁰, and there is a growing demand driven by downstream customers, investors, and regulation to reduce this through the provision of low-carbon raw materials. Demand is so strong that 77% of survey respondents believe there will be a carbon-based price differential in the next 5-years. Northvolt, the leading European battery maker, has announced it will carry a carbon footprint which is approximately one third that of comparable industry producers⁴¹. The company is targeting a 25% share of the global battery manufacturing market by 2030.

Carbon emissions are not the only environmental concern associated with a downstream critical minerals industry. The chemical processing required for many of the materials can create harmful by-products, some of which are even radioactive.

The Australian environmental regulatory framework is extremely effective in managing these risks. Despite this seeming (to some investors) as an additional cost burden when compared to other jurisdictions, the justification is clear – the Australian government will not support or allow an environmentally irresponsible industry. Coupled with strong industrial relations, Australia's working conditions are considered some of the best in the world.

64% of survey respondents believe Australia's ESG regulations increase the viability of critical minerals projects. Companies that do choose to establish themselves here can use these ESG credentials as a market advantage, as it becomes an increasingly important condition of supply as pressures from customers, investors and the community continue to increase.

"We need to find an avenue to monetise our environmental stewardship. We are the best" – Mining Company CEO

³⁷ IHS Markit

³⁸ Geoscience Australia

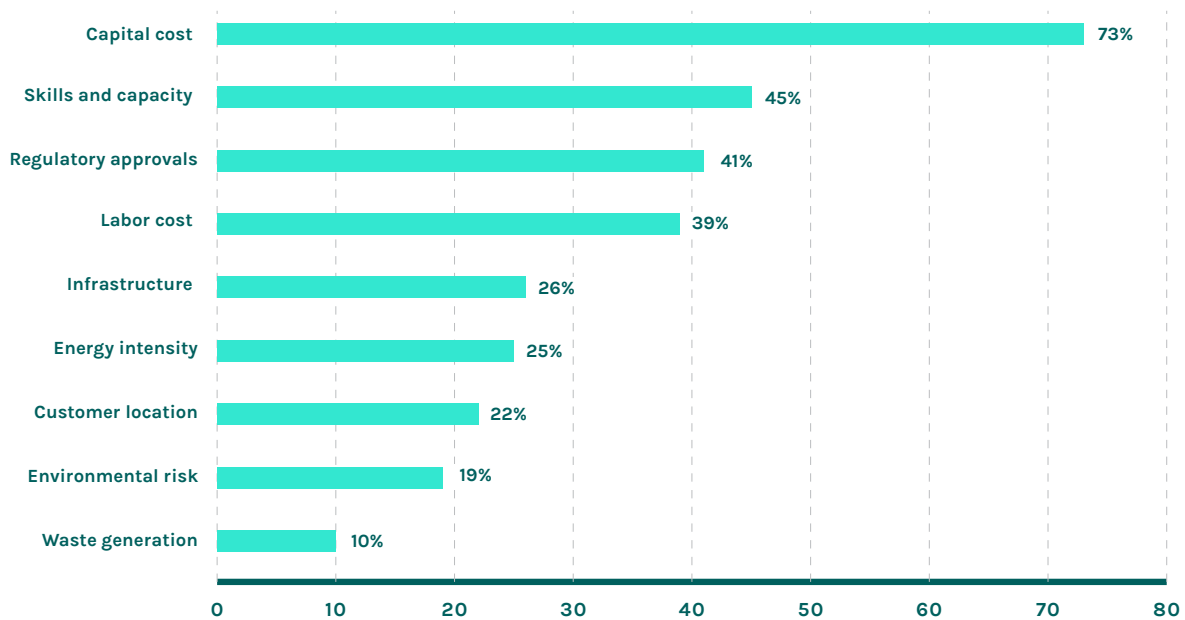
³⁹ Electric Mine Consortium

⁴⁰ Tesla

⁴¹ Northvolt

WE ASKED: WHAT ARE THE MAJOR BARRIERS TO ESTABLISHING LOCAL DOWNSTREAM PROCESSING OR MANUFACTURING CAPABILITY?

BY % OF RESPONDENTS GIVEN THREE OPTIONS



Addressing the cost equation

When considering the major barriers to establishing local downstream processing or manufacturing capability, almost three quarters (73%) of respondents saw capital costs as overwhelmingly the largest barrier.

When compared with China, these are predicted to be between 20-50% more expensive in Australia⁴². First movers in Australia are prime exemplars of such differences. Both Tianqi and Albemarle's respective lithium hydroxide plants in WA experienced cost-blowouts and commissioning delays⁴³. Iluka's Eneabba rare earth separation facility would likely not have gotten off the ground had it not been for the Australian Government's \$1.25 billion loan, and Nickel West's nickel sulphate plants' initial capital costs blew out by almost double before being commissioned⁴⁴.

⁴² OECD

⁴³ Australian Financial Review

⁴⁴ Australian Financial Review



41% of respondents cited regulatory approvals as a major barrier. In the context of capital cost competitiveness, such response can be interpreted as the impact pace and ease of navigating approvals can have on project development costs. In discussions with expert interviewees, the sentiment was the majority of environmental and social restrictions are less rigorously applied in China when compared to Australia, meaning a faster commissioning process. Despite these comments, respondents did not agree that Australia therefore needs to lower its environmental standards to compete.

Finally, 39% of respondents saw labour cost as another barrier to establishing a downstream critical minerals industry. Skilled or technical labour can be upwards of 10 times more expensive in Australia than that of China. Technology innovation is well recognised as a key mechanism to address this disadvantage, as evidenced by Albemarle's investment in its WA lithium hydroxide plant, which has been built to be the most advanced plant of its kind in the world, utilising advanced processing techniques that are world first.

COST VARIABLES FOR COUNTRIES MANUFACTURING LITHIUM-ION BATTERY CELLS

	Factory Construction Cost USD/m ²	Skilled Technical Labour USD/ hr
Australia	578	60
Chile	554	9
China	333	5
USA	656	85
South Korea	950	22

Sources: Turner and Townsend; OECD; National Renewable Energy Laboratory; CEIC; Korean Times. It should be noted that the above table does not take account of effective productivity.

Whilst Australia's ESG credentials, cheaper energy inputs, advanced technology and co-location to raw materials may slightly even the ledger, unless the capital cost equation is addressed, majority of manufacturers will likely look to commission in alternative jurisdictions.

The skills to get it done

45% of respondents viewed skills and capability as a major barrier. Despite Australia having an established skilled workforce that can currently support our conventional extraction and processing industries, the technical know-how and capability required for higher-purity processing and downstream manufacturing is in its infancy.

Notwithstanding the current global skills shortage, in the longer-term, Australia is well placed to train, up-skill, and re-skill our workforce to bridge any gaps. To achieve this, Australian companies should leverage their relationships with the international technology providers, OEMs, and local resource companies already at their doorstep.

"I expect that, if any country can do it, Australia can do it. We would find the expertise, we would find the people we would find the solutions, for sure" – Mining Company CEO

Examples of this already occurring include Pilbara Minerals downstream joint venture agreement with their offtake partner, POSCO⁴⁵. The 18% stake in the Korean based battery-makers lithium hydroxide facility offers a clear pathway for information and knowledge flow back to Australia and supports Pilbara Minerals long-term objective of becoming a fully integrated lithium raw materials company.

Australia's next moves

A global fight for investment

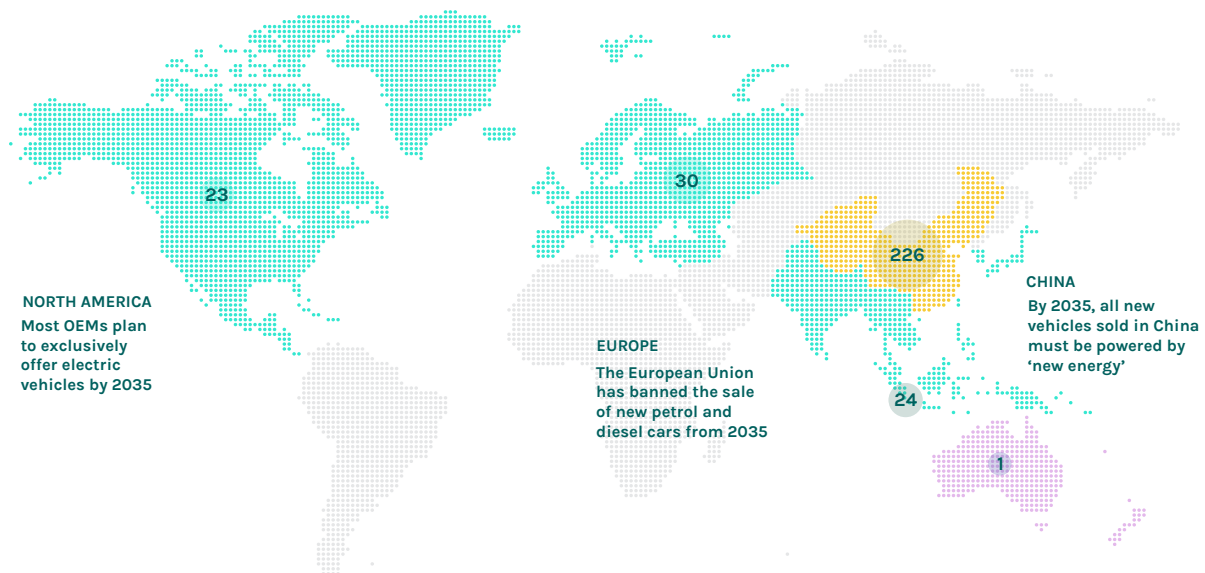
Australia needs to make itself known globally as a preferred destination for downstream processing and manufacturing investment. To achieve such status, the Federal Government has a role to play in having a material impact in the initiation of a domestic ecosystem for investment. We recognise that action has already been taken (incl. Federal Government's \$2b critical mineral facility), however when compared with other jurisdictions, industry believes more can be done.

Australia is competing with larger jurisdictions that are making short-term financial sacrifices to attract companies to invest. In 2014 the state of Nevada offered Tesla approximately US\$1.25 billion in tax incentives over 20 years to build a Gigafactory (including no tax for the first 10 years)⁴⁶. The European Union will issue around US\$3.5 billion over the next decade to help jump start their battery development industry⁴⁷, meanwhile India has announced its plans to make US\$4.6 billion in incentives available to battery makers⁴⁸.

The effects of these incentives are already starting to flow through to market, attracting supplementary private investment as well. The global Gigafactory pipeline currently has 300 plants in the works, dominated by China (226), and followed by Europe (30) and the US (24)⁴⁹. Australia has just the one so far – Energy Renaissance, a local company, who has spent the last 7-years bringing this to fruition. They achieved it with no financial support from the federal government⁵⁰. Whilst a great achievement for the Australian market, when other jurisdictions can get a Gigafactory up and running in less than 2-years⁵¹, there is clearly a role that Australian governments can play in supporting companies like Energy Renaissance to deliver solutions to market much faster.

GLOBAL GIGAFACTORY PIPELINE HITS 300 AS CHINA DOMINATES BUT THE WEST GATHERS PACE

The global lithium-ion battery production capacity expected to reach over **6 terawatt-hours by 2030**.



⁴⁶ FBICRC

⁴⁷ EU Battery Alliance

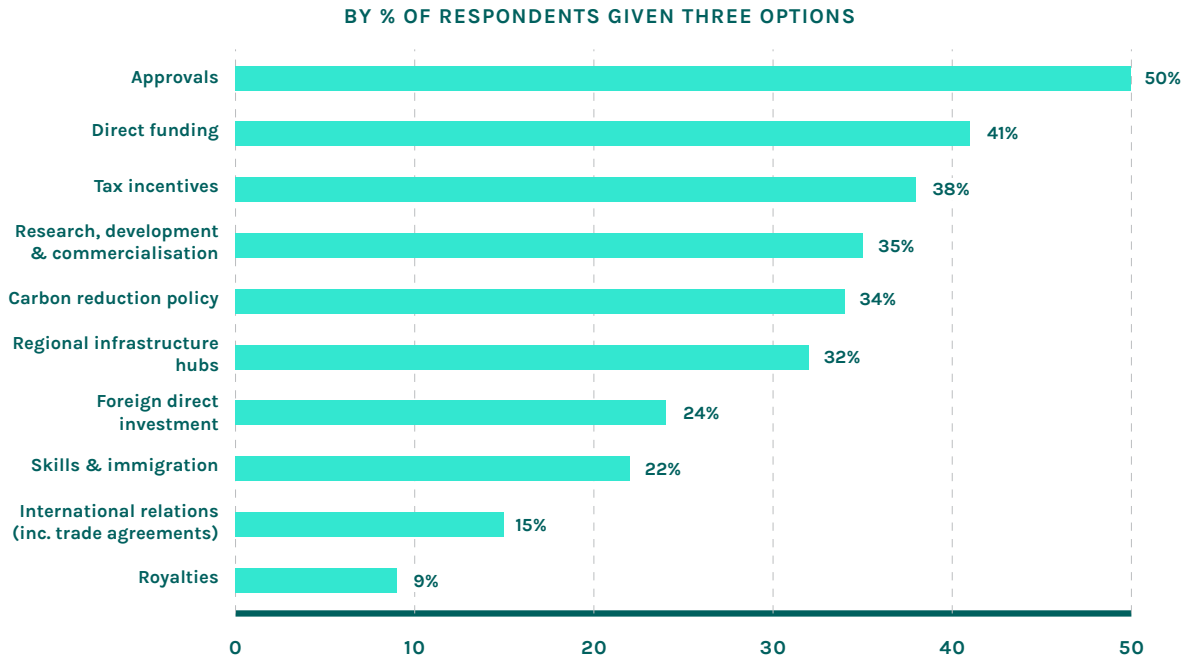
⁴⁸ Reuters

⁴⁹ BMI

⁵⁰ CleanTechnica

⁵¹ Bloomberg

WE ASKED: HOW CAN GOVERNMENT POLICY BEST ACCELERATE INVESTMENT IN CRITICAL MINERALS?



Policy areas for immediate impact

When asked where the most significant constraint to critical mineral supply is in the value chain, 65% of respondents answered project development. Similarly, when asked how government policy could best accelerate investment in critical minerals, 50% of respondents said approvals.

Throughout several interviews held with industry representatives, a more nuanced definition of what respondents may mean when they say "approvals" was discovered.

Firstly, majority of industry is aware that entirely reinventing the approvals process is substantial, likely too slow of a task, and risks undoing the good work Australia has done in establishing its ESG credentials. They recognise the approvals process is a necessary and robust procedure. They do believe however there are clear opportunities to increase efficiencies and reduce delays, particularly through that of government-led preparation of 'investment ready' opportunities.

For example, critical mineral processing assets (which are essentially chemical processing plants), need to be located in heavy industrial areas. If the respective state

governments can prepare appropriate land ready for development, it would go a long way in increasing the attractiveness of the investment opportunity. Instead of an international technology supplier coming here and having to navigate a three-year environmental approval window, the respective government could have already completed and approved aspects of the pre-assessment phase (e.g., heritage listing, environmental assessments, water resource analysis etc.⁵²).

Provision of 'investment ready' land likely falls under the broader umbrella of a 'strategic industrial area' concept, of which Australia already has a handful of these hubs or clusters. Kwinana (WA) is currently touted as the best example; however, it is fast running out of space with no real scope for expansion.

Both state and federal governments are currently exploring new potential locations for such industrial clusters. The Queensland government has launched a \$30m regional manufacturing hubs program⁵³, meanwhile the WA government has launched a \$100m Investment Attraction and New Industries Fund, which includes a \$2.5 million study into establishing an advanced manufacturing industry in the states Southwest.⁵⁴

⁵² Australian Government – Department of Climate Change, Energy, the Environment and Water

⁵³ Australian Government – Global Australia

⁵⁴ Government of Western Australia

To take a bigger leap, government may consider investing in building critically important infrastructure to improve and connect these hubs to global markets. Things such as energy, water, waste facilities, rail, road, and ports hold important potential in amplifying the attractiveness. Initiating an ecosystem for manufacturing will have flow on effects for value-creation. For example, once a battery cathode producer has commissioned in an area, an anode player may follow suit, followed by a cell manufacturer, and ultimately an industry emerges.

"What you should be talking about is tax free, free land, free services, ultimate infrastructure. Our effort, to be honest, looks really token compared to what you're competing with" – Mining Company CEO

Foundational government support

Becoming a cornerstone investor in shared processing facilities has been suggested as a viable option in accelerating a downstream industry throughout the research. Over half of survey respondents believe it can increase the supply of Australian critical minerals.

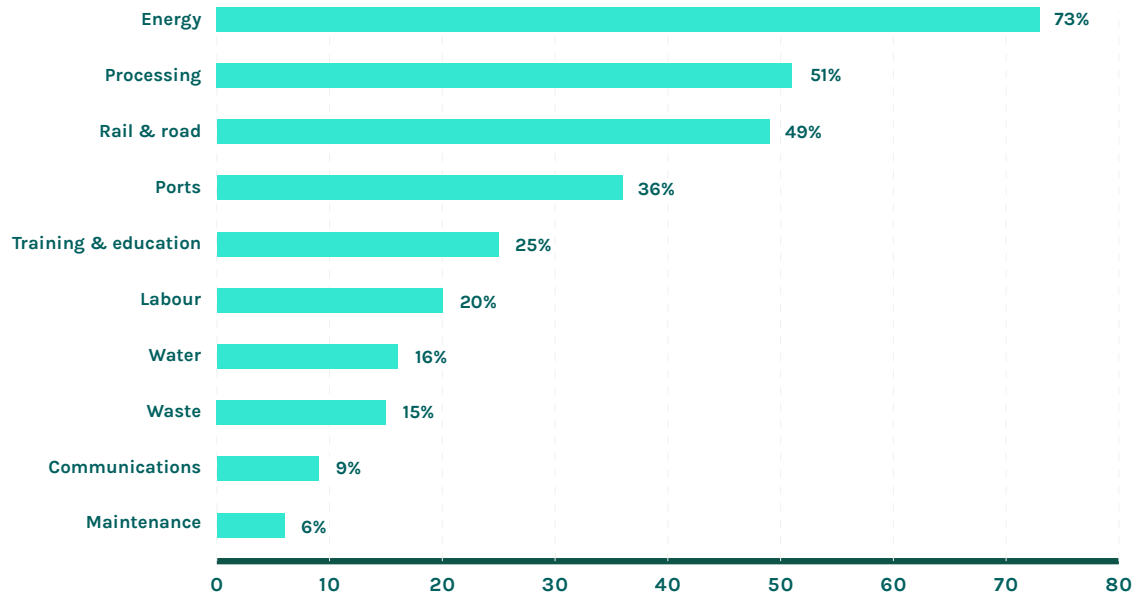
There are examples of government playing this role in recent Australian history. In the early 60's, three Australian mining companies merged to form 'Western Aluminium NL', with the aim to develop an integrated aluminium industry. The WA government injected a significant amount of capital in the form of both finance and access to power, water, and other critical infrastructure to make this a reality. A partnership was fostered with American technology providers for further capital contributions as well as technology support. Such interaction between government, local resource companies and international technology suppliers led to the initiation of what was to become the then world's biggest bauxite-alumina-aluminium industry, known upon its inception as Alcoa of Australia⁵⁵.

Fast-forward 60-years to today, and our government, local resource companies and international technology suppliers find themselves facing a similar prospect. Government should play a leading role in constructing the partnerships and commercial arrangements to overcome the "first mover" hurdles, and kick Australia's downstream processing industry into gear. The three lithium hydroxide facilities that have been commissioned or are currently being built in WA (IGO & Tianqi; Mineral Resources & Albemarle; Wesfarmers & SQM) will see Australia export approximately 10% of the world's lithium hydroxide by 2024, and 20% by 2027⁵⁶. The ability for government to support progress like we have seen in lithium with other critical minerals is worth billions to the Australian economy.

"We are one of the world's great hubs for cathode materials, it's an absolute no brainer for cathode makers around the world who should already be building now, and why government should be incentivising them like there's no tomorrow to come here. Because that's exactly what the rest of the world is doing" – Mining Company CEO

WE ASKED: WHAT SHARED INFRASTRUCTURE CAN INCREASE THE SUPPLY OF AUSTRALIAN CRITICAL MINERALS?

BY % OF RESPONDENTS GIVEN THREE OPTIONS



The role of technology?

The adoption and application of new technology has the capacity to accelerate the sophistication of critical minerals markets and increase the supply. Despite this, majority of the recommendations in this report are anchored in government policy.

The reason for such emphasis is not due to the relative importance of technology. It is due to the rapid pace of project delivery being demanded, and the sequencing or prioritisation of the challenges critical minerals producers need to overcome.

The pace at which the mining industry is being demanded to produce more critical minerals does not align with traditional technology development timeframes. Proving a new technology at scale can be expensive and sometimes take decades. From our discussions with industry leaders, in a heightened pricing environment, producers are more inclined to adopt previously demonstrated technology to speed up project development and ensure they get their product to market as soon as possible.

"It is hard for a junior miner to start a project with uncommercialised technology. We need to use proven ways" – Mining Company CEO

Furthermore, when asking industry what they believed the biggest barrier holding back critical minerals supply was, the answer was not technology. Overwhelmingly, the most significant constraint was in project development, which encompasses the financing and market complexities mentioned previously in this report. The industry believes these complexities should be overcome first, before focusing their efforts on advanced technology development and adoption.

It is anticipated technology will ultimately play a leading role in value creation once critical mineral markets become more orderly and mature. Four key technology have been identified:

Processing technology

When asked which technology area should be prioritised to accelerate critical mineral supply, processing technology was ranked #1. Additionally, 47% of respondents believe it is the most likely source of competitive advantage for critical minerals businesses. These responses align with the sentiment that Australia should establish a sophisticated downstream critical minerals processing industry in Australia.

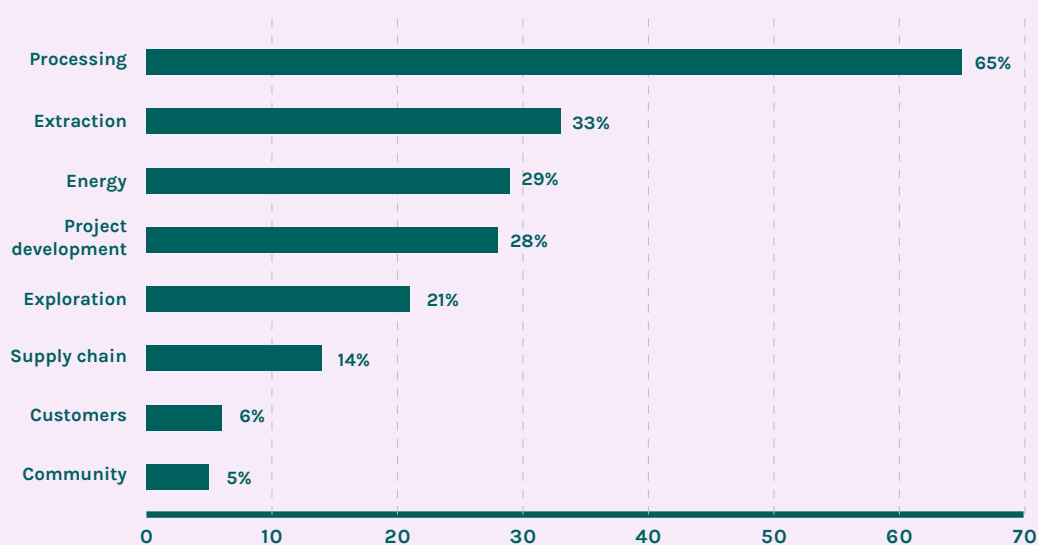


Traditionally, there has been little collaboration in the processing space, with individual producers staying relatively confined to their segment of the periodic table. However, these relationships may change in the future. Examples of companies collaborating on processing are evident, with Iluka signing an agreement to process concentrate

from Northern Minerals' Browns Range project⁵⁷, and BHP's Nickel West has been accepting third-party feedstock to its nickel concentrator in Kambalda⁵⁸. Initiatives like these promote risk sharing, reduce costs and foster opportunities for technology innovation.

WE ASKED: WHERE IN THE VALUE CHAIN SHOULD TECHNOLOGY DEVELOPMENT BE PRIORITISED TO ACCELERATE ECONOMIC SUPPLY OF CRITICAL MINERALS?

BY % OF RESPONDENTS GIVEN TWO OPTIONS



⁵⁷ Mining Technology

⁵⁸ BHP Nickel West

Extraction technology

Advancements in extraction technology have the capacity to fundamentally change the economics of an ore body. For marginal or low volume critical mineral assets, a step-change in the use of extraction technology would be immensely valuable.

Lithium for example, has already seen significant shifts in the way it is extracted. The traditional hard-rock extraction flowsheet is being redeveloped, large amounts of lithium from brine resources is set to hit the market in the next 1-2 years, and other forms of extraction such as from clays, geothermal water and micas are emerging as viable, low-emission, and cost-efficient methods. As the once nascent critical mineral markets mature, examples like this are likely to emerge for many other commodities.

Energy technology

Whilst central to the global energy transition away from fossil-fuels, critical minerals can be highly carbon-intensive to mine. As markets become more orderly and less competitive for supply, the impetus on raw materials suppliers to reduce emissions will become greater.

The use of renewable energy to power mine sites and processing facilities, as well as the adoption of electric or hydrogen-based fleets has the capacity to reduce scope 1 and 2 emissions by up to 100% and reduce operating costs by between 15-30%⁵⁹. The flexibility of renewable energy generation promotes the optimisation of energy use in both the extraction and processing stages, allowing for the ramping-up and down of activity in response to operational changes.

New energy technology is available now, and critical minerals producers will benefit from exogenous amounts of investment into its development. Producing a low-carbon product will become increasingly important as critical minerals markets become more mature.

Circular economy technology

When asked which extraction technologies will likely be adopted to enhance critical mineral recovery, the re-mining of waste was ranked #1. As mentioned earlier in this report, many critical minerals are currently mined as by-products, and are often viewed as waste material. The ability to develop 'side stream' processing capability that captures the value of what was once considered a waste, is becoming increasingly important.

Castile Resources, a gold project based in the Northern Territory, is building an additional cobalt processing module to supplement its primary gold product, and create another revenue stream, whilst simultaneously reducing mine waste. In a similar vein, Rio Tinto has invested in the construction of a scandium processing module at its titanium refinery in Quebec, and a tellurium processing module at its Kennecott copper refinery in the US⁶⁰.

"It may well be that waste processing is the technology that disrupts the industry and takes the heat out of the fire" – Mining Company CEO

Mining produces over 100 billion tonnes of solid waste annually⁶¹. For those businesses with legacy waste facilities, technology may be able to unlock their ability to become a critical minerals producer. The world's annual phosphate production is estimated to contain approximately 100,000 tonnes of REEs. Cobalt, indium, and antimony are well-known to end up in copper waste streams. Coal ash deposits have scandium and vanadium. Funding is flowing into the development of technology to extract critical minerals from waste, including from that of multiple Australian universities and resource companies such as BHP Nickel West, Rio Tinto, and New Century Zinc.

Recycling was the second most popular response when asked which extraction technologies will likely be adopted to enhance critical mineral recovery. In the coming years, an influx of end-of-life batteries will be put into waste. The IEA estimates recycling lithium-ion-batteries can reduce primary supply requirements of some critical minerals by up to 10%. Heightened pricing environments will encourage investment in recycling technology, as will the development of local downstream processing industries, as end-of-life materials can be injected back into a proximal processing and refining chain.

"Battery recycling by 2035 will reach a meaningful quantity where we no longer need to mine to get supply stable, only to accelerate it" – Mining Company CEO

⁵⁹ Electric Mine Consortium

⁶⁰ Australian Resources and Investment

⁶¹ Mining Technology

Conclusion

Australia again finds itself in the midst of an unprecedented resources boom. In the past forty years, Australia has benefitted from the Japanese reconstruction funded by Japanese investors through the 1980s, followed by the China boom through the 2000s, the natural gas boom through the 2010s and now finally the critical minerals boom of the 2020s - which may wind up being the largest and longest of all.

Demand for critical minerals is enormous, broad based and rapidly exceeding all forecasts at every step. The current scarcity of minerals required for the energy transition is threatening progress towards meeting net-zero ambitions – however, Australia is ideally placed to help fill the emerging gap in supply across most key critical minerals.

What makes this boom so complex is the interplay between global decarbonisation objectives, national security objectives and the rising competition and tension between China and much of the developed world, led principally by the United States. Critical minerals are key inputs to decarbonisation technology, but also commonly to defence technology as well. The result is a highly dynamic and unpredictable market for investment and development.

Australia has the choice to sell its minerals to itself for processing and refining – rather than to ship raw materials elsewhere for value adding investment. As the demand is relatively new, most of the infrastructure and projects required have not yet been financed or built. The opportunity to attract large swathes of this emerging supply chain is real.

In this, both economics and politics appear to be on Australia's side. As a country rich in renewable energy resources and sparse in population, Australia may be able to offset the cost of having a highly skilled and paid workforce through abundant cheap energy. And as the

major democratic powers seek to construct a supply chain beyond the control of China – who dominate approximately 75% of the current critical mineral supply chain – Australia stands as a key pillar for an alternative or new source of supply.

Australia's mining industry has already responded quickly and decisively to provide more raw minerals for these supply chains. Australia's lithium industry has gone from less than \$1 billion of combined market capitalisation to many \$10s of billions of dollars in less than five years. While there are many issues that impact the efficiency and speed of this growth, such as regulations, financing, price transparency and technical complexity, the Australian mining industry's rapid growth will continue across all key commodities. It is a mature and capable industry underpinned by informed policymakers and regulators.

The larger and more pertinent question regards the growth of a local downstream industry - which remains nascent and immature. Australia's governments will play a key role in whether this industry eventuates at any relevant scale.

As in previous booms, when supporting a mining industry that was also initially nascent and immature, creative policy and regulation will largely determine whether the country can attract the foreign investment required, de-risk the development of major projects, support market transparency and governance critical for pricing investments, and communication to the Australian community of the value and benefits of doing so.

Australian miners, Australian governments and investors will need to move beyond past differences to collaboratively set the country up for a more highly skilled, more prosperous, and more secure period of economic growth.





SLATE

