An investment strategy for a resource-intensive future

MINERALS+

Minerals Council of Australia

PRODUCTIVITY

A Stronger Australia

The pathway to a resilient and more productive economy is achieved by doubling down on Australia's strengths in mining.

INVESTMENT

Future Proofing

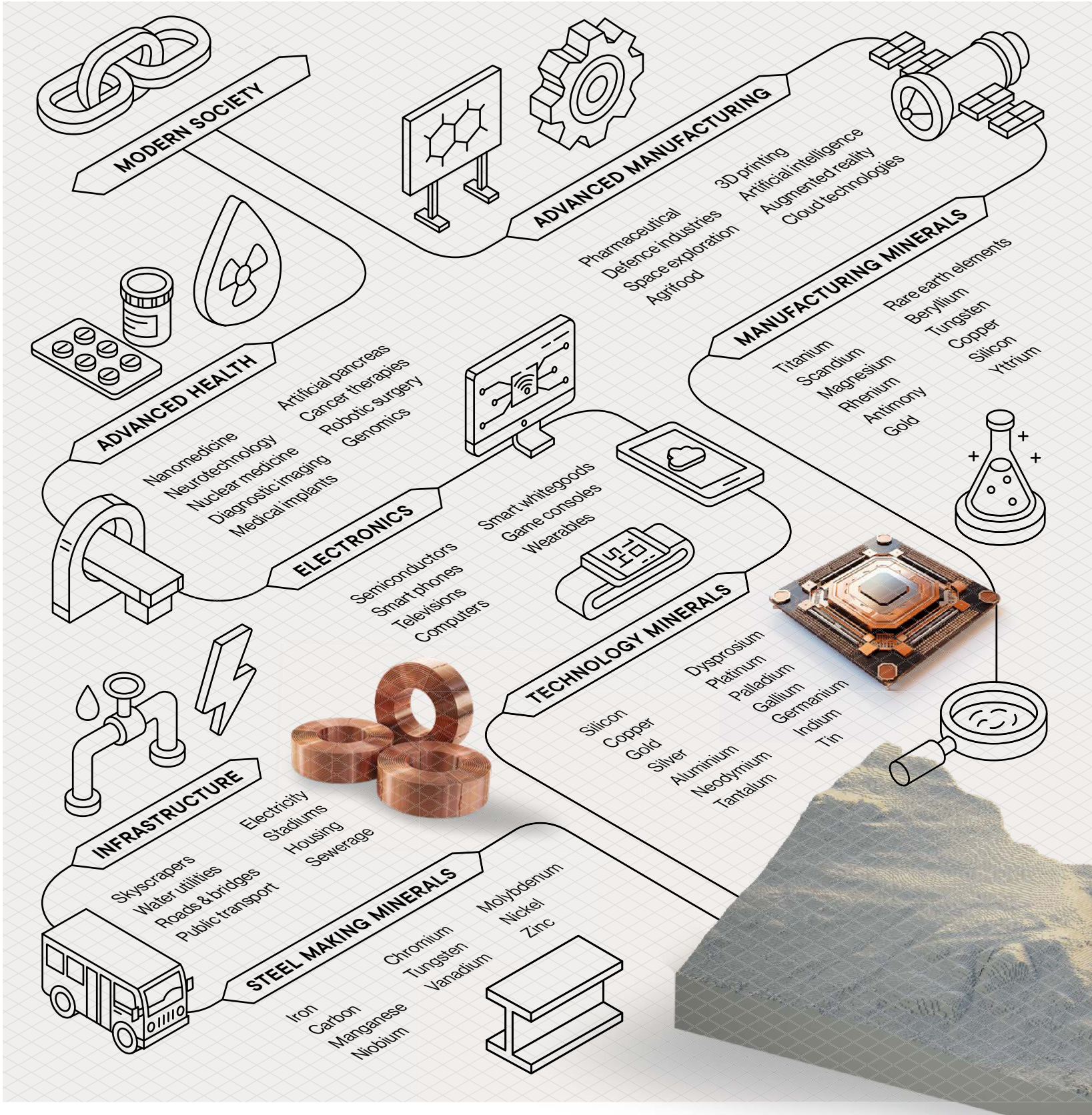
Making Australia's mining industry attractive to investors is the best way to cultivate the comparative advantages of tomorrow.

VALUE-ADD

Global Opportunities

Australia has the mineral wealth and expertise to integrate industry in clean energy supply chains, with the right policies.

Resourcing tomorrow
Australian Mining
minerals.org.au



Global supply chain integration and resilience ...

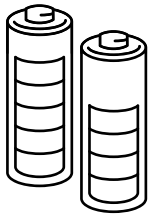
Minerals-plus builds on Australia's comparative advantages to strengthen and integrate industry in fast growing, high demand global supply chains.

SUPPLY CHAIN

Batteries

Australia has all of the critical battery minerals and is the global leader in lithium production.

20 – 23

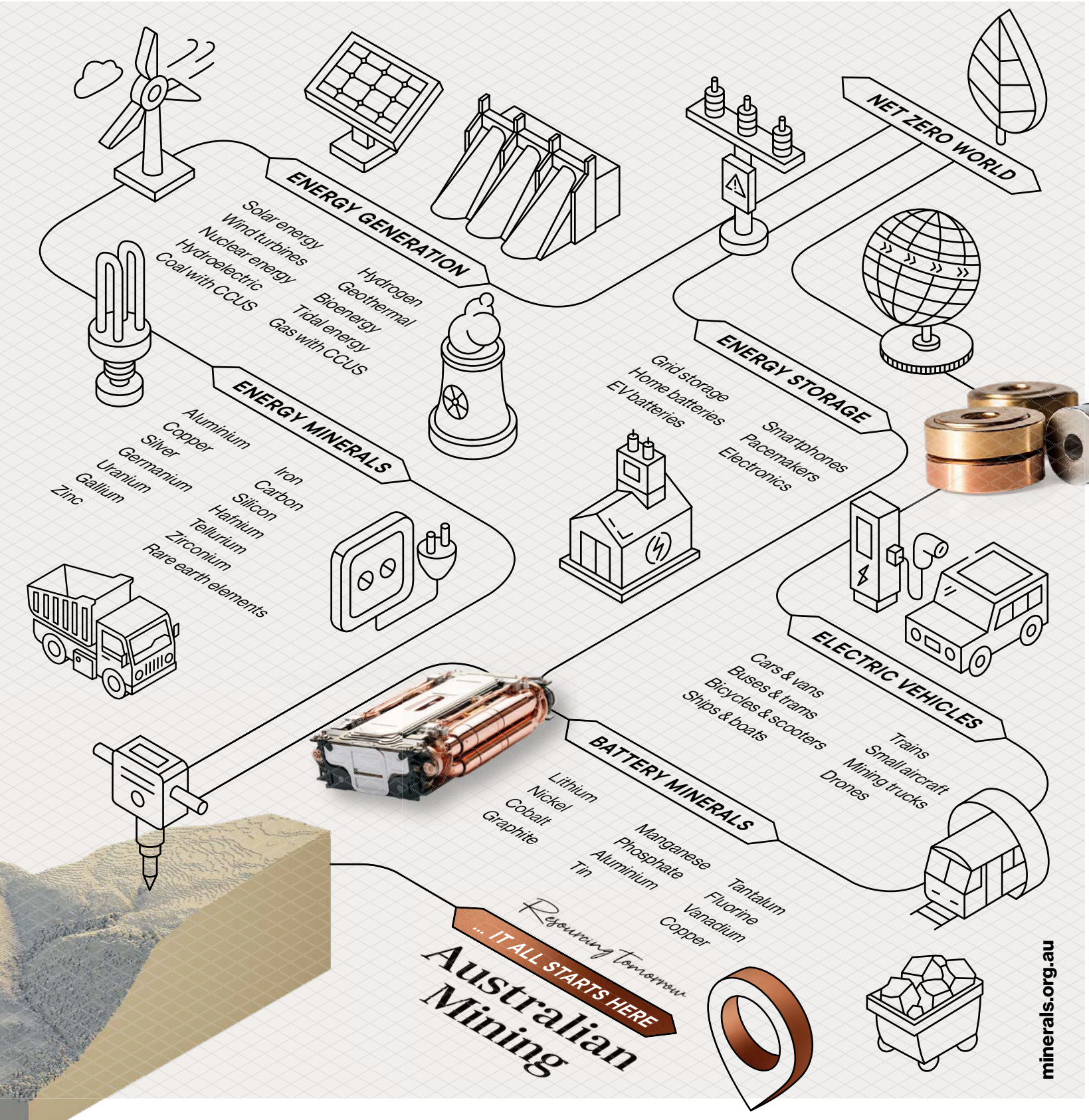


SUPPLY CHAIN

Magnets

Australia is a major producer of rare earth elements used to make permanent magnets.

24 – 27



starts with exploration and mining.

SUPPLY CHAIN

Semiconductors

Australia has an opportunity to process gallium and germanium from existing operations.

28 – 31

SUPPLY CHAIN

Energy generation

A massive upscale in mining is required to meet clean energy ambitions at home and abroad.

32 – 35

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INSIDE

FOREWORD

MINERALS+

An Australia that wants to build things again starts with a strong and productive mining industry.

Mining investment matters for the future prosperity of all Australians. It adds to the nation. By adopting a proactive approach to mining's growth, expansion and diversification, Australia can create more.

This is the heart of a Minerals-plus strategy.

The Federal Government has an ambition to reshape the nation as a renewable energy superpower and move up the value chain of clean energy technologies, such as battery production, renewable hydrogen and green metals.

To achieve this ambition it is critical to recognise that there will be no downstream processing or moving along the value chain without a strong vibrant mining sector. It's where it all starts.

But there are challenges. Mining capital stock has not grown for the last seven years. The issue is not a shortage of potential projects, but rather a challenging business environment for proponents committing to investment. This is occurring at a time when Australia should be playing a much greater role in the global clean energy transition.

Geopolitical and geoeconomic conditions, combined with the race to net zero, are shifting the role of governments. Policies being implemented in many countries, including Australia, aim to realign national and economic security interests and capture economic opportunities from the growing demand for clean energy and advanced technologies. In this landscape, industry policy can strengthen and create comparative advantages.

Standing alone, however, industry policies do not guarantee sustainable economic benefits. To build new comparative advantages requires an ongoing commitment to productivity-enhancing policies. In turn, this enables new comparative advantages in downstream activities, such as minerals processing, refining and mining-related manufacturing.

Good policy is critical to creating an internationally competitive cost base to attract mining investment. Policies and regulations must enable markets to efficiently allocate resources to where they are most valuable and address weak links between the complementary activities of productive sectors. This is important owing to mining's strong and extensive linkages to supply chains for goods and services and the significant contribution to economic and productivity growth this generates.

There is no single lever for improving mining's productivity. To unblock the investment pipeline, policy must aim to continually improve investment conditions. This includes delivering internationally competitive tax settings, expanded trade and investment opportunities, efficient regulatory settings including faster environmental planning,

productive workplace arrangements that balance worker and employer needs, an efficient transition to net zero and industry-focused skills and training.

The Federal Government can help unlock private sector mining investment through well targeted policies and public investment to augment private capital. There are many ways to do this. In some cases, sticking to current policy will make a difference. Providing certainty on policy settings, such as retaining the fuel tax credit scheme, can improve the investment environment or retain existing investment.

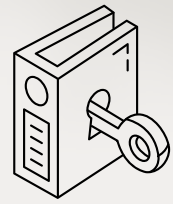
Small changes can do a lot too. Helping junior explorers find the mines of the future, or making it easier for project proponents through an effective single front door, or more efficient state and federal approvals processes, are some of these ways. In other cases, making sensible changes to avoid duplicative and overlapping federal and state emissions reduction policies can dramatically improve the investment outlook.

There is also a case for government to play a greater role. Crowding-in investment by creating new markets through strategic partnerships for mining, minerals processing and refining; and providing common user infrastructure will attract new investment and open new mineral provinces. All government interventions should be measurable, accountable and selected to ensure economy-wide benefits, including for host communities.

The opportunity before Australia is unprecedented. While Australia already adds significant value to its resources, there are opportunities for further integration into global value chains for technologies such as batteries, permanent magnets and semiconductors. But these opportunities will only be realised with a strong, internationally competitive mining industry.

This is the time to build on the success of capital-intensive sectors such as mining. While Australia should always be seeking out new and innovative economic opportunities to boost growth, productivity and jobs, we must also strengthen, build on and leverage the industries that Australia is good at and in which the nation has a demonstrated comparative advantage.

Minerals-plus is an investment strategy that further enables mining to achieve this. Doing otherwise risks foregoing opportunity and putting Australia on a pathway to lower living standards.



Good policy is critical if Australia is to realise its vision of becoming a clean energy superpower.

Tania Constable
Chief Executive Officer
Minerals Council of Australia

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Australian Mining
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MINERALS+

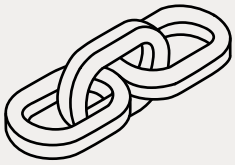
RECOMMENDATIONS

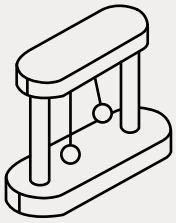
SAFEGUARD MECHANISM

NO NEW TAXES

RECOMMENDATION

2 **Ensure least-cost abatement under the safeguard mechanism**





RECOMMENDATION

1 **Retain the fuel tax credit scheme and commit to no new or additional taxes**

ADDRESS THE WEAK LINKS

LET MARKETS DO THEIR THING

Good regulation will strengthen mining

- Build on comparative advantages
- Tackle small inefficiencies before they get big
- Anticipate the effects of other countries' policies
- Design regulation for productivity

RECOMMENDATION

Increase efficiencies of mining assessments and environmental approvals **3** PROJECT APPROVALS

WORKPLACE RELATIONS

RECOMMENDATION

Put productivity at the heart of workplace relations and reverse adverse changes **4**

COMMUNITY BENEFITS

RECOMMENDATION

Improve community benefits and liveability in mining's host communities **5**

Mining is not just 'dig and ship'

- Recognise mining is complex
- Make any regulation pro-business
- Acknowledge every task is necessary
- Don't let bad policy impact productivity

WHAT IS...

Comparative advantage

A country has a comparative advantage if it can produce and export goods at a lower cost than its trading partners, where cost is measured in terms of the value forgone from the next best alternative activity: the opportunity cost of production.[1]

Productivity

Getting the most output for the least input is what matters for comparative advantage and trade.[2] Australia's mining and agriculture sectors are among the world's most productive industries.[3]

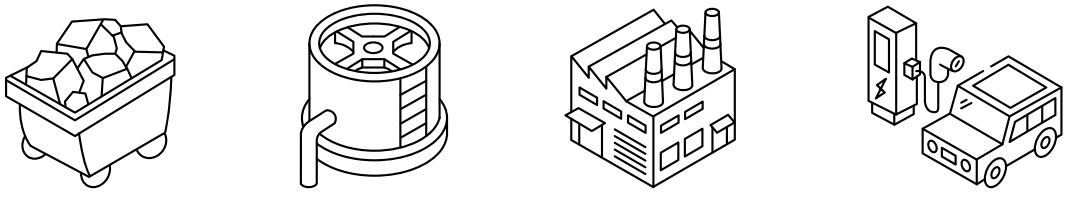
Endowment

Australia's relatively large mineral endowment compared to the size of the economy means that it has a comparative advantage in extraction and processing, as well as some beneficiation processes.

Technology

World-class mining technology, geoscience data, advanced exploration, skilled workforce and frontier mining and processing technologies underpins Australia's comparative advantage.

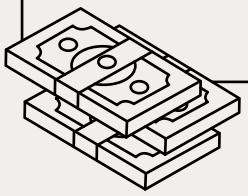
Comparative advantage across the supply chain



	Extraction	Processing	Components	End product
Australia	HIGH	HIGH – MEDIUM	MEDIUM – LOW	LOW
Trading partner	LOW	LOW – MEDIUM	MEDIUM – HIGH	HIGH

OBJECTIVE **Build on Australia's comparative advantage in mining and minerals processing** to strengthen and integrate industry in fast growing, high demand supply chains.

AUGMENT PRIVATE CAPITAL



Guardrails for public investment

- Subject industry policy to checks and balances
- Make public investment complementary
- Mobilise public investment in public goods
- Crowd-in to unlock private investment

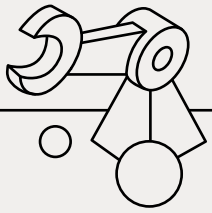
SECURE ENERGY

EXPLORATION

RECOMMENDATION **6**
Level the playing field for generators to deliver least-cost, secure electricity

RECOMMENDATION **7**
Invest in common user mobile assay laboratories for quick testing of exploration samples

LEVERAGE DOWNSTREAM OPPORTUNITIES



RECOMMENDATION **8**
Integrate Australian mining into global clean technology supply chains

STRATEGIC PARTNERSHIPS

SINGLE FRONT DOOR

RECOMMENDATION **9**
Activate and resource a single front door service for project investors

COMMON USER INFRASTRUCTURE

RECOMMENDATION **10**
Deliver and fund a common user infrastructure plan within two years

Downstream success starts with mining

- Mining is core to industry policy
- Improve mining investment conditions
- Identify factors that add value downstream
- Invest in mining complementarity

EXPLORATION. MINING. PROCESSING.
MADE IN AUSTRALIA
Building supply chain resilience and integration

INGREDIENTS

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Doubling down on Australia's comparative advantage =

+ Deep input markets
Efficient, developed supply chains

+ Frontier innovation
Advanced R&D & best practice ESG

+ Skills building
Technical training know-how

+ Capital markets
Mature financing & entrepreneurship

+ International networks
Investment channels & linkages

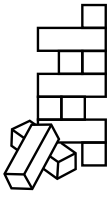
+ Transport & logistics
Existing road, rail & port infrastructure

HOW TO LEVERAGE...

Complementarity

Every industrial process is a bundle of individual tasks carried out together to achieve a final output. New areas of comparative advantage that are highly productive require superior performance in each task.[4]

New activities are more likely to be successful if they compound a national comparative advantage.[5] Activities that are adjacent to mining or involve the industrial benefits that mining generates have the best chance of success.



One policy misstep can jeopardise the whole endeavour.

THE SOLUTION

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Leverage mining's strengths in new areas of comparative advantage =

+ Leverage spillovers
Extend mining benefits to other sectors

+ Improve coordination
Connect mining outputs to future industries

+ Provide public inputs
Design with multi end users in mind

+ Build on planning expertise
Leverage mining's regional planning expertise

+ Create strategic linkages
Tap into mining's international networks

Meeting the global challenges starts with mining

From net zero ambitions to supply chain resilience, a strong mining industry is critical to navigating 21st century challenges.

The clean energy imperative

The demand outlook for minerals and metals has undergone the biggest shift in history as the world transitions to net zero emissions by 2050. Global demand for critical minerals has doubled over the past five years to $320 billion driven by the growth of clean energy technologies and EVs.[6]

By 2030, 120 new lithium, nickel and cobalt mines will be needed to supply the materials required to meet demand for battery storage. And much of the estimated 6.5 billion tonnes of end use materials required up to 2050 will be steel, copper and aluminium.[7] This makes the minerals and raw materials produced by resource-rich countries increasingly critical over coming decades.

It also presents an unprecedented opportunity for Australia. A Minerals-plus investment strategy that encourages more discoveries, reactivation of mothballed mines, expansion of existing mines and development of new mines, can place Australia at the forefront of global decarbonisation efforts.

The global supply chain imperative

Temporary shortages in the supply of certain essential and critical goods and services, and disruptions to international trade during the COVID-19 pandemic, heightened the sense of supply chain vulnerability among policy makers around the world.[8]

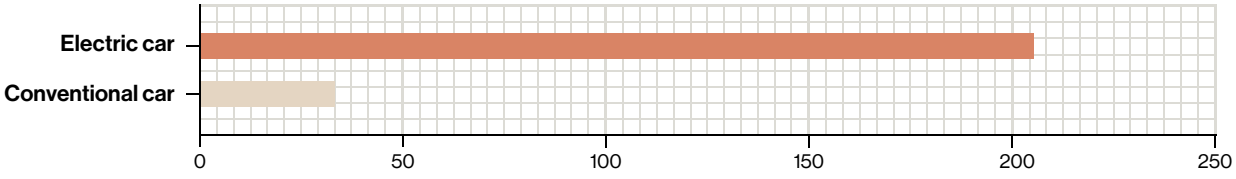
While markets generally performed well during this 1-in-100 year event, a flux of new policies to shore up supply chain resilience have followed. These have typically taken the form of onshoring and supply chain diversification. Any additional policies must improve the investment environment for Australia and its strategic partners rather than add to the impediments that Australia's minerals industry already faces.

Minerals-plus provides a pathway for stronger and more resilient supply chains through the integration of Australia's mining industry into global value chains. This strengthens Australia's, and Australian businesses', strategic partnerships.

FIGURE 1

EVs use six times more minerals than a conventional vehicle

Minerals intensity of an EV (kg/vehicle)



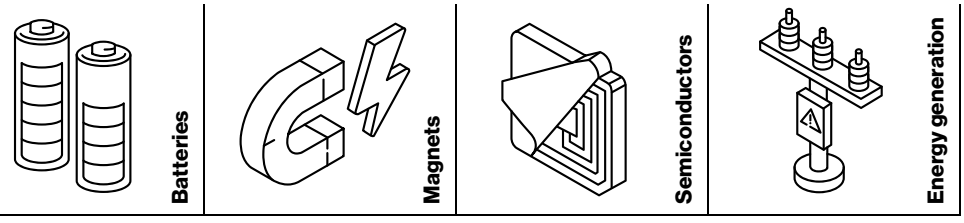
SOURCE IEA, *The Role of Critical Minerals in Clean Energy Transitions*, 2022

SOURCE International Energy Agency

Minerals in EVs kg per MW

Electric vehicles	66.3 kg	53.2 kg	39.9 kg	24.5 kg
Conventional vehicles	0.0 kg	22.3 kg	0.0 kg	11.2 kg
	Graphite	**Copper**	**Nickel**	**Manganese**
Electric vehicles	13.3 kg	8.9 kg	0.5 kg	0.1 kg
Conventional vehicles	0.0 kg	0.0 kg	0.0 kg	0.1 kg
	Cobalt	**Lithium**	**Rare earths**	**Zinc**

Value chains with potential for integration

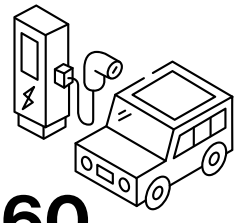


The national security imperative

Geopolitics is becoming increasingly complex and uncertain. As nations recover from the turmoil of the pandemic, old political issues have continued to simmer and new tensions have emerged between the world's largest economies.

Australia's mining and processing capacity is deeply embedded in the region. It plays a pivotal role in the minerals and energy supply chains of countries across Asia and in the economies of key trading partners. Governments' anticipation of future supply chain disruption has resulted in policy makers believing there is a greater need for sovereign capability of critical goods and services.

But developing sovereign capability that is not driven by commercial realities, or in some cases runs counter to comparative advantage, requires significant public resources. Without careful policy design there are risks that this type of intervention requires ongoing government support, which is not typically sustainable over the longer term.



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New mines

Cobalt, nickel, lithium and copper mines required by 2030 if the world is to meet demand for battery minerals.

Source: IEA, S&P Global

It starts with mining

Modern, low emission, tech-dependent economies are built on minerals and metals. From cloud robotics to space exploration, quantum computing to clean energy generation, the pace and progress of human advancement depends on the extraction of minerals and metals.

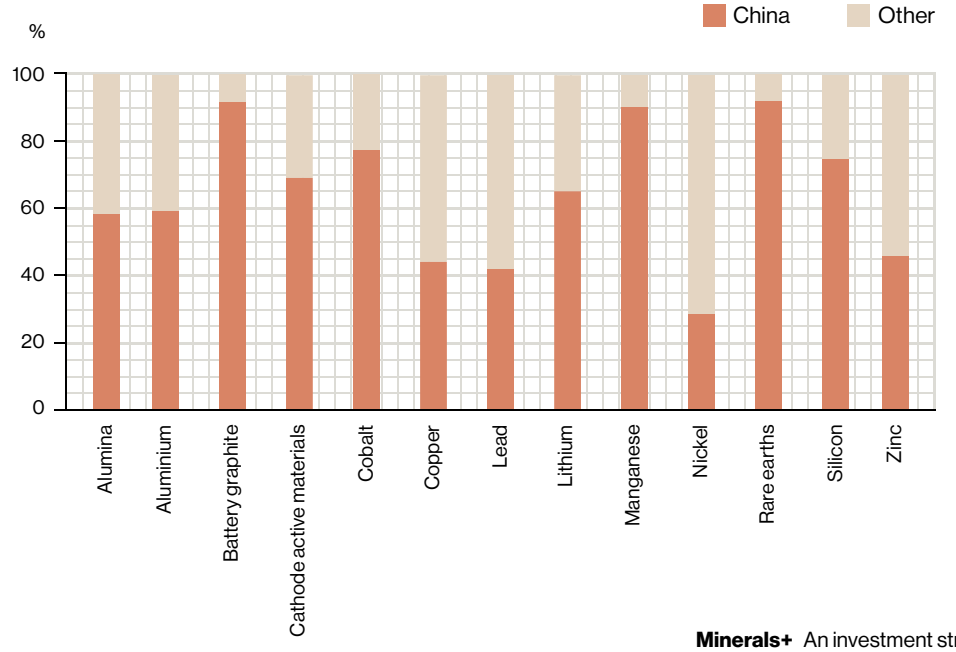
While Australia's mining industry has underpinned decades of high living standards as the nation's largest exporter and company taxpayer, supplying global demand for minerals critical to the clean energy transition presents a new challenge for our nation – and an equally big opportunity.

Australia cannot afford to take mining's economic contribution for granted. Addressing home grown policy challenges is key for the minerals industry to compete with other resource-rich economies. A Minerals-plus strategy builds on Australia's comparative advantages – abundant resources, world-class geoscience and human expertise – towards future participation in global supply chains.

FIGURE 2

China is the world's largest processor of critical minerals

Location of minerals processing critical to the energy transition, % share



SOURCE

International Aluminium Institute (alumina, aluminium); IEA (battery graphite, cobalt, copper, lithium, nickel, rare earths); Statista (CAM, silicon); International Lead and Zinc Study Group (lead, zinc); S&P Global Market Intelligence (manganese)

NOTE

Ownership may differ significantly from location. For example, Chinese ownership of nickel will extend to parts of Indonesian nickel processing.

Seizing tomorrow's opportunity with Minerals-plus

Abundant natural resources and a world-leading mining industry gives Australia a comparative advantage in mineral extraction and processing.

Modern tech starts with mining

From iron ore and metallurgical coal for steel, lithium and cobalt for batteries, and rare earth elements for permanent magnets, mining is the first step in obtaining the minerals required to fuel the global clean energy transition and meet society's ever advancing technological requirements.

Extracted and processed in regional and remote communities, Australia's minerals are critical components of technologies that underpin living standards in developed and developing nations alike. Successful production of a mobile phone, computer, EV or nuclear power plant requires success at every stage of an interconnected web of activities taking place throughout the world.

Tracing back from the final product in the hands of the consumer, through all the complex stages of production, Australian miners are more often than not at the origin: modern tech starts with mining.

Leveraging comparative advantage

Australia's minerals industry is optimised for value. Some metals are processed and refined in Australia, like copper and gold; while others are exported as concentrate like alumina, mineral sands, nickel and zinc. Overseas processing tends to be in locations closer to the manufacturing stage as materials are converted from minerals, to intermediate goods, and finally to consumer products.[9]

The pattern of an economy's trade, determined by which activities take place in particular locations, tends to be influenced by where a country's comparative advantages lie. Countries have a comparative advantage when they are the lowest opportunity cost producer of a particular good.[10]

Having large endowments of minerals usually gives a country's producers a head-start for comparative advantage. Leveraging Australia's comparative advantage is at the heart of a Minerals-plus economy.

FIGURE 3

There's more to Australian mining than 'dig and ship'

Mining's technological drivers

Mining deploys more innovation across its operations than almost any other industry.

Downstream opportunities

The pace and scale of change in global trade and development means there are opportunities to expand Australia's existing minerals complex into new downstream stages of production.

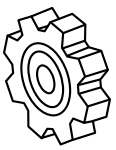
Mining's strong inter-industry linkages combined with complementarity between mining outputs and other Australian-based intermediate goods could underpin commercially feasible downstream investment, whether that be in the next physical stage of production, or any bundle of activities that are inputs along any stage of production. This is the most likely strategy to result in a commercially sustainable value-add in Australia.

Further processing down the value chain of mineral production in Australia will ultimately rely on whether policies successfully cultivate comparative advantage in other areas of the economy and whether emerging markets in our region create the demand for Australian goods.

$50 bn

Mining outputs

Used in manufacturing in Australia – 20% of domestic manufacturing's total spend.



$12 bn

Manufacture outputs

Used as inputs in mining. That's about 10% of what mining spends on inputs.

Source: ABS

Good policy is critical

The effect of policy on business investment is cumulative: every adverse impact on the cost and risk of the complex set of necessary activities amplifies the threshold required for new investment. On the other hand, every policy that improves productivity will improve investment.

Even small inefficiencies in the wide variety of inputs and activities that go into processing minerals in Australia – whether that be skills, energy, reagents, engineering and business services, and especially the policies that regulate their use – are magnified into large inefficiencies in production.[11]

The first step in achieving more value-add activities in Australia, rather than overseas, is for government policy to improve the business conditions for strong mining investment, and set out clear, simple objectives in areas where it is feasible that Australian industry could develop a comparative advantage over time that builds on mining.

Every tonne of ore mined in Australia is the product of a complex network of world-leading geoscience, advanced technology and human expertise.

Geoscience Australia
A world leader at mapping and targeting new mineral provinces.

World-class datasets
Adapting complex and diverse datasets to better understand how deposits form.

Skilled workforce
More mining faculties are offering engineering degrees with a greater focus on big data, AI and VR skills.

3D imaging
Used to target exploration efforts for greater efficiency, accuracy and safety.

Autonomous machines
From trucks to trains to drills, autonomous machines remove humans from harm's way.

Alternative energy
Miners are turning to wind and solar energy, as well as battery storage, to reduce emissions and power off-grid operations.

Ore-sorting sensors
Sensor-based ore-sorting reduces waste and improves efficiencies, maximising mineral recovery.

Predictive maintenance
Maintenance schedules are optimised from data collected from a complex network of equipment sensors.

Precision mining
From pit to port, GPS technology informs every aspect of an operation.

Remote operations
Integrated Operation Centres monitor and analyse data from a remote operation to provide real time intelligence.

Additive printing
3D printing and laser scanning can be used to produce spare parts on remote mine sites, saving time and money.

Market logistics
Blockchain, machine learning and AI support commodity and financial markets, facilitating faster transactions and decisions.

Electric haul trucks
Miners are working with manufacturers to replace diesel trucks with electric trucks.

Virtual reality
From skills development to remote maintenance, virtual and augmented reality helps keep workers safe and machinery functioning efficiently.

Blockchain
Blockchain provides product assurance and provenance documentation for customers.

Meeting the investment challenge with Minerals-plus

Effective industry policy that improves investment conditions is the first step to integrating Australian industries in fast growing global supply chains.

Let markets do their thing

An economy's productive factors tend to follow comparative advantage. Effective regulation that works alongside comparative advantage can deliver improved environmental and social outcomes. Policies can then leverage strengths to build comparative advantages in new areas and let markets capitalise on them.

Unlocking the private investment needed for the clean energy transition requires related industries to be internationally competitive.

Mining CEOs look decades ahead when planning new projects. Investment decisions are based on whether they believe durable agreements can be made with reliable partners. The availability of least-cost secure energy, an industrial relations framework that fosters productivity and timely permitting processes are important factors.[12] CEOs need good policy settings so that market forces determine investment, and not the other way around.

Address the weak links

Mining operations are complex. Most Australian mines run 24-hour operations and rely on the seamless integration of many activities, including scheduling and resourcing of rotating work rosters, equipment and maintenance schedules, supplies, deliveries, product logistics and export shipping. Each activity is exposed to government policies and regulations that influence its success.

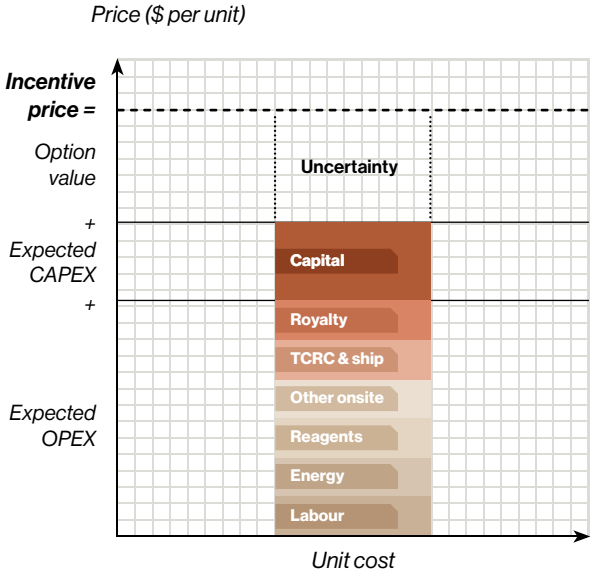
Given the complementarity of these activities, a problem with any activity can substantially reduce or stop mineral production getting to market, lessening the commercial sustainability of operating mines and delaying investment in new mines.

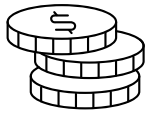
A Minerals-plus investment strategy recommends new activities be selected through processes that productively address any externalities, resolves any coordination failure and efficiently provides public good inputs, without adversely impacting any of the necessary activities required for commercial operations and investment.[13]

FIGURE 4

Cumulative effects of bad policy makes investment harder to achieve

Stylised determinants of the project final investment decision (FID) thresholds





Every dollar counts

For every $1 increase in expected unit cost of a potential mining project, the FID price threshold increases by more than $1.

Accelerate investment

Good policy settings that reduce downside risk improve the likelihood that a potential project reaches FID and is committed to.

Sustain operational mines

Policy settings that allow projects to retain exposure to upside risks help sustain mining activities in turbulent times.

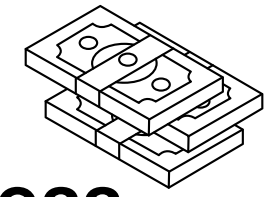
MINING INVESTMENT RULES OF THUMB

Augment private capital

Government should avoid 'picking winners' when committing taxpayer funds to public investment. Public spending or risk-taking requires appropriate checks and balances with well thought through guardrails and exit ramps. While private capital investment is determined by commercial realities, government programs are not always subject to the same discipline.

Recent trends in industry policy cautions that public investment should be complementary to private investment, and lead to technological spillovers or place-based initiatives that would not otherwise be achieved.[14]

A Minerals-plus strategy instead puts the focus on mobilising public investment in exploration geoscience, R&D in extraction and processing technologies, or development of common user infrastructure – areas most likely to crowd-in or 'unlock' further private sector investment.



$933 bn

Stagnant investment

Mining capital stock has plateaued at $933 billion over the last five years.

Source: ABS, *Australian System of National Accounts*, table 58

Leverage downstream opportunities

Australian mining's value-add is staggering compared to other activities in the economy. The iron ore industry's value-add grew from about $4 billion in 2000 to over $110 billion in 2021-22.[15]

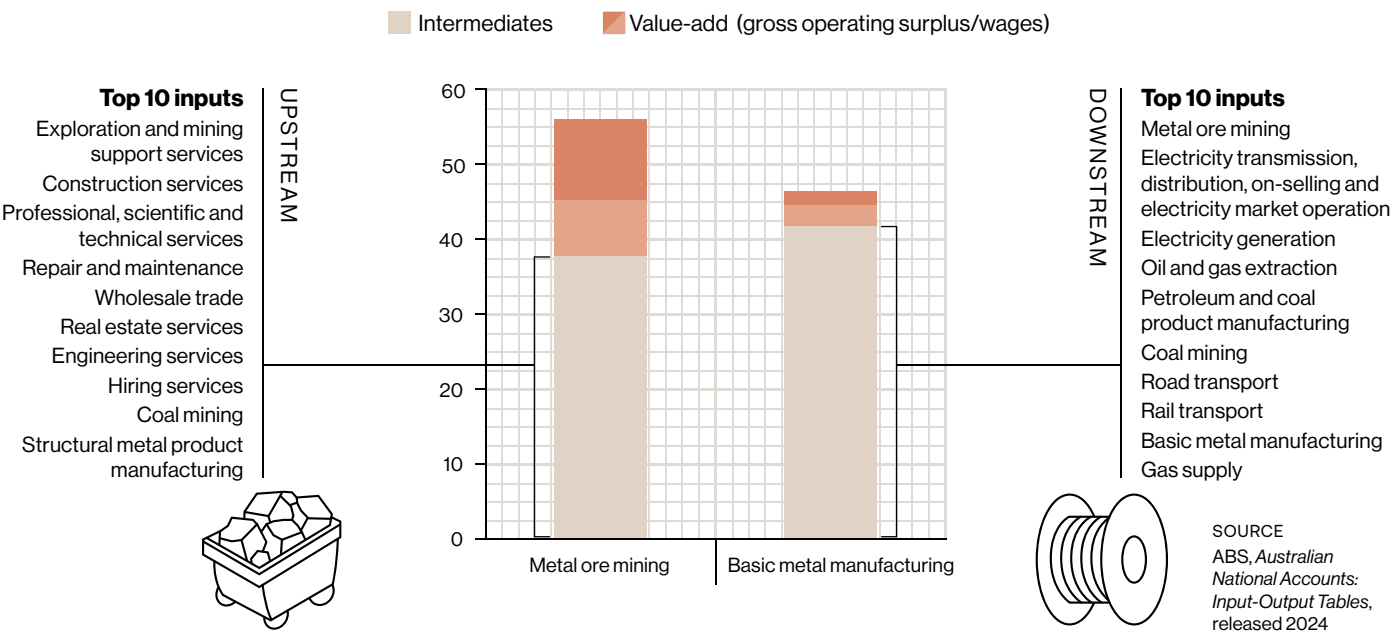
Commercial success of downstream value-add is predicated on a productive upstream mining sector. This is because mining inputs are a significant component of materials purchased for downstream activities, alongside key shared inputs from the energy, construction, transport and business service industries.

Policies that drive efficiencies in mining will also drive greater potential value-add in direct downstream processing, refining and manufacturing. And complementary, well-targeted public investment in mining R&D, technology and skills and training will create spillover benefits that will flow from Australia's frontier mining industry to related sectors.

FIGURE 5

Leveraging comparative advantage into downstream opportunity

Value-add for metal ore mining and processing, $ billion



SOURCE
ABS, *Australian National Accounts: Input-Output Tables*, released 2024

The high cost of business uncertainty

Every major project that falls over before the starting line robs the nation of new jobs, income, and shared wealth creation.

Unblocking the investment pipeline

High dropout rates and low conversions to final investment decision (FID) plague new project development in Australia. The stock of major resource and energy projects has increased year-on-year since 2017, but final decision and completion rates are both low and unpredictable.[16]

Despite the recent run-on in potential projects, many are discontinued at early stages consistent with a high degree of project uncertainty. FID conversion rates are low, with only 1 in 20 major projects on average in Australia moving from 'feasibility' stage to 'committed' in any given year.[17]

The upside is that industry policies that reduce downside risks are likely to convert more potential projects into new mines, expansions or reactivations. Prudent public investment may catalyse new private capital in mining, but social licence, crowding-in and de-risking loom large for policy.

De-risking operations

Mining investment is among the riskiest of all sectors. It involves large, long-lived capital outlays that are mostly irreversible – once made they tend to be location specific and difficult to liquidate. There is a strong 'time value of waiting' for mining investment as proponents trade-off 'larger versus later' when deciding to pull the trigger.

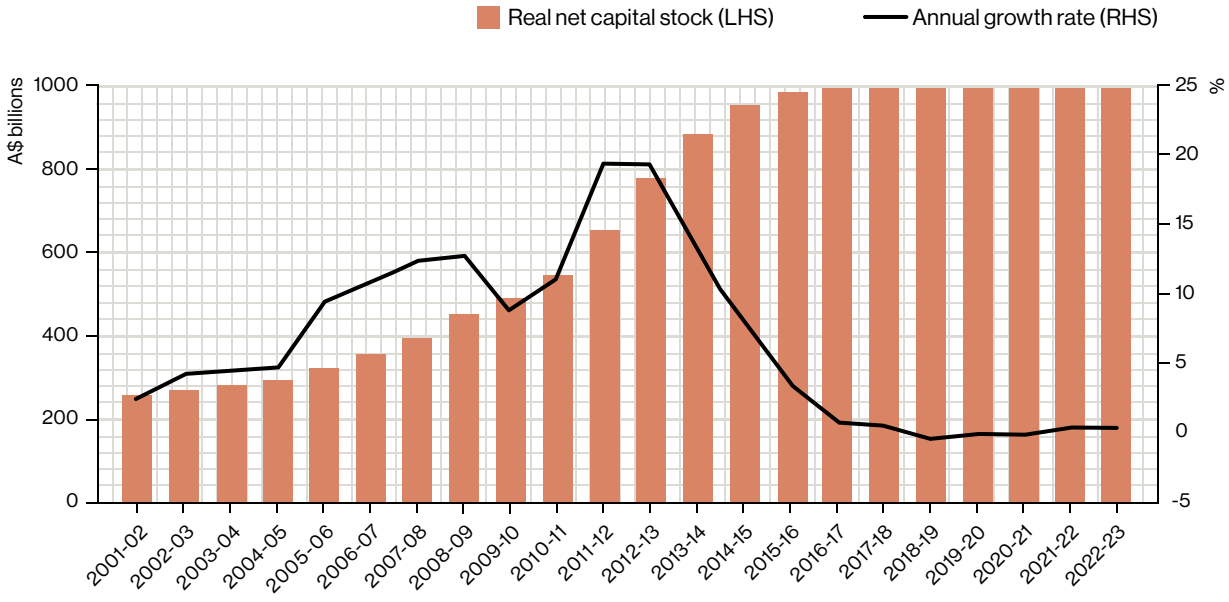
While mining companies are specialists in managing their own risks, they are fully exposed to policy risks. Even small policy changes affecting expected returns amplify project risks, undermining current operations and deterring investment.

Government intervention must safeguard efficient risk-bearing and preserve high-powered incentives for project proponents. This is achieved through appropriate public spending and risk taking that catalyses growth in minerals projects without crowding out private investment.

FIGURE 6

Australia's mining industry's net capital stock is plateauing

Mining real net capital stock



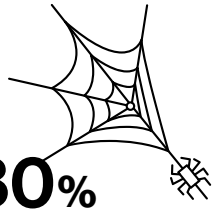
SOURCE
ABS, *Australian System of National Accounts*, table 58, October 2023

Managing structural adjustment

The redistribution of activity and resources among businesses, industries and regions during a transition are influenced by both market and government actions. Understanding the social consequences of transition and the likely distribution of costs and benefits is key to designing good policy and securing social licence.

The direct cost to business adjusting to bottlenecks where access to scarce inputs like skills and professional services, technological know-how and specialist business and finance inputs, is another factor.

While strong competition underwrites sound industry policy as a general principle, policies that avoid bottlenecks through efficient planning and sequencing can reduce unnecessary adjustment costs.[18] This will ensure the transition path is as smooth as possible.



80%

Abandoned

Debut projects on the major projects list that are discontinued altogether.

70%

Decade of decline

Value of committed projects dropped from $255 billion in 2013 to $75 billion in 2023.

Source: DISR, *Resource and Energy Major Projects*, 2012-2023

It begins and ends with investment

Mining accounts for the largest share of Australia's invested capital, but total business investment as a share of the economy is in long-term decline.[19] Worryingly, the mining sector's net capital stock of almost a trillion dollars has barely changed over the past seven years (figure 6).

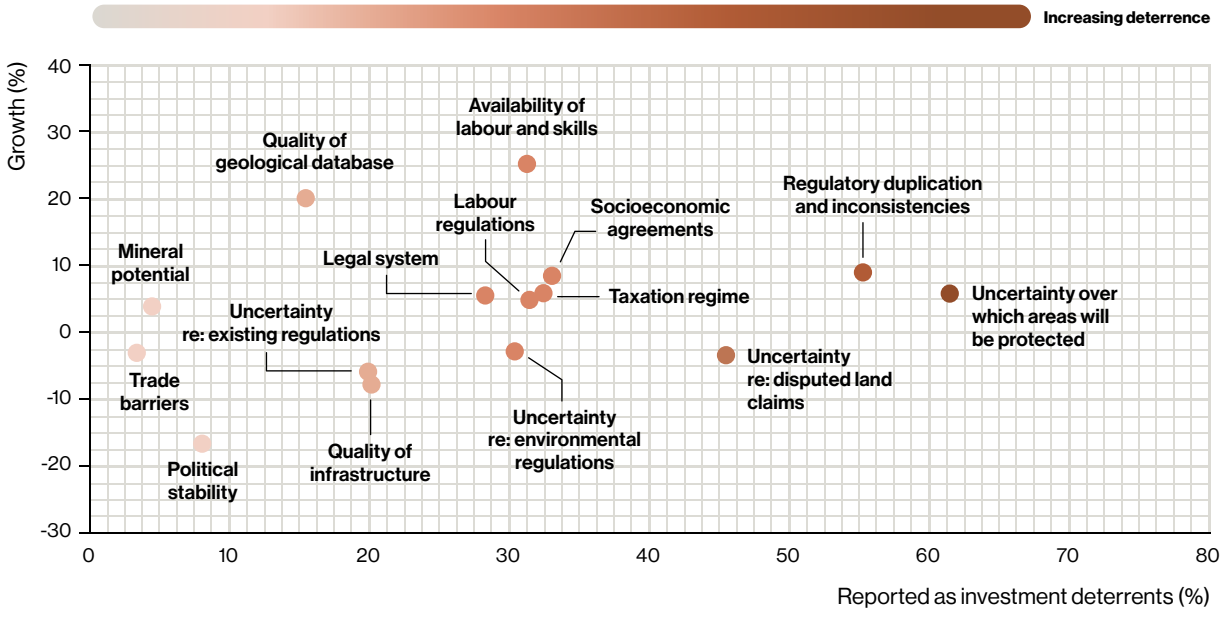
Minerals-plus aims to reverse this downward investment spiral by restoring policy conditions to attract global capital. Australia's capital intensive industries must remain internationally competitive to attract investment. If investment flows to projects in other countries, Australia's economic growth and productivity growth will remain weak.

Building on the nation's productive capital stock – the buildings and structures, equipment, machinery and technology – through increasing business investment, is the key to achieving real growth in incomes, wages and productivity.

FIGURE 7

Regulatory duplication and uncertainty are major investment deterrents in Australia

Policy factors



SOURCE

Fraser Institute, *Annual Survey of Mining Companies*, 2019-2024; National measure derived using mining GVA weights from ABS, *National Accounts: State Accounts*, 2023

Recommendations

Small policy changes can unlock large amounts of private sector investment in Australian mining.

Recommendation 1

Retain the fuel tax credit scheme in its current form and commit to no new or additional taxes

Ensure that Australia has internationally competitive and stable tax settings to attract investment in mining, processing and related manufacturing. Any tax incentive must be fiscally responsible, time-bound and well-governed to prevent rent-seeking and loss of competition. Production tax credits for minerals processing may make sense when operations are adversely affected by policies in other countries or there are benefits of increasing investment, and if needed should not be delayed.

Recommendation 2

Urgently reform commonwealth, state and territory emissions reduction approaches to ensure least-cost abatement under the safeguard mechanism

Exempt safeguard mechanism-covered facilities from additional state or territory-based emissions reduction obligations to avoid uncertainty, regulatory overlap and duplication between jurisdictions. Additional state and territory interventions incompatible with the safeguard mechanism are unnecessarily distortionary, increase the regulatory burden on operations and new investment, and can negatively impact the safeguard mechanism's effectiveness.

Recommendation 3

Increase efficiency of mining approvals including devolving environmental assessments to the states and territories

Remove duplication in project assessments by conducting an integrated evaluation against both state and Commonwealth requirements. To address the shortage of assessment officers, devolve assessment responsibilities to state and territory governments while the Commonwealth maintains responsibility for assurance, with a focus on outcomes rather than process.

Recommendation 4

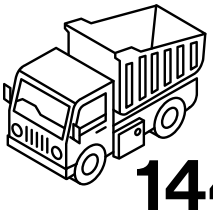
Put productivity at the heart of workplace relations and reverse productivity-destroying changes as a priority

Government commit to not imposing further workplace relations changes that would reduce productivity, impose unnecessary costs and reduce scope for sustainable wage increases. Unlocking value along the entire materials supply chain requires a productive workplace system that allows for businesses to increase productivity and continue to provide the most competitive terms and conditions to attract and maintain workers.

Recommendation 5

Improve community benefits from economic empowerment and liveability in host communities in mining regions

Create guidelines and/or statements of intent that encourage project proponents to explore how their activities will generate localised benefits and opportunities for host communities. Ensure the bodies representing Traditional Owners are adequately resourced to enable project opportunities to deliver demonstrated outcomes for communities with certainty through equitable agreement making and timely cultural heritage surveys.



144

Mining projects

Almost 1 in 5 projects have been closed, withdrawn or lapsed between 2008-2024.

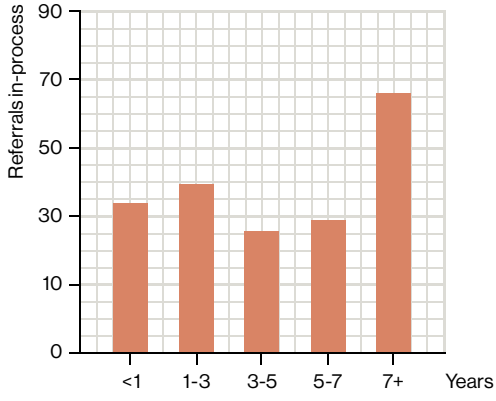
Source: DCCEEW

NO DECISION

FIGURE 8

Mining projects locked in referrals

EPBC mining referrals in-process



SOURCE DCCEEW EPBC Act, *All Referrals 2008 - 2024 – Public Portal*, accessed 23 July 2024

Recommendation 6

Level the playing field for electricity generators to enable the market to deliver least-cost secure electricity supply

Government commit to a technology neutral policy for electricity generation that considers all low and zero-emissions technologies, including by lifting the ban on nuclear electricity generators and reinstating funding for carbon capture, use and storage (CCUS). This will allow delivery of least-cost secure electricity and give the market and households confidence that downward pressure will be put on electricity prices.

Recommendation 8

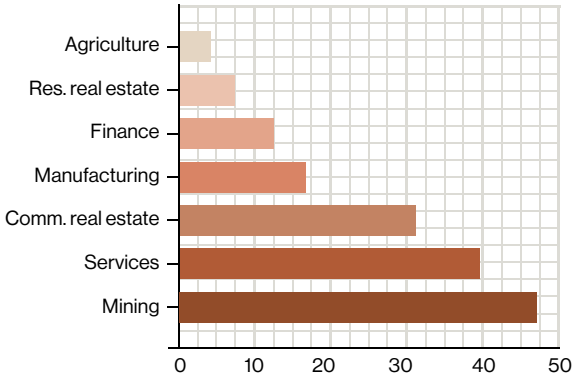
Create strategic partnerships to integrate Australian and international industry policies to support mining, processing and refining

Design policy measures with strategic partners to address identified supply chain risks and assess the economy-wide benefits of entering into new supply chain agreements. Agree to put in place mutually beneficial supply chain arrangements and associated measures. This could take the form of joint government commitment to actions, MOU undertakings, financial support, physical stockholdings and investment in infrastructure.

FIGURE 9

Mining leads foreign investment

FIRB approvals in 2023

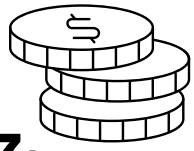


SOURCE FIRB, *Quarterly Report on Foreign Investment*, Jan to Dec 2023, Treasury, Canberra

Recommendation 9

Create a single front door for investors in the Department of Prime Minister and Cabinet and resource it to deliver outcomes

Establish a single front door to complement the Net Zero Economy Agency and benefit from the central coordinating role of the Prime Minister's Office. A single front door should provide a specialised concierge service to assist project proponents navigate government agencies, policies and regulations. It should be delivered by a small unit of senior officials, headed by at least a deputy secretary.



$47 bn

Project value

Mineral projects approved by the Foreign Investment Review Board in 2023.
Source: FIRB

Recommendation 7

Invest in common user mobile assay laboratories for quick testing of exploration samples for small explorers

Provide mobile assay laboratory services at strategic remote locations to fill a gap in the analytical market and extend these services to small explorers. This will stimulate exploration activity and improve its efficiency. Currently, analytical services are configured for processing large volumes rather than handling smaller volumes from junior explorers, are in locations far from the remote exploration sites and can be prohibitively expensive for smaller explorers.

Recommendation 10

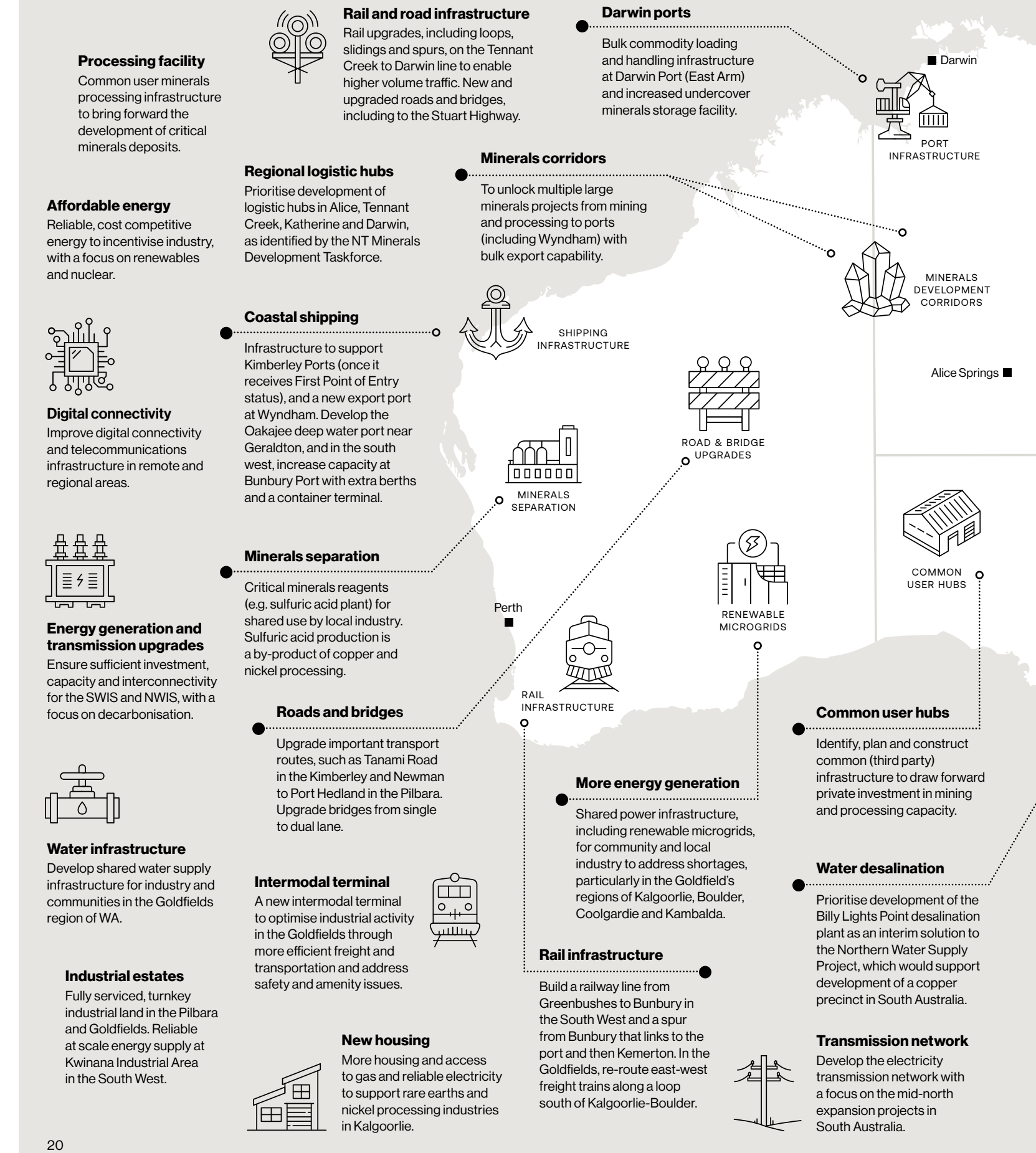
Deliver and fund common user infrastructure plan within two years

Assign a senior public official with commercial acumen to lead the $10.2 million national common user infrastructure planning and investment review and require the delivery of a common user infrastructure plan within two years. The plan, supported by economic, commercial and geological data, must demonstrate how recommended investment in infrastructure would draw forward new commercial investment in mining and processing capacity and deliver benefit to the taxpayer and local communities.

FIGURE 10

Common user infrastructure opportunities

Identified projects and shared benefits



Processing facility
Common user minerals processing infrastructure to bring forward the development of critical minerals deposits.

Affordable energy
Reliable, cost competitive energy to incentivise industry, with a focus on renewables and nuclear.

Digital connectivity
Improve digital connectivity and telecommunications infrastructure in remote and regional areas.

Energy generation and transmission upgrades
Ensure sufficient investment, capacity and interconnectivity for the SWIS and NWIS, with a focus on decarbonisation.

Water infrastructure
Develop shared water supply infrastructure for industry and communities in the Goldfields region of WA.

Industrial estates
Fully serviced, turnkey industrial land in the Pilbara and Goldfields. Reliable at scale energy supply at Kwinana Industrial Area in the South West.

Rail and road infrastructure
Rail upgrades, including loops, slidings and spurs, on the Tennant Creek to Darwin line to enable higher volume traffic. New and upgraded roads and bridges, including to the Stuart Highway.

Darwin ports
Bulk commodity loading and handling infrastructure at Darwin Port (East Arm) and increased undercover minerals storage facility.

Regional logistic hubs
Prioritise development of logistic hubs in Alice, Tennant Creek, Katherine and Darwin, as identified by the NT Minerals Development Taskforce.

Minerals corridors
To unlock multiple large minerals projects from mining and processing to ports (including Wyndham) with bulk export capability.

Coastal shipping
Infrastructure to support Kimberley Ports (once it receives First Point of Entry status), and a new export port at Wyndham. Develop the Oakajee deep water port near Geraldton, and in the south west, increase capacity at Bunbury Port with extra berths and a container terminal.

Minerals separation
Critical minerals reagents (e.g. sulfuric acid plant) for shared use by local industry. Sulfuric acid production is a by-product of copper and nickel processing.

Roads and bridges
Upgrade important transport routes, such as Tanami Road in the Kimberley and Newman to Port Hedland in the Pilbara. Upgrade bridges from single to dual lane.

Intermodal terminal
A new intermodal terminal to optimise industrial activity in the Goldfields through more efficient freight and transportation and address safety and amenity issues.

New housing
More housing and access to gas and reliable electricity to support rare earths and nickel processing industries in Kalgoorlie.

More energy generation
Shared power infrastructure, including renewable microgrids, for community and local industry to address shortages, particularly in the Goldfield's regions of Kalgoorlie, Boulder, Coolgardie and Kambalda.

Rail infrastructure
Build a railway line from Greenbushes to Bunbury in the South West and a spur from Bunbury that links to the port and then Kemerton. In the Goldfields, re-route east-west freight trains along a loop south of Kalgoorlie-Boulder.

Common user hubs
Identify, plan and construct common (third party) infrastructure to draw forward private investment in mining and processing capacity.

Water desalination
Prioritise development of the Billy Lights Point desalination plant as an interim solution to the Northern Water Supply Project, which would support development of a copper precinct in South Australia.

Transmission network
Develop the electricity transmission network with a focus on the mid-north expansion projects in South Australia.

Renewable energy

Renewable energy supply to support Mt Isa's north west minerals precinct. This will add to scale and reliability when CopperString 2032 is fully energised by 2029.

Rail corridor

Rail upgrade (Townsville port to Mt Isa) to increase reliability and capacity, and better utilise the road network from industrial operations to the rail line.

Townsville port

Expansion of the bulk commodities terminal to increase export capacity out of the north west minerals province.

Electrification

State energy infrastructure electrification is the biggest opportunity to decarbonise Queensland's aluminium industry. The bauxite-alumina-aluminium industry is also critical for the secure supply of gallium and HPA.

BULK COMMODITY CAPACITY

RENEWABLE ENERGY

Water infrastructure

Water and renewable energy infrastructure to facilitate development, mining and processing of critical minerals deposits across Queensland.

WATER INFRASTRUCTURE

Power to the regions

Upgrade and improve the reliability of electricity supply to regional centres, and the mining and the manufacturing hubs that sustain them.

Brisbane

Electricity transmission

Transmission and renewable energy infrastructure in central west New South Wales to unlock Sunrise Energy Metals' project and ASM's Dubbo REE project.

WATER DESALINATION

ELECTRICITY TRANSMISSION

INFRASTRUCTURE STUDY

Sydney

Infrastructure study

Investigate options for common user infrastructure to support a critical minerals mining and processing precinct in the Parkes region.

NSW port access

Port access arrangements, including terms and conditions of access, to enable a broader range of minerals and materials to be exported.

Adelaide

FREIGHT RAIL UPGRADES

Melbourne

Rail infrastructure

Review the Murray Basin Freight Rail Project to ensure the Murray Basin mineral sands projects will be well served by freight rail upgrades underway.

Rail access to ports

Connect potential mine sites to rail heads or allow road freight of mine products access to ports of Geelong or Portland.

Geological database

Increase Tasmania's capacity to hold, store and conduct analysis on core samples, geological data and other mineral samples.

Hobart

Storage facility

Expand undercover critical minerals storage facility at Burnie Port.

Processing facilities

Common user facilities in Victoria, such as a heavy mineral concentrate separation plant or a pilot plant similar to Queensland's common user model.

Resourcing tomorrow
Australian Mining
minerals.org.au

Electric vehicles

Top producers, select minerals (2023)

Supply chain

Fe Iron
1 **Australia**
2 Brazil
3 China

Dy Dysprosium
1 **China***
2 United States
3 Burma

Cu Copper
1 **Chile**
2 Peru
3 Congo

Pt Platinum
1 **South Africa**
2 Russia
3 Zimbabwe

Au Gold
1 **China**
2 Australia/ Russia
3 Canada

Ti Titanium
1 **China**
2 Japan
3 Russia

ELECTRIC MOTOR

An electric motor contains close to 2 km of copper wiring used to convert electric energy into mechanical energy.

Copper Development Association

SENSORS

An electric vehicle uses six times more minerals than a conventional car and are on average 340 kg heavier.

International Energy Agency

CAR FRAME

Mn Manganese
1 **South Africa**
2 Gabon
3 Australia

V Vanadium
1 **China**
2 Russia
3 South Africa

Mo Molybdenum
1 **China**
2 Chile
3 Peru

CHASSIS

Al Aluminium
1 **China**
2 India
3 Russia

Mg Magnesium
1 **China**
2 Kazakhstan
3 Brazil/ Israel

Zn Zinc
1 **China**
2 Peru
3 Australia

* Rare earth elements are mined together. Separation of rare earth elements occurs during later processing.

† Carbon in the form of graphite.

USGS reports inadequate information to make reliable estimates of world production of germanium.

1 **China**
2 Brazil
3 Norway

1 **China#**
2 N/A
3 N/A

1 **China**
2 Morocco
3 United States

Si Silicon

Ge Germanium

P Phosphorus

MICROCHIPS

China accounts for 98 per cent of global gallium production and 68 per cent of the world's refined germanium.

USGS

Li Lithium

Ni Nickel

BATTERIES

Co Cobalt

Mn Manganese

C Carbon†

Let's take a closer look at...

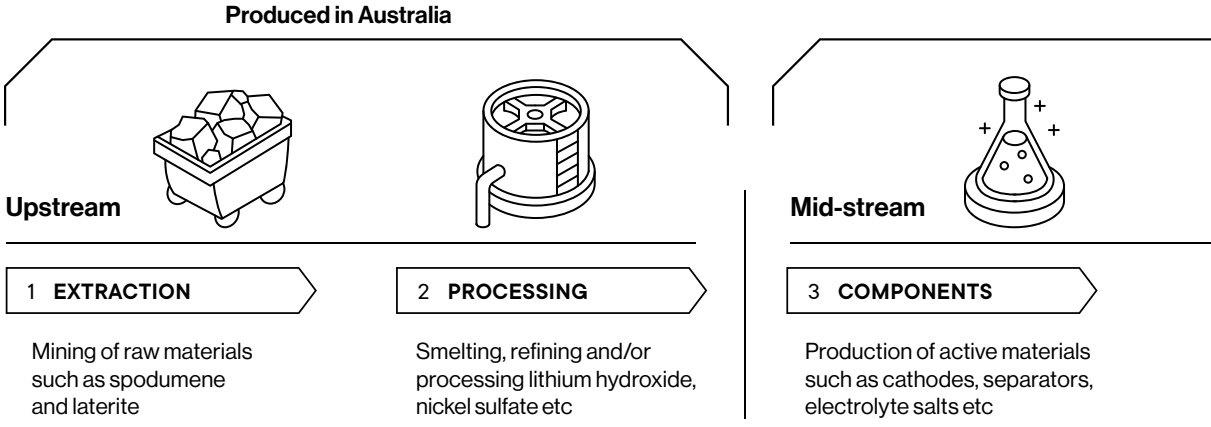
SOURCE
United States Geological Survey, *Mineral Commodity Summaries 2024*

1

Batteries

Batteries have transformed the way we power the modern world. Everything from EVs to public transportation, consumer electronics and medical devices to industrial tools, depend on the versatility of batteries. Batteries are also increasingly important in home energy systems and the power sector. Large grid-scale batteries can help to reduce the variability of renewable electricity from wind and solar generation, as well as preserve energy for peak periods or during blackouts. But global demand for the raw materials needed to produce batteries, such as lithium, nickel, cobalt, manganese and graphite, threatens to outpace supply. More than 260 new lithium, cobalt, nickel and copper mines will be needed by 2030 if the world is to meet global demand for minerals-intensive electric vehicles and energy storage batteries alone.

Battery supply chain
Select steps



SOURCE
Based on Li-Bridge, *Building a robust and resilient US lithium battery supply chain,* Argonne National Laboratory, 2023

Batteries

Australia has significant reserves of all critical battery minerals and is the global leader in lithium production.[20]

State of play in Australia

Australia's endowment of battery minerals gives local producers a comparative advantage. The availability of all battery minerals in one jurisdiction is unique among competitors. However, Australia currently has little footprint in manufacturing battery active materials, cell manufacturing or battery pack assembly.

While extraction of battery minerals takes place in Australia, the Democratic Republic of Congo and China, the technologies required to refine minerals into battery chemicals are concentrated in the hands of few. Processing and manufacturing of the raw materials into battery cells primarily takes place in China, South Korea and Japan.

Supply of battery minerals, however, is not keeping pace with global demand for batteries to power EVs and grid-scale storage systems forecast to grow at 34 per cent per annum to 2030.[21] This means there is growing potential for Australian mining, with both trade reliability and high ESG credentials, to export more battery minerals and materials to emerging EV and energy storage system manufacturers.

Barriers facing Australia

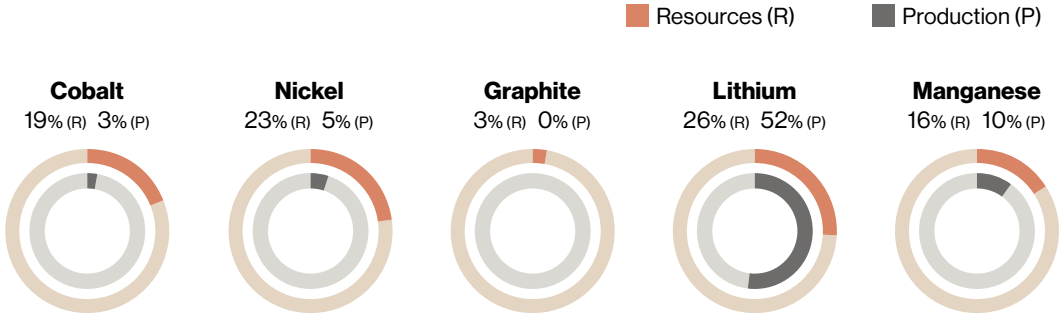
Australian mining is already facing increased competition from the industry policies of other mining jurisdictions which is working against our comparative advantage. For example, the impact of Chinese investment into the Indonesian nickel industry resulted in the mothballing of some Australian mines, and greater uncertainty delaying or putting off new project development.

Narrow margins and high capital costs of refining and processing critical minerals and battery active materials underscores the importance of both scale and productivity. This means new investment will only be underwritten on the basis of access to the necessary volumes of domestic feedstock to achieve minimum efficient scale, and growth in new demand centres with long-term marketing arrangements in place.

Creation of an end-to-end battery industry capability will also require an industry complex that brings together expertise in geology, metallurgy, chemistry and engineering to focus research and development effort in transforming Australian minerals into battery active materials.

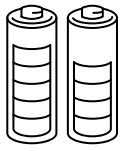
FIGURE 11

Australia has an abundance of battery minerals
World share of resources and production, 2022

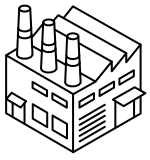


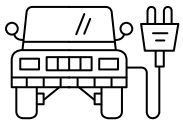
SOURCE
Geoscience Australia, *Australia's Identified Mineral Resources 2023,* March 2024

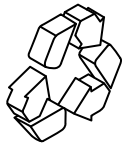
Dominated by China, Japan, the US and the EU



Downstream







4 BATTERY CELL

Fabrication of battery cells

5 MODULE & PACK

Assembly including electronics, sensors and management system

6 END PRODUCT

Integration of battery system into end product

7 REUSE & RECYCLING

Recovery, reuse and recycling of used batteries

THE SOLUTION

Minerals+

The Federal Government's **Critical Minerals Production Tax Incentive** is targeted at creating additional downstream processing of feedstock from Australian critical minerals. And the government's **National Battery Strategy** and its initiatives highlights the need to create new projects and new technologies to develop Australian industries further down the battery value chain. Deeper investment in battery minerals mining projects, and leveraging off mining's comparative advantage, will give full effect to these initiatives.

NEXT STEPS

+ Boost feedstock through new battery mineral mines

Bring more high quality mines online. This will require policy settings which encourage new mining investment through lower cost energy and infrastructure services, access to flexible labour markets, streamlined approvals, and certainty in climate and taxation policy frameworks.

+ Extend the scope of strategic partnerships to battery active materials

Build on critical mineral bilateral agreements with the US, UK, India, Japan, Republic of Korea, France and Germany, and develop new arrangements within emerging east Asian manufacturing centres, to reach a larger market for Australia's high quality ESG critical minerals, as well as battery active materials.

+ Promote Australian mining's high quality ESG performance

Look for opportunities to raise the international profile of the Australian mining industry's commitment to high quality ESG outcomes. Markets that value the industry's high ESG credentials will attract more investment in mining, processing and refining.

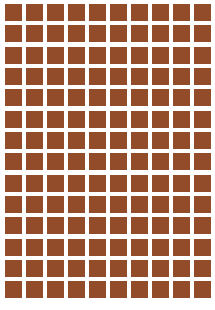
+ Link battery technology investment to mining R&D

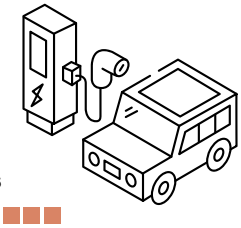
Draw on the Australian mining industry's expertise in geology, metallurgy and chemistry to tailor new battery technology to Australian conditions in collaboration with the government's Powering Australia Industry Growth Centre.

FIGURE 12

The battery minerals shortfall demands hundreds of new mines by 2030

Global demand driven by electric vehicles and energy storage batteries





SOURCE

S&P Global, *Metal producers will need to double capex to meet net zero by 2050*, 2020; IEA, *The Role of Critical Minerals in Clean Energy Transitions*, 2022

Renewable energy

Top producers, select minerals (2023)

1 **China***
2 Burma
3 Other REE producers

1 **Chile**
2 Peru
3 Congo

1 **South Africa**
2 Russia
3 Zimbabwe

Pt Platinum

Cu Copper

Y Yttrium

1 **Turkey**
2 Chile
3 China/Peru

1 **Australia**
2 South Africa
3 China

1 **Kazakhstan**†
2 Canada
3 Namibia

HYDROGEN

When hydrogen is used to produce energy, the only thing it leaves behind is pure H_2O as a byproduct.

US Department of Energy

U Uranium†

Zr Zirconium

B Boron

NUCLEAR ENERGY

The zirconium used in jewellery is also a superstar in nuclear reactors – used to encase fuel rods for safe, stable energy production.

World Nuclear Association

SOLAR PANELS

Si Silicon

Cd Cadmium

Te Tellurium

1 **China**
2 Brazil
3 Norway

1 **Chile**
2 Rep of Korea
3 Japan/Canada

1 **China**
2 Japan/Russia
3 Canada

HYDROELECTRIC

Fe Iron

C Carbon

Mn Manganese

1 **Australia**
2 Brazil
3 China

1 **China**
2 India
3 Indonesia

1 **South Africa**
2 Gabon
3 Australia

Supply chain

* Most of the world's yttrium production took place in China and Burma (USGS). Yttrium is a rare earth element. Rare earth elements are mined together and separated during processing. China, the United States and Australia are the top 3 producers of rare earths globally.

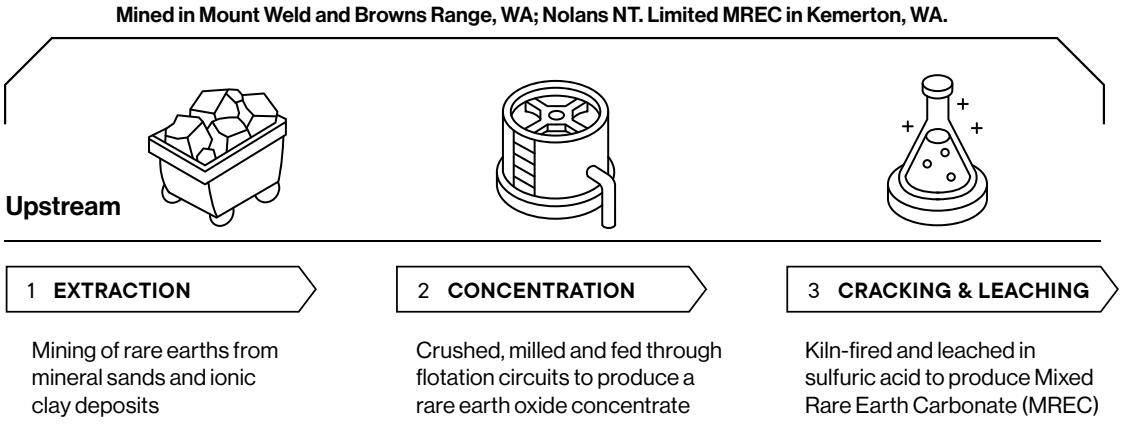
† Uranium producer rankings from World Nuclear Association.

2

Magnets

Permanent magnets are made from alloys of rare earth elements. These powerful magnets drive energy efficient motors in wind turbines and EVs, reducing power consumption and greenhouse gas emissions. The rare earths are a group of 17 elements, including scandium, yttrium, and the lanthanides. Of the lanthanides, neodymium, praseodymium, dysprosium and terbium are most in demand because they are essential to the production of advanced technologies. Other high tech applications for permanent magnets can be found in defence, medicine, aerospace, agriculture, catalysis, and the chemical industry. And while the name might suggest otherwise, rare earths are actually quite plentiful. Extraction and separation is expensive, however, and energy, chemical and water intensive.

Magnet supply chain
Select steps



SOURCE
Based on similar by Goldman Sachs Global Investment Research and Wood Mackenzie

Magnets

Australia has a rich endowment of rare earth elements critical to new and emerging clean energy technologies.

State of play in Australia

Australia is ranked third in the world for global production of REE, and also holds the world's sixth largest reserves of the in-demand elements. One of the world's richest deposits high in neodymium and praseodymium is in Mount Weld, Western Australia. Other abundant reserves are at Browns Range, also in Western Australia, as well as the Nolans Project near Alice Springs in the Northern Territory.[22]

Demand for permanent magnets is projected to surge – especially sintered neodymium-iron-boron magnets which are used in clean energy technologies. And with it, demand for REEs is expected to climb, extending to minerals such as neodymium, praseodymium and dysprosium which are critical for production of high-performance permanent magnets.[23]

While Australia has a comparative advantage in extraction and globally important reserves of these critical minerals, as well as world-leading ESG credentials important to potential customers and strategic partners, there are currently no separation operations in Australia.

Barriers facing Australia

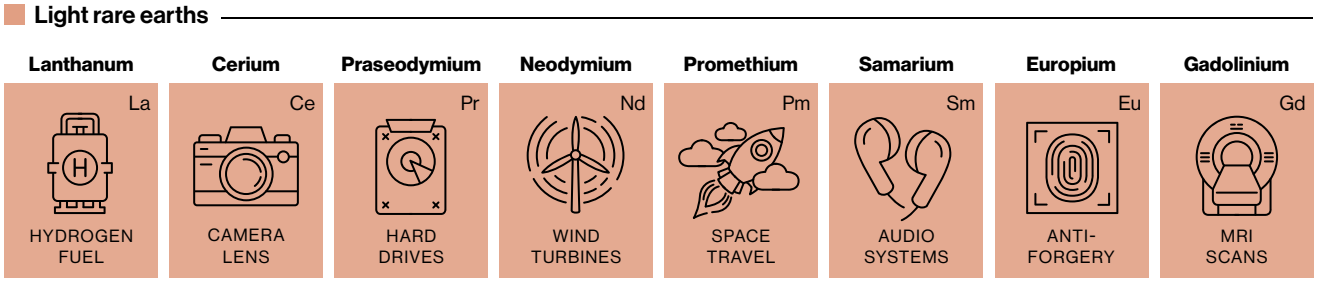
China's integrated REE complex covering extraction, processing and refining as well as magnet manufacturing is highly efficient, making it extremely difficult to compete against. While Australia has a comparative advantage in REE extraction, development of a fully integrated REE complex – whether located in Australia or coordinated with strategic partners – would strengthen competitiveness of new REE projects.

REE processing and refining is extremely complex. REEs are extracted and refined through dozens of chemical processes to separate the different rare earth elements and remove impurities, with each additional process adding to costs.[24] Energy costs loom large for REE and access to infrastructure is a key constraint in getting new projects over the line.

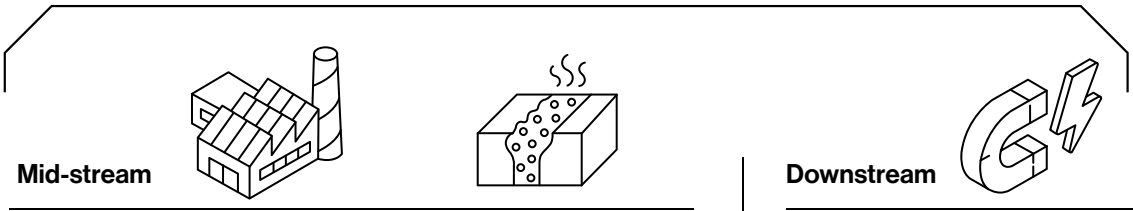
No two REE deposits are the same. Specialised technologies are tailored to each ore for refining.[25] Further downstream, Japan, China, South Korea and the US dominate property rights for bonded and sintered magnet technologies.[26] Stronger collaboration with magnet technology owners may open up greater Australian project possibilities.

FIGURE 13

Meet the rare earth elements
Common name, symbol and select applications



Dominated by China, the United States, Japan and South Korea.



Mid-stream

4 REFINING

Refined to produce NdPr oxide, Tb-Dy and other rare earth by-products

5 METAL/ALLOY

NdPr converted to metal/ alloy which is ready to be made into magnetic material

Downstream

6 MAGNET

High strength magnets produced and transported for assembly manufacture

7 END PRODUCTS

Magnets used in products such as wind turbines, EVs and electronics

THE SOLUTION

Minerals+

The **Critical Minerals Facility**, **Export Finance Australia**, **Northern Australia Infrastructure Facility** and the **Modern Manufacturing Initiative** have committed more than $2 billion in funding to rare earth mining and refining projects to boost Australian separated rare earth oxide production, including praseodymium, dysprosium, neodymium and terbium. By addressing key REE project constraints and leveraging off mining's comparative advantage, development of an internationally competitive integrated REE complex may be feasible.

NEXT STEPS

+ Boost exploration and develop rare earth elements reserves

Increase REE reserves and public information about the geology of new REE mineral deposits through provision of common user assay laboratories for quick testing of exploration samples for small explorers.

+ Streamline REE mining, processing and refining projects

Assist REE project proponents to navigate government projects through a single front door and make the approvals process less duplicative by delegating assessment of environmental approvals to state and territory governments.

+ Integrate REE mines into new international processing and refining complexes

Facilitate the transfer of magnet technologies and development of long-term contracting arrangements to build new REE complex in collaboration with strategic partners.

About REE

Rare earth elements are comprised of the lanthanide series on the periodic table, as well as Scandium and Yttrium. Of the 15 lanthanides, those with higher atomic numbers are typically referred to as heavy rare earth elements (HREE); those with low atomic numbers are light rare earth (LREE) – though classification is inconsistent between sources. Scandium and Yttrium are considered REE because they exhibit similar chemical properties and tend to occur in the same ore deposits as the lanthanides.

Heavy rare earths — **Other**

Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium	Scandium	Yttrium
Tb	Dy	Ho	Er	Tm	Yb	Lu	Sc	Y
LCD SCREEN	ELECTRIC VEHICLE	LASER EYE SURGERY	5G NETWORK	X-RAY MACHINE	SEISMIC MONITOR	CANCER THERAPY	AIRCRAFT	SATELLITE

Smartphones

Top producers, select minerals (2023)

Supply chain

Indium (In)
1 **China**
2 Rep of Korea
3 Japan

Tin (Sn)
1 **China**
2 Burma
3 Indonesia

Europium (Eu)
1 **China***
2 United States
3 Burma

Neodymium (Nd)
1 **China***
2 United States
3 Burma

Gadolinium (Gd)
1 **China***
2 United States
3 Burma

Nickel (Ni)
1 **Indonesia**
2 Philippines
3 Russia

TOUCHSCREEN

There are more than 40 minerals and precious metals in a smartphone.
National Museums Scotland

MICROPHONE

China accounts for 70 per cent of global rare earth ore extraction and 90 per cent of rare earth ore processing.
Centre for European Policy Studies

ELECTRONICS

Gold (Au)
1 **China**
2 Australia/ Russia
3 Canada

Copper (Cu)
1 **Chile**
2 Peru
3 Congo

Tantalum (Ta)
1 **Congo**
2 Rwanda
3 Brazil

CASING

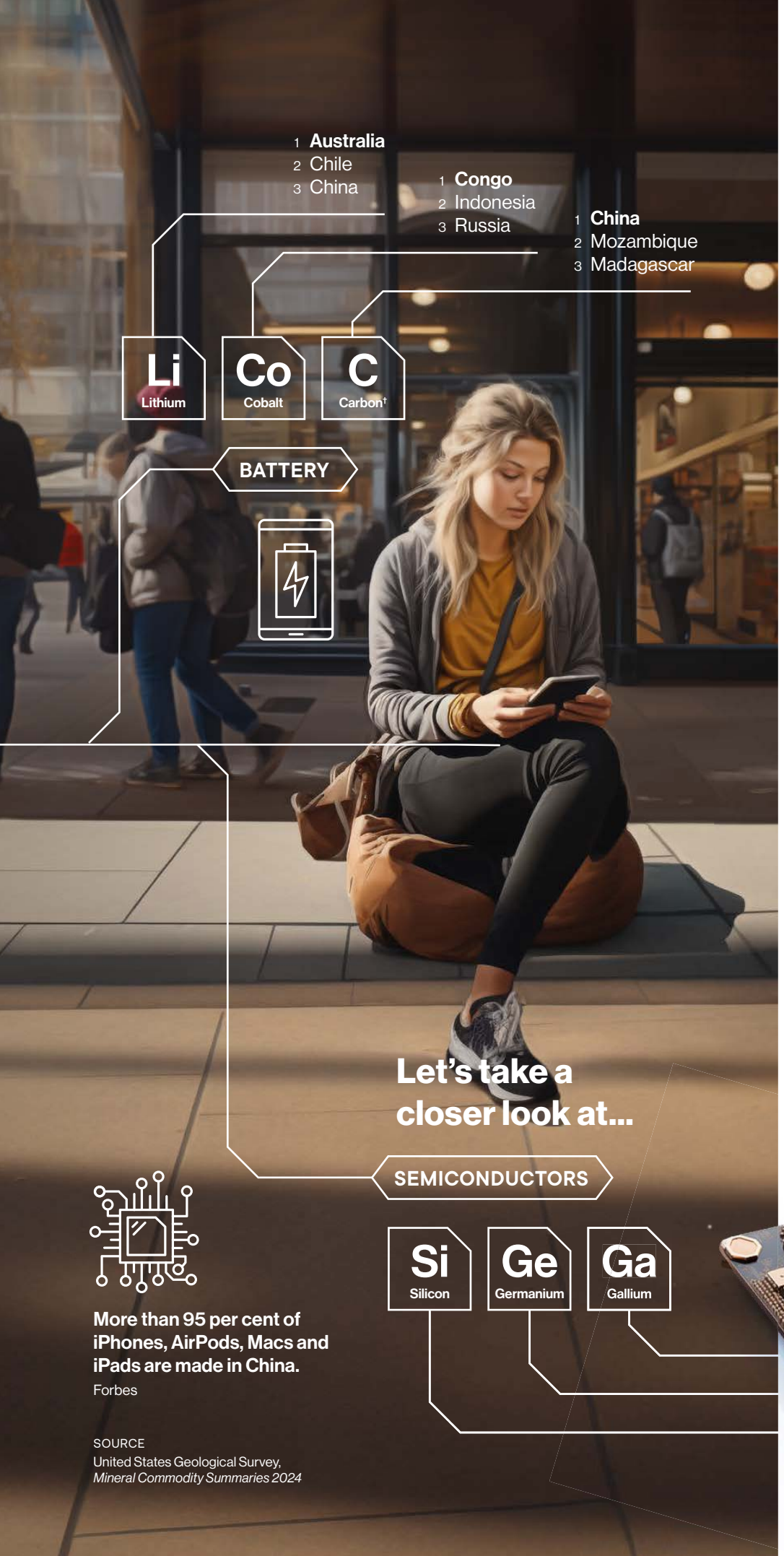
Aluminium (Al)
1 **China**
2 India
3 Russia

Magnesium (Mg)
1 **China**
2 Kazakhstan
3 Brazil/ Israel

Titanium (Ti)
1 **China**
2 Japan
3 Russia

* Rare earth elements are mined together. Separation of rare earth elements occurs during later processing.

† Carbon in the form of graphite.



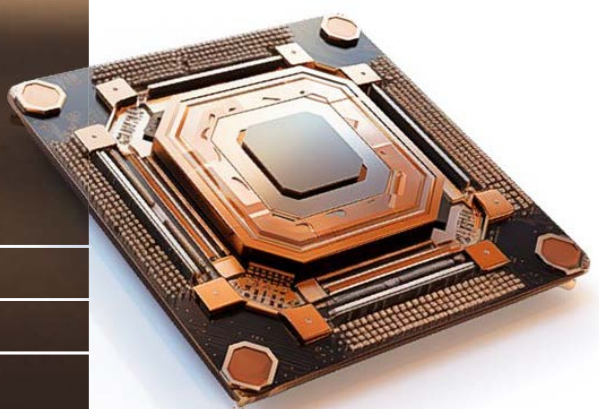
3

Semiconductors

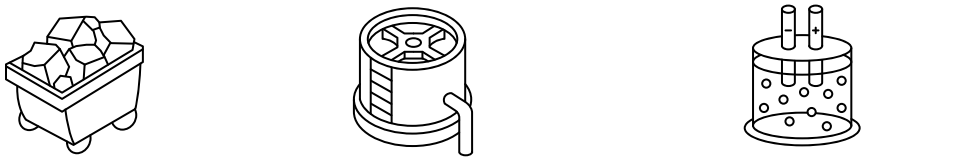
Semiconductors are the unsung heroes of the digital world. They power our cars, connect our homes, drive medical advancements – even send astronauts into space! Made from raw materials, including high purity polysilicon, germanium, gallium arsenide, and indium phosphide, semiconductors are a fingernail-sized slip of material that conducts electricity along millions of tiny circuits, enabling the seamless integration of technology into our everyday lives. Found in everything from smartphones to computers, dishwashers to pacemakers, spacecraft to fighter jets, semiconductors have revolutionised the way we live, work and communicate. As nations race to develop ever more advanced chips, which offer ever greater computing power, the semiconductor industry is not surprisingly on its way to becoming a trillion-dollar market by 2030.

More than 95 per cent of iPhones, AirPods, Macs and iPads are made in China.
Forbes

SOURCE
United States Geological Survey,
Mineral Commodity Summaries 2024



Aluminium supply chain
Select steps



Mining of bauxite, the raw material for aluminium

Bauxite is crushed and alumina extracted using a chemical solution and high temperatures

Alumina is smelted into aluminium through a process of electrolysis

SOURCE
Based on similar by Australian Aluminium Council

Semiconductors

Australia has an untapped opportunity to extract and process gallium, germanium and other critical minerals from existing bauxite, alumina and zinc operations.

State of play in Australia

Australia has significant reserves of all the raw minerals and metals used in semiconductors and a comparative advantage in finding and producing the bauxite, zinc and other ores that contain them.

While extraction and processing takes place in Australia, China is the world's leading producer of gallium, germanium, indium and polysilicon, driven largely by its processing and refining capacity. Japan and South Korea also produce the refined materials, giving them more control over key inputs to their electronics industries. [27]

However, supply of semiconductor materials is not keeping up with global demand – a situation expected to worsen as technological advances in defence, modern life and the transition to net zero accelerates. This presents an opportunity for Australia to extract more value from the bauxite, zinc and other ores it exports. Supply of these minerals critical to future industries face challenges on multiple fronts, including increasing geopolitical tensions, the ongoing race for technology leadership, and the fear of capacity overbuilding.

Barriers facing Australia

Australia's mineral processing, refining and smelting is already facing energy and other cost pressures that are working against the expansion of zinc, alumina and aluminium processing and manufacturing. Narrow margins, aging plant and high capital and energy costs can make it uneconomic to construct and expand existing plant to extract and process trace commodities such as germanium, gallium and indium.

This means that new investment will only be underwritten on the basis of competitive prices for the primary material (zinc, alumina and aluminium), access to the necessary feedstock to achieve minimum efficient scale with long-term supply arrangements in place, including through support from strategic partner economies seeking supply chain security.

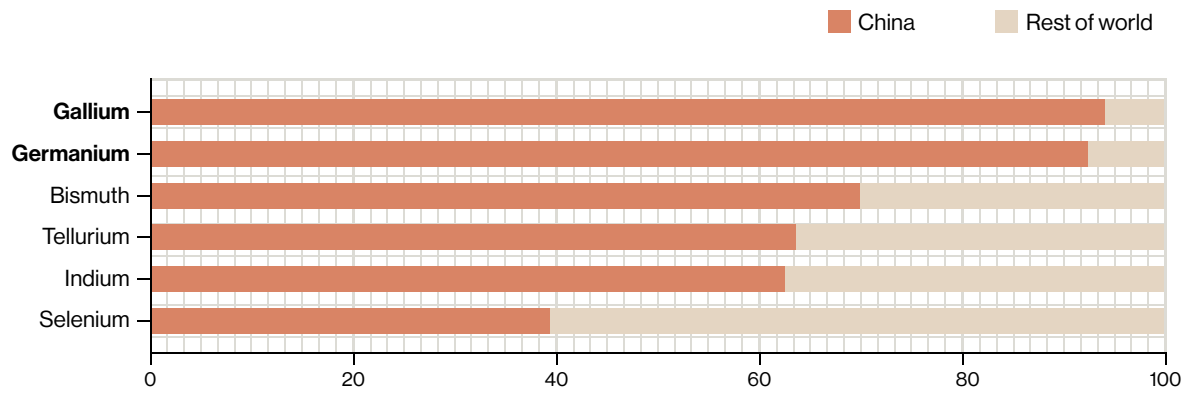
Creation of a semiconductor materials industry in Australia will also require industrial capability that brings together expertise in metallurgy, chemistry, engineering and electronics to focus research, development and product verification.

98%

Gallium production
China produces about 98 per cent of the world's gallium.
Source: USGS

FIGURE 14

China controls a large share of critical minerals supply
World share of production, %



SOURCE
Bloomberg with British Geological Survey; European Commission

Mid-stream

4 SEMI-FABRICATION

Aluminium is turned into rods, sheets, castings, extrusions, pigments and powders

Downstream

6 END PRODUCTS

Everything from housing and transportation to whitegoods and electronics

7 RECYCLING

Aluminium is infinitely recyclable – about 75% ever produced is still in use today

No.1

Bauxite miner

Australia is the world's largest bauxite producer, and second largest producer of alumina.
Source: USGS

THE SOLUTION

Minerals+

Policies to achieve net zero emissions and economic resilience through energy intensive processing, together with domestic economic reform to improve global competitiveness, will help Australia move further along the supply chain towards semiconductor materials manufacture. Activation of key **strategic partnerships** will also be central to this outcome, including through collaboration with South Korean and Japanese governments, use of the US Defense Production Act and the European supply collaboration under the **Critical Raw Materials** security funding mechanism.

NEXT STEPS

+ Invest in common user energy infrastructure

Utilise the government's common user infrastructure plan to map the energy requirements for gallium and germanium extraction and identify suitable locations for investment in energy generation infrastructure.

+ Include semiconductor materials in sector planning

Assess the feasibility of integrating semiconductor materials mining, processing and refining through sector planning and build eligibility through government programs aiming to achieve net zero and economic resilience.

+ Strengthen strategic partnerships with key partners

Drive government and private investment into the establishment of alternative and secure supply chains for semiconductor materials through stronger partnerships with key trading partners.

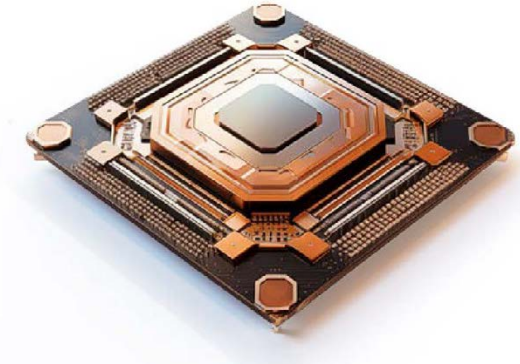
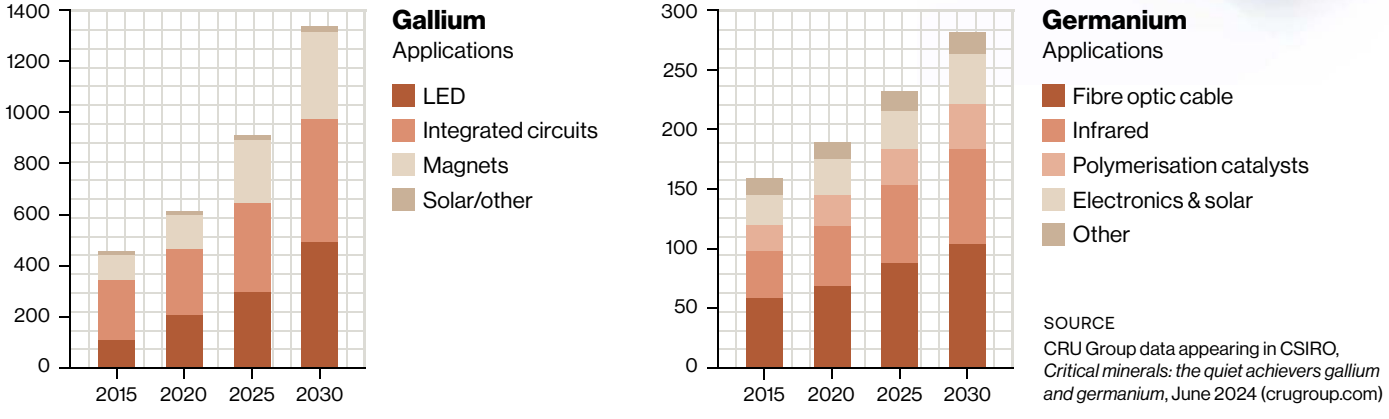


FIGURE 15

Demand by application for gallium and germanium
2015-2030, tonnes



SOURCE
CRU Group data appearing in CSIRO, *Critical minerals: the quiet achievers gallium and germanium*, June 2024 (crugroup.com)

Around the home

Top producers, select minerals (2023)

1 **China**
2 Australia
3 Mexico/United States

1 **China**
2 Tajikistan
3 Turkey

1 **China#**
2 N/A
3 N/A

Ge Germanium

Sb Antimony

Pb Lead

1 **China***
2 United States
3 Burma

1 **China**
2 Rep of Korea
3 Japan

1 **China**
2 Russia
3 Japan

HOME SECURITY

Ga Gallium

In Indium

Ce Cerium

Rare earth elements in LEDs produce vivid colours while consuming far less energy than traditional bulbs.

US Department of Energy

LED LIGHTING

Minerals like bismuth melt at low temperatures, triggering fire sprinklers to release water and stop fires before they spread.

Scienceviews.com

FIRE SPRINKLERS

Bi Bismuth

Sn Tin

Cd Cadmium

1 **China**
2 Laos
3 Rep of Korea

1 **China**
2 Burma
3 Indonesia

1 **China**
2 Rep of Korea
3 Japan/Canada

WHITEGOODS

C Carbon

Cr Chromium

Si Silicon

1 **China**
2 India
3 Indonesia

1 **South Africa**
2 Turkey/ Kazakhstan
3 India

1 **China**
2 Brazil
3 Norway

Supply chain

* Rare earth elements are mined together. Separation of rare earth elements occurs during later processing.

\# USGS reports inadequate information to make reliable estimates of world production of germanium.

SOURCE
United States Geological Survey,
Mineral Commodity Summaries 2024

4

Energy generation

Reliable, affordable and decarbonised energy systems are essential for reducing global emissions to net zero by mid-century. The path to net zero economies is by increasing electrification supplied by clean energy. The transformation of energy systems requires an immense upscaling and rapid deployment of clean energy technologies. A mix of generation technologies ranging from renewables and nuclear energy to fossil fuels (coal and gas) combined with carbon capture and storage is needed to deliver a reliable, affordable clean energy future. Intermittent wind and solar, and the battery storage to support them, are materials intensive and cannot be built without a massive increase in the supply of energy-related materials, including critical minerals.

The looming challenge
Based on AEMO ISP Step Change

90 GW
Current capacity

2025

Australia's current electricity capacity requirements.

82%
Renewables pledge

2030

Australian Government's 2030 renewables target.

20 GW
Coal retirement

2035

Approximate coal-fired power retirements by 2035.

Period of risk

- **Coal is retiring faster than announced**

Energy generation

A massive upscaling in mining activities will be required to meet clean energy ambitions at home and abroad.

Energy is fundamental

Australia needs least-cost and secure energy to build on our comparative strengths in mining, attract new investment and leverage downstream opportunities. As major energy users, mining companies are decarbonising their operations and contributing in a meaningful way through the minerals they mine to the clean energy transition.

Materials-intensive clean energy technologies such as renewables and batteries, along with coal and gas with CCUS, nuclear and hydrogen will be critical with global electricity demand projected to at least double to 54,000 TWh by 2050.[28]

In Australia, demand for reliable, low cost energy has also never been higher. Data centres and AI is only adding to demand – an AI internet search uses almost 10 times the electricity of a standard search.[29] Data centres are already using around 5 per cent of electricity from the national grid. One large data centre can draw as much energy as 50,000 homes.[30]

Barriers facing Australia

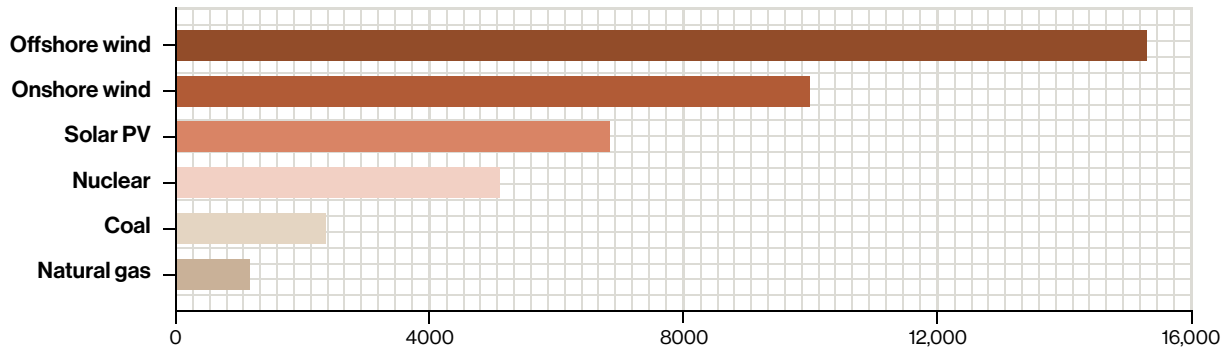
Difficulty in predicting the global deployment of clean energy technologies elevates uncertainty and raises already high investment hurdles for Australian mining and minerals processing projects. Policy settings that reduce profits or constrain activity impede mining investment and the industry's productivity and competitiveness at a time when a significant scale-up in global minerals demand is expected.

Constraining clean energy systems to rely largely on weather dependent renewables and battery and hydro storage technologies risks raising the cost base and reducing the international competitiveness of Australia's mining and minerals processing operations today and in the future.

Legislated Commonwealth, state and territory prohibitions on nuclear activities also jeopardise Australia establishing comparative advantages in industries requiring process heat, such as hydrogen production or green metals.

FIGURE 16

Minerals intensity of select energy generation sources
Power capacity (kg per MW)



SOURCE
IEA, *The Role of of Critical Minerals in Clean Energy Transitions*, 2022

6700 km
Transmission lines

2040

Needed to be built by 2040 to connect renewables to the grid.

183 GW
More wind & solar

2045

Three times more wind and solar energy capacity by 2045.

294 GW
Planned capacity

2050

Australia's required energy capacity must treble by 2050.

SOURCE
AEMO, *2024 Integrated System Plan*, Canberra May 2024

- **Renewables roll out plagued by delays and high costs**
- **Nuclear energy can support renewables beyond 2050**

THE SOLUTION

Minerals+

The Federal Government aims to establish comparative advantages in industries including renewable hydrogen, critical minerals processing and green metals (iron, steel, alumina and aluminium). The **Capacity Investment Scheme** encourages new investment in renewable generation, such as wind, solar and battery storage. Lifting the nuclear ban would allow private investors to consider nuclear energy as part of the future energy mix. This may provide the firmed up supply that the **National Energy Market** needs to meet the ambitious renewable energy targets and support continued transition well beyond 2050.

NEXT STEPS

+ Remove the legislated Commonwealth, state and territory prohibitions on nuclear activities

Agree a legislative agenda with the states and territories to allow the establishment of a nuclear industry. Nuclear power can provide reliable, clean energy needed for the net zero transition. It can also provide process heat for existing and new industrial applications.

+ Consider all clean technology options in making energy policy

Assess all technology options able to deliver least-cost, reliable and clean energy systems for the success of government's priority industries, while ensuring Australian mining and minerals processing are not competitively disadvantaged.

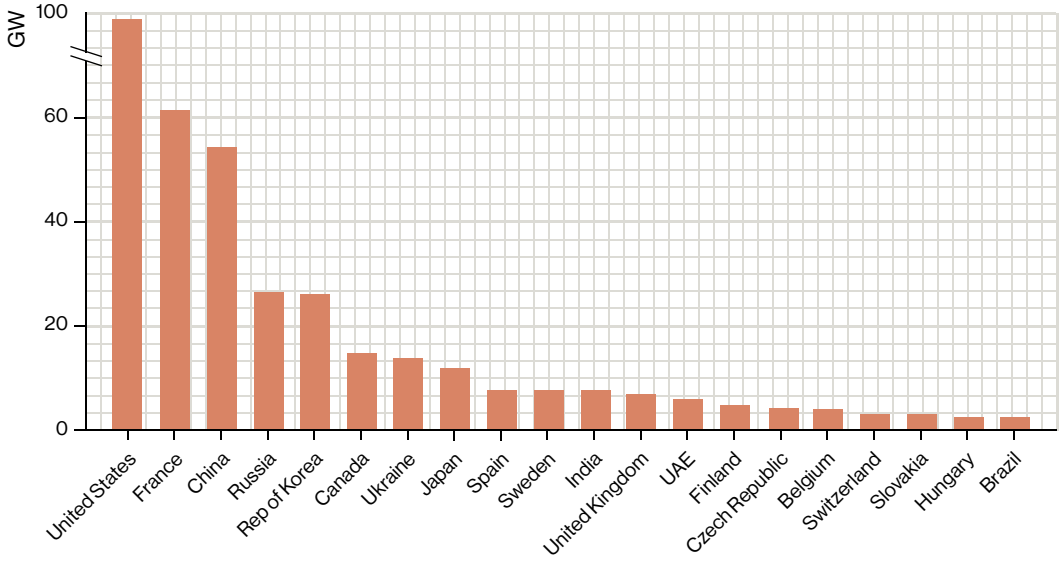
+ Strengthen Australian mining in new clean energy supply chains

Avoid policy uncertainty, overlap and duplication affecting mining at Commonwealth and state and territory levels to reduce impediments to investment. This includes tax and royalty settings, emission reduction obligations and project approvals.

FIGURE 17

Every advanced economy relies on nuclear energy – except Australia

Total nuclear capacity by country, 2024



440
Nuclear reactors

Operating safely in 32 countries, with 60 new reactors under construction and a further 110 planned.
Source: World Nuclear Association

SOURCE
International Atomic Energy Agency, Power Reactor Information System database, accessed August 2024

FIGURE 18

Australia's rich endowment of future critical minerals

EDR 2022, production and world share rankings

C Australia's Critical Minerals List S Australia's Strategic Minerals List

	Antimony	Bauxite	Black coal
Resources	139.4 kt (▲2%)	3521 Mt (▼1%)	72,875 Mt (▼3%)
World rank (resources)	6 (7% share)	3 (12%)	4 (10%)
Production	2.3 kt (▲9%)	102.3 Mt (▼1%)	520 Mt (▼6%)
World rank (production)	6 (2% share)	1 (27%)	5 (6%)

	Cobalt	Copper	Fluorine
Resources	1742 kt (▲10%)	101.50 Mt (▲1%)	343 kt (0%)
World rank (resources)	2 (19%)	2 (11%)	9 (minor)
Production	5.8 kt (▲9%)	0.82 Mt (0%)	Minor
World rank (production)	4 (3%)	8 (4%)	Minor

	Gold	Graphite	Ilmenite (Titanium)
Resources	12,159 t (▲1%)	8.5 Mt (▲6%)	303.3 Mt (▲11%)
World rank (resources)	1 (22%)	8 (3%)	2 (27%)
Production	306 t (0%)	Minor	0.7 Mt (▲34%)
World rank (production)	3 (10%)	Minor	6 (5%)

	Iron ore	Lead	Lithium
Resources	58,286 Mt (▲3%)	34.81 Mt (▼3%)	7046 kt (▲5%)
World rank (resources)	1 (31%)	1 (42%)	2 (26%)
Production	945 Mt (▲2%)	0.44 Mt (▼10%)	75 kt (▲36%)
World rank (production)	1 (35%)	2 (10%)	1 (52%)

	Magnesium	Manganese	Molybdenum
Resources	284 Mt (▼2%)	496 Mt (▲79%)	687 kt (▲5%)
World rank (resources)	4 (4%)	4 (16%)	5 (6%)
Production	0.5 Mt (▼44%)	4.5 Mt (▼8%)	0.277 kt (n.a.)
World rank (production)	9 (2%)	3 (10%)	Minor

	Nickel	Niobium	Platinum
Resources	24.1 Mt (▲11%)	216 kt (0%)	359.3 t (▲45%)
World rank (resources)	1 (23%)	Unknown	Minor
Production	0.16 Mt (▲3%)	n.a	0.492 t (▲5%)
World rank (production)	5 (5%)	Unknown	Minor

	Potash	Rare earths	Rutile (Titanium)
Resources	47.3 Mt (▲7%)	5.70 Mt (▲34%)	39 Mt (▲15%)
World rank (resources)	12 (1%)	6 (4%)	1 (65%)
Production	<0.1 Mt (n.a.)	0.016 Mt (▼30%)	0.2 Mt (▲5%)
World rank (production)	Minor	3 (5%)	1 (27%)

	Scandium	Silver	Tantalum
Resources	36.65 kt (0%)	93.65 kt (▼1%)	110 kt (▲5%)
World rank (resources)	Unknown	2 (17%)	Unknown
Production	0 kt (0%)	1.17 kt (▼12%)	0.1 kt (0%)
World rank (production)	Minor	8 (5%)	5 (4%)

	Tin	Tungsten	Uranium
Resources	623 kt (▲6%)	568 kt (0%)	1236 kt (▲1%)
World rank (resources)	4 (13%)	2 (15%)	1 (32%)
Production	9.0 kt (▲2%)	0.23 kt (▼8%)	4.555 kt (▲20%)
World rank (production)	8 (3%)	Minor	4 (9%)

	Vanadium	Zinc	Zircon
Resources	8510 kt (▲5%)	64.30 Mt (▼3%)	88.3 Mt (▲12%)
World rank (resources)	2 (32%)	1 (31%)	1 (74%)
Production	0 kt (0%)	1.24 Mt (▼6%)	0.5 Mt (▼10%)
World rank (production)	Minor	3 (10%)	2 (25%)

FIGURE 19

Other minerals on Australia's Critical Minerals List and Strategic Minerals List

Data unknown or primarily a by-product of other metals and minerals processing

SOURCE

Geoscience, *Australia's Identified Mineral Resources 2023*, Canberra 2023

High purity alumina

A 99.99% or higher form of aluminium oxide.

Arsenic

By-product of smelting process for metal ores.

Beryllium

By-product of coal combustion and blasting.

Bismuth

By-product of metal refining (i.e. lead, copper, tin, silver).

Chromium

Produced by reducing chromite in a furnace.

Gallium

By-product of processing bauxite and zinc ores.

Germanium

By-product of zinc ore processing.

Hafnium

By-product of zirconium processing.

Indium

Primarily a by-product of zinc metal processing.

Rhenium

Rhenium is extracted from molybdenum.

Selenium

By-product of base metal mining and processing.

Silicon

Silicon is extracted from the mineral quartzite.

Tellurium

By-product of electrolytic refining of copper and lead.

Aluminium

Smelted from alumina which is refined from bauxite ore.

Phosphorus

Extracted from phosphate rock minerals.

Conclusion

A significant increase in mining investment is required if Australia is to position itself as a world-leading supplier of future critical minerals.

The Australian mining industry's real net capital stock has plateaued over the past seven years and the new mining investment expected to flow to the economy has not occurred.

The problem lies in Australia's investment environment. Committing to mining projects involves considerable risk to capital. Commodity price volatility, a high cost base and growing uncertainty make investment decisions highly sensitive to policy settings.

Many advanced economies are now embracing clean energy industry policies to shape their economies and capture opportunities as the world transitions to net zero emissions. Industry policies do not guarantee sustainable economic benefits. Misallocation of public funding and risk-taking in the pursuit of growing and shaping industries can quickly turn potential benefits into wasteful outcomes.

Good policy is critical and effective alignment to outcomes, as well as striking the right balance between the roles of the private and public sectors, is crucial.

A Minerals-plus investment strategy is an ongoing commitment to the sound, productivity-enhancing policies that builds on and leverages Australia's comparative advantages in mining that has made the Australian minerals industry a global leader. It enables new comparative advantages in downstream activities, such as minerals processing, refining and mining-related manufacturing.

Policy must also aim to continually improve investment conditions for mining. This includes delivering internationally competitive tax settings, expanded trade and investment opportunities, efficient and effective regulatory settings, productive workplace arrangements, an efficient transformation to net zero emissions and industry-focused skills and training.

In addition, well targeted policies and public investment to augment private capital in mining and leverage downstream opportunities in sectors connected to mining will help unlock private sector investment and drive greater potential value-add.

In some cases, sticking to current policy will make a difference. Providing certainty on policy settings can attract new investment and keep existing investment, such as retaining the fuel tax credit scheme and making changes to avoid duplicative and overlapping federal and state emissions reduction policies.

In other cases, small policy changes may catalyse large amounts of private sector investment. Large returns on public investment can be achieved by helping junior explorers more efficiently find the mines of the future, making it easier for project proponents through access to an effective single front door, or having more efficient state and federal approvals processes.

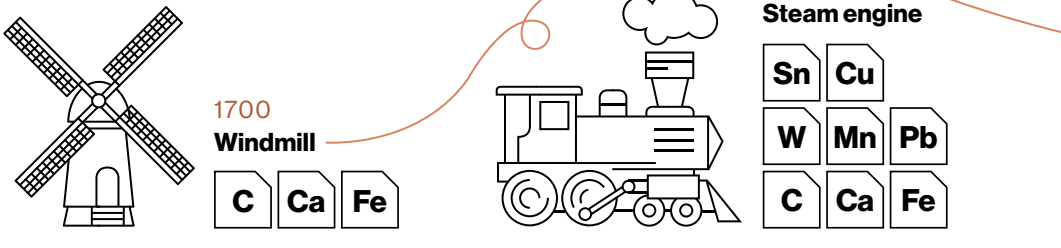
Government can also play a greater role through initiatives that crowd-in investment, such as creating new markets with strategic partners for mining, minerals processing and refining and providing common user infrastructure to bring forward capital investment.

A Minerals-plus investment strategy gives Australia the best chance of successfully responding to industry policies in other countries by ensuring mining remains a vital pillar of our nation's prosperity, now and into the future.

FIGURE 20

Energy through the ages

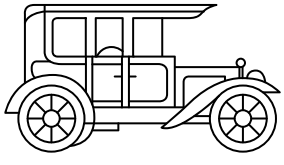
How resource intensity has changed with the advent of new energy generation



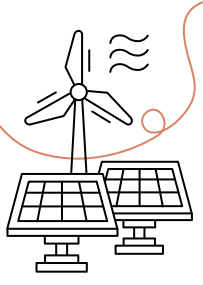
SOURCE

Based on Reuter & Van Schaik, *Evolution de la diversité des métaux utilisés dans les technologies*, 2016

1900
Combustion engine



Pt	Si	Th	Ti	V
Sn	Cu	Mg	Mo	Ni
W	Mn	Pb	Co	Cr
C	Ca	Fe	Al	Ree



2000 **Renewable energy**

Pt	Si	Th	Ti	V	Pd	Rh	Ta	Te
Sn	Cu	Mg	Mo	Ni	U	Ru	In	K
W	Mn	Pb	Co	Cr	Li	Nb	P	Re
C	Ca	Fe	Al	Ree	Ge	Ga	Cd	Ag

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