



Australian Government
The Treasury

Future Made in Australia

National Interest Framework

Supporting paper

14 May 2024



Executive Summary

The strong fundamentals that have underpinned Australia's past economic success will continue to be fundamental to Australia's competitiveness. However, the net zero transition and heightened geostrategic competition are transforming the global economy. These factors are changing the value of countries' natural endowments, disrupting trade patterns, creating new markets, requiring heightened adaptability and rewarding innovation.

Australia's comparative advantages, capabilities and trade partnerships mean that these global shifts present profound opportunity for Australian workers and businesses. Our abundant natural assets and resource endowments create significant opportunities to foster new globally competitive industries that can boost our economic prosperity and resilience, while supporting decarbonisation. When combined with Australia's strong trade partnerships, fair and competitive markets and commitment to open trade and international investment, this will help make Australia an indispensable part of global supply chains.

The *Future Made in Australia* agenda takes steps to foster and encourage the significant private sector investment into priority industries necessary to harness these opportunities and ensure our future prosperity. In certain circumstances, targeted public investment can strengthen the alignment of economic incentives with Australia's national interests and crowding-in private investment at scale to develop priority industries.

In considering the prudent basis for public investment, the following factors have been considered: Australia's grounds for lasting competitiveness, the role the industry will play in securing an orderly path to net zero and in building Australia's economic resilience and security, whether the industry will build key capabilities, and whether the barriers to private investment can be resolved through public investment in a way that delivers compelling public value.

These tests have informed the development of a National Interest Framework structured around two streams:

- The **Net Zero Transformation Stream** will include industries that will make a significant contribution to the net zero transition and are expected to have an enduring comparative advantage, and public investment is needed for the sector to make a significant contribution to emissions reduction at an efficient cost.
- The **Economic Resilience and Security Stream** will include industries where some level of domestic capability is necessary or efficient to deliver adequate economic resilience and security, and the private sector would not invest in this capability in the absence of public investment.

The Government will also apply Community Benefit Principles in relation to investments in priority industries. These principles will have a focus on investment in local communities, supply chains and skills, and the promotion of diverse workforces and secure jobs.



This paper outlines the National Interest Framework that provides rigour to Government decisions on significant public investments in industry on the basis of the national interest, particularly when they are used to incentivise private investment at scale. In this way, this Framework complements existing Government investment processes and policy frameworks, adding rigour to relevant policy assessments without replacing complementary processes.

To demonstrate its application, the paper also applies the Framework to the Government's plan to make Australia a Renewable Energy Superpower, providing a point in time assessment of how renewable hydrogen, green metals, low-carbon liquid fuels, processing and refining of critical minerals and manufacturing of clean energy technologies align with the principles identified in this Framework. The findings of this assessment support the meaningful but targeted incentives for private investment included in the 2024–25 Budget *Future Made in Australia* package.

The *Future Made in Australia* package also includes broader investments in the Government's growth agenda, including critical technologies, defence priorities, skills in priority sectors, a competitive business environment and reforms to better attract and deploy investment. Treasury will be responsible for the operation of the Framework and further details will be made available and consulted on as part of the *Future Made in Australia* legislative package.



A Future Made in Australia

The Government's 2023 Intergenerational Report identified five domestic and global forces that will continue to shape the trajectory and composition of Australia's economic growth over the next 40 years: population ageing; the rising demand for care and support services; technological and digital transformation; climate change and the net zero transformation; and geopolitical risk and fragmentation. The Government is acting across a range of fronts to respond to these forces and ensure our future prosperity, including through employment and industry policy.

Investing in modernising and diversifying Australia's industrial base is a core part of the Government's plan to make Australians the beneficiaries of the changing global economic and strategic landscape. The 2023 Employment White Paper outlined how coordinated industry and regional policy, combined with a strong enabling environment, policy certainty and leadership, can deliver a dynamic and inclusive labour market.

The *Future Made in Australia* package in the 2024–25 Budget delivers on this priority by attracting and enabling investment, making Australia a Renewable Energy Superpower, value adding to our resources and strengthening economic security, backing Australian ideas and investing in people and places. This includes targeted public investment to strengthen the alignment of economic incentives with Australia's national interests and incentivise private investment at scale to develop priority industries.

Achieving the global net zero transformation is a critical imperative. Policy decisions are needed to allow markets to internalise the negative externalities from emissions, drive efficient decarbonisation, spur long-term investment in clean, emissions-lowering technologies and industries, and seize the economic opportunities this transformation presents. This is a critical environmental challenge, but also provides a significant opportunity to attract private investment and ensure Australia becomes a more productive and competitive economy, by capitalising on our existing and emerging strengths and comparative advantages.

Intensifying strategic competition and rising geopolitical risks, combined with recent events such as the COVID-19 pandemic and recent conflicts around the world, have heightened the focus on economic resilience and security in most nations. This has been met with a renewal of industrial policies in many major economies. As a medium-sized open economy, Australia's economic prosperity is linked to the fortunes of the global economy, which is becoming increasingly fragmented. Strengthening critical global and domestic supply chains, including in some cases through a higher degree of domestic capability, will help to respond to these changes and improve our long-term economic security.

In navigating these structural changes in the global economy, Australia will continue to benefit from the strong foundations and institutions that have supported the strength and resilience of our economy over recent decades. Since the mid-1980s, predictable macroeconomic policy and an ongoing focus on fiscal sustainability have supported strong and sustainable growth, with low inflation and low unemployment. Microeconomic reforms that have promoted healthy competition and a strong commitment to free trade have lowered costs for households and business, provided access to global goods and services, and driven productivity improvements.



Australia has clear advantages

Australia is ideally placed to benefit from the global transitions underway, given our unique combination of strengths covering access to renewable energy sources, resources, research and development, human capital and strong international partnerships.

Our abundant natural assets and resource endowments create significant opportunities to foster new globally competitive industries that can boost our economic prosperity while supporting both domestic and global decarbonisation. In particular, our vast renewable energy potential provides the basis for sustained comparative advantage in new clean-energy-intensive industries.

Transforming Australia's electricity grid to one powered by low-cost renewable energy is a pre-requisite for capitalising on Australia's comparative advantage in producing cleaner, cheaper energy. The Government's Capacity Investment Scheme is unlocking more than \$65 billion of private investment in renewable energy generation and clean dispatchable capacity, helping to deliver the Government's target of an 82 per cent renewable electricity grid by 2030.

Australia is home to some of the world's largest reserves of critical minerals such as lithium, cobalt and rare earths needed to diversify supply chains and support low emissions technologies. The global demand for critical minerals will need to increase by around 350 per cent by 2040 as the world progresses towards its net zero commitments.ⁱ Australia is already the world's largest producer of lithium and is well placed to meet future global demand, with exports projected to double over the next five years.ⁱⁱ

Australia has the ability to leverage its track record as a trusted and reliable trade partner, with established links into key markets in North Asia, the United States and Europe, to be a reliable supplier into the growing markets of the future. Australia has been a strong advocate and champion of the multilateral trading system and a rules-based approach. We will continue to actively engage in the relevant international fora to uphold existing rules and develop new rules to address contemporary challenges.



Role for government

The private sector is responding to these major structural changes and harnessing these new opportunities. In many instances, businesses and investors possess the skills, market information, risk-taking frameworks, agility and flexibility to make the necessary and appropriate long-term investments in new markets and technologies. However, there are also circumstances where economic incentives are not aligned with broader national interest objectives.

Government plays an important role to create a positive investment and enabling environment in which businesses can take appropriate risks. This needs to be partnered with rigorous assessment of where there may be a case for public investment to incentivise private investment at scale in the national interest.

Given the major forces shaping our external environment, more direct government interventions may be justified where particular market failures are present, such as:

- Where the negative externalities from more emissions-intensive production methods are not appropriately priced into global markets, so cleaner production methods that present cost effective abatement opportunities are not able to compete on a level playing field with existing industry. This 'green premium' will lead to an undersupply of products drawing on cleaner production methods.
- Where private firms fail to appropriately price in the required level of economic resilience and security in critical sectors and supply chains, resulting in unacceptable levels of risk to Australia's national interest or broader economy.
- When technologies that are critical to the net zero transformation or broader national interest are nascent, and public investment in innovation can generate important learnings that help those that come later to produce at a lower cost. These learnings represent a positive externality that early movers cannot internalise in their decision making. Given the presence of positive externalities, without government support, there will be an underinvestment in cleaner production methods, which slows down the learning-by-doing process and prolongs the use of more emissions-intensive production processes.

Deliberate and targeted policy actions to improve the investment climate and address market failures will help the private sector to navigate the risks and challenges posed by changes to the global landscape and build a stronger and more resilient Australian economy for the future.



A National Interest Framework

The Government has committed to introduce a *Future Made in Australia Act* (the Act) that promotes and facilitates investment in the public interest. The Act will include a new National Interest Framework (the Framework) that clearly articulates how priority sectors will be identified. The Framework will be used to impose rigour on Government's decision making on significant public investments, particularly those used to incentivise private investment at scale.

In considering the prudent basis for public investment, the following factors have been considered: Australia's grounds for lasting competitiveness, the role the industry will play in securing an orderly path to net zero, the role the industry will play in building Australia's economic resilience and security, whether the industry will build key capabilities, and whether the barriers to private investment can be resolved through public investment in a way that delivers compelling public value.

These five tests have informed the development of the Framework, which provides practical principles for identifying priority industries under two streams and guidance for assessing public support. Given that technology and global markets will continue to evolve rapidly, sectors prioritised under the Framework will be reviewed regularly.

The Government will consult on the details of this Framework as part of the consultation on the Government's *Future Made in Australia* legislative package.



The National Interest Framework

Identifying priority industries in the national interest:

There are two streams under which an industry may warrant Government intervention to attract private investment at scale.

The **Net Zero Transformation Stream** will identify priority sectors where:

- Australian industry is expected to have a sustained comparative advantage in a net zero global economy; and
- Public investment is needed for the sector to make a significant contribution to emissions reduction at an efficient cost.

An industry is more likely to qualify for support under this stream if the industry:

- is energy-intensive and capable of substantially reducing its carbon emissions by taking advantage of our abundant renewable energy resources;
- has output that embodies low carbon emissions and can help contribute to decarbonisation in other areas of the economy;
- can leverage Australia's highly skilled workforce, using technological improvements to reduce labour intensity;
- is able to achieve economies of scale in Australia; and
- aligns with our international trading partners' current or future needs and is complementary to actions taken by our strategic partners.

The **Economic Resilience and Security Stream** will identify priority sectors where:

- some level of domestic capability is a necessary or efficient way to protect the economic resilience and security of Australia, and the private sector will not deliver the necessary investment in the absence of government support.

Consideration under this stream will include factors such as:

- The global and domestic concentration of supply and supply chains;
- The vulnerability of supply to disruption;
- How critical the industry or product is to our security and resilience; and
- Whether the industry can prevent, absorb, adapt or transform processes to limit the consequences of a shock to our national interests.

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The National Interest Framework (continued)

Policy approach

In certain circumstances, targeted public investment can strengthen the alignment of economic incentives with Australia's national interests, and incentivise private investment at scale to develop priority industries. Common barriers to investment include:

- The failure of markets to price in externalities, such as emissions from production, and positive externalities from learnings generated by early movers;
- Non-financial barriers, such as uncertainty about approval processes, access to skilled labour and a lack of enabling regulation (i.e. certification and standards); and
- Financial barriers such as high up-front capital costs, requiring concessional financing, or the cost difference between a low emissions product and its incumbent emissions-intensive competitor, requiring temporary production support.

Under both streams, the Framework recommends considering how industry-led solutions, trade partnerships, regulatory approaches, or supply agreements could be used to efficiently align these incentives. Government should consider whether the barriers to private investment can be resolved through public investment in a way that delivers compelling public value, relative to these complementary approaches.

Public support should be designed in a way that complements Australia's strategic partnerships and should be consistent with Australia's obligations under its bilateral and multilateral trade agreements.

Community benefit principles

The Government will apply community benefit principles in relation to investments in priority industries. These principles will have a focus on building capability through investment in local communities, supply chains and skills, and the promotion of diverse workforces and secure jobs.



Net Zero Transformation Stream

As outlined in the previous section, the Net Zero Transformation Stream of the National Interest Framework will be used to identify sectors assessed to have grounds for sustained comparative advantage in a net zero global economy, and public investment is needed for the sector to make a significant contribution to emissions reduction at an efficient cost.

In a world of intensifying global competition for clean energy industries, Australia is expected to have several areas of comparative advantage. These include:

- An abundance of low-cost bulk renewable energy capacity;
- Access to, and abundance of, critical inputs and bulk raw materials;
- Existing strengths in research and development;
- Access to deep capital markets, low sovereign risk and a stable political environment; and
- Proximity to fast growing Indo-Pacific markets and a strong track record as a reliable and trusted exporter of energy and resources.

Australia is more likely to be globally competitive without long-run support if the industry:

- is energy-intensive and capable of substantially reducing its carbon emissions by taking advantage of our abundant renewable energy resources;
- has output that embodies low carbon emissions and can help contribute to decarbonisation in other areas of the economy;
- can leverage Australia's highly skilled workforce, using technological improvements to reduce labour intensity;
- is able to achieve economies of scale in Australia; and
- aligns with our international trading partners' current or future needs and is complementary to actions taken by our strategic partners.

Over time, the development of market mechanisms here and overseas are expected to increase demand for low- or zero-emissions goods and production methods, reducing barriers to investment in these sectors. Examples of where the Government has contributed to the development of market mechanisms in Australia include the Safeguard Mechanism, New Vehicle Efficiency Standards and the Guarantee of Origin scheme which accredits and certifies the emissions content of key industrial goods. The Government's Sustainable Finance Strategy is also supporting the maturation of markets for sustainable products through improving disclosure of climate risks and opportunities, and enabling better labelling of sustainable finance products.



Energy Intensity: Australia’s Comparative Advantage

Australia has a comparative advantage in the production of decarbonised energy intensive goods due to our abundant, low-cost renewable resources, particularly wind and solar. This is expected to support globally competitive renewable electricity prices as the world transitions to net zero. This reflects a range of factors including declining capital costs, ongoing technological improvement in solar and wind generation and storage, and abundant solar and wind resources that enable scale and better capacity utilisation.

Chart 1: Australia’s renewable electricity price is expected to be globally competitive



Source: CSIRO, 2023ⁱⁱⁱ

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Energy Intensity: Australia's Comparative Advantage (continued)

One example of where Australia is expected to have a comparative advantage because of our abundant sources of renewable energy and our endowments of raw materials is green iron for steel production. Steel production is currently responsible for around 10 per cent of global emissions because it uses coking coal for both the chemical reaction to strip oxygen from iron ore and to generate the heat needed to produce molten iron and turn iron into steel.^{iv}

Steel production can be decarbonised using zero-emission hydrogen for both the heat and the chemical reaction in the iron-making process, and renewable electricity to power steelmaking in an electric arc furnace. However, it can be challenging to transport hydrogen, making it more economic to produce green iron close to where hydrogen can be produced (further detail in Priority Sectors, Green Metals).

The appropriate nature, scale and duration of support for emerging Net Zero Transformation Stream priority industries will depend on the maturity of the low- or zero-emissions technology available to the industry, the specific barriers to private sector investment and the expected contribution to domestic and global decarbonisation.

For very nascent technology, research and development grants and support for demonstration or pilot projects may be the most appropriate way to support the sector, to help accelerate learning by doing and incentivise private companies to invest efficiently in innovation and diffusion activities that have significant public benefit.

For more mature technologies, the barriers to private investment are more likely to include uncertainty around project approval processes and financial barriers, which may include:

- high upfront capital costs to install or retrofit zero emissions facilities, which are difficult to commit to given highly uncertain policy and technology pathways; and
- the cost differential between low-emissions products and incumbent emissions-intensive competitors (where markets are not pricing in the externalities from emissions).

In these circumstances, capital grants and different forms of concessional finance may be appropriate to help overcome upfront capital cost barriers, while direct production support may be more appropriate to temporarily bridge the gap (or 'green premium') between low emissions products and incumbent competitors. These measures can help to de-risk priority projects and improve rates of return for investors, crowding in private investment.

Policy support for industries identified under the Net Zero Transformation Stream should generally be time-limited, encourage early-movers and bridge the gap until an appropriate market signal is established or until the green premium in cleaner production costs shrinks. Over time, barriers to investment are likely to decline as certainty improves around global emissions reduction pathways and early-stage projects provide critical learnings for future investors. Providing temporary support will drive earlier decarbonisation activity within Australia while maintaining the international competitiveness of Australian companies.



Economic Resilience and Security Stream

The Economic Resilience and Security Stream includes sectors where some level of domestic capability is necessary or efficient to deliver adequate economic resilience and security, and the private sector would not invest in this capability in the absence of public investment.

To qualify under this stream, a shock or disruption to supply in the relevant sector would need to have unacceptably high impacts on safety, national security, economic stability or wellbeing in the absence of sufficient domestic capability and capacity. The importance of ensuring access to supply can also be considered for emerging sectors. To assess the materiality of these risks, consideration will be given to the following factors, among others:

- The global and domestic concentration of supply;
- The vulnerability of supply to disruption or other barriers to access;
- How critical the sector or product is to our security and resilience; and
- Whether the industry can prevent, absorb, adapt or transform processes to limit the consequences of a shock to our national interests.

The Government regularly undertakes comprehensive scans of the economy to identify products and sectors that are both critical for economic resilience or security and face an elevated risk of disruption from international and domestic shocks. Some risk events, such as a disruption or shortage of non-critical goods or services, will have a relatively low impact, while other shocks may have an unacceptably high impact. Assessing the ability of the private sector to respond to potential supply disruptions requires data-led supply chain mapping and consultation across Government and with relevant industries to determine the capability of business to:

- Pre-emptively diversify its suppliers and develop stronger business-to-business links;
- Absorb or adapt to disruptions, such as through accessing alternative suppliers; and/or
- Transform production processes during disruptions.

Where substantial risks to the national interest remain, a range of targeted responses – from ‘light-touch no-regrets’ actions through to direct government intervention – can be considered to manage unacceptable residual risks at least cost. Industry-led solutions, hedging through financial market instruments, government-to-government supply agreements with strategic partners, or regulation, should be prioritised. Where these are not sufficient or appropriate to address risks to economic security and economic resilience, public investment should be considered if it can deliver compelling public value.



The enabling environment

Building a stronger, more diversified and more resilient economy powered by clean energy will require Australia to attract significant private sector investment and establish an environment that supports new businesses to grow and new industries to develop lasting sources of competitiveness. The Government is focused on promoting a competitive and dynamic economy, supported by the *National Competition Review*, delivery of the Government's five-pillar productivity agenda, and investment in a skilled and adaptable workforce, as outlined in the *Employment White Paper* policy roadmap.

As part of the *Future Made in Australia* agenda, the Government is taking further steps to attract and facilitate investment, including establishing a new front door to facilitate private investment. This new front door will support investors with major transformational investment proposals by:

- providing a single point of contact for investors and companies with major investment proposals,
- delivering a joined-up approach to investment attraction and facilitation,
- identifying priority projects related to the Government's *Future Made in Australia* agenda,
- supporting strengthened and streamlined approvals decisions, and,
- connecting investors with the Government's specialist investment vehicles.

The Government is also streamlining approval processes in ways that strengthen standards. Through smarter use of data, better decision-making processes and appropriate resourcing, the Government is delivering faster pathways to better decisions on environmental, energy, planning, cultural heritage and foreign investment approvals. This will help to facilitate development of nationally significant projects in priority sectors, while also balancing protection of our environmental and cultural heritage.

The Government is putting in place the financial system architecture necessary to ensure Australia can mobilise private capital towards the transition to net zero. Building on actions including mandating climate disclosure and issuing sovereign green bonds, the 2024–25 Budget funds the development of an investment product labelling regime, extension of the sustainable finance taxonomy to the agricultural sector and the development of best practice transition plan guidance for businesses.

Continued collaboration across the Government's special investment vehicles will crowd-in private investment in projects that are in the national interest, including through the National Reconstruction Fund. As part of the *Future Made in Australia* package, the Government will expand the scope of the National Interest Account to provide additional avenues for financing projects in the national interest, leveraging the investment expertise of Export Finance Australia.

These initiatives complement foundational investments in Australia's net zero transformation and strong trade partnerships in a changing international environment.



Other complementary frameworks

The Government will continue to apply other industry policy and national resilience frameworks to complement the Framework and shape our future security and prosperity.

For example, the Government will continue to invest in emerging critical technologies which will create opportunities to transform a wide range of sectors across the economy. In the *Critical Technologies Statement*, the Government has prioritised action on AI, robotics and automation and quantum technologies among other fields. The Government applies an integrated national interest model to evaluate economic security, national security and social cohesion implications and makes targeted interventions when required. This ensures that Australia's development of, access to and choices in technologies are secure, reliable and cost effective. The Government's recent investments in quantum computing are an example of this approach in action.

The Government has chosen to invest directly to build domestic industrial capacity for key defence technologies and capabilities. Australia's defence industry plays an integral part in the whole-of-nation preparedness uplift in response to the complex strategic circumstances we face. A capable, resilient, competitive and innovative sovereign defence industrial base is an important element, even though Australia's defence industrial base will never be completely self-reliant. The recently announced *2024 National Defence Strategy* outlines the Government's approach to national defence, and the accompanying Integrated Investment Program sets out the specific capabilities the Government will invest in to give effect to the Strategy. The Sovereign Defence Industrial Priorities in the *Defence Industry Development Strategy* will also support industry's ability to deliver Australian Defence Force priorities and contribute to broader industry and workforce resilience.

The Government will also continue to provide programs and support to other sectors to achieve specific government priorities and objectives, such as through the Government's National Reconstruction Fund or the Northern Australia Infrastructure Facility.

Community Benefit Principles

In addition to the Framework, the *Future Made in Australia Act* will outline Community Benefit Principles for decision makers to apply when designing policies or considering investment decisions that are designed to promote private investment at scale in industries aligned with the National Interest. These principles will have a focus on investment in local communities, supply chains and skills, and the promotion of diverse workforces and secure jobs. They will be applied in ways that promote private investment that builds sustainable industries by broadening opportunity, investing in future workforce, and strengthening supporting supply chains, without limiting the competitiveness of emerging industries.

The Government will consult on the details of these Principles as part of the consultation on the Government's *Future Made in Australia* legislative package.



Priority sectors

Initial work conducted across government as part of the Government's plan to become a Renewable Energy Superpower identified a number of priority industries that align with the principles included in the National Interest Framework, under either the Net Zero Transformation or Economic Resilience and Security streams.

These assessments illustrate how the National Interest Framework can inform consideration of where public investment may be required to strengthen the alignment of economic incentives with Australia's national interests. In particular, they have contributed to Government consideration of whether public support is warranted to incentivise private investment at scale in these industries, and the most appropriate policy approaches to do so.

Assessments have been made at a point in time and are subject to review as policy circumstances and market conditions evolve. Consistent with the purpose of the National Interest Framework, they are not intended to inform all government decisions or replace other policy frameworks. Treasury will consult on the details of this framework as part of the consultation on the Government's *Future Made in Australia* legislative package.

Net Zero Transformation Stream

Renewable hydrogen

There is a strong case for including renewable hydrogen as a priority industry under the Net Zero Transformation Stream. Most notably, it:

- is highly energy intensive and can take advantage of our abundant renewable resources;
- can make a major contribution to decarbonisation in other areas of the economy; and
- it aligns with our international trading partners current and future needs.

Contribution to net zero

Hydrogen is expected to play a key role in the net zero transformation as it can be produced in ways that have limited or no emissions and replace emissions-intensive fuels in other processes.

Hydrogen is a flexible fuel, which is transportable and storable to varying degrees depending on the derivative. It can be used for high-temperature industrial processes and is a key feedstock for producing chemicals with diverse uses such as ammonia and methanol. When used as a fuel, the only by-product is water and there are no carbon emissions at that point.

Renewable hydrogen is truly a zero or low-emissions fuel that can be produced at a commercial scale through electrolysis, which extracts hydrogen from water using electricity. If renewable electricity is used, this process produces no carbon emissions, and is known as either 'green' or 'renewable hydrogen'. Most hydrogen today is made using either gas (via steam methane reforming) or, less commonly, coal (via gasification). These processes are carbon intensive, but

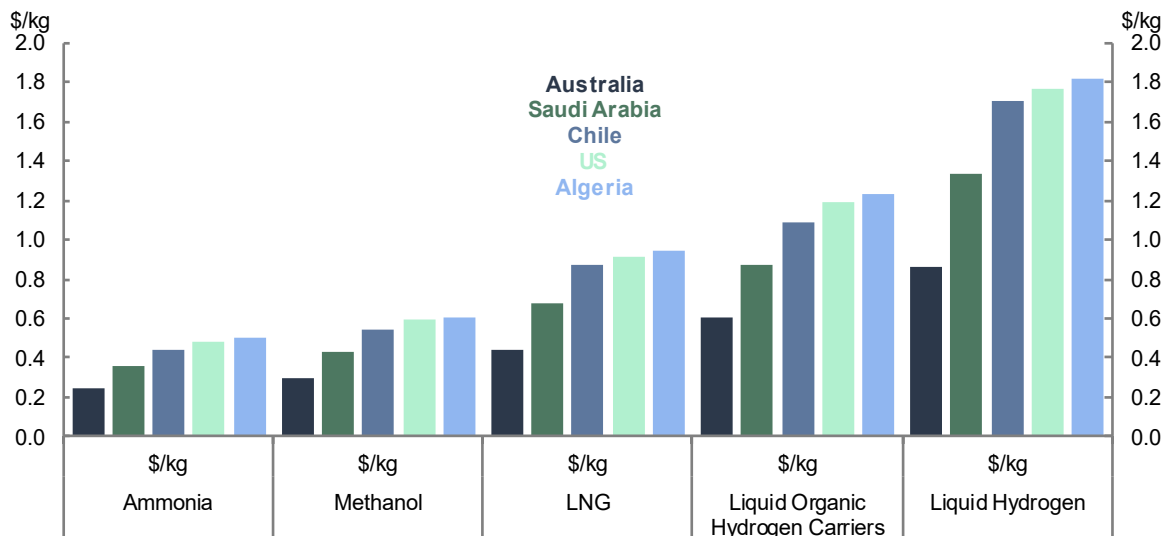


if the associated emissions are successfully captured and stored, this is called ‘blue’ or ‘low-emissions hydrogen’, with more emissions than renewable hydrogen.

Beyond decarbonising existing uses of hydrogen in the economy, such as in producing ammonia, renewable hydrogen is an enabler of green manufacturing, with the potential to underpin green commodity production in a range of sectors, particularly where electrification is not an option. This could include decarbonising fertilisers, opening up value-added export industries such as green iron, and as an input to emerging types of Low Carbon Liquid Fuel (LCLF).

Key trading partners, such as Europe, India, Japan and the Republic of Korea see hydrogen as a critical part of their transition to net zero, making exports of Australian renewable hydrogen an important opportunity for facilitating global decarbonisation. The costs of transporting, converting and storing hydrogen and its derivatives are currently high relative to unabated fossil fuels. However, this is exacerbated by distance, which means that Australia may be a competitive source of supply for key trading partners such as Japan in the future (Chart 2). It is in Australia’s interests to position adaptively for a range of hydrogen-adjacent opportunities besides hydrogen export – for example, using hydrogen as a feedstock in clean-energy embodied goods, such as green iron, as a practical way to embed hydrogen in energy-intensive goods.

Chart 2: Cost of exporting hydrogen carriers to Japan



Source: Daiyan and Macgill, University of New South Wales, 2022^v



Comparative advantage

Australia holds several key advantages that suggest that we will have a comparative advantage in producing renewable hydrogen. Principally, Australia has world class renewable energy resources at prices that should be internationally competitive (Chart 1). This provides Australian producers an advantage because energy costs make up more than half the cost of producing hydrogen using present-day electrolyser technology.

There are costs involved in both storing and transporting hydrogen. While this presents challenges for exporting renewable hydrogen, using hydrogen where you make it avoids many of these costs. It may be more competitive to directly supply renewable hydrogen embodied products, like green metals and ammonia that other countries need but cannot produce as cost competitively as Australia. An adaptive National Hydrogen Strategy will allow Australia to position for a portfolio of opportunities depending on how markets and technologies develop.

Our long history as a reliable and trusted energy exporter will be attractive for foreign investment and some of our closest trading partners have announced significant use and import targets for hydrogen, such as:

- Japan is targeting using 3 million tonnes per year of hydrogen including 1 million tonnes of imports by 2030.
- Republic of Korea is targeting the use of 3.9 million tonnes of hydrogen per year by 2030, up from 220,000 tonnes in 2021.
- European Union is targeting the import of 10 million tonnes of hydrogen in 2030 (plus 10 million tonnes of domestic production).

Australia's skilled workforce will also be advantageous to establish a domestic renewable hydrogen industry, but our clean energy workforce will need to be scaled up to meet the full potential of renewable hydrogen in Australia.

Green Metals

Australia has significant potential to become one of the lowest-cost producers of green metals. The industry:

- Is highly energy intensive and can take advantage of our abundant renewable resources;
- Can make a major contribution to decarbonisation;
- Can achieve economies of scale in Australia; and
- Aligns with our international trading partners' current and future needs.



Contribution to net zero

Decarbonising metal production will play a critical role in the net zero transformation because metals are essential inputs into core infrastructure, current methods are emissions-intensive and the relative cost of abatement means green metals will make an important contribution to cost-efficient decarbonisation pathways.

Significant quantities of iron, steel, alumina and aluminium will be required to support the energy transition, globally and domestically, because they are used in industries that support the net zero transformation including wind turbines, solar panels and electric vehicles. They are also essential inputs to other sectors of the economy, including construction, manufacturing, infrastructure, energy and defence, that will need to decarbonise. According to Wood Mackenzie, global demand will increase by around 61 per cent for aluminium^{vi}, and 13 per cent for steel^{vii} between 2023 and 2050 in a scenario that is consistent with a 1.5 degrees trajectory.

Current production technologies are highly emissions intensive. Producing metals requires large amounts of energy, resulting in substantial carbon emissions if using traditional production methods. The global steel sector accounts for around 10 per cent of global carbon emissions^{viii}, and the aluminium and alumina industry accounts for around 3 per cent of global carbon emissions.^{ix} As the world progressively targets net zero while prioritising least cost abatement, emissions from metals production will ultimately need to decline.

Australia already has a significant metals industry, with the iron, steel, aluminium and alumina industries accounting for around 11 per cent of Australia's emissions.^x Reducing emissions from Australian metals production would make a key contribution to Australia's net zero target and prevent 'carbon leakage', where emissions-intensive tradable activities shift production to regions with less ambitious emissions reduction targets. Australia's metals producers are also large employers in regional areas. Supporting the decarbonisation of these industries will support the transition of these regions and the retention of highly skilled and specialised roles across the Australian economy.

The private sector is already starting to invest in green metals technologies. Earlier this year Rio Tinto signed Australia's largest renewable power purchase agreement (PPA) to date to supply its Boyne aluminium smelter.^{xi} CSIRO, ARENA, universities, and the private sector have built extensive expertise in low-emission steel and aluminium technologies to guide future demonstrations and industry development.

Green building standards are also creating demand for green metals, and around 85 per cent of Australian exports in 2020 went to countries that have net zero emissions pledges.^{xii}

However, markets that clearly differentiate low-emissions products are still nascent, demand for green metals at a price that incorporates the benefits of abatement is limited, and early-movers face significant capital risk and innovation costs. There is a role for government to improve certification and trade of low-emissions metals, promote demand at a price that accounts for the additional cost of efficient abatement, and to spread the costs and benefits of overcoming innovation challenges across the industry.



Comparative advantage

Australia's significant endowment of the ores used to forge metals underpins Australia's current comparative advantage in metals production. Australia is the world's largest producer of iron ore and second largest producer of bauxite – producing 39 per cent of global iron ore and 26 per cent of global bauxite in 2023.^{xiii} Supported by this foundational advantage, Australia's green metals industry could operate at significant scale and leverage skilled workers and advanced technologies to deliver highly efficient operations.

Australia has the potential to produce variable and firm renewable energy at competitive prices (Chart 1). Combined with Australia's natural advantages in the production of metallic ores, Australia's comparative advantage is expected to strengthen as demand for metals shifts towards low-emissions products and favours countries with plentiful renewable energy. Some metal industries are also located in industrial precincts, some of which are proximate to renewable energy generation. Australia has potential to become one of the lowest cost places in the world to make green metals. In addition, Australia has an existing skilled workforce, strengths in research and development and proximity to fast growing Indo-Pacific markets.

Low Carbon Liquid Fuels

Australia is likely to have a comparative advantage in the production of some feedstocks used to produce LCLFs, or in the production of LCLFs, or both. The sector:

- is energy-intensive and capable of substantially reducing its carbon emissions by taking advantage of our abundant renewable energy resources;
- has output that embodies low carbon emissions and can contribute to decarbonisation in other areas of the economy;
- is able to achieve economies of scale in Australia; and
- aligns with our international trading partners' current or future needs.

Contribution to net zero

LCLFs will play a key role as the global and Australian economies transition to net zero, offering viable decarbonisation pathways for many sectors. These fuels are expected to be utilised by hard to abate sectors where performance requirements are high and few alternative emissions abatement options are likely to become available, such as medium-long distance domestic aviation, heavy road vehicles, maritime and non-transport sectors.

The Australian economy currently relies on liquid fuels for around half of its final energy demand. This is particularly the case for transport, which accounts for around 70 per cent of Australia's consumption of refined liquid fuel products. Sectors of the economy reliant on liquid fossil fuels are starting to transition to lower carbon options to achieve emissions abatement targets, often through electrification. This is most apparent in passenger motor vehicles. However, other liquid fuel-dependent categories are less advanced and in some cases the decarbonisation pathway is not yet clear. These include medium-long distance domestic aviation, heavy road vehicles, maritime and non-transport sectors such as mining, agriculture

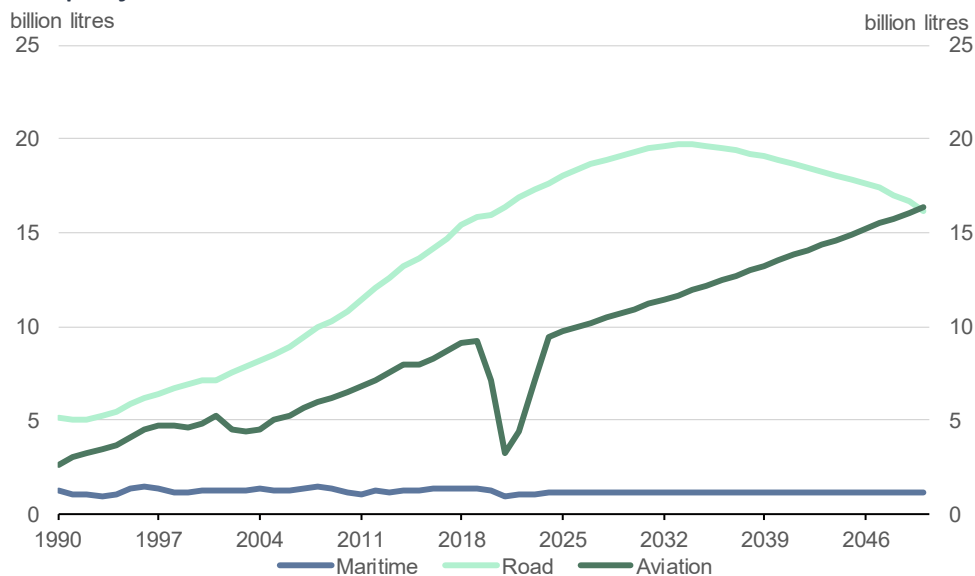


and construction, which will represent close to 20 per cent of Australia’s emissions out to 2030.^{xiv} Current Government projections for these sectors suggest they will remain reliant on liquid fuels – particularly jet fuel and diesel (or their equivalents) – to 2050 (Chart 3).

LCLFs provide an alternative option to start reducing emissions. LCLFs have low- to zero-net lifecycle emissions during their production and use, compared with the fuels they are displacing, and can currently be produced sustainably from waste materials and biomass. In the long term it may be possible to produce LCLFs by combining hydrogen from low- or zero-carbon feedstocks with captured carbon dioxide. LCLFs can be produced using a variety of technology pathways and feedstock inputs, each with different emissions abatement potential and cost. Depending on the fuel, some internal combustion engines in current use can tolerate 100 per cent LCLFs as a full replacement for conventional fossil fuels, whereas others will require blending or gradual incorporation.

Currently, sustainable aviation fuel (SAF) is approximately two to five times the cost of conventional jet fuel, but provides the cheapest available approach to abatement for the aviation industry.^{xv} Renewable diesel is estimated to be more than twice as expensive as conventional diesel, though this estimate depends heavily on market movements and international supply. Technology costs for fuels with higher abatement are expected to decrease over time as production processes and scale improve. Early investments in this area can lay the foundations for a future LCLF industry.

Chart 3: Australia’s jet fuel, road and maritime transport diesel fuel demand projections



Source: Unpublished Bureau of Infrastructure and Transport Research Economics estimates, Treasury



Comparative advantage

Australia's landmass, temperate climates, advanced farming practices, access to renewable feedstocks, established supply chains and renewable energy potential are all assets in developing a range of feedstocks to support a domestic LCLF industry to operate at scale.^{xvi}

The CSIRO estimates Australia has enough biogenic feedstocks to produce 60 per cent of local SAF demand by 2025, growing to 90 per cent by 2050 as biogenic sources continue to grow and hydrogen production ramps up. This equates to \$10 billion of fuel at production costs in 2025 and \$19 billion in 2050. Australia is already a competitive producer of feedstocks used for LCLFs, exporting 400 kt of tallow and approximately 3.4 Mt of canola seed to Europe in 2022. Competitiveness in this segment of the supply chain contributes to broader cost competitiveness as feedstock costs are a primary driver of the total costs of producing LCLFs.

One of the principal challenges of achieving commerciality is aligning sufficient offtake agreements with feedstock providers with demand for sustainable fuels, at a scale that supports establishing a production facility. However, the Australian aviation industry is large enough to provide demand for commercial-scale refineries, provided there is broad adoption of SAF as part of the transition to net zero.

The CSIRO analysis suggests Australia has significant potential to be a competitive producer of SAF over time if the industry scales up. CSIRO reports under a 'high scenario', that includes government policies to support a LCLF industry, that Australia could potentially produce 9,794 million litres of SAF by 2050. This compares to 717 million litres for New Zealand, 12,139 million litres for Indonesia, 5,803 million litres for Vietnam, and 4,221 million litres for Malaysia. There is currently less analysis about the prospects for other LCLF types, including renewable diesel.

Government's role in incentivising investment in net zero industries

There is significant private sector interest in building new competitive, renewable hydrogen, green metals and LCLF industries in Australia. However, private investment has been limited by immature supply chains for key renewable inputs, innovation challenges, lack of differentiated product markets and the emerging nature of demand for green products.

Immature supply chains for low-emissions energy and fuels

In many cases, building new low-emissions industries at scale requires sustainable energy and fuels to be available at scale. Accelerating the delivery of low-cost, reliable renewable energy is foundational to realising Australia's competitive advantages in energy-intensive, low-emissions industries. In this regard, there are also interdependencies between the sectors considered in this paper, with the availability of low-cost renewable hydrogen being a key enabler of commercial green metals operations.



Renewable hydrogen is currently substantially more expensive than unabated gas but is expected to become cost-competitive over time as the cost of producing hydrogen from renewable energy declines. Similarly, the majority of current green metals pathways require large quantities of cost-competitive renewable hydrogen. Growing production and reducing the costs of renewable energy, renewable hydrogen and LCLFs will be key to enabling efficient investment in products that use these fuels and key inputs.

Promoting innovation and technology diffusion

Transforming industrial processes to be low in emissions will require significant innovation. For example, even if the required volumes were available, the current costs of processing iron ore and refining alumina using renewable hydrogen are far higher than what can be achieved using coal and gas. Cost reductions are expected as key technologies such as electrolyzers improve, new industrial processes like low-emissions direct iron reduction are developed, and early movers improve the viability and efficiency of production at scale through learning-by-doing.

Public investment should focus on establishing strong incentives for the private sector to invest in innovation activities that have broad public benefits, and supporting the diffusion of these technologies and capabilities. In many cases, effective innovation is linked to strong trade partnerships and international engagement, to ensure innovations developed overseas are efficiently transferred to Australian industries. The case for public investment in Australian innovation is particularly strong where innovation challenges and opportunities are Australia-specific – such as the case for research and development to support the prospects of processing ores more commonly available in Australia (such as haematite).

Promoting efficient capital investment

Developing large-scale net zero industries require substantial investment in infrastructure. This includes port infrastructure, electricity networks, water infrastructure, as well as broader transport and social infrastructure to support regional workforces. Many of these infrastructure requirements have common-use benefits so may require coordinated or public investment to justify efficient investment. In other instances, new net zero industries require bespoke commercial infrastructure. This includes dedicated pipelines to transport hydrogen and new commercial-scale green metals facilities.

In some instances, these new capital needs are incremental and can be delivered within business-as-usual levels of capital expenditure. A recent report from the Australian Industry Energy Transitions Initiative found that around \$625 billion of coordinated investment is required to decarbonise Australia's industry and energy system, with around \$400 billion of investment relating to capital that would have been replaced or upgraded over this period under business-as-usual conditions.^{xvii} However, uncertainty around the timing and price of demand for green products can discourage early movers from making large capital investments.



Green premium and absence of strong markets

The costs of net zero products are expected to decline over time as key inputs are produced more efficiently, innovation barriers are overcome and efficient infrastructure is established. However, some products that will play an essential role in delivering a low-cost net zero transformation are still expected to have higher production costs than high-emissions alternatives, as they include the cost of efficient abatement.

As green markets mature, demand for green products is expected to grow and the ability for consumers to differentiate between products on the basis of their emissions intensity is expected to improve. Governments have an important role to play in developing these markets: creating demand for green products through standards and regulations, supporting the certification of products' emissions intensity, promoting well-functioning markets that allow customers to prefer green products, and promoting competitive trade that minimises carbon leakage and supports the achievement of global net zero emission commitments.

However, during the period where these markets are maturing, the additional cost of low-emissions products that aligns with the emissions reduction benefits embedded in the product may not be sufficiently valued by the market. This can limit the efficient development of these technologies, with an absence of demand causing an absence of supply. In these instances, public investment that aligns with a cost-efficient 'green premium' may be justified.

The role of government

Government needs to take steps to help circumvent these barriers to enable these sectors to achieve their potential.

From an enabling perspective, that means delivering renewable energy, supporting well-targeted innovation, and partnering with the private sector to deliver impactful infrastructure. It also means government should work to ensure regulatory and international trade settings work to build well-functioning markets and promote demand for products that deliver efficient abatement. Over time, this should establish efficient price signals.

However, in the meantime, there may be cause for public support that aligns private price signals with broader public value, and helps sectors to bridge up-front capital cost hurdles. In some cases, this could include production support or contributions to the capital investments necessary to transition to green production processes.



Economic Resilience and Security Stream

Critical Minerals Processing

A stable and diversified supply of critical minerals is critical to the smooth operation of global and domestic supply chains, including to support the net zero transformation, defence industries and a range of other applications. However, currently:

- Global supply is highly concentrated and vulnerable to disruption;
- There is limited capacity for the industry to quickly adapt and respond to any shock; and
- The consequences of a serious supply disruption would be significant.

Criticality to economic resilience and security

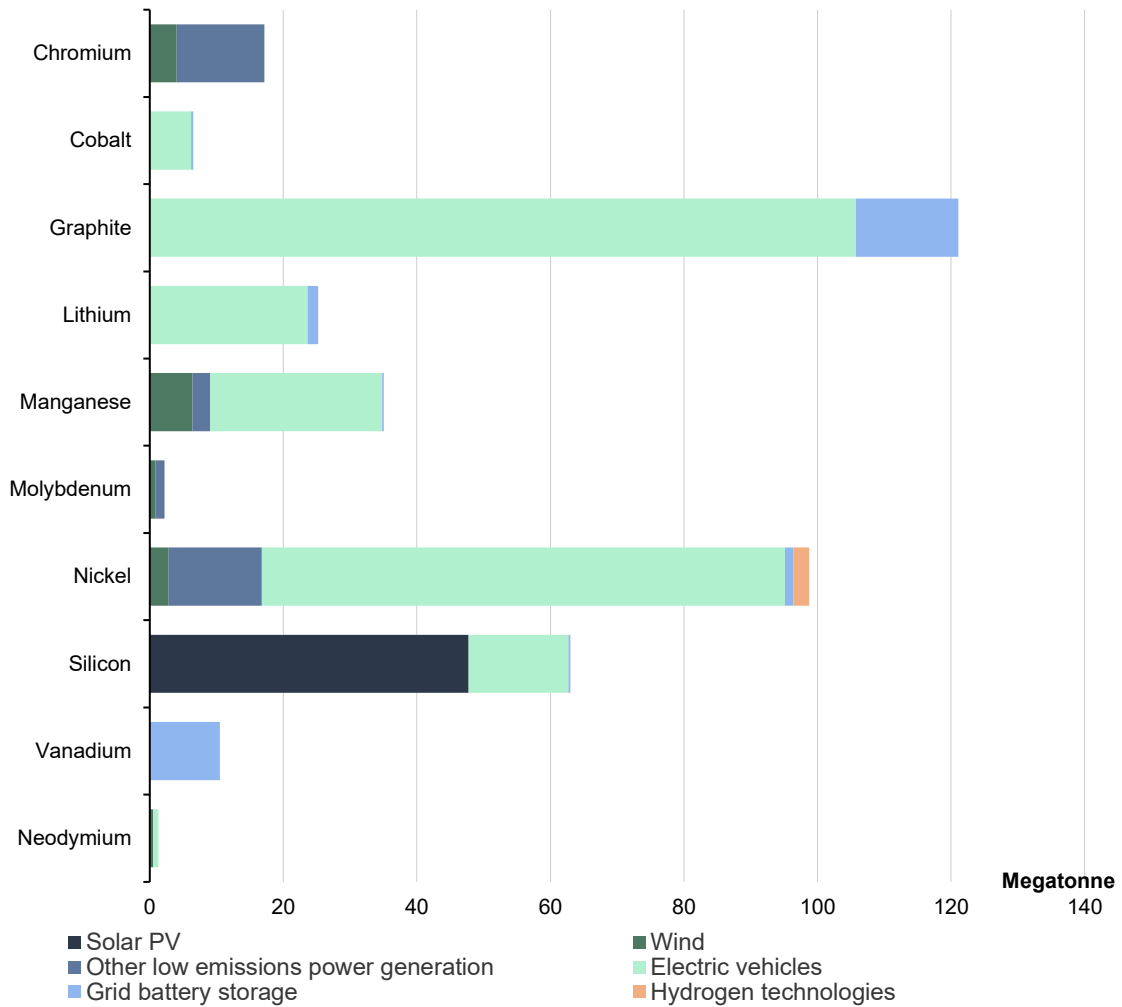
Critical minerals are metallic or non-metallic elements that are essential inputs across a range of sectors that support the net zero transformation, economic resilience and security and defence, and underpin global supply chains that are vulnerable to disruptions.^{xviii} The net zero transformation will increase the demand for critical minerals that are required for renewable energy technologies such as hydrogen electrolyzers, batteries and solar panels (Chart 4).^{xix} Under scenarios that achieve net zero emissions by 2050, global demand for critical minerals is expected to increase by around 350 per cent by 2040.^{xx}

Critical minerals are important to the economic resilience and security of countries because they enable a range of technologies required for the basic functioning of a modern society, including defence and communications technologies. The global race to secure supplies of critical minerals is accelerating rapidly.

Critical mineral supply chains are also prone to disruption because mineral production and processing is heavily concentrated in particular locations, facilities or companies. Supply chains that are highly concentrated, are typically fragile, volatile and lack transparency. Under these conditions markets and their participants cannot adequately price and manage risks, making it hard for businesses to access commercial investment and compete on a level playing field.



Chart 4: Global cumulative minerals demand for new installed capacity to 2050



Source: International Energy Agency, Critical Minerals Data Explorer, 2023



Australia’s role in supply chain diversification

Australia is well placed to help meet expected demand for critical minerals. The geographic and economic footprint of our critical minerals sector has grown, and we are becoming a globally significant producer of raw and processed critical minerals. Australia has some of the world’s largest reserves of critical minerals such as lithium, cobalt and rare earth elements (Table 1).^{xxi} In addition to significant known reserves, Australia has potential for more undiscovered minerals, with around 80 per cent of the land mass largely under-explored.^{xxii}

Australia’s critical minerals and broader mining sector has long-standing expertise in extracting minerals and a track record as a stable, reliable and responsible exporter of resources to support the scale of investment required. Australia has a clear comparative advantage in the extraction and export of minerals and mining engineering and services, which has been developed through innovation, economies of scale and a skilled workforce. We also have long-standing relationships with key partners that has supported investment.

Table 1: Global significance of Australian minerals

Commodity	Geological Potential	World Ranking for Economic Resources	Share of World Economic Resources	World Ranking for Production	Share of World Production
Antimony	Moderate	6	7%	6	2%
Cobalt	High	2	19%	4	3%
Graphite	Moderate	8	3%	-	0%
Lithium	High	2	26%	1	52%
Manganese Ore	High	4	16%	3	10%
Nickel	High	1	23%	5	5%
Rare Earths	High	6	4%	3	5%
Vanadium	High	2	32%	-	0%

Source: Geoscience Australia, Australia’s Identified Mineral Resources 2023; Department of Industry, Science and Resources, Australia’s Critical Minerals List and Strategic Materials List, 2024.

Global markets are increasingly placing emphasis on the provenance of minerals. Consumers and financiers want to have confidence that the minerals in their supply chains have been produced using high environmental, social and governance (ESG) standards. Companies may need to increasingly engage with minerals provenance issues as policy settings evolve globally. This places Australia in a favourable position to capitalise on our high ESG standards, acting as a differentiating factor compared to some other countries.



Barriers to private investment and role for government

Critical minerals producers face complex operational and market challenges. Projects often involve technical risks associated with complex mineralogy, the need for specialised processing, and the challenges of operating in remote areas and securing access to significant energy supply. These projects can also be difficult to finance and operate due to high capital requirements, opaque markets, volatile prices and a lack of recognition of ESG standards. Together, these factors can pose challenges for securing offtake, equity and debt finance.

Well-designed government support can de-risk investment and crowd in private sector funding, including from international investors who value secure and reliable sources of supply. Common-use infrastructure can help first-movers achieve commerciality and help precincts achieve economies of scale. Tailored public financing arrangements can also help projects manage price risk over a long time period, and unlock further financing opportunities.

Expanding a secure and sustainable supply of high quality refined critical minerals is also of geostrategic value to Australia and key trading partners. Private sector customers are not always well placed to manage the risk of supply chain disruption and may not account for the broader public costs of this risk. For this reason, strategic products such as critical minerals, with supply chains that are highly exposed to disruption and where there are few alternative sources of supply to support diversification, may require public support that accounts for the public value of prudent management of geostrategic risk and promotes private investment at scale.

Clean energy manufacturing

Clean energy products are critical for Australia's transition to net zero and supporting energy security through that process. There may be a case for developing domestic capacity where:

- Global supply is highly concentrated and vulnerable to disruption;
- There is limited capacity for the industry to quickly adapt and respond to any shock; and
- The consequences of a serious supply disruption would be significant.

Criticality to economic resilience and security

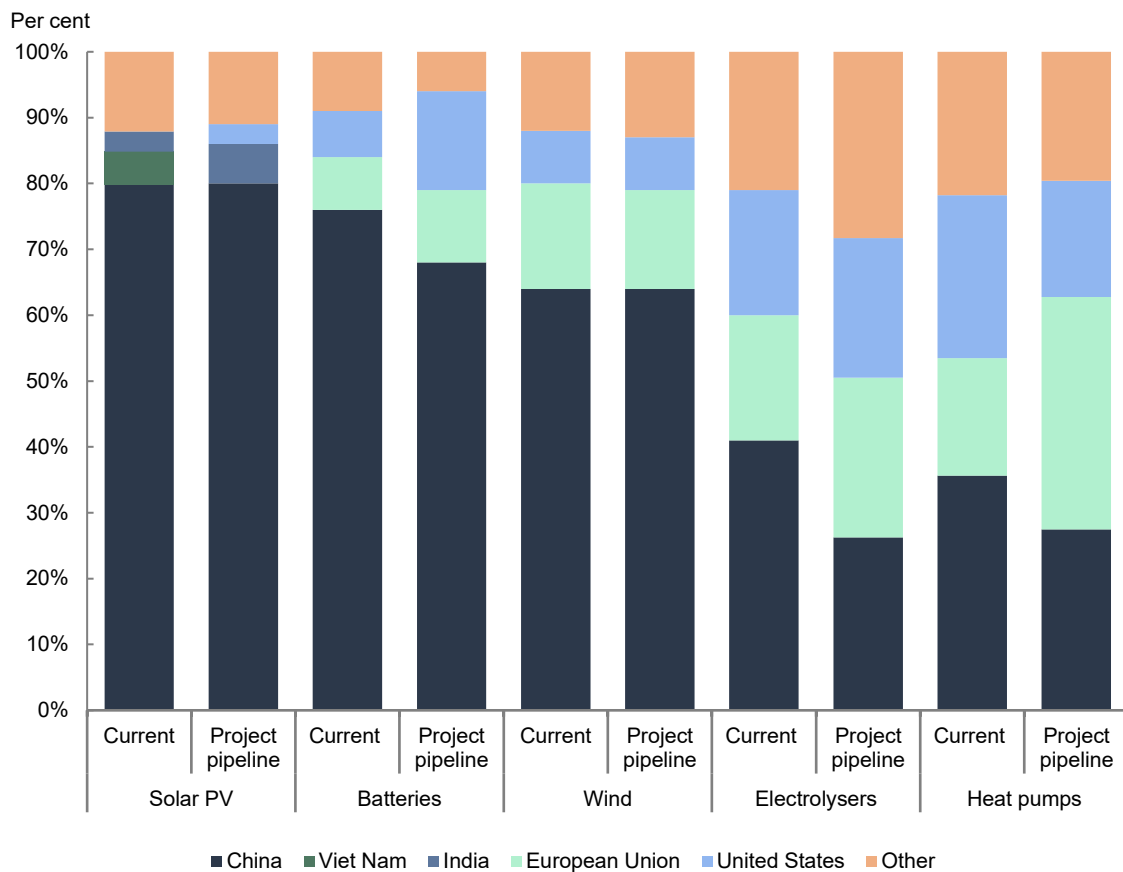
Australia is undergoing a significant energy transition in response to the global decarbonisation imperative and the significant improvements in the economics of renewable generation. The success of this transition will be contingent on having a reliable supply of clean energy technologies to ensure Australia's ongoing energy security, as a critical enabler of Australia's economic prosperity and standard of living.

The high concentration of supply chains of key clean energy technologies poses risks to energy security and economic resilience. More than 75 per cent of the supply of solar panel and battery technologies comes from one country (Chart 5). This creates exposure to trade disruptions, competition for scarce supply, and unexpected events such as natural disasters that could impact production in a particular location. Supply and demand imbalances across different clean energy technologies are already causing long delivery times for some critical components. For example, high voltage transmission cables are reported to have a seven year wait for supply,



and hydrogen electrolyzers are expected to require significant increased production beyond current capacity.

Chart 5: Production is relatively highly concentrated for solar and batteries



Source: International Energy Agency, 2023.

Strong trading partnerships will ensure Australia continues to benefit from low-cost technologies manufactured in countries with highly competitive manufacturing cost bases for reasons including economies of scale. For example, China’s global competitiveness in manufacturing and government investments over several decades has allowed it to develop significant scale and expertise in clean energy technology, particularly solar photovoltaic (PV) supply chains. Access to these products reduces the cost of renewable energy production in Australia, strengthening Australia’s potential to become a renewable energy superpower.

Australia’s role in supply chain diversification

Globally, countries are responding to the extreme concentration of solar and battery supply chains by diversifying where clean energy technologies are manufactured. The United States’



Inflation Reduction Act provides significant tax incentives for clean energy technology manufacturing. Europe, Canada, France and India are implementing incentives likely to drive domestic manufacturing in areas such as solar PV and batteries. It is likely these subsidies will lead to lower geographic concentration for specific technology in the future, and Australian consumers will benefit from any improvement in supply chain diversity and competition, subsidised by international taxpayers.

Accessing cheap clean energy technologies that are manufactured offshore supports Australia's ambition to become a renewable energy superpower. Strong trade partnerships, such as those in place with jurisdictions such as the United States and India, can be used to diversify Australia's supply and reduce supply chain risks.

Australia is also making an important contribution to the development of clean energy technologies, leveraging our considerable capabilities in research, discovery and development. Developing and commercialising new technologies, especially those relevant to Australia's unique conditions and comparative strengths, will continue to be an important area for private and public cooperation to reduce critical economic vulnerabilities, and an important contribution to Australia's trade partnerships.

Barriers to private investment and role for government

The most significant barrier to private investment in clean energy manufacturing in Australia is the cost competitiveness of alternative manufacturing locations, and the fact that Australia has higher operating costs. The competitiveness of Australian producers is typically driven by their product differentiation and design innovations that attract a premium from particular market segments.

Where some degree of domestic capability is assessed to be prudent, due to global concentration of supply and pronounced geopolitical risks, there may be a case for the Government to support the development of targeted domestic manufacturing capabilities.

Where public investment is intended to reduce geopolitical risks, it should be done in a way that strengthens trading partnerships and encourages Australia's integration into global supply chains. This should complement trade and resilience initiatives which improve Australia's access to critical products in the circumstance of supply chain disruptions.



Conclusion

The global environment is changing rapidly. The net zero transformation is a critical global challenge that requires clear market signals and consistent policy direction. At the same time, a more contested geostrategic environment and recent shocks have increased the value of resilient and diversified global supply chains.

The strong fundamentals that have underpinned Australia's past economic success will continue to serve us well in this changing world. Our natural advantages, most notably our abundant renewable energy resources and critical mineral deposits mean we are well placed to prosper in the years ahead and play a critical role in the net zero global economy.

The private sector and government both have a critical role to play to seize these opportunities. The *Future Made in Australia* agenda takes steps to foster and encourage the significant private sector investment into priority industries necessary to harness the opportunities of this changing global environment.



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