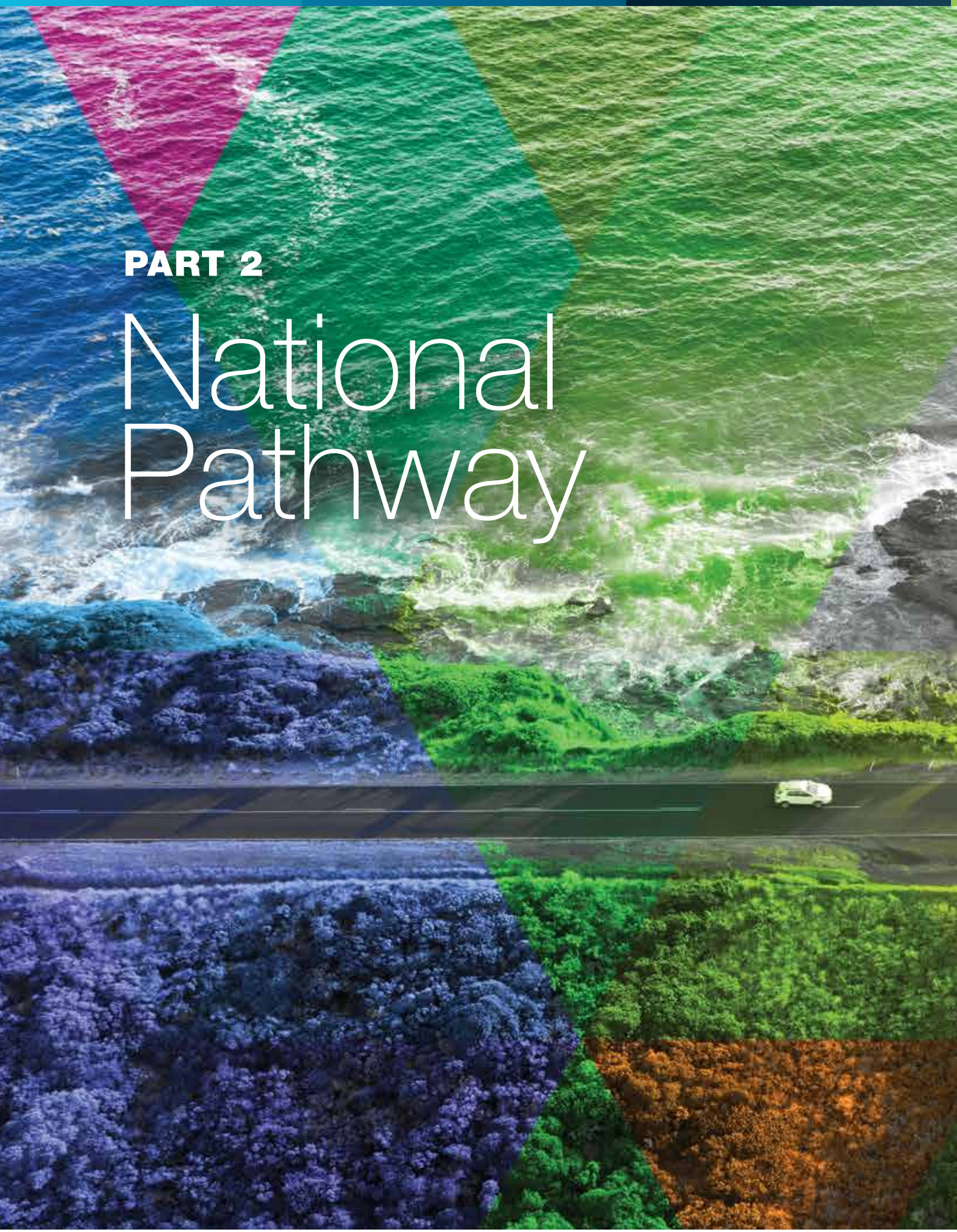


PART 2
National Pathway

National pathway

The technologies described in this report cannot be deployed in isolation, but instead need to be integrated and coordinated as part of rapidly transforming systems, some of which cut across multiple sectors, regions and jurisdictions. Forging a viable national pathway involves addressing sector-specific barriers, some of which will be common to multiple sectors, as well as resolving economy-wide questions that stem from the need for integration, from feedback and from the need to prioritise. All levels of government, industry and communities will need to engage if these national challenges are to be met.

This part of the report reviews pathways to net zero from the national perspective and, together with the sector pathways above, identifies six strategies and sets of actions for Australia to double down on to achieve net zero emissions by 2050, as set out at the start on pages 11-15 of this report:

1. Overcome the 'green premium'

2. Accelerate the deployment of net zero infrastructure

3. Strengthen the foundations for social licence and a just transition

4. Think global, act local

5. Rapidly address workforce shortages

6. Address information and data gaps

NP.1 How do the sector pathways add up to net zero?

For Australia to reach net zero emissions, every sector must contribute, but emissions in each sector will decline at different rates. Figure NP.1 shows the emissions reduction pathways for each sector under the two scenarios the CSIRO modelled for the authority for this review. In its ground-up analysis of each sector, the authority considered the range of real-world factors not well captured by economic modelling that enhance understanding of the unique emissions trajectories available to each sector and their respective roles in the economy as a whole achieving net zero. The authority's analysis and the CSIRO's modelling of potential sector pathways are summarised in Figure S.1 in the Summary section, with green bands illustrative of the range of potential pathways. See Appendices B and C for more information about the authority's analysis and modelling approaches.

For some sectors, the authority's ground-up analysis and the two modelled scenarios closely align. In the electricity and energy sector, the technologies exist, the transition is well underway, and there is more certainty about what can be achieved with the right policies. This is also the case for the transport and built environment sectors, although their transitions are less well progressed.

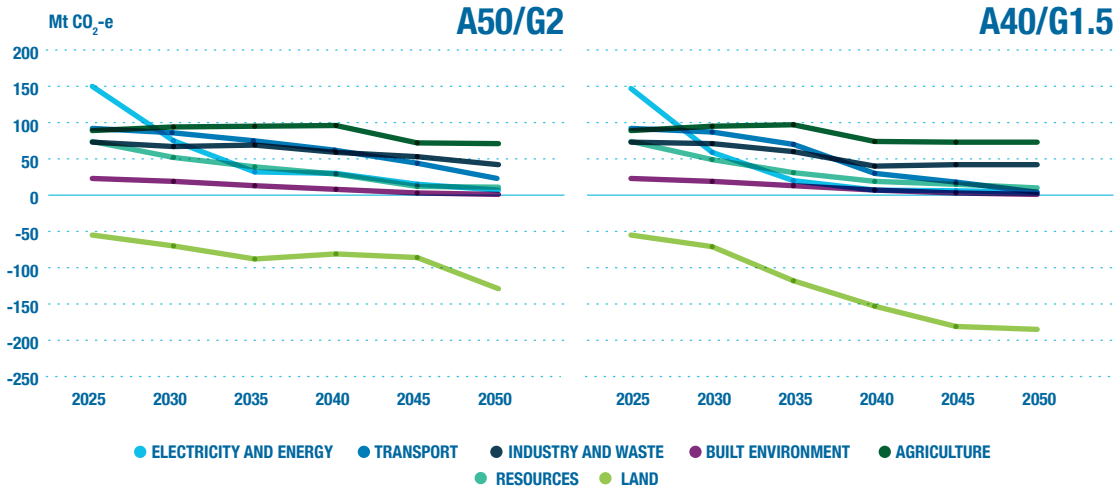
For other sectors there is more uncertainty, reflected by the range of outcomes across the modelling scenarios and ground-up analysis. In the resources, and agriculture and land sectors, the authority's ground-up analysis

found that there are considerable real-world barriers that make the modelled outcomes difficult to achieve. Conversely, the authority's view is that there are opportunities in the industry and waste sector to achieve greater emissions reductions than the modelling suggests.

Ultimately, there are many sets of sector pathways that can combine to achieve net zero by 2050. A clear conclusion from the authority's analysis is that none of the potential sets of pathways will be easy and every sector will need to play a unique but important role. Across all sectors, a significant and urgent ramp up in effort, investment and coordination is required and there are barriers that will need to be overcome if Australia is to achieve its target.

> An economy-wide net zero target does not mean that all emissions from a sector are necessarily eliminated by 2050. There are likely to be residual emissions in most sectors that need to be counterbalanced with carbon dioxide removals to achieve net zero emissions economy-wide.

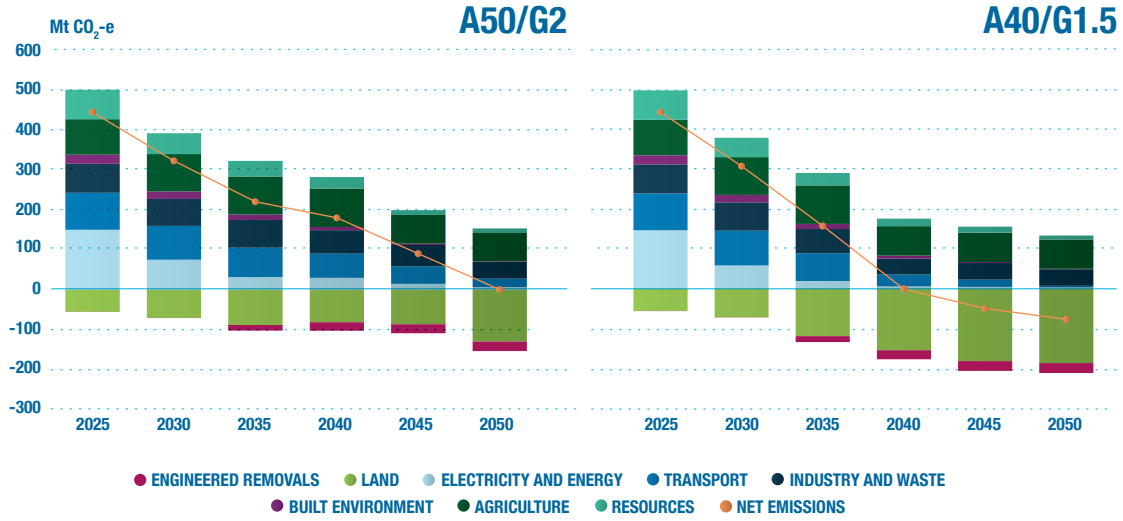
Figure NP.1: Different sectors will reduce emissions at different rates



Source: CSIRO modelling in AusTIMES commissioned by the Climate Change Authority
Note: This figure separates the agriculture and land sector into agriculture and land subsectors. See Figures S.1 and S.2 in the Summary section and the sector chapters for the results of the authority's ground-up analysis.

Australia's most feasible pathways to net zero emissions by 2050 involve reducing emissions as quickly as possible while at the same time scaling up the removal of carbon dioxide from the atmosphere. Figure NP.2 illustrates how the emissions of each sector and carbon removals together achieve net zero emissions by 2050.

Figure NP.2: Gross emissions, removals and a net emissions trajectory, 2025 to 2050



Source: CSIRO modelling in AusTIMES commissioned by the Climate Change Authority
Note: This figure separates the agriculture and land sector into agriculture and land subsectors. See Figures S.1 and S.2 in the Summary section and the sector chapters for the results of the authority's ground-up analysis.

The land sector is the only sector to remove more carbon than it emits. There is broad agreement among business, academia and environmental groups that removals must not delay urgent emissions reductions and that any offsetting of avoidable emissions be limited (Investor Group on Climate Change, Australian Council of Superannuation Investors, Climateworks Centre, Green Building Council of Australia, Qantas Group, Climate Recovery Institute, Australian Council of Social Service, Environmental Defenders Office, Bushfire Survivors for Climate Action, Biocare Projects, Climate Integrity, Sydney Environment Institute, WWF Australia, Australian Conservation Foundation, submissions, 2024).

> *"In the short term, CDR [carbon dioxide removal] is essential in counterbalancing residual emissions from sectors that are difficult to decarbonise quickly. Crucially, CDR is not a substitute for deep and rapid emissions reductions of these sectors – rather it is now necessary to buy back time we have lost from not acting sooner. In the long term, CDR is essential in becoming 'net negative' and removing historical emissions to return Earth's climate to a safe balance. It is an industry that will outlast the energy transition and will likely grow well into the 22nd century."*
>
> *Climate Recovery Institute submission, 2024*

Policy guardrails could be deployed to ensure Australia's carbon removal potential is used in ways that optimise economic and environmental outcomes. This includes considering how to manage access to different removals for compensating different emissions activities. Access should be prioritised for emissions with no near-term decarbonisation options. Further information about carbon removals can be found in the authority's 2023 insights paper, Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation (CCA, 2023b).

Market-based approaches to allocating removals across the economy entail risks. The authority heard concern from stakeholders that landholders were selling the carbon stored on their land as offsets, without realising that they could not also count the abatement themselves. Furthermore, land-based removals are a one-shot option because once the carbon is removed from the atmosphere it must be stored for a very long term (known in carbon markets as 'permanence'). For that reason, land-based removals should be treated as a finite resource. The authority observed that market participants have a low level of understanding of the finite nature of Australia's land-based removals resources. The authority further notes this could indicate a market failure if, due to low levels of 'climate literacy', permanence is not appropriately valued in offsets markets.

In developing its Net Zero Plan, the government could consider other ways to allocate removals across the economy. Policy options include setting sector targets and policy interventions based on the removal potential of the sector in the absence of trading, capping the use of offsets (particularly land-based removals), and allocating different types and/or quantities of removals to different sectors. For example, biological removals could be prioritised for use within the agriculture and land sector.

NP.2 What is the government's role?

The government has an important role in articulating the vision for a net zero Australia, how the different parts of the economy can contribute to that vision, and leading Australia to overcome the barriers that stand in the way. The transition to a net zero economy requires collaboration and coordination across many decision-makers in governments, businesses and communities. By providing a compelling and credible vision for decision-makers to work towards, governments can lay the groundwork for more effective collaboration. The Australian Government's Net Zero Plan is an opportunity for it to provide this vision.

> A zero-carbon mindset must become the new normal so that it permeates operational, policy and investment decisions across governments, businesses and communities.

Governments also set the institutional landscape in which the transition will take place. Having the right institutions working together in the right ways can enable planning and coordination that spans political cycles. In Australia, the primary institutions at the national level that focus on the long-term pursuit of the net zero vision include the Net Zero Economy Authority, the Clean Energy Finance Corporation, the Australian Renewable Energy Agency, the Clean Energy Regulator, and the Climate Change Authority. The energy market bodies, including the Australian Energy Market Operator, also form an important part of the institutional landscape.

All levels of government must work together in planning for and coordinating the transition to net zero emissions, to ensure policy architecture, investment horizons and regulatory environments are aligned (BCA, 2023). Although the Australian Government is the relevant party to the Paris Agreement and therefore accountable for fulfilling its legal obligations, the states and territories have a significant role to play given their authority over many energy, infrastructure and transport projects (DCCEEW, 2022a). Close cooperation between the Australian Government and states and territories will therefore be necessary to ensure policy and legislative alignment. Similarly, responsibility for skills, education and training is shared between the federal and state and territory governments. Local governments play a significant role in land use planning and development within their jurisdiction, and are often best-placed to engage with the community to provide education and gather input and feedback on planning and development matters (ICLEI Local Governments for Sustainability & Ironbark Sustainability, 2021).

The scale of financing needed to achieve net zero requires all levels of government to accelerate and coordinate financial contributions. Cost-sharing arrangements between the Australian Government, state and territory governments at a whole of economy level are guided by the Federation Funding Agreements Framework (CFFR, 2020). In addition, the National Energy Transformation Partnership, agreed in 2022 by Commonwealth, state and territory energy ministers, provides a framework for cooperation across governments to support the transformation of Australia's energy sector (Energy Ministers, 2022). It provides for the Australian Government to negotiate new bilateral Renewable Energy Transformation Agreements with state and territory governments to meet shared objectives in the renewable energy transition (DCCEEW, 2024). Implementing similar frameworks for cooperation across all sectors of the economy, with first ministers overseeing coordination across portfolios, could help progress towards net zero.

> *'This rate of growth cannot be achieved unless Australian federal and state governments work together with industry to expedite projects, mobilise capital, and prepare Australian workers to make the most of this opportunity.'*
>
> Tesla submission, 2024

The Australian Government's Net Zero Economy Authority can play a central role in coordinating place-based implementation of net zero measures across governments, industry, and communities. It could also coordinate co-design of initiatives with local governments to support the development of place-based responses, which account for the different needs and aspirations of individual communities (see also sections NP.4 and NP.8).

Box NP.1: System transformation: Renewable electricity

The transformation of the electricity system requires the concurrent and rapid deployment of renewable generation, firming and transmission. The build out of supply must be timed to match rising demand due to electrification in the transport, built environment, resources and industry sectors as ageing coal generators exit the system.

At the same time, the grid will need to be geographically extended to provide renewable energy to electrifying industry and mines and to connect Renewable Energy Zones. Consumer energy resources will also need to be orchestrated to contribute to grid stability and reduce costs.

Governments will also need to carefully coordinate the contributions of different energy sources to the economy across time and locations, including optimising the mix of electricity, gas, hydrogen, and renewable fuels.

> *'Cost-effective, reliable, secure, renewable, and low GHG emissions energy is fundamental to delivering the large-scale emissions reductions required to achieve the world's collective climate goals and producing the commodities to drive the transition.'*
>
> BHP submission, 2024

Box NP.2: System transformation: Industrial decarbonisation

Low emissions industrial precincts can facilitate the decarbonisation of the industry sector by co-locating industrial facilities and supporting infrastructure such as renewable electricity generation and storage, transport hubs, carbon capture and storage infrastructure, hydrogen infrastructure, water infrastructure, waste processing facilities, training centres, higher education and research institutions, and housing and amenities for workers.

'[Government should use] …a suite of policies to enable the design and implementation of Net Zero Industrial Precincts (NZIPs)… NZIPs are the international gold standard for enabling heavy industry to engage with and support a 1.5°C temperature goal. They offer an economic and policy approach that can rapidly transition existing industries and build new green exports. Australia has room to catch up in regard to the formal declaration of NZIPs, associated targets, and in the public-private investment needed to build infrastructure and deploy clean technologies.'

Climateworks submission, 2024

NP.3 How do we prioritise competing land uses?

While Australia is a large country, the transition to net zero requires balancing competing priorities for land use. Agriculture and forestry make up around 57% of the country, protected areas and other natural environments around 39%, and water around 3%. Only around 1% is for all other uses (DAFF, 2024a). Overlapping with these land use categories, the First Nations estate makes up 57% of the country (DAFF, 2022). As Australia transitions to net zero emissions, competing land uses are likely to include:

- cultural, social, biodiversity and environmental uses
- resource extraction, location of heavy industry, renewable generation and transmission projects
- production of food, fibre, timber products, carbon credits, and biomass for energy.

Much of Australia's environment is arid and at risk of becoming more so due to climate change (CSIRO & BOM, 2022) and this is likely to exacerbate competition for suitable land.

> Australia can successfully transition to net zero while protecting important cultural and environmental priorities and maintaining its food security and agricultural industries.

Australia can successfully transition to net zero while protecting important cultural and environmental priorities and maintaining its food security and agricultural industries. Reforming Australia's planning system in a way that manages competing priorities while also accelerating planning and approval decisions, will need to be a key priority for governments. This will involve establishing benefit sharing practices with governments, landholders, developers, First Nations people and communities (see also section NP.8). Community participation and acceptance should be central to decisions about how Australia uses its land.

A sustainably focused agriculture and land sector can manage and enhance carbon stored in vegetation and soils (land-based removals), generate employment, provide timber and wood products, and reduce climate risks to biodiversity. Stakeholders consulted by the authority highlighted the opportunity to achieve both biodiversity and carbon benefits through the integration of environmental outcomes with carbon markets, such as the ACCU Scheme (Climateworks Centre, Department for Environment and Water – South Australia, Infrastructure Sustainability Council, Eco-Markets Australia, Climate Friendly, Australian Climate and Biodiversity Foundation, submissions, 2024).

Others called for greater coordination of land use policies and strategies across sectors and levels of government (AFI, 2023). This can help ensure decisions made about the transition to net zero balance community values with other environmental and economic outcomes.

Regional-scale planning that supports inclusive community participation can help ensure emissions reduction and removals activities are successful, balance competing priorities and achieve multiple positive outcomes (Dumbrell et al., 2024).

NP.4 How can planning and approval processes accelerate and enable the transition?

Government coordination is essential for effective community consultation and approval processes for major transition projects. Planning and coordination can also help to ensure that a skilled workforce is available at the location where the new infrastructure and industries are being built (see also section NP.7). The authority observes that the Net Zero Economy Authority would be well-placed to lead such efforts, with the appropriate mandate and resources.

Australia's energy transition requires an unprecedented infrastructure build, often with multiple projects and proponents in the same region. For example, the development of renewable energy zones with generation, storage and transmission infrastructure, and low emissions industrial precincts with multiple facilities and pieces of infrastructure involve concentrating multiple projects in a relatively small area. Separate consultation processes for multiple projects in the same community can cause consultation fatigue and diminish community support for energy transition projects (DCCEEW, 2024b). Governments can assist by proactively leading and coordinating engagement with communities to provide information, facilitating benefit sharing, receiving feedback and negotiating outcomes.

> In formulating its Net Zero Plan, the Australian Government will need to consider how regulatory frameworks can enable the rapid development of infrastructure required for decarbonising the economy.

In formulating its Net Zero Plan, the Australian Government will need to consider how regulatory frameworks can enable the rapid development of infrastructure required for decarbonising the economy. Australian planning processes are often complex, requiring the involvement of multiple government agencies and multiple levels of government to progressively approve elements of a project. The authority welcomes the Australian Government's decision in the 2024 Budget to provide $134.2 million to strengthen and streamline environmental approval decisions on priority projects, including renewables and critical minerals projects. The commitment includes $24.5 million for improving planning and working with state and territory governments in seven priority regions to clarify where developments can and can't occur.

Another essential role for governments is anticipating and coordinating solutions to 'chicken-and-egg' problems. Common user infrastructure such as electricity transmission, pipelines, hydrogen infrastructure and ports need sufficient certainty there will be customer demand before they can attract investment. But customers need to know the infrastructure will be there, costs will not be prohibitive, and the risk of extended downtime of their new equipment can be managed before making their own investment decisions. Government coordination and financial support can help plan for and de-risk investment and enable progress of these developments.

> *'Significant coordination of public and private planning and investment will be required to transform and replace industries that have been at the centre of our historic economic growth and create a new green industrial base.'*
> National Australia Bank submission, 2024

Coordination is also required to ensure the size of the infrastructure build matches industry demand over time. The authority welcomes the Australian Government's Critical Minerals National Productivity

Initiative, which provides $10 million to work in partnership with states and territories to develop pre-feasibility studies of common user infrastructure for the critical minerals sector (Australian Treasury, 2024a).

> *'Regionally targeted approaches to developing common-use infrastructure for electricity transmission, under programmes like Rewiring the Nation, will be critical, particularly in mining centres like the Pilbara.'*
>
> Fortescue submission, 2024

NP.5 How will these technologies be financed?

Globally, it is estimated more than USD 10 trillion will be needed annually from 2031 to 2050 to support a 1.5°C compatible pathway (CPI, 2023). In Australia, recent modelling by the Australian Energy Market Operator found the lowest-cost path to reduce emissions in the National Electricity Market in line with the government's net zero by 2050 target would require $122 billion in upfront capital investment (the present value of investment required over the period in utility-scale generation, storage, firming and transmission infrastructure) (AEMO, 2024). The cost of Australia's transition will depend on the policy mix, which if developed well, can capture new opportunities for economic growth (see also section NP.9).

Governments around the world, including the United States with its *Inflation Reduction Act 2022* and the European Union with its Green Deal Industrial Plan, have taken the lead on co-financing the net zero transition.

Governments around the world, including the United States with its *Inflation Reduction Act 2022* and the European Union with its Green Deal Industrial Plan, have taken the lead on co-financing the net zero transition. The Australian Government has set out its plan—Future Made in Australia—for maximising the economic and industrial benefits of the move to net zero (see Figure NP.3). A key objective of the plan is attracting and enabling investment. It builds on Australia's other co-funding initiatives, implemented through institutions and programs such as the CEFC, ARENA, the National Reconstruction Fund, the Capacity Investment Scheme and Rewiring the Nation. The government also has in place measures that put a value on reducing greenhouse gas emissions, thereby encouraging finance to flow to low and zero emissions activities, including the Safeguard Mechanism and ACCU Scheme.

Figure NP.3: Summary of the Future Made in Australia package announced by the Australian Government in the 2024-2025 budget

The 2024-25 Budget provided $22.7 billion for the Future Made in Australia Package

GREEN METALS AND CRITICAL MINERALS PROCESSING

$7 billion from 2027-2040 for production tax incentive associated with refining and processing of critical minerals plus $10 million for pre-feasibility studies for critical minerals common-user processing facilities

$1.2 billion in strategic critical minerals projects including through the Critical Minerals Facility

$18.1 million over six years from 2024-25 for supporting the emergence of Australia's green metals industry

RENEWABLE HYDROGEN

$6.7 billion over ten years from 2027 through the Hydrogen Production Tax Incentive for renewable hydrogen

Additional $1.3 billion to the existing Hydrogen Headstart program

LOW CARBON LIQUID FUELS

$20.9 Million over four years for the consultation work to explore expansion of the Guarantee of Origin scheme to low carbon liquid fuels

SOLAR AND BATTER SUPPLY CHAINS

$835.6 million over ten years to establish the Solar Sunshot program

$523.2 million Battery Breakthrough Initiative

ENABLING ENVIRONMENT

$1.7 billion allocated for a Future Made in Australia Fund (administered by ARENA)

$17.3 million over four years from 2024-25(and $3.1 million per year ongoing) to improve sustainable finance markets

$68.0 million over four years from 2024-25 to support investment

$182.7 million over eight years from 2023-24 (and $4.5 million ongoing from 2031-32) to improve approval processes

$68.4 million over seven years from 2024-25 for initiatives delivered through the new Skills and Training Academy

Source: Budget Paper No. 2 (Australian Treasury, 2024a).
Note: listed initiatives do not cover all Future Made in Australia funding.

There is no one-size-fits-all financial instrument that is appropriate for public finance for Australia's transition. However, the best approaches will ensure efficient public investment leverages private investment to align risk and return profiles with the appetites of both parties. The authority's analysis in each sector chapter shows that understanding the context is fundamental to making sure the investment instrument is suitable (summarised in Table NP.1).

Table NP.1: Summary of financial instruments responding to sectoral barriers and enablers

Financial Barrier	Possible Financial Instrument	Example Enabler
Commercial viability of investment	Grants or concessional finance to support technology development	Investment in research and development for agriculture and carbon removal technologies
Low return on investment	Direct investment or debt/equity finance	Common user infrastructure
Limited evidence of commercial returns	Targeted subsidies directed at improving risk-return ratio	Tax credits to incentivise faster asset turnover
Unfavourable risk profile	Guarantees or insurance measures to underwrite investments	Contracts for difference for energy projects
High upfront costs	Concessional finance through grants, low-cost loans or incentive schemes	Discounted household upgrades
		Electric vehicle incentives

Australia will need to attract foreign investment to support its transition to net zero. However it recently became a net exporter of capital for the first time since the mid-1970s (RBA, 2023). The authority heard from stakeholders including private investors, industry and business that policy stability and predictability are fundamental for investment and particularly important when investing in new technologies or industries.

> *'Compared to international competitors, Australia has low rates of investment relative to the size of its economy. Capital follows the strongest investment signals and Australia's policy signals are currently too weak to attract globally relevant industrial abatement and investment capital.'*
>
> Australian Aluminium Council submission, 2024

A 'National Interest Framework' to guide public investment under the government's Future Made in Australia plan is currently before the parliament (Future Made in Australia Bill 2024). It has two streams for identifying investment aligned with in the national interest:

- 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 in which public investment is needed for the sector to make a significant contribution to emissions reductions 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.

In addition to articulating the rationale for public investment under the Future Made in Australia plan, the framework commits the government to applying community benefit principles to investments. The authority considers that further articulation of community benefit principles should include non-financial considerations such as climate resilience and intellectual property rights.

Government should also establish a clear and transparent process for ending investment at a point of project success or failure. Finite public capital means investments should be outcome-focused and time-bound to avoid inefficiency and over-subsidisation. Clear exit strategies that are publicly communicated and consistent can support this investment approach. In its submission, Chevron Australia noted "incentive oriented programs should be designed with the goal of ultimately enabling technologies and products to compete without government support" and encouraged the incorporation of established sunset dates (Chevron Australia submission, 2024, 2024). The authority supports clear end dates or principles for ceasing public investment, supported by regular monitoring and reviewing of investments against pre-established and transparent performance metrics such as cost declines, efficiency increases, or emissions reductions (Meckling et al., 2022; Productivity Commission, 2008).

Transparency mechanisms, such as climate-related financial risk disclosures and the Guarantee of Origin assurance scheme (being designed to track and verify emissions associated with hydrogen and renewable electricity made in Australia), also play an important role in informing investment and consumer decisions (CER, 2024). Standards and labelling are another way to mandate or assist consumer decisions and channel finance towards the transition, while also helping householders choosing products that reduce cost-of-living over time. Examples include Australia's Greenhouse and Energy Minimum Standards (GEMS) scheme that promotes the development and adoption of appliances and equipment that use less energy and produce less emissions.

Standards and labelling are another way to mandate or assist consumer decisions and channel finance towards the transition, while also helping householders choosing products that reduce cost-of-living over time.

The government is well progressed in overcoming information barriers to private investment, with policies and measures addressing climate-related financial disclosures and the development of a sustainable finance taxonomy. However, barriers remain. The development of sustainable finance policy in Australia must be met by an uplift in a domestic workforce capable of understanding sustainable finance needs. Research by the Australian Sustainable Finance Institute found "a significant skills and capability gap in sustainable finance professionals remains" and improved skills are necessary given forthcoming mandatory climate disclosures (ASFI, 2023). Improving market competence must happen quickly and there is opportunity for government, industry and academia to come together to develop the training and implementation of comprehensive and targeted courses for market participants.

Data gaps remain a key barrier to mobilising finance for decarbonisation. Digital reporting is only voluntary under Australia's financial reporting requirements (ASIC, 2014). The authority suggests anticipated mandatory climate-related financial disclosures could be used as a pilot for widespread digital reporting. Digital reporting should create opportunities to enhance the availability and accessibility of accurate, consistent and comprehensive information on emissions and decarbonisation, which will help decision-makers reduce risk and realise opportunities.

A review of the Australian tax and transfer system could potentially reveal opportunities to reallocate public funding to better align with the government's Net Zero Plan. For example, the Fuel Tax Credit could be phased out and revenue redeployed towards the deployment of low and zero emissions vehicles and machinery instead. The Fuel Tax Credit currently costs taxpayers 1.4% or $10 billion of government expenditure annually (Parliamentary Budget Office, 2023) and provides a refund for a proportion of fuel costs associated with the tax for eligible types of vehicles and machinery (ATO, 2021). The mining industry has obtained the largest total value of credits claimed – more than triple that of the agriculture sector (Grattan Institute, 2023).

A review of the Australian tax and transfer system could potentially reveal opportunities to reallocate public funding to better align with the government's Net Zero Plan.

A competitive economy is fundamental in supporting the innovation and efficiency necessary to reach net zero. However, the authority heard from several stakeholders that a lack of clarity around competition law was creating reluctance to collaborate and innovate. With the government taking a more active role in industry participation (Productivity Commission, 2023a), the time is right to ensure laws foster innovation and collaboration, while promoting competitive markets. For example, the government could permit the pooling of resources or time-limited regulatory sandboxes to encourage innovation and collaboration while retaining oversight (Hellenic Competition Commission, 2024).

Box NP.3: Common user infrastructure

The role of public finance in establishing new industries and overcoming high-upfront costs through developing common user infrastructure has a strong precedent in Australia. The West Australian and Australian Governments were integral in establishing the North-West Shelf gas venture off Western Australia in the 1970s. Government provided a demand signal by committing to allow exports for 20 or more years of 6.5 million tonnes per annum of liquefied natural gas, with the state government committing to long-term (20-year) contracts for fixed volumes of gas (Western Australian Government, 1979). Alongside demand signals, the state government also committed to:

- financing and development of the gas pipeline from Dampier and Bunbury
- contributing to the construction costs of new public roads in Dampier
- establishing and operating a local port authority
- constructing public facilities (such as schools or hospitals) to support operations
- making land available for land sale to house workers.

This common user infrastructure model is being adopted in other jurisdictions to accelerate net zero industrial policy. Through the United States' Infrastructure Investment (US) *and Jobs Act 2021*, the Department of Energy is investing USD 7 billion to create regional hydrogen hubs. These hubs will form the foundation of a national clean hydrogen network that will contribute to decarbonising sectors of the economy like heavy industries and heavy-duty transportation (United States Department of Energy, 2023). This funding will mainly be provided through grants, contracts or cooperative agreements, and complement Inflation Reduction Act (2022) tax credits related to hydrogen (United States Department of Energy, 2022).

Beyond hydrogen, the Inflation Reduction Act 2022 (US) is already having an impact with USD 265 billion in new investment in the United States in 12 months across the manufacture and deployment of clean energy, clean vehicles, building electrification and carbon management technology, up 39% from the previous year (CIM, 2024).

NP.6 How can we better signal the cost of carbon across the economy?

Achieving net zero requires that emissions reduction opportunities are pursued across all the sectors of the economy. As the Climate Change Authority (2020) and Productivity Commission (2023b) have observed, a broad, market-based policy approach that establishes a consistent price for emissions is generally accepted to be the most efficient way to achieve emissions reductions across the economy. Policy to establish a price signal is necessary because otherwise the cost of greenhouse gas emissions in causing global warming is not reflected in the activity that led to the emissions. Price signals alone are not sufficient to deliver the net zero transition – additional policies are required to solve coordination problems, build social licence and address other barriers.

Climate policy has evolved in Australia in a manner that has led to federal, state and territory governments implementing a variety of policy measures across different sectors of the economy, resulting in a fragmented approach to establishing a signal for the cost of carbon. At the federal level, market mechanisms currently in place include:

- the ACCU Scheme, which enables voluntary carbon abatement to be credited with saleable carbon units (ACCUs) and in practice has operated mainly in the land sector
- the Safeguard Mechanism, which imposes declining emissions-intensity baselines on Australia's highest-emitting industrial facilities and allows companies to trade Safeguard Mechanism Credits (SMCs) and ACCUs to meet their baselines
- the Capacity Investment Scheme, which uses auctions to award underwriting agreements to competitive renewables and storage projects
- the Renewable Energy Target, which allocates tradeable certificates for the output of renewable generation
- the New Vehicle Efficiency Standard, which allow trading of credits between manufacturers to stay below a baseline efficiency level.

There are a range of other policy interventions across levels of government that drive lower emissions outcomes, including emissions and energy efficiency standards and regulations, and government subsidies. None of these approaches directly impose a price on carbon, but they do all have the effect of imposing indirect, implicit or 'shadow' carbon prices (Productivity Commission, 2023b).

In addition, many companies and, more recently, areas of government at both the federal and state level, are using various estimates or projections of the cost of carbon, or value of emissions reductions, to inform decision-making (Infrastructure Australia, 2024; NSW Government, 2023). Should the government decide to implement a carbon border adjustment mechanism (DCCEEW, 2023b) that will necessitate determining the penalty to apply to the emissions-content of certain imported goods.

The authority notes there can be significant political and social challenges in implementing a broad-based market mechanism for pricing greenhouse gas emissions. Attempting to do so in Australia currently is likely to be disruptive and create, rather than alleviate, policy uncertainty at a time when several new and important measures (e.g. the expanded Safeguard Mechanism, the New Vehicle Efficiency Standard and the expanded Capacity Investment Scheme) are commencing. It is also the case that much of the policy and institutional architecture currently in place, or being put in place by the government (e.g. Net Zero Economy Authority), is required for a successful transition to net zero irrespective of whether implementation of a broad-based mechanism is revisited.

However, there are two ways in which the government can work towards achieving a more consistent carbon pricing signal across the economy over time and hence more efficient, least-cost pathways to net zero.

First, as a means of harmonising and simplifying the approach to pricing carbon across the economy, the government can look to expand the coverage of the ACCU Scheme and Safeguard Mechanism, and possibly link them with other schemes. Relatedly, the authority has previously recommended (CCA, 2022; 2023a) the government develop a National Carbon Market Strategy, and the government has indicated that its Net Zero Plan will articulate Australia's vision for ensuring robust and high-integrity carbon markets, and how the government intends to engage in carbon markets to meet its emissions reduction targets (DCCEEW, 2023a).

Second, the government can seek to establish an authoritative voice on estimates of the cost of carbon now and into the future, to promote consistent and robust analysis and decision-making in a range of settings. Such a function could be performed by the Treasury or an independent advisory body such as the Climate Change Authority.

NP.7 Who will build what Australia needs?

Workforce shortages are already seen as a barrier to decarbonising almost every sector of the economy, as set out in Part 1. Workforce demand in several transition trades will exceed supply in the coming decade according to modelling undertaken for Jobs and Skills Australia (JSA, 2023b). Failing to address these shortages present significant risk to costs and project delivery schedules necessary in the transition (Infrastructure Australia, 2021).

> *'If we don't fine tune our workforce pipelines, skills shortages could prevent us from reaching net zero by 2050, and opportunities to broaden our industrial base will be missed.'*
>
> JSA, 2023b

Jobs and Skills Australia's The Clean Energy Generation report suggested decarbonisation plans embed workforce planning to address shortages and enable the workforce of the future. The authority recommends governments work together and with businesses to prioritise workforce diversification and a fit-for-purpose education system.

Workforce mobility

The build out and transformation of facilities and infrastructure required across the country will require a workforce that is flexible and mobile. Much of this work will be in regional and remote areas and will require different numbers and kinds of workers for various stages, from initial construction to ongoing maintenance. Ensuring that workers can easily move to where they are needed will enable an efficient transition.

The build out and transformation of facilities and infrastructure required across the country will require a workforce that is flexible and mobile.

Providing incentives for temporary housing solutions, such as modular housing, can help accommodate workers in these areas. Programs that offer financial support or subsidies for relocation costs will also encourage workers to move to where they are needed most. Governments and project proponents will need to be sensitive to impacts on local communities from a temporary influx of workers and heavy equipment, such as damage to local roads, and price increases caused by sudden increases in demand for food and housing.

Workforce diversification

Diversifying workforces can increase participation of under-represented groups and represents one of few ways to address the acute workforce shortages being experienced by transition industries now. As Jobs and Skills Australia (2023a) observed, workforce skill shortages are exacerbated when a large portion of the population faces barriers to entering and remaining in a sector. Analysis by Jobs and Skills Australia also found that the majority of occupations with skills shortages are dominated by one gender (JSA, 2023a).

In trade roles, gender discrimination, limited apprenticeship opportunities, lack of facilities (such as bathrooms), harassment and unsuitable workwear limit women's participation (Jobs Queensland, 2021). Many trade positions lack flexible working hours or training opportunities, particularly affecting women with family caring responsibilities (Jobs Queensland, 2021). Government, industry and other groups could encourage and enable employers to diversify by increasing awareness of the benefits and providing information about how the barriers listed above can be overcome. In addition, addressing lack of social services in regions could reduce barriers for those with family caring responsibilities from entering the transition workforce (ABS, 2022).

> *'Equal representation of women in engineering… will go a long way towards meeting Australia's need for vastly greater numbers of qualified engineers if we are to fulfil our ambitious development targets over the next decade'*
>
> Engineers Australia, 2022

A fit for purpose education system

Increasing the pipeline of adequately skilled workers is critical to meeting the short and long-term workforce needs of the transition (JSA, 2023b).

> *'A slow and unwieldy VET system has been a brake on the development of relevant and meaningful qualifications for electrical and mechanical tradespeople in renewable energy.'*
>
> Clean Energy Council, 2022

Australia has a trainer shortage to deliver the training necessary for the near-term priorities of deploying renewable energy and housing upgrades (JSA, 2023b). Educators in the VET system are often attracted to private industry and this pattern will likely intensify as industry demand increases (Tyler & Dymock, 2021).

Regional Australians face additional barriers to accessing training due to the limited offerings nearby. Lack of training opportunities within a reasonable distance from home can be a disincentive and barrier to entering transition workforces (JSA, 2023b). These disincentives can be partly addressed through on-the-job training and by increasing the supply of courses in regional areas experiencing – or projected to experience – increased labour demand (JSA, 2023b). Temporary job surges in regions (e.g. during construction phases of industry transition) also require anticipatory planning to ensure that local communities are not negatively impacted. For example, arranging temporary accommodation (such as dongas and portables) for an influx of transient workers can mitigate potential pressure on local housing supply (Jobs Queensland, 2018).

Australia's education system must be prepared for the new industries and skills required for the transition (JSA, 2023b). A well-planned education system with better integration of university and VET training systems can deliver the workforce of the future (Department of Education, 2023). TAFE Clean Energy Centres of Excellence could also provide an avenue for industries, universities, communities and governments to collaboratively build courses to meet the needs of regional industries and support local workforces to adapt to technologies (JSA, 2023b). Inspiring and encouraging school-aged students to pursue careers that will be in high demand will be important to foster enrolments in these university, VET and TAFE courses.

> A well-planned education system with better integration of university and VET training systems can deliver the workforce of the future.

As remote-based industries, including critical minerals and hydrogen production, grow, more innovative training models will be necessary (Beasy et al., 2023; DISR, 2023). Hub-and-spoke models combined with group training organisations permit trainees to complete competency requirements in regional centres while still working in remote sites (JSA, 2023b).

Regions are likely to experience a boom during the construction phase of a project before it settles into the operational stage (DITRCA, 2024). Modelling undertaken for Jobs and Skills Australia revealed that growth in job opportunities would be stronger in regional Australia than metropolitan areas (JSA, 2023b). Improving planning, access to training and education alongside robust workforce data is necessary to maximise these benefits and manage longer-term regional impacts (Rutovitz et al., 2021).

A lack of data is impeding planning for the impact of the transition on local labour markets. Jobs and Skills Australia advises that workforce data on what is necessary for Australia's future energy needs is limited and inconsistent (JSA, 2023b). Reinstating the Australian Bureau of Statistics Employment in Renewable Energy Activities series, with greater granularity of occupations and regional disaggregation, could provide greater assistance to regional planners. The National Energy Workforce Strategy may be an avenue to consider this option and ensure data can inform regular reports like an Australian Energy Employment Report.

Climate change will influence workforce productivity

At the same time as the workforce is delivering the transition to net zero, increased heat exposure will likely impact labour productivity, and require changes to work practices in exposed industries. Workers in industries where outdoor daytime work is common may need to change the way they work to reduce their exposure to heat. This is likely to reduce the outputs of the agriculture, construction, manufacturing and services sectors, with impacts worsening under higher global temperature scenarios (Australian Treasury, 2023). The impact of climate change on labour productivity is already being seen. In 2022, the global potential loss of earnings was $863 billion, equivalent to 0.87% of gross world product (Romanello et al., 2023).

NP.8 What does a fair and equitable transition for Australia look like?

For Australia to build the infrastructure necessary for the transition, government and industry must obtain the social licence to operate from affected communities. Gaining and maintaining social licence through trust, legitimacy and credibility is a critical success factor for projects necessary in Australia's transition to net zero. Without it, these projects are at risk of delays and additional costs, and even failure.

'For the net zero transition to be successful, all Australians must feel that they are sharing in the benefits.'

Centre for Policy Development submission, 2024

> Gaining and maintaining social licence through trust, legitimacy and credibility is a critical success factor for projects necessary in Australia's transition to net zero.

Repeated or consistent failures to obtain social licence and share benefits risk eroding the social and political support that will be required for the transition. The authority defines just transition as 'the process and the outcome in which burdens and benefits are shared equitably as Australia accelerates emissions reductions, adopts new ways of doing things, and continues to prosper as the world transitions to net zero emissions' (CCA, 2023a).

Australian governments, businesses and communities need to prepare for the unavoidable and varied impacts of the transition, particularly in regions. Regions where emissions-intensive industries are the 'lifeblood' of community generally have less diverse economies than other areas and therefore face greater economic and social challenges from the transition (Hammerle & Phillips, 2023). Emissions-intensive industrial regions must be provided the support and planning to transition and attract emerging industries. Effective transition planning should focus on the community as a whole and seek to support the broader economy to diversify and become more resilient (Hammerle & Phillips, 2023).

Subject to passage through parliament, Australia's *'Net Zero Economy Authority will promote orderly and positive net zero economic transformation for Australia, its regions, industries, workers and communities. It will do this by coordinating effort, brokering investments that create jobs in regions, and supporting workers through change'* (PM&C, 2024). As set out above, the Net Zero Economy Authority could play a central role in coordinating place-based implementation of net zero measures across government, industry, and communities. It could also coordinate co-design of initiatives with local governments to support the development of place-based responses, which account for the different needs and aspirations of individual communities.

First Nations voices must be central to the transition so that their ongoing contributions to Culture, caring for Country and Australia's economic prosperity can continue. First Nations peoples have occupied and cared for Australia's land and sea for over 65,000 years (McConnell et al., 2021). Modelling by Net Zero Australia suggests that to reach net zero, about 43% of renewable energy infrastructure will need to be co-located on the First Nations Estate (NZA, 2023). Therefore, First Nations peoples must have a leadership role in the transition if benefits are to be shared equitably (FNCEN, 2024).

Best practice engagement with First Nations communities can help Australia achieve a rapid transition while respecting First Nations' community decision-making and Culture. Here in Australia and overseas, failure to consider First Nations' rights has increased project costs, delayed approval timelines, prevented communities from sharing in transition benefits and threatened project viability (Kårtveit, 2021; Lee et al., 2023; Lyons et al., 2023). The Australian Council of Superannuation Investors noted that increased costs from unconstructive relationships with First Nations peoples represent a material risk, and that investors need assurance this risk is being mitigated through respect for rights and Culture (ACSI, 2021). Genuine engagement with First Nations can build social licence for low emissions industries.

For best practice engagement to occur, partnerships with First Nations peoples must be based on the principles of free, prior and informed consent (FPIC) and the right to self-determination (NIAA, 2022; UN General Assembly, 2007). FPIC means collective decisions made by communities that are free from coercion and produced with adequate time to consider all available information (UNHRC, 2018). The rapid rollout of transitional infrastructure is a potential risk to investing the necessary time for relationship and trust building with First Nations communities (CCA First Nations Roundtable, 2024). Nevertheless, emerging industry and First Nations partnerships on renewable energy projects demonstrate that when Community has ongoing participation in decision making, projects can be implemented quickly and traditional knowledge can assist in reducing impacts to Country and Culture (Yindjibarndi Energy, 2023).

The majority of First Nations representative bodies are not adequately resourced to build internal capacity and engage expertise when considering impacts of infrastructure on Country (Woods et al., 2021). To provide informed consent for developments and for industry to undertake best practice engagement, First Nations peoples require equal access to information and capacity to understand and utilise complex engineering, financial and policy subject matter (ASFI, 2024; Clean Energy Council and KPMG, 2024). Government has an important role to play in supporting this capability uplift, but existing mechanisms such as the Australian Government's PBC Capacity Building grant scheme have been identified as unfit for purpose and are under evaluation (NIAA, 2023). To enable Australia's transition to proceed at the pace required, the government should prioritise support for First Nations communities to realise meaningful opportunities in the transition (CCA First Nations Roundtable, 2024).

Historically, First Nations people have been excluded from accessing the capital necessary to develop decarbonisation projects themselves (ASIC, 2023). Lack of trust from financial institutions and mis-categorisation of First Nations assets are significant barriers to inclusion (Evans & Polidano, 2022). Recent initiatives, including start-up financing and procurement loans provided through Indigenous

Business Australia as well as grants through the Indigenous Advancement Strategy have assisted First Nations owned and led enterprises to acquire equity. However, limitations in longitudinal data can make the success of these policy interventions difficult to evaluate (Evans & Polidano, 2022). The Indigenous Economic Power Project has made progress towards achieving more comprehensive measurement, reporting and demonstration of the economic, employment and social contributions provided by First Nations businesses (Evans et al., 2024). Continued support and resources from government and industry are necessary to ensure First Nations people have access to capital and equity.

> Continued support and resources from government and industry are necessary to ensure First Nations people have access to capital and equity.

Supporting First Nations-led businesses in the transition has important benefits for Community, Culture and the Environment that should be formally acknowledged. Growth of the First Nations carbon industry, which now numbers over 38 projects (ICIN, 2024), has assisted in bringing First Nations peoples back to Country and supported the handing down of Traditional Knowledge from Elders to future generations (ILSC, 2022). Broader environmental benefits of the First Nations carbon industry include reduced wildfire risk, and increased habitat diversity and biodiversity (Gebbie et al., 2021). Initiatives that include a non-carbon benefit component, such as the Queensland Land Restoration Fund (2024) have the potential to improve the financial viability of First Nations carbon industry projects by rewarding caring for Country practices (ILSC, 2022). Further investment by government and industry to formalise recognition of these benefits could assist First Nations led projects to attract equity and diversify revenue streams (CCA First Nations Roundtable, 2024).

NP.9 What will it take for Australia to continue to prosper?

Australia is an emissions-intensive export economy. Its four largest exports are iron ore ($124 billion in 2022-23), LNG ($92 billion), thermal coal ($66 billion) and metallurgical coal ($62 billion) (DISR, 2024). Australia's fossil fuel exports (mainly coal and LNG) account for around 35% of Australia's $686 billion total goods and services exports (ABS, 2023; DISR, 2024). When these fuels are burned by our export partners, they produce more than double Australia's domestic emissions (CCA, 2024).

The IPCC (2022) and IEA (2023) have concluded that, globally, new fossil fuel projects are incompatible with achieving the Paris Agreement goal of limiting warming to 1.5°C, and that global demand for fossil fuels will need to significantly decline over the period to 2050. According to the IPCC (2022), demand for natural gas and coal will need to reduce by as much as 62% and 99% respectively by 2050. The IEA (2023) has similarly identified reductions of 78% and 92% respectively in its net zero by 2050 scenario.

The demand for critical minerals and low emissions metals is expected to increase to enable the global net zero transition. The IEA estimates demand for critical minerals could nearly triple by 2030 and grow to over 3.5 times current levels by 2050 in a net zero by 2050 scenario (IEA, 2024). These shifts in demand underscore the significant changes required in global energy and resources markets to achieve the goals of the Paris Agreement.

For Australia's economy to thrive and grow, and also do its part to contribute to the goals of the Paris Agreement, it will need to adjust its export mix by ramping up exports that will be in demand in a net zero global economy and working with trade partners to manage an orderly transition away from fossil fuels.

> *'[Australia will see its] …fossil-fuel heavy export revenue decline. Australia's key trading partners have all committed to net-zero targets, and demand for Australia's fossil fuel commodities are expected to fall. Overall, this presents an unprecedented economic risk to the Australian economy that requires a proportionally adequate response to safeguard Australia's future and livelihoods… Endowed with world-leading renewable resources that are critical to powering competitive clean industries, Australia has the potential to grow its revenue from new clean exports to $333 billion by 2050. But it must move quickly, the global race is well underway in major economies such as China, the USA and Europe who are moving fast to attract investment and secure market share. Low cost solar and wind will be essential to capturing Australia's clean export opportunity'*
>
> Beyond Zero Emissions submission, 2024

'As one of the world's leading coal exporters, Australia is a trusted partner supporting the energy security of import-reliant economies like Japan and South Korea. However, with our major export destination countries committing to their own net zero targets, Australia will need to adapt and develop new export industries to retain our advantage. Critical minerals mining and processing and hydrogen production represent promising opportunities, and the policy attention they are attracting from federal and state governments is warranted'

Mining and Energy Union submission, 2024

'WWF-Australia through its Renewables Nation program has advocated for Australia to capture the jobs and growth opportunities presented by becoming a renewable energy superpower. The window of opportunity to realise these opportunities is small and narrowing.'

WWF Australia submission, 2024

To facilitate an orderly transition, working with trading partners to establish bilateral decarbonisation agreements will give Australia certainty about the timing of changes in demand for fossil fuels and low emissions exports, while also giving its trading partners certainty about their energy security as they transition their own economies to net zero. These agreements could also be used to facilitate an orderly transformation of global supply chains, which will require shifts in the location of production of energy intensive materials, like aluminium, iron and steel, to countries like Australia with abundant renewable energy. Participation in multilateral processes that are developing standards and definitions for low carbon products (e.g. steel and cement) – such as the Climate Club (2023) and the Inclusive Forum on Carbon Mitigation Approaches (OECD, 2024) – will also be important to ensure that global norms are compatible with the needs of Australian industry.

'In advising the Government on fossil fuel phase out, the CCA should consider… opportunities for Australia to cooperate with key trading partners to support wider fossil fuel phase out while ensuring energy security, including through exporting renewable resources and skills to support energy transition in developing export destination economies—noting such actions could achieve substantial emissions reductions compared to decarbonising Australia's economy alone.'
Carbon Market Institute submission, 2024

The Australian Government articulated its vision for maximising the economic and industrial benefits of the move to net zero and securing Australia's place in a changing global economic and strategic landscape through its Future Made in Australia plan announced in the 2024 Budget (see also section NP.5). Decisions under the plan about where to target significant public investment are subject to a 'National Interest Framework' that is currently before the parliament to provide additional rigour beyond existing government investment processes (Future Made in Australia Bill 2024, 2024). The framework has two streams under which an industry may warrant government intervention to attract private investment:

- The 'Net Zero Transformation Stream' is aimed at identifying industries that will make a significant contribution to the domestic and global net zero transformation and in which Australia is well placed to be competitive in global markets. The government has identified renewable hydrogen (referred to as electrolytic hydrogen in this report), green metals (referred to as low emissions metals in this report), and low carbon liquid fuels (referred to as renewable fuels in this report) as aligned with this stream.
- The 'Economic Resilience and Security Stream' is aimed at identifying industries that are critical to Australia's economic resilience, are vulnerable to supply disruptions and that require support to unlock sufficient private investment. The government has identified critical minerals processing and clean energy manufacturing, including in battery and solar panel supply chains, as aligned with this stream.

Australia has an opportunity to develop new industries that leverage its relatively small, high wage but highly skilled workforce to produce bulk exports from its abundant renewable energy sources and resources deposits. By investing in necessary infrastructure and skills development, and incentivising investment, Australia can create a new industrial base and build a stronger, more diversified and more resilient economy powered by renewable energy, in a way that creates secure, well-paid jobs and delivers benefits to communities across the country.

By investing in necessary infrastructure and skills development, and incentivising investment, Australia can create a new industrial base and build a stronger, more diversified and more resilient economy powered by renewable energy, in a way that creates secure, well-paid jobs and delivers benefits to communities across the country.

Australia is already a significant global producer of raw ores, such as iron ore, bauxite and lithium (DISR, 2024). Australia can reduce its domestic emissions by transitioning to net zero emissions mining practices (see Resources sector chapter). In addition, Australia's abundant sun and wind resources provide an opportunity to process more of these ores domestically into higher value products before they are exported. For example, large scale renewable energy installations with storage could power the processing of more iron ore into low emissions iron and steel, more bauxite into alumina and aluminium, and more lithium into lithium hydroxide. Iron, steel, alumina, aluminium and lithium are used in the production of transition technologies like wind turbines, solar panels, batteries and electric vehicles, and demand is likely to increase as the global net zero transition gathers pace (IEA, 2024).

Companies that use metals and critical minerals in their products, as well as their customers and financers, are increasingly demanding supplies that have been produced using high environmental, social and governance standards (PWC, 2024). Australia is well placed to capture a share of this

growth in demand for high integrity, low emissions metals and critical minerals, but cannot ignore the need to be efficient and compete on cost to be competitive in global markets. Global market volatility and geopolitical influences will impact the opportunity for the Australian resources sector.

By doing more energy-intensive refining of ores before export and reducing the need for that processing to occur in other countries that use fossil fuels and produce emissions, Australia can also contribute to reducing global emissions. More domestic processing also means a lower volume of material is being exported, saving on emissions associated with shipping. In its submission, Tesla explained that by refining lithium ore into the lithium hydroxide used in batteries for electric vehicles and energy storage before exporting it, Australia could capture a much larger share of the electric vehicle value chain (2024). This would help reduce global emissions by ensuring renewable energy is used in the onshore refining process and by reducing transport emissions (and costs) tenfold by concentrating the ore down into a smaller volume.

> *'Specifically, value adding extraction and export supply chains through making 'green metals' is the next logical step in developing Australia's alternative to fossil fuel exports. Importantly, this has the dual benefit of not only affirming Australia's economic prosperity through establishing a profitable revenue stream, but it has also been said that it could offset global emissions by as much as 6-9 per cent. In the context of Australia's current contribution to global emissions of around one per cent, this is a substantial and profound opportunity.'*
>
> Engineers Australia submission, 2024

A number of organisations have attempted to quantify the value of the export opportunity. In its submission, Fortescue presented modelling results indicating Australia's current US$151 billion in annual fossil fuel export revenues could be replaced with new low emissions exports generating US$1.2 trillion in revenue per year by 2035 in an ambitious scenario or US$436 billion in a conservative scenario. Beyond Zero Emissions (2021) found that annual low emissions exports could grow to $333 billion by 2050, more than triple the value of Australia's fossil fuel exports at the time of the report. Accenture modelling for the Sunshot Alliance (2023a) found that five priority low emissions exports could result in an additional $314 billion of revenue per year by 2040. The EY Net Zero Centre (2023) conducted modelling indicating that if Australia capitalises on some of the business opportunities in low emissions iron and other energy transition minerals and metals, it could add more than $40 billion to national income and $65 billion to Australian economic activity by 2050, in a conservative scenario if around 10% of Australian iron ore production is used to make green iron for export.

Decarbonising Australia's exports at the same time as decarbonising its domestic economy will create challenges because the domestic and export transitions are tightly coupled. They will compete for access to infrastructure and supply chains, and for resources like land, water, electricity, and labour. The government will need to carefully plan and coordinate both transitions to manage these competing demands and maximise efficiency.

As set out in section NP.5 above, there is a global reorientation in trade and investment underway as governments, regulators, and markets around the world transition to net zero emissions and Australia needs to adapt to these changes or risk the economic opportunities flowing to other countries (CCA, 2021). The United States has committed substantial support through its *Inflation Reduction Act 2022*. Estimates of the total fiscal cost of the *Inflation Reduction Act 2022* over its 10 year life range between around US$800 billion (Credit Suisse, 2022) and US$1.2 trillion (Goldman Sachs, 2023). Other jurisdictions like the European Union, Canada, the Republic of Korea, Japan, India and Indonesia also have implemented policies to capture the opportunities of the global transition (Accenture, 2023b; King & Wood Mallesons, 2023). Companies are responding to these policies. In its submission, Tesla observed:

> *'As battery supply chains re-route and scale up in real time, Australian IP, jobs and potential investments are at risk of migrating overseas. Indeed, this is already happening. For example, Ioneer secured US$700m for its Nevada project, Novonix received US$240m for its Tennessee graphite plant, and Lynas was awarded US$120m to build its Heavy Rare Earths Facility in Texas. Pilbara Minerals is partnering with POSCO to build a lithium hydroxide refinery not in the Pilbara, but in South Korea. And Fortescue Future Industry has committed to building its Battery Hub in the US, citing incentives as a key factor'*
>
> Tesla submission, 2024

Australian iron ore exports face growing competition from jurisdictions like Africa, Brazil and the Middle East that have low emissions energy resources and magnetite ore deposits that are better suited to direct reduced iron processes using hydrogen than

the hematite ore that makes up the bulk of Australia's current exports. Accelerating the development of a low emissions iron industry in Australia that uses locally produced electrolytic hydrogen to process Australian ore into low emissions iron could prevent Australian iron ore losing market share to other jurisdictions (IEEFA, 2023). Achieving this will require commercialising emerging low emissions technologies that are suited to Australia's hematite ores or increasing extraction from Australia's large magnetite deposits.

Table NP.2 below summarises potential new export opportunities beyond low emissions metals and minerals that draw on Australia's natural advantages.

Table NP.2: Potential new low emissions export opportunities beyond metals and minerals

Opportunity	Description
Hydrogen and its derivatives	· Electrolytic hydrogen is produced using renewable electricity and electrolysis. · Powering a hydrogen export industry would require a substantial increase in renewable electricity generation (AEMO, 2024). · Complexities and energy penalties associated with compressing, liquefying or chemically converting hydrogen gas into a transportable state (Hassan et al., 2023) are likely to limit its seaborne trade as an energy carrier. · More attractive opportunities are likely to lie in using domestically produced hydrogen close to its source to make products that are more readily transported, such as low emissions iron, alumina, fertiliser, explosives, petrochemicals and ammonia (EY Net Zero Centre, 2023). · Countries with high energy needs that are currently reliant on fossil fuels and have limited domestic energy resources like the Republic of Korea and Japan are likely to be demand centres for hydrogen and its derivatives (DCCEEW, 2022b). · The government's Guarantee of Origin scheme will enable Australia to verify the low emissions credentials of its hydrogen-based exports (DISR, 2021).
Storage of carbon dioxide	· CO_2 can be stored in onshore geological formations or beneath the seabed offshore. · Australia could leverage its science and engineering expertise and vast geological formations to establish a CO_2 storage and use industry. Partnering with other countries would help Australia to scale a geological storage industry. · Key trading partners of Australia are looking abroad for carbon management solutions to support their national net zero targets. Japan, the Republic of Korea and Singapore are all committed to CCS to support their emissions reduction targets (Australian Senate Environment and Communications Legislation Committee, 2023). · The Australian Government regulates storage of CO_2 offshore through a series of Commonwealth laws. A regulatory framework would need to be established to manage the importation, transportation and long-term storage of CO_2, ensure environmental and social safeguards are in place, manage risks such as leakage during transport, injection and storage, and address interactions with Article 6 of the Paris Agreement (trade of abatement between countries).
Energy intensive data centres	· Data centre capacity is expected to increase significantly due to the rise in artificial intelligence and cloud computing (Goldman Sachs, 2024). · The demand for low emissions data centres is increasing as organisations seek energy-efficient facilities to support their net zero commitments (ATIC, 2024). · Australia's direct subsea data connections to the Asia-Pacific region and renewable energy resources mean that Australia is emerging as a hub for low emissions data centres in the Asia-Pacific region (ATIC, 2024). · A reliable electricity system and opportunities to install back-up systems or microgrids are also important considerations for data centre owners because they require a continuous power supply with a steady voltage and frequency. · Australia is a lower cost location to build and operate data centres than competing Asian locations (Turner & Townsend, 2023). · The National Australian Built Environment Rating Scheme (NABERS) allows data centre providers to benchmark energy use and emissions, enabling credible sustainability claims to national and international customers. · GreenSquareDC is already developing low-emissions data centres in Australia, targeting international demand and using large-scale renewable energy and efficient liquid cooling systems.

The authority has identified five main barriers to establishing new low emissions industries:

1. Access to low-cost, firmed renewable electricity

Critical to Australia capitalising on the opportunities of the transition is certainty for investors about reliable access to renewable electricity at globally competitive costs. Metals and minerals extraction and processing are energy-intensive. To attract investment in these industries at the scale required to service their high energy needs and to make them major parts of Australia's economy, governments will need to coordinate with industry to dedicate vast amounts of new renewable electricity capacity to these facilities.

> *'It is important that critical minerals mining and processing has access to reliable, firmed, low-cost, and clean electricity. Grid connected facilities benefit from significant government incentives aimed at decarbonising the National Electricity Market (NEM), but off grid facilities do not. Off-grid electricity generation should not be penalised when compared to on-grid facilities that benefit from lower emissions generation being put in place to decarbonise the NEM.'*
>
> Minerals Council of Australia submission, 2024

> *'The greatest barrier to green energy projects today in Australia is the cost of power – not lack of demand for green products. Data from the International Energy Agency and CSIRO indicates that substantial scale up in renewable capacity can halve the cost of green energy generation in Australia by 2035… Investment in transmission and energy storage infrastructure must accelerate and policy settings must be put in place to enable significant reductions in the cost of green energy, enabling Australia's green industries to take off.'*
>
> Fortescue submission, 2024

2. Access to skilled workers at new mining and refining sites

Government coordination and assistance will be required to ensure skilled workers are attracted to likely locations of new industries. Wherever possible, coordinating the location and timing of new industries with the location and timing of declining fossil fuel industries will also help communities transition and make use of existing infrastructure (JSA, 2023b).

3. Site availability and approvals

Coordination of site availability and permitting will be crucial to new industries being able to scale rapidly (CEDA, 2024). By anticipating the areas best suited to new industries, identifying specific sites and approving developments in advance, governments can attract investors seeking speed and certainty

in approvals processes, without reducing the time needed to assess and manage environmental, cultural and community impacts.

> *Because the refining industry will need to scale rapidly, jurisdictions that can offer short and certain permitting for sites will be at a significant advantage. This need not reduce environmental outcomes if sites are identified and approved in advance, anticipating the unprecedented expansion required in coming years.*
>
> Tesla submission, 2024

4. Access to low-cost electrolytic hydrogen

Access to electrolytic hydrogen is a key enabler of new low emissions metals and minerals operations. Growing production and driving down costs in locations where low emissions metals and minerals will be processed will be crucial. The authority notes that as part of the 2024 Budget, the government announced a Hydrogen Production Tax Incentive to provide $2 per kilogram of renewable hydrogen to operate alongside the Hydrogen Headstart program, which supports early investments in the hydrogen industry (Australian Treasury, 2024d).

5. Capital and operating costs

The authority notes that as part of the 2024 Budget, the government announced a Critical Minerals Production Tax Incentive of 10% for eligible entities to support downstream refining and processing of Australia's 31 listed critical minerals to improve supply chain resilience (Australian Treasury, 2024b). This clear, targeted, production-linked credit will provide an incentive to value add to raw ores onshore and put Australia on a level playing field with other countries that have similar production incentives.

In addition to the Production Tax Incentive, which lowers operating costs for projects, the government is assisting project proponents to overcome the high up-front capital costs and risks associated with being a first-mover through the Critical Minerals Facility, the Critical Mineral Development Program and the Northern Australia Infrastructure Facility.

The government is investing in foundational initiatives to expedite the emergence of Australia's low emissions metals industry, including through enhanced industry and research collaboration, exploration of opportunities to improve the use of Australian scrap metal and undertaking of further consultation on incentives to support the production of green iron, steel, alumina and aluminium (Australian Treasury, 2024a).

As identified in the Treasury's Future Made in Australia National Interest Framework supporting paper (2024c) there may be sound economic resilience and security reasons to foster targeted domestic manufacturing capabilities in some areas, and others where there are not. For example, Australia's successful transition will rely on supply chains for solar PV and battery technologies, which are heavily concentrated in China and for which Australia does not have a meaningful sovereign manufacturing capability. Overwhelmingly, however, the commoditised equipment, appliances and vehicles Australia needs to decarbonise will be sourced from overseas manufacturers in countries with low-cost manufacturing.

Transition technologies like solar panels, wind turbines, electric vehicles, batteries, heat pumps, electrolysers and electrified industrial equipment need to be manufactured at scale to meet the global decarbonisation task. Other countries have a cost advantage over Australia. To make manufacturing in this higher cost environment viable, it makes sense for Australia to instead manufacture smaller-scale products that have unique quality, design or technology attributes that can attract a premium.

A heavy reliance on importing transition technologies from overseas means it will be essential for governments to work with industry and international partners to establish supply chains resilient to global economic, climate and geopolitical disruptions. This cannot be achieved by onshoring transition technology manufacturing in Australia alone. Australia will have the biggest impact and stand to benefit most by encouraging and working with trading partners who are better placed to become bulk manufacturers of commoditised transition technology to establish manufacturing operations and supply chains in their countries.

Australia has the existing heavy industry and skill base, renewable energy sources and resource deposits to become a dominant supplier of materials to its trading partners that are positioning themselves to become manufacturers of commoditised transition technologies. The extraction and processing of these metals and minerals is energy intensive and highly technical. The United States, the Republic of Korea, Japan, India, and Europe are already implementing incentives for transition technology manufacturing (Accenture, 2023b). The biggest contribution Australia can make to strengthening these supply chains is to expand its contribution as a supplier of key processed metals and minerals.

References: National Pathway

ABS (Australian Bureau of Statistics). (2022). *Childcare still largest barrier to female participation.* https://www.abs.gov.au/media-centre/media-releases/childcare-still-largest-barrier-female-participation

ABS. (2023). *International Trade: Supplementary Information, Financial Year.* https://www.abs.gov.au/statistics/economy/international-trade/international-trade-supplementary-information-financial-year/2022-23#key-statistics

Accenture. (2023a). *Sunshot: Achieving global leadership in clean exports.* https://assets.wwf.org.au/image/upload/Sunshot_-_Achieving_Global_Leadership_in_Clean_Exports_Final_Report?_a=ATO2Ba20

Accenture. (2023b). *Sunshot in 2023: Accelerating towards Australia's renewable exports opportunity.* https://assets.nationbuilder.com/auscon/pages/21744/attachments/original/1678743723/Sunshot_2023_-_Final_Report.pdf?1678743723

ACSI (Australian Council of Superannuation Investors). (2021). *ACSI Policy on Company Engagement With First Nations People.* https://acsi.org.au/wp-content/uploads/2021/12/ACSI-Policy-on-Company-Engagement-with-First-Nations-People.Dec21.pdf

AEMO (Australian Energy Market Operator). (2024). *2024 Integrated System Plan*. https://aemo.com.au/-/media/files/major-publications/isp/2024/2024-integrated-system-plan-isp.pdf?la=en

AFI (Australian Farm Institute). (2023). *Creating a sustainable, net-zero, food-secure Australia: Australian Farm Institute submission on the agriculture & land sector plan.* https://haveyoursay.agriculture.gov.au/agriculture-and-land-sectoral-plan

ASFI (Australian Sustainable Finance Institute). (2023). *Australian Sustainable Finance Progress Tracker 2023*. https://www.asfi.org.au/publications/australian-sustainable-finance-progress-tracker-2023

ASFI. (2024). *ASFI submission to NIAA Indigenous Procurement Policy (IPP)* reform. https://static1.squarespace.com/static/6182172c8c1fdb1d7425fd0d/t/65e7dacf6de35a617f6f5aeb/1709693648456/02020E~1.PDF

ASIC (Australian Securities & Investments Commission). (2014). *Digital Financial Reports.* https://asic.gov.au/regulatory-resources/financial-reporting-and-audit/preparers-of-financial-reports/digital-financial-reports/

ASIC. (2023). *ASIC's Indigenous Financial Services Framework - Driving change to support First Nations peoples to achieve and experience positive financial outcomes.* https://download.asic.gov.au/media/35wn0xyp/asic-indigenous-financial-services-framework-published-february-2023.pdf

ATIC (Australian Trade and Investment Commission). (2024). *Australia: APAC's rising regional hub for green data centres.* https://international.austrade.gov.au/en/news-and-analysis/news/australia-apacs-rising-regional-hub-for-green-data-centres

ATO (Australian Taxation Office). (2021). *Fuel tax credits - business*. https://www.ato.gov.au/businesses-and-organisations/income-deductions-and-concessions/incentives-and-concessions/fuel-schemes/fuel-tax-credits-business

Australian Senate Environment and Communications Legislation Committee. (2023). *Environment Protection (Sea Dumping) Amendment (Using New Technologies to Fight Climate Change) Bill 2023* [Provisions]. https://parlinfo.aph.gov.au/parlInfo/download/committees/reportsen/RB000184/toc_pdf/EnvironmentProtection(SeaDumping)Amendment(UsingNewTechnologiestoFightClimateChange)Bill2023[Provisions].pdf

Australian Treasury. (2023). *Intergenerational Report 2023: Australia's future to 2063.* https://treasury.gov.au/sites/default/files/2023-08/p2023-435150.pdf

Australian Treasury. (2024a). *Budget Measures Paper No. 2.* https://budget.gov.au/content/bp2/download/bp2_2024-25.pdf

Australian Treasury. (2024b). *Critical Minerals Production Tax Incentive - Consultation paper.* https://treasury.gov.au/sites/default/files/2024-06/c2024-541266-cp.pdf

Australian Treasury. (2024c). *Future Made In Australia National Interest Framework* . https://treasury.gov.au/sites/default/files/2024-05/p2024-526942-fmia-nif.pdf

Australian Treasury. (2024d). *Hydrogen Production Tax Incentive - Consultation paper.* https://treasury.gov.au/sites/default/files/2024-06/c2024-541265-cp.pdf

BCA (Business Council of Australia). (2023). *Seize the moment: A plan to secure Australia's economic future.* https://assets.nationbuilder.com/bca/pages/7307/attachments/original/1692333523/BCA_SEIZE_THE_MOMENT-FINAL-WEB.pdf?1692333523

Beasy, K., Emery, S., Pryor, K., & Vo, T. A. (2023). *Skilling the green hydrogen economy: A case study from Australia.* International Journal of Hydrogen Energy, 48(52), 19811–19820. https://doi.org/10.1016/j.ijhydene.2023.02.061

Beyond Zero Emissions. (2021). *Export Powerhouse: Australia's $333 billion opportunity*. https://www.bze.org.au/research/report/export-powerhouse

CCA (Climate Change Authority). (2020). *Prospering in a low-emissions world: an updated climate policy toolkit for Australia*. https://www.climatechangeauthority.gov.au/sites/default/files/2020-09/Prospering%20in%20a%20low-emissions%20world.pdf

CCA. (2021). *Paris Plus - Trade and investment trends in a decarbonising world.* https://www.climatechangeauthority.gov.au/news/paris-plus-trade-and-investment-trends-decarbonising-world

CCA. (2022). *2022 Review of International Offsets.* https://www.climatechangeauthority.gov.au/publications/2022-review-international-offsets

CCA. (2023a). *2023 Annual Progress Report.* https://www.climatechangeauthority.gov.au/sites/default/files/documents/2023-11/2023%20AnnualProgressReport_0.pdf

CCA. (2023b). *Reduce, remove and store: The role of carbon sequestration in accelerating Australia's decarbonisation*. https://www.climatechangeauthority.gov.au/publications/reduce-remove-and-store-role-carbon-sequestration-accelerating-australias-decarbonisation

CCA. (2024). *2024 Issues Paper: Targets, pathways and progress.* https://www.climatechangeauthority.gov.au/media-release-targets-pathways-and-progress-issues-paper-released-consultation

CEDA (Committee for Economic Development of Australia). (2024). *Clean Energy Precincts: How to seize the green export opportunity.* https://cedakenticomedia.blob.core.windows.net/cedamediatest/kentico/media/attachments/ceda-clean-energy-precincts-how-to-seize-the-green-export-opportunity.pdf

CER (Clean Energy Regulator). (2024). *Guarantee of Origin.* https://www.dcceew.gov.au/energy/renewable/guarantee-of-origin-scheme

CFFR (Council on Federal Financial Relations). (2020). *The Federation Funding Agreements Framework.* https://federalfinancialrelations.gov.au/federation-funding-agreements-framework

CIM (Clean Investment Monitor). (2024). *Q1 2024 Update.* https://www.cleaninvestmentmonitor.org/

Clean Energy Council. (2022). *Skilling the Energy Transition*. https://www.cleanenergycouncil.org.au/resources/resources-hub/skilling-the-energy-transition

Clean Energy Council and KPMG. (2024). *Leading Practice Principles: First Nations and Renewable Energy Projects.* https://assets.cleanenergycouncil.org.au/documents/resources/reports/Leading-Practice-Principles-First-Nations-and-Renewable-Energy-Projects.pdf

Climate Club. (2023). *Climate Club Work Programme 2024.* https://climate-club.org/wp-content/uploads/2023/11/CC-Work-Programme-2024_bf_final.pdf

CPI (Climate Policy Initiative). (2023). *Global Landscape of Climate Finance 2023.* https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2023/

Credit Suisse. (2022). *US Inflation Reduction Act: A tipping point in climate action*. https://www.credit-suisse.com/treeprintusinflationreductionact

CSIRO & BOM. (2022). *State of the Climate*. https://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate

DAFF (Department of Agriculture, Fisheries and Forestry). (2022). *Australia's Indigenous land and forest estate (2020)*. https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/spatial-data/indigenous-land-and-forest

DAFF. (2024a). *Catchment scale land use of Australia and commodities – Update December 2023.* https://www.agriculture.gov.au/abares/aclump/land-use/catchment-scale-land-use-and-commodities-update-2023#about-the-catchment-scale-land-use-of-australia--commodities--update-december-2023-spatial-dataset

DCCEEW (Department of Climate Change, Energy, the Environment and Water). (2022a). *Australia's 8th National Communication on Climate Change.* https://unfccc.int/sites/default/files/resource/NatComm8%20Biennial%20Statement_2022_v8%2021%20Dec.pdf

DCCEEW. (2022b). *State of Hydrogen 2022.* https://www.dcceew.gov.au/sites/default/files/documents/state-of-hydrogen-2022.pdf

DCCEEW. (2023a). *Annual Climate Change Statement 2023.* https://www.dcceew.gov.au/climate-change/strategies/annual-climate-change-statement-2023

DCCEEW. (2023b). *Carbon Leakage Review Consultation Paper*. https://www.dcceew.gov.au/climate-change/emissions-reduction/review-carbon-leakage

DCCEEW. (2024). *Australia's energy strategy and frameworks.* https://www.dcceew.gov.au/energy/strategies-and-frameworks

DCCEEW. (2024b). *Community Engagement Review.* https://www.dcceew.gov.au/energy/renewable/community-engagement-review

Department of Education. (2023). *Australian Universities Accord Final Report.* https://www.education.gov.au/download/17990/australian-universities-accord-final-report-document/36760/australian-universities-accord-final-report/pdf

DISR (Department of Industry, Science and Resources). (2021). *A Hydrogen Guarantee of Origin scheme for Australia - Discussion Paper.* https://consult.dcceew.gov.au/hydrogen-guarantee-of-origin-scheme

DISR. (2023). *Critical Minerals Strategy 2023–2030.* https://www.industry.gov.au/sites/default/files/2023-06/critical-minerals-strategy-2023-2030.pdf

DISR. (2024). *Resources and Energy Quarterly June 2024.* https://www.industry.gov.au/sites/default/files/2024-06/resources_and_energy_quarterly_june_2024_-_historical_tables.xlsx

DITRCA (Department of Infrastructure, Transport, Regional Development, Communications and the Arts). (2024). *State of Australia's Regions 2024.* https://www.infrastructure.gov.au/sites/default/files/documents/state-of-australias-regions-2024.pdf

Dumbrell, N. P., Robinson, C. J., Rickets, K. D., Urzedo, D., Walker, L., & Bong, A. J. (2024). Toward land restoration transitions: elevating regional voices and the provenance of co-benefits in Queensland rangelands. *The Rangeland Journal, 46(1)*. https://www.researchgate.net/publication/378372755_Toward_land_restoration_transitions_elevating_regional_voices_and_the_provenance_of_co-benefits_in_Queensland_rangelands

Energy Ministers. (2022). *National Energy Transformation Partnership*. https://www.energy.gov.au/sites/default/files/2022-08/National%20Energy%20Transformation%20Partnership.pdf

Engineers Australia. (2022). *Urgent need to address the lack of women in engineering.* https://www.engineersaustralia.org.au/news-and-media/2022/07/urgent-need-address-lack-women-engineering

Evans, M., & Polidano, C. (2022). *First Nations Businesses: Progress, Challenges and Opportunities| Bulletin–June 2022.* Reserve Bank of Australia. https://www.rba.gov.au/publications/bulletin/2022/jun/first-nations-businesses-progress-challenges-and-opportunities.html

Evans, M., Polidano, C., Dahmann, S. C., Kalera, Y., Ruiz, M., Moschion, J., & Blackman, M. (2024). *Indigenous Business and Corporation Snapshot Study 3.0. The University of Melbourne*. https://static1.squarespace.com/static/609c5b6fed6253178f23bdff/t/661c86c93796505e176452dc/1713145580800/Snapshot+3.0.pdf

EY Net Zero Centre. (2023). *Seizing Australia's energy superpower opportunities: Assessing the outlook for Australia in a net zero world.*

FNCEN (First Nations Clean Energy Network). (2024). *Response to the Hydrogen Headstart Consultation Paper.* https://www.firstnationscleanenergy.org.au/submissions

Future Made in Australia Bill 2024 (2024). https://parlinfo.aph.gov.au/parlInfo/download/legislation/bills/r7219_first-reps/toc_pdf/24084b01.pdf;fileType=application%2Fpdf

Gebbie, L., Miller, D., & Keenan, R. (2021). *Opportunities for Traditional Owners in the Carbon Economy.* In Pursuit, University of Melbourne. https://pursuit.unimelb.edu.au/articles/opportunities-for-traditional-owners-in-the-carbon-economy

Goldman Sachs. (2023). *Carbonomics: the third American energy revolution.* https://www.goldmansachs.com/intelligence/pages/gs-research/carbonomics-the-third-american-energy-revolution/report.pdf

Goldman Sachs. (2024). *GS SUSTAIN: Generational Growth — AI/data centers' global power surge and the sustainability impact.* https://www.goldmansachs.com/intelligence/pages/gs-research/ai-data-centers-global-power-surge-and-sustainability-impact/report.pdf

Grattan Institute. (2023). *Fuelling budget repair: how to reform fuel taxes for business.* https://grattan.edu.au/wp-content/uploads/2023/02/Fuelling-budget-repair-Grattan-report.pdf

Hammerle, M., & Phillips, T. (2023). *Making Our Way: Adaptive capacity and climate transition in Australia's regional economies .* https://cpd.org.au/work/making-our-way/

Hassan, Q., Algburi, S., Sameen, A. Z., Jaszczur, M., & Salman, H. M. (2023). *Hydrogen as an energy carrier: properties, storage methods, challenges, and future implications.* Environment Systems and Decisions. https://doi.org/10.1007/s10669-023-09932-z

Hellenic Competition Commission. (2024). *Sustainable Development Sandbox.* https://www.epant.gr/en/enimerosi/sandbox.html

ICIN (Indigenous Carbon Industry Network). (2024). *Industry Snapshot*. https://www.icin.org.au/latest_industry_snapshot

ICLEI Local Governments for Sustainability, & Ironbark Sustainability. (2021). *Australian Local Government Climate Review 2021.* https://ironbarksustainability.app.box.com/s/p6ylewyv92c6rkfh2k44vwjr9b6r9ltc

IEA (International Energy Agency). (2023). *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach - 2023 Update.* https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf

IEA. (2024). *Global Critical Minerals Outlook 2024.* https://iea.blob.core.windows.net/assets/ee01701d-1d5c-4ba8-9df6-abeeac9de99a/GlobalCriticalMineralsOutlook2024.pdf

IEEFA (Institute for Energy Economics and Financial Analysis). (2023). *Australia faces growing green iron competition from overseas*. https://ieefa.org/sites/default/files/2023-08/Australia%20faces%20growing%20green%20iron%20competition%20from%20overseas_Sep23.pdf

ILSC (Indigenous Land and Sea Corporation). (2022). *Discussion paper: Indigenous participation in the carbon industry*. https://www.ilsc.gov.au/wp-content/uploads/2022/05/Indigenous-participation-in-the-carbon-industry.pdf

Infrastructure Australia. (2021). *A National Study of Infrastructure Risk.*

Infrastructure Australia. (2024). *Valuing emissions for economic analysis*. https://www.infrastructureaustralia.gov.au/publications/valuing-emissions-economic-analysis

IPCC (Intergovernmental Panel on Climate Change). (2022). *Climate Change 2022 - Mitigation of Climate Change* (Intergovernmental Panel on Climate Change (IPCC), Ed.). Cambridge University Press. https://doi.org/10.1017/9781009157926

Jobs Queensland. (2018). *Supporting workforces during industry transition: Key elements for success.* https://jobsqueensland.qld.gov.au/wp-content/uploads/2018/11/supporting-workforces-transition-report.pdf

Jobs Queensland. (2021). *Apprenticeship, women and workplace culture.* https://jobsqueensland.qld.gov.au/wp-content/uploads/2022/07/Apprenticeship-women-and-workplace-culture-Literature-review-October-2021-1.pdf

JSA (Jobs and Skills Australia). (2023a). *2023 Annual Jobs and Skills Report.* https://www.jobsandskills.gov.au/publications/towards-national-jobs-and-skills-roadmap

JSA. (2023b). *The Clean Energy Generation*. https://www.jobsandskills.gov.au/download/19313/clean-energy-generation/2385/clean-energy-generation/pdf

Kårtveit, B. (2021). *Green colonialism: The story of wind power in Sápmi.* In Stories of change and sustainability in the Arctic regions (pp. 157–177). Routledge.

King & Wood Mallesons. (2023). I*ndonesia's nickel rush - riding the waves of the EV battery revolution.* https://www.kwm.com/cn/en/insights/latest-thinking/indonesias-nickel-rush-riding-the-waves-of-the-ev-battery-revolution.html

Lee, D., Schelly, C., Gagnon, V. S., Smith, S., & Tiwari, S. (2023). *Preferences and perceived barriers to pursuing energy sovereignty and renewable energy: A tribal nations perspective.* Energy Research & Social Science, 97, 102967. https://doi.org/10.1016/j.erss.2023.102967

Lyons, P., Mynott, S., & Melbourne-Thomas, J. (2023). *Enabling Indigenous innovations to re-centre social licence to operate in the Blue Economy.* Marine Policy, 147, 105384. https://doi.org/https://doi.org/10.1016/j.marpol.2022.105384

McConnell, A., Janke, T., Cumpston, Z., & Cresswell, I. D. (2021). *Heritage: Indigenous heritage.* In Australia State of the environment 2021. Australian Government Department of Agriculture, Water and the Environment. https://doi.org/10.26194/7w85-3w50

Meckling, J., Aldy, J. E., Kotchen, M. J., Carley, S., Esty, D. C., Raymond, P. A., Tonkonogy, B., Harper, C., Sawyer, G., & Sweatman, J. (2022). *Busting the myths around public investment in clean energy.* Nature Energy. https://www.nature.com/articles/s41560-022-01081-y

NIAA (National Indigenous Australians Agency). (2022). *Commonwealth Closing the Gap - Annual Report 2022.* https://www.niaa.gov.au/sites/default/files/documents/inline/publications/niaa-closing-the-gap-annual-report-2022.pdf

NIAA. (2023). *2023 Commonwealth Closing the Gap Implementation Plan*. https://www.niaa.gov.au/2023-commonwealth-closing-gap-implementation-plan/copyright

NSW Government. (2023). *Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08*. https://www.treasury.nsw.gov.au/sites/default/files/2023-03/20230302-technical-note-to-tpg23-08_carbon-value-to-use-for-cost-benefit-analysis.pdf

NZA (Net Zero Australia). (2023). *How to make net zero happen: Mobilisation report*. https://www.netzeroaustralia.net.au/wp-content/uploads/2023/07/Net-Zero-Australia-Mobilisation-How-to-make-net-zero-happen-12-July-23.pdf

OECD (Organisation for Economic Co-operation and Development). (2024). *Towards more accurate, timely, and granular product-level carbon intensity metrics.* https://doi.org/10.1787/4de3422f-en

Parliamentary Budget Office. (2023). *2023-24 Budget Snapshot.* https://www.pbo.gov.au/publications-and-data/publications /budget-charts/2023-24-budget-snapshot

Prime Minister and Cabinet. (2024). *Net Zero Economy Authority.* https://www.pmc.gov.au/netzero/net-zero-economy-authority

Productivity Commission. (2008). *Industry Policy for a Productive Australia*. https://www.pc.gov.au/media-speeches/speeches/cs20080806

Productivity Commission. (2023a). *5-year Productivity Inquiry: Advancing Prosperity.* https://www.pc.gov.au/inquiries/completed/productivity/report

Productivity Commission. (2023b). *5-year Productivity Inquiry: Managing the climate transition.* https://www.pc.gov.au/inquiries/completed/productivity/report/productivity-volume6-climate-transition.pdf

PWC. (2024). *Sustainability Reporting in Australia: A tipping point*. https://www.pwc.com.au/sustainability-reporting/sustainability-reporting-in-australia-a-tipping-point-2024.pdf

Queensland Government. (2024). *The Land Restoration Fund and Australia's carbon market.* https://www.qld.gov.au/environment/climate/climate-change/land-restoration-fund/about/australian-market

RBA (Reserve Bank of Australia). (2023). *The Extraordinary Decline in Australia's Net Foreign Liabilities.* https://www.rba.gov.au/speeches/2023/sp-so-2023-10-18.html

Romanello, M., Napoli, C. di, Green, C., Kennard, H., Lampard, P., Scamman, D., Walawender, M., Ali, Z., Ameli, N., Ayeb-Karlsson, S., Beggs, P. J., Belesova, K., Berrang Ford, L., Bowen, K., Cai, W., Callaghan, M., Campbell-Lendrum, D., Chambers, J., Cross, T. J., … Costello, A. (2023). *The 2023 report of the Lancet Countdown on health and climate change: the imperative for a health-centred response in a world facing irreversible harms*. In The Lancet (Vol. 402, Issue 10419, pp. 2346–2394). Elsevier B.V. https://doi.org/10.1016/S0140-6736(23)01859-7

Rutovitz, J., Visser, D., Sharpe, S., Taylor, H., Jennings, K., Atherton, A., Briggs, C., Mey, F., Niklas, S., Bos, A., Ferraro, S., Mahmoudi, F., Dwyer, S., Sharp, D., & Mortimer, G. (2021). *Developing the future energy workforce. Opportunity assessment for RACE for 2030.* https://www.racefor2030.com.au/wp-content/uploads/2021/10/RACE-E3-Opportunity-Assessment-FINAL-REPORT-October-2021.pdf

Turner & Townsend. (2023). Data centre cost trends. https://reports.turnerandtownsend.com/dcci-2023/data-centre-cost-trends

Tyler, M., & Dymock, D. (2021). *Attracting industry experts to become VET practitioners: a journey, not a destination.* https://www.ncver.edu.au/__data/assets/pdf_file/0039/9669603/Attracting_industry_experts_to_become_VET_practitioners_a_journey_not_a_destination.pdf

UN General Assembly. (2007). *United Nations declaration on the rights of indigenous peoples. In UN Wash (Vol. 12).* https://social.desa.un.org/issues/indigenous-peoples/united-nations-declaration-on-the-rights-of-indigenous-peoples

UNHRC (United Nations Human Rights Council). (2018). Free, prior and informed consent: a human rights-based approach. https://www.ohchr.org/en/documents/thematic-reports/free-prior-and-informed-consent-human-rights-based-approach-study-expert

United States Department of Energy. (2022). *Financial Incentives for Hydrogen and Fuel Cell Projects.* https://www.energy.gov/eere/fuelcells/financial-incentives-hydrogen-and-fuel-cell-projects

United States Department of Energy. (2023). *Biden-Harris Administration Announces $7 Billion For America's First Clean Hydrogen Hubs, Driving Clean Manufacturing and Delivering New Economic Opportunities Nationwide.* https://www.energy.gov/articles/biden-harris-administration-announces-7-billion-americas-first-clean-hydrogen-hubs-driving

Western Australian Government. (1979). *North West Gas Development (Woodside) Agreement.* https://www.legislation.wa.gov.au/legislation/prod/filestore.nsf/FileURL/mrdoc_8880.pdf/$FILE/North%20West%20Gas%20Development%20(Woodside)%20Agreement%20Act%201979%20-%20%5B00-00-00%5D.pdf?OpenElement

Woods, K., Markham, F., Smith, D., Taylor, J., Burbidge, B., & Dinku, Y. (2021). T*oward a perpetual funding model for Native Title Prescribed Bodies Corporate.* Canberra, ACT: Australian National University, Centre for Aboriginal …. https://openresearch-repository.anu.edu.au/items/4a065c69-f0d8-4ae6-8dd3-5462dafd577e

Yindjibarndi Energy. (2023). *Traditional Owners to lead large-scale renewable energy development in WA's Pilbara region.* Media Release. https://acenrenewables.com.au/2023/07/traditional-owners-to-lead-large-scale-renewable-energy-development-in-was-pilbara-region/