Building an Investment Pipeline to Decarbonise Regional Queensland

Pathways For Positive Action

Queensland Decarbonisation Hub

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Executive Summary – Allan Dale and Liz Young

New pathways to achieve net zero targets by 2050 were formalised through recent legislative changes passed in Queensland's Parliament in 2024; a legislative agenda that sets clear targets for the decarbonisation of the state's economy. These changes were bolstered by the Australian Government's recent establishment of the new Net Zero Authority in September 2024 and substantive new policies and programs aimed at supporting renewable energy development, Australian manufacturing and the exploration and development of critical mineral reserves across the nation. Much of the effort and activity envisaged through these initiatives will occur in regional Queensland, and Queensland's new LNP State Government continues planning for these commitments.

As a key foundational research analysis undertaken by the new **Queensland Decarbonisation Hub and** building on several years of strategic research across four universities associated with Queensland's Rural Economies Centre of Excellence (RECoE), this paper seeks to explore both the risks and opportunities facing decarbonisation in Queensland's regions. It explores the preconditions needed for Queensland to attract quality investment to achieve net zero targets *and* regional development.

Methodologically, we consider, in line with global and national understandings of **development**, that outcomes from decarbonisation policies need to be **sustainable** and **inclusive** while also building community and regional **resilience**. We consider that infrastructure investment approaches taken in Queensland's regions need to be able to meet well-defined national and state **investment principles**. Finally, we consider that development needs to cater for supporting decarbonisation across multiple sectors, scales and places. In short, we take the view that Queensland's regions need to achieve decarbonisation of their economies, while concurrently delivering improved economic, social and environmental outcomes relative to the status quo. This means preparing for investment in decarbonised efforts at the sector-wide, regional, community, business and household scales.

With this in mind, we analyse issues and lessons learned across all steps of the **investment pipeline** needed to secure quality finance and investments for making progress across various project proponents from the not-for-profit, private and government sectors. To achieve a comprehensive approach, this means paying attention across several investment pipeline steps, inclusive of the following scales and approaches in the regions: (i) sector-wide approaches to decarbonisation (ii) regional land use and infrastructure planning; (iii) placed-based approaches to decarbonisation; (iv) strengthening Indigenous institutions; (v) decarbonising large, medium and small enterprises; (vi) workforce development; (vii)

maintaining regional resilience; (viii) research and development (R&D) in the regions; and (ix) finance brokerage and closure in the regions. We consider that building this investment pipeline relies on the health of the wider global trade environment and our relationship within the Indo-Pacific region within which this investment occurs. Finally, we consider how these issues sit in the system of governance for Queensland's decarbonisation agenda. This paper represents the Decarbonisation Hub's first steps towards exploring this comprehensive approach.

This analytical framework has enabled us to explore existing arrangements in each step of the investment pipeline for decarbonising regional Queensland. We explore where the strengths and weaknesses are in each step in the system, and finally, we recommend actions or pathways that could be considered to strengthen the decarbonisation agenda in ways that improve regional development outcomes in Queensland. In support of such an approach, our overall findings include that there is:

- A need for Queensland to develop deliberative strategies to enable decarbonisation that delivers regional and community benefits from household to regional *and* sectoral scales; and
- Potential for the Australian and Queensland Governments to work closely with regional universities as anchor institutions within Queensland's regions to support this journey.

Within this context, some of our key recommended actions envisaged across all scales include:

- More needs to be done to quantify and mobilise significant investment opportunities through the adoption of innovations in all key economic sectors that can drive decarbonised effort;
- More effective regional planning, with a bioregional focus, will require strong and combined Australian Government, state and local government cooperation, effective land use and infrastructure planning at regional scale, and the full integration of new science/technologies;
- At the community transition scale, Queensland's Communities in Transition pilot model provides a strong platform for government supported and whole-of-community future pathway setting and local economic transition with a focus on investment attraction;
- There is a need to proactively negotiate progress towards First Nations' self-determination through the coming energy transition at regional and local scales;
- Queensland's decarbonisation pathway must engage deeply in the transition of energy intensive urban environments through new demonstration concepts and opportunities;

- In regional economies dominated by small and medium-sized enterprises, cohesive decarbonisation frameworks can be applied to help enterprises to decarbonise;
- Cohesive programs and partnerships are required in regional Queensland to facilitate house-hold scale transitions to renewable energy, more circularised waste management and opportunities to reduce emissions as a result of current working from home arrangements;
- More cohesive partnerships with regional universities and the vocational sector are needed to develop a well-trained and skilled workforce in the face of a decarbonised economy;
- More pilot studies are needed to develop a better systems-based understanding of how regions can stay resilient while decarbonising their economy;
- The need to develop improved and bilaterally agreed policy and program design to stimulate investment in large-scale decarbonised effort in the regions;
- A more strategic framework for supporting the engagement of regional Queensland in decarbonisation efforts across the wider Indo-Pacific region; and
- Investment in regionally-based hubs of research and innovation within regional universities as anchor institutions for facilitating diverse decarbonisation activities.

Decarbonisation Challenges in Regional Queensland – Allan Dale, Liz Young, John Rolfe, Delwar Akbar and Ben Lyons

Transitioning to a decarbonised economy is one of the most complex and consequential challenges facing our society. The Miles Labor Government, through the *Clean Economy Jobs Act 2024* set ambitious new targets of reducing emissions to net zero (100%) by 2050 and 75% by 2035 (Queensland Government, 2024a). Achieving these goals in a way that is both sustainable and inclusive (and that strengthens community and regional resilience) requires not only reducing emissions, but also delivering a well-planned energy system transformation, driving industrial innovation and a fair transition for workers and communities. It also means undertaking a thorough assessment of our natural capital and the ecosystem services that it supports.

When the Miles Labor Government introduced the *Clean Economy Jobs Act 2024*, it argued that decarbonising Queensland would create a range of co-benefits, including new jobs, increased investment, environmental protection, economic diversification and improved community resilience (Queensland Government, 2024a). The newly elected Liberal-National Party (LNP) Crisafulli Government has reaffirmed its commitment to decarbonisation by announcing the development of a Net Zero Roadmap (due by the end of 2025) that will outline its vision and priorities for achieving this (Queensland Treasury, 2025a; Queensland Government, 2025a).

The Queensland Government's previous *Resources Industry Development Plan* similarly sets out a new strategy to develop the critical minerals sector in Queensland in support of global decarbonisation efforts (Queensland Government, 2022a). This is complemented by the past Queensland *New Industry Development Strategy* which prioritises the development of: (i) renewable energy manufacturing and infrastructure; (ii) critical mineral processing and products; (iii) battery industry; (iv) green hydrogen; (v) circular economy including resource recovery; and (vi) bioeconomy, including biofuels and sustainable aviation fuels (DSDILG&P, 2023). At the national level, the Australian government is also committed to decarbonisation through an enhanced focus on renewable energy expansion, support for the critical minerals sector, and investments into the establishment of associated manufacturing and mining industries in Australia (Albanese, 2024; Sinclair & Coe, 2024).

While regional Queensland is significantly impacted by the changing climate, the key drivers and investments emerging from global decarbonisation efforts allow this vast and highly

decentralised state to be at the epicentre of associated economic opportunities. As agriculture is a dominant employer and industry across regional Queensland, significant potential exists for value-added decarbonisation and diversification (ZNE-CRC, 2024), with key focal areas including low-emissions horticultural systems, investments in low-methane livestock, whole-farm system analysis, and investment in renewable energy and circular economy aspects of the value chain. However, major transitions are essential across a range of industries, particularly energy, agriculture, and manufacturing (Denis et al., 2014). Each Queensland region, however, will be affected differently.

Additional to impacts and changes within agriculture, how regional Queensland innovates within the critical minerals and energy sectors will also be key to decarbonisation and the long-term growth of regional workforces and communities (Queensland Government 2022b; Queensland Government 2023a). Unprecedented global demand for specialty mineral products that support decarbonisation will help drive the regional Queensland economy. Challenges include ensuring vulnerable ecosystems and communities are protected and that a circular economy perspective underpins extraction and processing (Sustainable Minerals Institute, 2024). Ensuring the transition creates robust protection of ecosystems, reduces energy intensity and captures value-added benefits across the supply chain will also be key to achieving success if the decarbonisation agenda is to be aligned with regional prosperity, resilience, and fairness; collectively making success both more likely and more durable.

While the agriculture, mining, manufacturing, tourism, transport and energy sectors will need to transform to adapt and to enable the decarbonisation in the regions, potential also exists to achieve better ecosystem service outcomes and to establish new ecosystem market services. Indeed, key opportunities and investments exist in regional Queensland that can provide robust carbon storage and offsetting activities. In addition to supporting landholders, these efforts can generate wider community benefits (CCA, 2023; ICIN, 2022). Similar opportunities exist in the emerging development of the nation's Nature Repair Market. These are new industry opportunities for regional Queensland.

To help set the scene for this policy think piece, we start with case studies from regional Queensland that are illustrative of challenges facing the achievement of a net zero economy differentially across regional Queensland, while also emerging with stronger regional development outcomes.

Case Study 1: Fitzroy Capricornia, Greater Whitsunday, and the Central West

The wider central Queensland region has much at stake in the decarbonisation challenge, with energy, agriculture and resource sectors having large footprints in the region. The region includes two major coal basins (the Bowen and Galilee basins) that produce both coking and

steaming coal, as well as significant gas production in the Bowen Basin and northern part of the Surat Basin. There is substantial infrastructure to support the extraction, use, and export of these commodities, including liquid natural gas processing facilities at Gladstone, and major ports at Gladstone, Mackay, and Bowen. The bulk of these resources are exported, so any impacts from decarbonisation may be limited. However, there are also emissions generated in the process of resource extraction that may also be difficult to address.

There are major energy-generating facilities within this region, with coal-fired power stations at Gladstone, Rockhampton (Stanwell), and Biloela (Callide), which together account for approximately 57% of Queensland coal-fired generating capacity. This regional concentration of generating capacity supports major industrial and minerals smelting activities at Gladstone and Rockhampton. There is also a gas turbine at Barcaldine. These carbon-based power generators are expected to close under any longer-term decarbonisation program. Consequently, the large industry requirements for baseload power at Gladstone and Rockhampton provide some element of risk to the energy transition.

Agriculture, however, provides the backbone of most communities in this region, with cattle grazed over the entire region and sugarcane along the coast in the Greater Whitsunday. Dryland and irrigated cropping occurs in the inland parts of the Fitzroy and Whitsunday regions, and there is some sheep and goat production in the far west. Rockhampton is considered the Beef Capital of Australia, with approximately two million head within a 400 km radius of the city. Issues for this industry are that it is a large user of fuel, where it is difficult to substitute other sources, and the beef sector generates significant methane emissions in extensive grazing systems that will be difficult to address.

There has been substantial growth in renewable energy generation in the region, driven in part by proximity to energy infrastructure, high demands for power, and opportunities to generate renewables. Many of the sugar mills in the Whitsunday region produce power for on-site use from burning bagasse. Major solar farms have been established at Barcaldine, Emerald and Collinsville (i.e., including the Hamilton and Whitsunday solar farms). There are substantial solar and wind projects being planned and constructed, particularly in the Banana Shire west of Gladstone and in the Rockhampton region, such as the Clarke Creek windfarm being built west of Marlborough.

Notable advances in the region include proposals to generate green hydrogen at Gladstone using power from nearby renewable sources. New, but complex and fragile investments in green hydrogen have been focussed in the Gladstone region. Broader energy planning will be supported in the Central Queensland Renewable Energy Zone (REZ) region (which encompasses four proposed REZs, including Callide, Calliope, Isaac, and Capricorn). At this

point in time, the broader REZ roadmap across Queensland doesn't focus on the need for hydrogen, but that could see adjustments in future updates.

Case Study 2: Darling Downs, Burnett and the South West

These three regions are possibly the most diverse and intensive energy corridors in Australia. The development of the Surat Basin Coal Seam Gas (CSG) industry in the 2000s and 2010s brought a dramatic increase in resource industry activities, and the region's annual gas production increased from 53 petajoules in 2006 to 254 petajoules in 2012 (SCER, 2012; APEA, 2012). This investment in infrastructure brought a number of challenges to what was previously a major agricultural region that produces more than 70% of Queensland's cotton, sorghum and wheat; and hosts a major concentration of Australia's feedlot cattle industry. There are approximately 97 beef cattle feedlots of over 2000 head capacity between Toowoomba and Roma (Beef Central, 2020). The majority of agricultural enterprises in these regions are operated by family companies or corporate entities. The expansion of CSG on agricultural land and the interaction with industry has raised many issues, including water impacts, use of productive land, the disruption of farm operations and biosecurity. Apart from energy and agriculture, these regions have relatively significant regional manufacturing (food processing and value adding), civil construction and logistics sectors as well as significant health and education service sectors, especially in the eastern sub-region (Cavaye & Kelly, 2015).

A relevant issue for the decarbonisation and future energy development in these three regions has been the associated development of electricity "infrastructure corridors" (Bailey, 2015). The infrastructure developed around CSG has laid the groundwork for new renewable energy projects, particularly in wind and solar power. It has also supported the emergence of large-scale batteries, biogas facilities, and geologically-based carbon capture initiatives. However, projects involving wind, solar, and carbon capture are increasingly sparking public debate over their "social licence" to operate. A notable example from 2023–24 is Glencore's proposal to store carbon dioxide emissions from the Millmerran power station in the Great Artesian Basin; an idea that has generated significant media coverage and community concern (Queensland Government, 2024c). Despite such controversies, development continues, especially with large-scale wind farms in the Cooper's Gap, McIntyre, Dulacca, and Jandowae areas, along with solar installations in the Western Downs and Southern Downs regions. The Burnett region, encompassing Kingaroy in the South Burnett local government area, is another region with transition concerns, mainly centred on the Tarong coal fired power station and its impending closure, which equates to more than 700 full time jobs in the region. A community-led project in conjunction with Stanwell has undertaken transition work looking at the Burnett's community challenges for managing this change.

The South West region is and should be treated as distinct from the Darling Downs (save for the Maranoa local government area). The reasons for this include, but are not limited to, the following: (i) it is one of the most drought-affected regions in Queensland; (ii) it lacks the larger resource industry companies and projects of the Darling Downs, Western Downs, and Maranoa; (iii) there are different agricultural production systems from rangelands to more mixed farming enterprises, lower levels of off-farm income and greater challenges in achieving economic diversification (Currey et al., 2024); (iv) it is more remote with limited access to transport networks and markets; (v) there is outward migration, especially of young people, from rural to urban areas; (vi) there is difficulty in attracting and retaining skilled workers; (vii) the region is highly sensitive to fluctuations in commodity prices, and (viii) the region lacks critical infrastructure such as digital connectivity and essential services.

Different Regions: Different Challenges

As the above case studies show, Queensland's regions will experience decarbonisation efforts at different speeds and intensities. There are different challenges, legacy issues and enablers facing each region. These issues also determine investment opportunities, but equity issues arise from the transition process in all regions. Decarbonisation efforts must address the social dimensions of change, including ensuring a *just transition* for workers and communities. Localised governance, inclusion, participation and community engagement are crucial for successful implementation (Bedford et al., 2023; Cahill, 2022; Fabre et al., 2023). Indigenous communities also face key barriers to participating in a decarbonised economy. A recent Indigenous Carbon Industry Network report, *Mapping the Opportunities for Indigenous Carbon in Australia Identifying opportunities and barriers to Indigenous participation in the Emissions Reduction Fund*, found several barriers to indigenous participation in the Emissions Reduction Fund (ERF). Some of these related to the geographic location of where Indigenous land interests overlap with an ERF method. Other barriers to involvement in the ERF include "low levels of institutional capacity, lack of access to appropriate information and resources, low levels of relevant (carbon) expertise and limited financial resources" (ICIN, 2022, p. 10). The report then makes recommendations to address these barriers namely: expanding the application of ERF methods within the Indigenous estate; building capability in Indigenous organisations; targeted method and organisational engagement; incentivising engagement with Indigenous organisations and building negotiation capability; highlighting the premium value of Indigenous carbon; and engaging in emerging environmental markets (ICIN, 2022).

Federal and state policy frameworks for decarbonisation are also only just emerging. Modernising policy and regulations is a critical job ahead as it provides certainty for regional investment (Cantley-Smith et al., 2023). There is a need to establish key principles that can particularly support public policy at local and regional scales, ensuring actions are

economically, socially, and politically feasible within Queensland's regions (Turnour et al., 2022). As aptly pointed out, "places can grow when policymaking is attuned to spatial particularities" (Pugalis & Gray, 2016, p. 181). Support for the development of regionally nuanced transition strategies and approaches that avoid ad hoc policy interventions in local communities is needed to avoid "engagement fatigue" (Yarnold et al., 2022).

The development of workforces that are available with requisite skills and training for transitions are also critical within our supply-stressed regions. The Senate Select Committee on Jobs for the Future of Regional Areas (2019) noted that "people living in the regions will require an increasing level of technical skills and professional knowledge to take advantage of the jobs that may be available … As part of this, workers will be expected to be more technologically adept as digital technologies and automation become increasingly integrated into working environments" (Commonwealth of Australia, 2019, p. 23). However, additional digital and technological challenges also impinge on the ability of regions to participate in the digital economy (Babacan, 2022a; Babacan et al., 2021).

In short, we consider that facilitating regionally appropriate, **place-based decarbonisation** initiatives will be critical to our diverse regions meeting the challenges associated with decarbonisation. There is potential to reap social and economic benefits for communities *while* delivering on net zero goals. This view is informed by the experience of regions around the world grappling with pre-existing institutional constraints, the uneven distribution of decarbonisation initiatives and fiscal limitations within local authorities (Bedford et al., 2023). There is a need for integrated planning, coordination, and local/regional leadership (Yarnold et al., 2022). Overall, decarbonising regional Queensland involves addressing many complex economic, environmental, educational, technological, and social challenges. Effective, regionally-driven and place-specific strategies must integrate local contexts, support economic diversification, enhance education and skills, promote sustainable practices and leverage renewable energy for economic development.

In this paper, we explore these challenges across various scales, from the sectoral, regional, local, village, business, neighbourhood and household scales. We then explore these issues through the lens of workforce challenges, and the wider Indo-Pacific context in which regional Queensland sits. Finally, we also explore the governance and investment context facing this transition in regional Queensland.

Sector Decarbonisation: An Agricultural Sector Example – Yvette Everingham and Ana Leite De Almeida

Several sectors dominate the economic landscape of regional Queensland, energy, tourism, transport, the built environment, social services, and agriculture. To support decarbonisation across all Queensland regions, a sector-wide approach is still needed, with regions learning and progressing together. Exploring regional efforts at the sectoral level offers valuable insights, and this section focuses on the agriculture sector to examine how such an approach can be applied.

According to the National Emissions Inventory Report (DCCEEW, 2023), agriculture accounted for 16.8% of Australia's net greenhouse gas (GHG) emissions in 2020–21. The Australian Government's Department of Agriculture, Fisheries and Forestry *National statement on climate change and agriculture* found that the sector's emissions are closely linked to current levels of production and are expected to increase slightly from 2020 levels in the short term due to favourable seasonal conditions before decreasing. As a result, reducing agricultural emissions will require continued sector-wide effort, including the development and introduction of novel technologies combined with an accelerated widescale adoption of new practices; all delivered through new partnerships between government, research and industry, particularly in the regions (Commonwealth of Australia, 2023).

Unlike most other sectors, where carbon dioxide is the dominant GHG, agricultural emissions in Australia are primarily composed of methane, which accounts for 79% of the sector's total emissions—mainly from livestock. This is followed by nitrous oxide (18%), largely from fertiliser use and manure management, while carbon dioxide contributes just 4%, primarily from the application of urea and lime (Commonwealth of Australia, 2023). The sector's increased awareness of GHG emission impacts have resulted in an accelerating search for technologically, environmentally and economically viable solutions to enable a transition to a less carbon-intensive agricultural economy.

Additionally, of importance to Queensland's regions, finance for decarbonisation in the investment and corporate community is often framed as part of each organisation's climate finance, responsible investment, or sustainable finance strategy. This approach is creating a positive cycle of investment opportunities driving decarbonised behaviour in the agricultural sector in Queensland's regions.

Decarbonisation Initiatives in the Agriculture Sector

The current Commonwealth Agriculture and Land Sectoral Plan is currently under development by the Australian Government and will focus on the emissions that come directly from activities in agriculture and on the land, as well as emissions associated with energy, fuel, and electricity use within the sector (Department of Agriculture, Fisheries and Forestry [DAFF], 2025). The Plan and associated initiatives provide opportunities for the adoption of clean technologies, innovations, and alternative economic models (e.g., circular economies). Currently, there is widespread support for decarbonisation of the agriculture sector in Australia within both the public and private sectors. Agricultural leadership bodies are proactively seeking to see industry shift toward a low-carbon economy and they are clear that this reflects market sentiment (QFF, 2021). Both the Australian and Queensland governments support a range of international and domestic initiatives and commitments to lower GHG emissions in the sector. Importantly, the National Farmers' Federation (NFF) also supports achieving net zero emissions by 2050 (NFF, 2024).

Increased awareness of GHG emissions in the agriculture sector has led it to develop a variety of decarbonisation initiatives and commitments including:

- The Australian Agricultural Sustainability Framework (led by the NFF) in partnership with Australian Farm Institute;
- The Australian Red Meat CN30 Roadmap (Red Meat Advisory Council and others);
- The Dairy Sustainability Framework;
- The Climate Change Policy for Grains that is seeking a 15% reduction in grain emissions by 2030 and net zero by 2050; and
- The Australian Pork Ltd.'s Pork Sustainability Framework (2021-2030) for carbon positive pork and net zero waste to landfill by 2050.

In terms of current and future initiatives of interest, several carbon crediting methods within the agriculture sector are also presently available to deliver tradable Australian Carbon Credit Units (ACCU). These include ACCU's that can be realised through beef cattle management, sequestration of carbon in soil and fertiliser use efficiencies in irrigated cotton with new methods relevant to the agriculture sector under development (DCCEEW, 2025).

Other Commonwealth-funded initiatives of relevance to Queensland's agriculture sector include:

- **The Carbon Farming Outreach Program (DCCEEW).** The University of Melbourne, in partnership with the Indigenous Carbon Industry Network and Indigenous Professional Services is developing a training package on behalf of the Australian

Government. It is providing $17.5 million in grants to independent advisers to participate in the train the trainer sessions and deliver the training package and provide advice (DCCEEW, 2024a);

- **Methane Emissions Reduction in Livestock (MERiL).** The Australian Government has committed to funding $29m via the MERiL program (2022 to 2026) to support research, development, and deployment of methane-inhibiting livestock feeds (DCCEEW, 2024b); and
- **National Soil Carbon Innovation Challenge and Soil Carbon Data Program.** The National Soil Carbon Innovation Challenge has supported feasibility studies and demonstration projects that were all aimed to fast-track low-cost, accurate, technological solutions for measuring soil carbon and improving the modelling of soil carbon in Australia's Full Carbon Accounting Model. The Soil Carbon Data Program aims to improve data for low-cost alternatives for measuring soil carbon through engaging CSIRO and their state-based partners under the Soil Organic Carbon Monitoring Project (SOC-M). The SOC-M project will access and collect new data from 300 original Soil Carbon Research Program sites to fast-track collection of data that can support estimates of changes in soil carbon over time (DCCEEW, 2024c).

Queensland's process for agriculture sector decarbonisation planning is also underway. The Queensland Government Department of Agriculture and Fisheries (DAF) has previously developed a *Low Emissions Agriculture Roadmap for 2022–2032*. Consisting of five pathways, with specific actions for each as well as an implementation plan, it distinguishes between actions that are to be accomplished in the short or medium term, long term, or on an ongoing basis.

The Queensland Government has also previously established the Land Restoration Fund (LRF), a $500 million fund committed to projects that generate landscape-based ACCUs while also delivering broader outcomes (co-benefits) such as ecological improvements, community and economic resilience, and benefits for Indigenous communities. The LRF also invests in research and science to enable the growth of carbon farming and new environmental markets. There are three priority land-related areas for the fund:

- Restoration to improve the health of wetlands and coastal ecosystems (including the GBR);
- Restoration for threatened species and ecosystems; and
- Restoration for social and economic sustainability.

In addition, the LRF promotes the expansion of carbon sequestration across Queensland, especially in regional areas, to generate new income streams for landholders. Projects are

expected to contribute meaningful environmental, social, and cultural outcomes and must align with Regional Natural Resource Management (NRM) Plans. In this context, there is potential to create new environmental markets. The LRF's approach combines advanced spatial data technologies (e.g., remote sensing or state-wide mapping) with environmental condition measurement frameworks, including those aligned with the Australian Government supported *Accounting for Nature* standards, to ensure rigorous monitoring and verification of environmental outcomes (Queensland Government, 2023b) The Land Restoration Fund Priority Investment Plan (Queensland Government, 2023b) is aligned with and builds upon existing work such as the Carbon Farming Industry Roadmap (CMI, 2022). Currently, several land sector methodologies exist for vegetation management and reforestation, fire management, livestock management, soil and cropping management.

Recommended Action Moving Forward

There are significant investment opportunities from innovations in the agriculture sector to encourage a shift towards a low-carbon economy, including the emergence of new ecosystem service economies. More needs to be done to quantify these regional opportunities, but some relate to the following.

Clean Technology Innovations

Clean technology innovations will play a critical role and offer significant investment opportunities in both mitigating and adapting to the impacts of climate change and environmental degradation (see Lockie et al., 2020). Advances in systems modelling and artificial intelligence (AI) could improve the efficiency of agricultural inputs such as fertiliser, water and pesticides by enabling more precise application technologies, delivering the right amount, at the right time, in the right place. Other promising innovations include systems modelling to optimise farm management, electric tractors and livestock technologies such as improved feed additives to reduce methane emissions. However, the potential of any new technology to support decarbonisation must be assessed in light of possible trade-offs, economic feasibility, alternatives, industry preferences and other relevant factors.

Renewable Energy for On-farm Use

Renewable energy is crucial for reducing emissions associated with agricultural production. The generation of low-carbon electricity from solar photovoltaics, onshore and offshore wind, and hydroelectricity, has been at the forefront in the development of new energy sources. In the context of agriculture, additional opportunities include fuels derived from biomass (e.g., "biofuels," such as bioethanol) which are promoted as low-GHG alternatives. However,

significant debate remains regarding the environmental impacts of large-scale biofuel production.

Carbon Storage by Capturing Carbon in the Soil

Sequestration by agricultural soils has been discussed as a promising way to offset fossil carbon while improving long term sustainability and resilience in the agriculture sector. Improved fertiliser use is crucial, not only to reduce emissions, but also to improve water quality. There is also an opportunity to reduce emissions within the supply chain by increasing the efficiency of fertilizer production and lowering the energy required to produce it, also bringing down costs. Better nutrient management, especially nitrogen, is essential for emissions reduction. However, we still lack complete knowledge about the optimal quantity of fertilisers to apply. Opportunities to reduce carbon emissions include adopting best practices such as minimum tillage in tropical agriculture and reducing the use of fertilizer and fuel, especially diesel. The use of alternative nitrogen sources, such as legumes, warrants further exploration. Good soil and input management could increase sequestration, creating an opportunity for emissions reduction.

Transition to a More Circular Economy and Blue Economy

Significant investment opportunities are emerging in the development of a circular economy, with companies increasingly integrating circular principles into their agricultural business model. A circular economy can reduce pressure on natural resources and support a transition to a low-carbon economy. The increasingly well-known blue economy has also recently gained greater attention within the regional decarbonisation investment agenda. Australia is considered a ‘blue carbon hotspot’, containing 12% of the world’s blue carbon ecosystems and holding 7–12% of global carbon stocks. The Australian Government is currently taking a range of measures to restore, conserve and account for these ecosystems. In January 2022, a blue carbon method was approved under the ERF, allowing projects that restore tidal flows in blue carbon ecosystems to generate ACCUs.

Regional Land Use and Infrastructure Planning – Allan Dale

Achieving Queensland's net zero targets will require very significant private and public sector investment in renewable energy generation and transmission infrastructure over the next decade. This investment will need to occur across vast swathes of the regional Queensland landscape, a part of the state with typically less well-developed land use and infrastructure planning than Queensland's southeast corner. Research efforts from the Cooperative Research Centre for Developing Northern Australia (CRCNA) and the emerging Queensland Decarbonisation Hub suggests that without cohesive new approaches to planning and development assessment, the evolution of this investment pipeline may be compromised. This raises the risk that Queensland may fall short of its net zero targets and lose investors to other Australian jurisdictions or international markets. With a highly decentralised state, and substantive renewable energy and water resources, Queensland has the potential to be a global powerhouse in the energy transition, but this means that it needs to be investor-ready; presenting an attractive and competitive investment environment. We argue that innovations in regional planning are a necessary tool to maximise investment opportunities and manage barriers.

The Problem

To achieve timely mitigation of climate risk *and* to replace Queensland's reliance on income and energy from coal mining and coal-based power generation, the Queensland economy will need to go through a very significant transition over the next 25 years to 2050. Several recent economic and transformational reports have highlighted the need for substantial reform to regional planning and development assessment processes (see Dale et al., 2022). Efforts to address similar challenges are also emerging internationally. The United States, for example, is tackling what has become known as the 'permitting problem' for renewables under the *Inflation Reduction Act* (USCC, 2024).

Based on the experience of rapid decarbonisation in Queensland's regions, new and effective approaches to regional planning will be required to:

- Ensure that areas of high biodiversity, social amenity and cultural value are protected from the outset from speculative energy generation and transmission proposals;
- Attract quality investors to the areas with the least environmental and cultural constraint, combined with the greatest opportunities for energy generation and transmission;
- Give the greatest level of process certainty for investors, reducing their investment risk;

- Prioritise and plan for the allied infrastructure (e.g. housing), services (e.g. workforce) and resources (e.g. water) required to support the decarbonisation investment required; and
- Maximise and maintain the State's social license for investment in rapid decarbonisation across regional Queensland.

Recommended Action Moving Forward

Overcoming these challenges and realising associated benefits will require coordinated action across all levels of government, effective land use and infrastructure planning at a regional scale, and the integration of emerging science/technologies. A new innovation pathway is needed. With the Australian Government's ongoing reforms to environmental laws (via the *Environment Protection and Biodiversity Conservation Act*), the establishment of REZs in Queensland, and with the Crisafulli Government's commitment to develop a Net Zero Roadmap, a three-step approach is proposed.

Step 1: Undertake a Rapid Strategic Assessment across Queensland's REZ Sub-regions

There is value in taking a rapid, state-wide approach to identifying priority areas for renewable energy investment and transition, provided this aligns with existing *EPBC Act* Strategic Assessment arrangements and the emerging regional planning processes and standards. This should particularly account for Queensland's recently released REZ and associated REZ-Readiness planning. Under the *EPBC Act*, Strategic Assessments are landscape-scale assessments, often negotiated between the Australian Government and the states, that allow a big-picture approach to protecting nationally significant (protected) animals, plants, habitats or places.

A rapid Strategic Assessment approach to facilitating urgent decarbonisation investment across Queensland's regions could: (i) be undertaken at a state-wide level, but focus particular attention on all of the state's newly identified REZ sub-regions; (ii) use existing Australian Government and State data-layers (e.g. regional vegetation mapping, biodiversity layers, etc.) to identify those areas of high environmental, social and cultural risk, combined with the most highly prospective solar, wind, hydro, biomass and geothermal assets; and (iii) identify the most prospective development opportunities and areas and transmissions corridors that support the most cost effective grid connectivity.

This Strategic Assessment activity could be rapidly developed and completed within a two-year timeframe and undertaken through effective collaboration between the state and Queensland's strong, university-based scientific capacities that could support such planning

(particularly the fields of planning, landscape ecology and social licence). It is crucial that any plans, responses or assessments be coordinated with broader REZ development timelines and objectives to retain relevance and value.

Step 2: Undertake a Phased Approach to Bioregional Planning

Queensland's emerging bioregional planning framework offers a practical mechanism for translating Strategic Assessment work into on-the-ground planning outcomes within REZs and their sub-regions. The Queensland Government is currently piloting three bioregional plans; two of which focus on renewable energy development in a North and North West Queensland locations. While conceptually aligned with the Australian Government's broader regional planning initiative and the proposed Regional Planning Standard under *EPBC Act* reforms, Queensland is advancing its own approach in cooperation with the Australian Government. The emerging bioregional planning model is designed to complement, not duplicate, Commonwealth reform efforts. It is also distinct from Queensland's REZ Roadmap: whereas REZs identify areas for targeted energy infrastructure investment, bioregional plans address broader regional considerations, including biodiversity, cultural heritage, and land-use pressures.

Although Queensland's approach does not depend on finalisation of the Australian Government's proposed environmental reforms under the *EPBC Act*, completing these reforms would enable more coordination between jurisdictions in the longer term. A five-year rollout of bioregional plans beyond this pilot phase, aligned with the REZ Roadmap. Priority could be given to regions under the greatest renewable energy and critical mineral investment pressure, undergoing significant economic transition, or where the social license for renewable energy development is most at risk. There is also clear value in negotiating joint Commonwealth–State investment through future bilateral agreements tied to the proposed *EPBC Act* reforms. Queensland should, however, continue to lead this process, ensuring its bioregional planning framework remains responsive to regional needs while consistent with evolving national policies and standards under the *EPBC Act*.

Step 3: Integration Within Queensland's Planning Frameworks

Over the next two years, in the lead up to the commencement of the proposed bioregional planning program of works outlined in Step 2, solid policy consideration should be given to determining the best way to integrate EPBC-oriented bioregional planning within Queensland's statutory planning frameworks. This would be needed to give (i) the best planning and regulatory effect to the outcomes of bioregional planning, and (ii) to offer the most effective processes to facilitate rapid development assessment coordination and

approval within areas prioritised or designated for development. This might include exploring a range of potentially viable options, including:

- The amendment or update of current regional plans under Queensland's land use planning regime, also delivering strong policy influence into local government planning schemes;
- The potential use of State Development Areas to enable more effective use of the Coordinator General's role in planning and development assessment; and
- Other innovative mechanisms available under the *State Development and Public Works Organisation Act*, Queensland's planning legislation, or Economic Development Queensland.

Placed-based Approaches to Community Transition – Allan Dale

Decarbonisation efforts at the local community scale, particularly at the local government level, have been largely overlooked in Queensland's regions. As Queensland started developing its Climate Action Plan early in the first term of the Palaszczuk State Labor Government, the Queensland Government aimed to strengthen community-scale economic resilience as part of its wider climate adaptation strategy. To support this goal, the then-Department of Environment and Science (DES) established the Communities in Transition Pilot Program (CTPP) to:

> *…support regional prosperity by equipping communities with the capacity to understand climate change and the global shift towards a low carbon economy, and identify their own pathway toward a positive social and economic future as Queensland moves towards zero net emissions by 2050.* (DES, as cited in CGCC, 2020, p. 1)

Details about the design and delivery of the CTPP can be found in the final CTPP synthesis report (CGCC, 2020). The pilot program was expected to:

- Build climate transition capacity in key economic and community development leaders in six Queensland communities (i.e. six local government areas);
- Support them to work with their community to identify and document shared objectives and pathways to a prosperous low-carbon future; and
- Support them to present their transition plans to the Queensland Government and other relevant partners and stakeholders for targeted investment support.

The project was required to design and deliver community development that could build climate transition relevant and/or economic development capacity within community leaders. In responding to the offer, a USQ, JCU, CSIRO and The Eco-Efficiency Groups-based consortium (the Clean Growth Choices Consortium) put forward an approach based around an expert team to:

- Co-develop place-based transition roadmaps scored by tangible project initiatives that accounted for the barriers and opportunities associated with clean growth choices; and
- Reduce barriers and promote opportunities for implementing clean growth choices.

Communities being able to make choices was a prerequisite outcome for the CTPP because building alternatives inside a regional economic and social system is an essential marker of resilience.

The Communities in Transition Approach

The Queensland Government approved the consent-based selection of six communities from an initial list of 12 to pilot the new approach. Participating communities adopted the process as the Consortium and associated State Government officers collaborated with these communities as genuine partners versus top-down planners. The shared aim was to facilitate the development of pathway-based plans for achieving community social and economic resilience against the background of the dominant megatrends of the time (but particularly the need to decarbonise the economy). This required the Consortium to work closely with the six pilot regional communities in a planning process that developed roadmaps and identified project ideas for business case development. Resources were directly invested in partner local government authorities to support the local community work.

There were significant variations in the methods applied across the pilot communities, reflecting the locally-specific level of community involvement and local pathway preferences. A combination of workshops, meetings, teleconferences, and working dinners facilitated collaboration. This also integrated teamwork and group commitment. In effect, the Consortium acted as a backbone institution to support these place-based processes, with the approach generally involving:

- **A Pathway-Based Working Group**. These wider (across the community) groups were established to determine community resilience, to agree the coming pressures facing the community and to determine future pathways forward; and
- **More Refined Business Case Development Working Groups and Workshops**. Several of these groups were established in each of the pilot communities to translate priority pathways into solutions-focussed business cases.

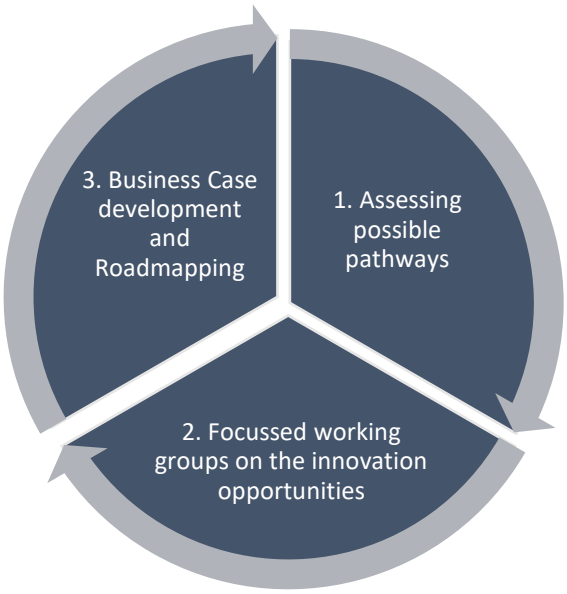

Figure 1: Key steps in the 18 months process explored in the Communities in Transition pilots.

Like the communities themselves, there was substantial diversity in the individualised approach taken by established working groups in six communities as remote and as different as Cooktown, Barcaldine, Rockhampton, Charters Towers, Central Highlands, and Goondiwindi. Nonetheless, the common thread in all participating pilot communities was:

- The strong degree of local ownership in the ideas developed into business cases;
- The positive and optimistic perspective taken by the wider community and working groups in their belief that they could shape and influence their future; and
- An almost universal view that the future would best be shaped by collaboration between all three levels of government, taking a long-term view, but one grounded in the real and stated aspirations of the communities themselves.

A central principle (and mantra) of the approach was its emphasis on the process being "locally led, regionally facilitated and State supported". This recognition of the value of volunteer community members working alongside government officials and elected representatives, as well as business and industry, was evident in the commitment of some of the participants to continue with such collaborative processes into the longer term. The program led to the development of roadmaps and business cases that reflected the specific context, needs, and opportunities of each region. The degree to which these business cases have been implemented depended on the level of energy and commitment mobilised by the communities, the interest of various levels of government and investment stakeholders, as well as by the entrepreneurs and businesses that could see opportunity in each idea and strategy. The framework for investment attraction looked as follows.

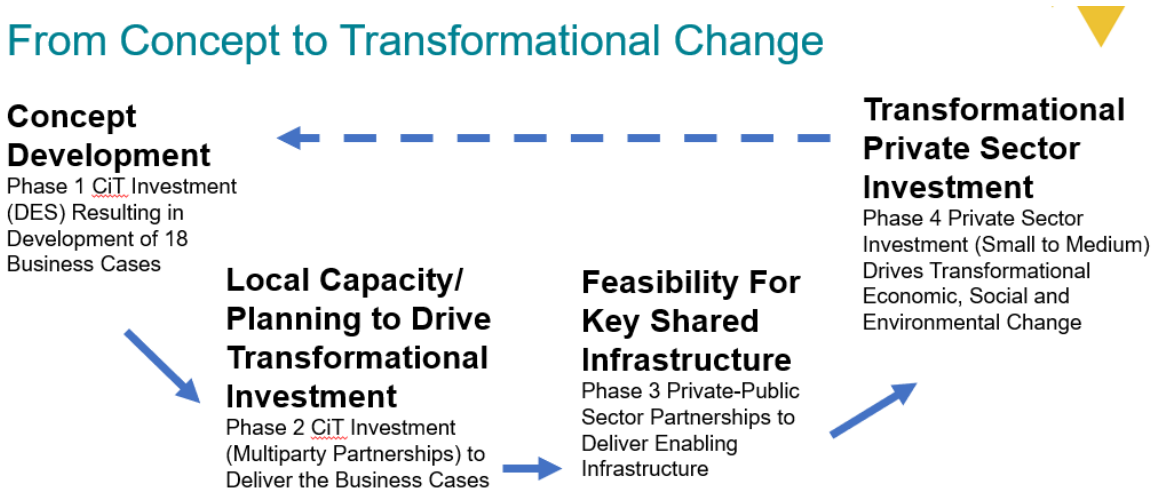

Figure 2: The concept of creating and investment pipeline through the Communities in Transition pilots.

Emerging Policy Implications and Opportunities from Communities in Transition

There were several policy implications arising from the CTPP pilots; all within the broader setting of national and global change; economic, social and ecological.

Energy, Ecosystem Services, and Catchments

The CTPP demonstrated a policy need to:

- Regionalise emerging national/state energy policy frameworks and improve regional energy planning investment frameworks (linked to land use);
- Adopt new models and technologies for energy generation, distribution and trading in regional and remote areas to give local people more control over costs and reliability;
- Establish a stronger, place-based ecosystem services trading framework integrating carbon, biodiversity and water quality (with reform in approaches to natural resource management); and
- Support reform of the current governance system of floodplain planning and management through stable authorities (integrating flood mitigation, land use planning and catchment repair).

Next Generation Agricultural Development

The CTPP demonstrated a policy need to:

- Support a strategic focus on coordinating and supporting new agricultural development (with more circular economies) particularly in Reef catchments;

- Support producers in moving to more regenerative models of agriculture as well as diversifying into new products and services that increase economic outputs per megalitre of water applied;
- Support more resilient and value-added supply chains, integrating production, energy and digital capacity; and
- Build new approaches for developing a major focus on next generation (transferable) workforce skills across agriculture production systems, supply chains and industry.

Other Emerging Policy Opportunities

Finally, the CTPP demonstrated a policy need to:

- Develop a much stronger and place-based focus on lifting digital connectivity and capacity within regions and individual local government areas and communities;
- Develop new approaches to lifting social and economic resilience as a key mechanism in building disaster and wider resilience in regions (adaptive capacity);
- Establish a new State-wide focus on lifting opportunities for rural and cultural tourism; and
- Extend and expand the CTPP and regularly explore cross-community policy and budget implications arising from program outcomes;
- Consider regional transition of government workforce arrangements by allowing remote and regional Queenslanders to gain employment and work from regional hubs; and
- Develop integrated consortium led, impact-oriented research, to provide evidence for implementation and assessment of transition plans, policies and practice.

Emerging Lessons From the Communities in Transition Approach

Rather than being constrained by the Queensland Government's Climate Transition Strategy, the CTPP resulted in six community pathway documents for transition, each influenced by regional priorities and needs. These community-based pathways were shaped to take account of broader regional opportunities for coordination and promotion delivering strong "grassroots" visions and propositions for strengthening economic resilience. However, the main outputs of the program at each regional level largely aligned with the adaptation focus of the Queensland Government's Climate Adaptation Strategy. It was effectively **locally-led, regionally coordinated, and state facilitated.** It is fair to conclude that each of the communities arrived at the original program destination envisaged by DES, but each pathway and destination was distinctively reflective of each region's local culture.

The key outputs of the pilot program, captured in their business cases and roadmaps, had a broader focus, extending well beyond 'conventional' low carbon economic transition strategies often including other regional megatrends. Having an adaptive methodology made it easier to

include practical projects and ideas that reflected local priorities, capabilities and the limited time people had to take part voluntarily. The community-oriented process was a reminder that achieving change is more complex and ambiguous than typically prescribed or envisaged in most policies and strategies. Ultimately, priority was placed on how each community saw its vision of progressive change rather than the implementation of a static set of top-down and often fragmented policy settings from the Australian and Queensland Governments.

The CTPP program reinforced the importance of local leadership, of people with capacity for vision setting, but also of people with the practical energy to execute action; skills manifestly evident in all six communities. Developing long-term plans relies on building trust and relationships, which takes considerable time. The CTPP was a deliberative, patient process, enabling sufficient time for ideas to evolve through discussion and consideration. Working groups ultimately were able to act as project advisory boards that, once supported and provided solid information, could consider and identify a direction forward. The experience suggests that a dedicated, independent system for place-based monitoring, evaluation, and learning should have been established from the beginning to better capture the program's insights and outcomes.

Recommended Action Moving Forward

As the CTPP now continues in its post-pilot phase, there are a number of challenges that have been posed with six diverse communities. Arguably, the most significant ongoing challenge is the critical need to ensure consistency in approach (i.e. "one project, not six") while allowing for sufficient flexibility and adaptability in implementation, traits that will be essential for the model to scale up into the future. One of the CTPP's most valuable legacies may be its ability to support community-wide planning that looks to the future, independent of, but aware of, political and ideological interests that might otherwise dominate and slow the adoption of more innovative approaches to regional development. There is good evidence the CTPP approach could be successfully extended to other regional communities using similar methodologies. As the original participating communities continue to translate their ideas into projects and tangible developments (like Rockhampton Regional Council's **Making Water Work** initiative) the CTPP has shown that the transition to a low carbon economy, while not without its challenges, is achievable for regional Queensland. Each region will need to continue to shape its own path, but the model provides a strong starting point (CGCC, 2020).

The success of the pilot suggests potential for broader rollout, but with long-term funding and a clear strategy for scaling, remain challenges. Addressing this will require cross-government coordination, including Queensland Treasury, Economic Development Queensland, Queensland Reconstruction Authority, State Development, the Department of Primary

Industries (DPI) and the Department of Environment, Tourism, Science and Innovation as well as engagement with the Local Government Association of Queensland. If funding is secured, the DPI-funded RECoE could be a strong delivery partner, given its existing partnerships and alignment with the program's goals.

Strengthening First Nations Governance to Facilitate Decarbonisation – Jim Turnour and Ellie Bock

Decarbonisation of the economy provides a unique opportunity to strengthen First Nations' governance and related institutions. This is important because First Nations peoples are the original custodians of Queensland's lands and waters, often holding statutory rights where key renewable energy and new economy minerals projects will be developed. This is particularly the case across regional Queensland and specifically in the north. These projects will therefore proceed more efficiently with the consent of First Nations peoples, working through their appropriate and designated institutions responsible for coordinated nation building and land dealings. Strongly governed First Nation institutions will enable decarbonisation projects to more easily gain the consent they need for development in places where they are supported by Traditional Owners. This will also ensure First Nations' business and employment opportunities can be maximised with resultant flow on economic and community development outcomes (First Nation Clean Energy Network, n.d.).

For the purpose of this paper, a First Nation is defined as a group of Indigenous peoples who self-identify as a group through their shared connections to country, language, culture and history. Different First Nation groups have their own cultural identity, traditional laws (or lore) and customs, which they seek to maintain and they expect to be respected. First Nations want to self-determine their own development, but this is dependent on good governance given that Indigenous peoples' rights and interests are held collectively within First Nations' institutions (both cultural and corporate institutions). Strong institutional structures and processes are required to support self-determination and the Free, Prior and Informed Consent (FPIC) needed of a First Nations group in decisions about planning and implementing projects (UN, 2007). There is a need to support First Nations rebuilding, which involves the reestablishment and strengthening of contemporary First Nations institutions and related governance structures and processes to support self-determined development (CFNG, 2017; Cornell & Kalt, 2007; Gertz et. al., 2025; Hunt et.al., 2008; NCFNG, 2009; Turnour, 2022).

Regional Queensland's energy transition is being driven by governments that are also putting new policy and regulatory systems in place to create an investment environment seeking to decarbonise national, state and local economies. These associated investments are enormous, and First Nations institutions need to be supported to lead and/or respond to such investment.

The Opportunity for First Nations Self-Determination through Decarbonisation

In Australia, First Nations peoples hold significant interests in land and statutory decision-making processes in relation to major infrastructure and resource developments (Smith & Field, 2024; Wood et. al., 2021). In Queensland, First Nations will hold significant interests in renewable energy projects, including wind, solar and pump hydroelectricity within priority REZs. The renewable energy transition, if done well, therefore provides an opportunity for First Nations economic independence through increased business and employment, including the potential to secure equity in or ownership of projects (First Nation Clean Energy Network, n.d.). Achieving this outcome requires governments to meet their stated commitments to Indigenous self-determination, enabling First Nations to determine how their land and resources are developed (O'Neill et. al., 2021; Quail et al., 2023).

The Australian Government committed to First Nations peoples' self-determination when it ratified the *United Nations Declaration on the Rights of Indigenous Peoples* (UNDRIP) (UN, 2007). The UNDRIP establishes a universal framework of minimum standards to safeguard and support the survival, dignity, and well-being of Indigenous peoples around the world. UNDRIP elaborates on existing human rights standards and fundamental freedoms as they apply to the specific situation of Indigenous peoples. Amongst other things, UNDRIP acknowledges Aboriginal peoples' rights to self-determination in relation to development (Article 32). Further, the UNDRIP upholds the FPIC principle which asserts that, when making policies or laws or undertaking activities that affect Indigenous peoples, governments and others should negotiate with those affected with the aim of obtaining their consent (Article 19) and that benefits from development should flow to Indigenous peoples (UN, 2007). The UNDRIP therefore provides a framework for supporting self-determination in relation to development and decarbonisation to which the Australian Government has already committed.

There are also multiple statutory requirements for First Nations' engagement in the transition to net zero, where Indigenous peoples own land and or hold native title rights. The *Native Title Act 1993 (Cth)* requires the proponents of major infrastructure and mining projects to negotiate and reach prior agreements with Traditional Owners for compensation or other benefits through an Indigenous Land Use Agreement (ILUA). There is also a range of other government legislation recognising First Nations' rights and interests in decision making about development, including planned reforms to the *Environment Protection and Biodiversity Conservation Act 1999 (Cth),* the *Aboriginal Cultural Heritage Act 2003 (Qld),* and the *Water Act 2000 (Qld)*. State-identified priority REZs are often overlayed by native title interests and are likely to contain areas where threatened species and ecological communities are protected under the *EPBC Act*. Cultural heritage interests within and across the landscape are also

protected through various Australian Government and State policy and legislative frameworks. These statutory requirements for the engagement of First Nations people in projects, if combined with FPIC principles, therefore provide a pathway for the meaningful involvement of Indigenous peoples in regional Queensland in the energy transition and critical minerals projects.

Realising These Opportunities

The FPIC principles discussed above are not currently enshrined in legislation, and existing renewable energy or new economy minerals plans do not clearly explain how governments propose to meet their policy commitments to self-determination. Hence, while there are significant opportunities, there are also risks for First Nations peoples and communities from the renewable energy transition (O'Neill et. al., 2021; Quail et al., 2023; Sinclair & Coe, 2024). Enshrining FPIC principles in policy and legislation as they relate to First Nations' interests and rights in the renewable energy transition, and long-term investment in rebuilding governance capacity of the First Nations institutions that hold these rights and interests, should be a priority for governments as part of the transition process. In relation to native title and land/sea management, these institutions include Registered Native Title Body Corporate (RNTBC) instigated after Federal Court determinations of native title and registered under the *Corporations (Aboriginal and Torres Strait Islander) Act 2006 (Cth).* Where native title is yet to be determined, Native Title Representative Bodies (NTRBs) continue to play a role in representing the interests of First Nations peoples. In Queensland, First Nations may also hold Aboriginal or Torres Strait Islander freehold land through a RNTBC or an Aboriginal or Torres Strait Islander Freehold Trust often referred to as a "Land Trust" under the *Aboriginal Land Act 1991 (Qld).*

While RNTBCs and Land Trusts are established to undertake and represent specific statutory responsibilities, there has been little to no investment in their governance capacity as First Nations institutions. RNTBCs can receive very limited core governance funding from the Australian Government through their NTRB. Land Trusts in Queensland receive no governance funding support. The statutory processes that establish RNTBCs and Land Trusts also support the creation of a *Corporations (Aboriginal or Torres Strait Islander)* (CATSI) Act-incorporated entity with a governance rule book for the group. Governments rarely invest in the necessary capability building, corporate or strategic planning and the development of policies and procedures to enable the effective functioning of any First Nations corporation post-determination or land transfer (Wood et. al., 2021). Statutory processes frequently create conflict within institutions or exacerbate remnant conflicts within and between groups and external stakeholders. These conflicts often need to be further resolved or managed (Australian Human Rights Commission & Gooda, 2011). Many First Nations institutions

include members with strong governance skills, but some individuals choose to not engage or get involved by personal choice to avoid conflict or the risks of working with an under-resourced and possibly poorly governed entity. With limited or no resources, and residual conflicts to manage, it is not surprising that many RNTBCs and Land Trusts struggle following initial establishment.

The recent review of the Closing the Gap (APC, 2024) reaffirmed that the solutions to Indigenous disadvantage must be driven by First Nations communities. RNTBCs and Land Trusts are foundational institutions within these communities as they hold the statutory rights and interests to native title and in land that underpins First Nations peoples economic development. Governments at all levels need to pivot to invest in building and supporting the core governance capacities of foundational First Nations' institutions as critical place-based delivery partners in economic decarbonisation.

Mitigating Risks for First Nations

When it comes to the development of renewable energy and critical mineral projects, there is often a distinct power imbalance between a mainstream corporate development entity driven by profit and more localised First Nation institutions (e.g., RNTBC or Land Trust) whose members have custodial responsibilities to their lands and waters under Aboriginal or Torres Strait Islander law, and often with limited capacity to negotiate development outcomes, impacts or sustainable benefits. The *Native Title Act 1993 (Cth)* requires development proponents to fund negotiations and ILUAs with common law holders through RNTBCs or a NTRB where native title is yet to be determined. Multiple significant risks arise where First Nations institutions like RNTBCs have limited governance capacity prior to the engagement in these negotiations. These risks include:

- FPIC of common law holders not being effectively achieved;
- increasing or sustained conflict or lateral violence within groups and across communities;
- inequitable or non-existent commercial outcomes for First Nations communities;
- corruption, or perceptions of corruption, of statutory native title processes (e.g. project or area-based ILUAs) given the sums of money involved and time pressures involved; and
- where agreements are reached, they may not be delivered on by project partners or RNTBCs might lack the capacity to take up negotiated enterprise and employment opportunities.

These risks are real and the impacts may not be fully understood, but they will be long lasting. Agreements are usually kept confidential and are likely to bind parties for decades given the

scale and life cycle of renewable energy and mining projects. A recent audit undertaken by Queensland South Native Title Services (QSNTS) found that five QSNT supported RNTBCs had $6.5 million owing to them by existing agreement stakeholders (Smith & Field, 2024). While First Nations and their institutions must self-determine their aspirations for development, there is indeed a responsibility on governments to support First Nations in proactively managing these risks. Failing this, it is highly likely that decarbonisation of Queensland's economy will be another missed opportunity to empower First Nations and to close the gap in Indigenous disadvantage.

New Approaches to Achieving Change

The Australian and Queensland governments have committed billions of dollars to leading the energy transition in Queensland and developing the resource projects needed to supply critical minerals for decarbonisation globally. There is a need to strategically build support for the governance capacity of First Nation institutions so that they are ready to engage in FPIC processes and negotiate approvals and benefits from these projects were supported by Traditional Owners. First Nations need such support and resources to ensure the robust and culturally appropriate FPIC of their members in decision-making about decarbonisation projects. Associated native title, cultural heritage and environmental approvals processes, benefit sharing through employment outcomes, or opportunities for the development of equity partnerships, are likely to be strengthened through a properly resourced strategic approach to strengthening First Nation governance.

Indigenous-led approaches to 'Nation Building' is an example of an approach to governance capacity building that is being applied in the context of the Gugu Badhun First Nation (Gertz, 2022) who have successful negotiated Gawara Baya Windlab project near Townsville (Gawara Baya, n.d.). The Eastern Kuku Yalanji First Nation north of Cairns, similarly, has plans for a renewable energy microgrid (Jabalbina Yalanji Aboriginal Corporation, 2022). The People, Place and Partnership (PPP) Framework and Traditional Owner Knowledge System (TraKS) database being implemented by QSNTS provides another example of the types of support that could be provided to RNTBCs in the process of rebuilding their First Nation. The PPP Framework consists of a series of First Nations-led workshops designed to build sustainable, self-determined governance, including strategic planning. The TraKS database is used to manage agreements with RNTBC partners to ensure these are being implemented as agreed (QSNTS, n.d.). There is also significant industry-based experience from the resources sector developed over the past 20 years in relation to best practice agreement making with First Nations that can be drawn on for the energy transition (see, for example, O'Neill et. al., 2021).

Working out how place-based governance capacity building and professional advice is resourced and initiated in each REZ should be codesigned with First Nations groups. This consideration also applies to planning in the energy sector more broadly. For example, the Priority Transmission Investment framework, which was established to accelerate the planning and building of critical transmission infrastructure at scale (Queensland Treasury, 2025b), could consider the inclusion of First Nations co-design opportunities. The Queensland Government's future energy, jobs and resource industry development plans should also include a strategic investment needed for supporting a place-based First Nations approach to the energy transition. This could be undertaken, for example, as part of planned REZ readiness assessments. Within these assessments, there is an identified need for a specific focus on the capacity and capabilities of First Nations institutions and First peoples (separate to those of other community stakeholders) given statutory native title and cultural heritage rights and interests. In the future, direct investments could be made into a range of place-based First Nations institutions, including RNTBCs, Land Trusts and or appropriate CATSI entities, or into NTRBs where a group has not established a statutory institution. There could be a mix of support mechanisms made available depending on a group's governance capacity and or articulated needs.

Recommended Action Moving Forward

The energy transition and the associated decarbonisation of the economy provides a unique opportunity to rebuild First Nations institutions and create income streams and employment opportunities for Indigenous peoples. Through the REZ assessment process, the then Queensland DEC engaged with First Nations groups and community members to better identify key impacts and opportunities arising from REZ developments. In progressing involvement in REZ decision making further, the Queensland Government could further identify a lead agency to coordinate and commit the necessary resources to support ongoing planning. To maximise these opportunities, however, the Australian and Queensland governments need to strategically invest in rebuilding the governance capacity of First Nations to realise these opportunities which could include:

- Investment in backbone institutional arrangements within current priority and emerging REZs to coordinate and build First Nation capacity and stakeholder partnerships;
- Direct investments in the capacity building of RNTBCs, Land Trusts and Indigenous businesses to realise opportunities from decarbonisation and the energy transition; and
- Progressing reforms to mitigate identified risks, including increasing transparency in relation to ILUAs and their implementation.

Precinct or Village Scale Approaches to Decarbonisation – Paul Sparshott and Ray Maher

As the world engages with the climate crisis, there is an urgent need to transition to a low carbon future. Cities and urbanisation are among the largest sources of GHG emissions and are essential to Queensland's pathway to decarbonisation, particularly in our regional cities. To progress thinking about this unique regional opportunity, research collaborations between the University of Queensland and James Cook University are being proposed to explore *Next Generation Urban Villages* (NGUVs). This can make a significant contribution to decarbonisation in Queensland's tropical regional cities; potentially presenting real opportunities across the tropical world.

As a keystone pilot to explore this concept, an emerging NGUV project proposal is supported by local and regional organisations, including Cairns Regional Council, Regional Development Australia, Cairns Chamber of Commerce, Wet Tropics Management Authority, and the Urban Development Institute Australia. The project will develop new models of compact urban development that support Queensland's transition to net zero cities, while enhancing flood-resilient, community-friendly, and tropical urban design. The model will be based on research and applied through real life NUGV projects in Cairns. A 'Living Lab' approach will inform future developments through continuous prototyping.

Approaching decarbonisation through traditionally siloed infrastructure and community sectors risks increasing total costs and overlooks significant co-benefits through integration. In contrast, this NGUV proposal takes a holistic 'systems' approach which integrates decarbonisation strategies across eight themes, and across three physicals scales from regional, master planning, and buildings. In this way, many complementary decarbonisation strategies can deliver a paradigm shift towards net-zero cities, while providing many co-benefits (summarised below). The proposal would inform significant local, state, and national strategies including "Towards 2050: Shaping Cairns Growth Strategy", the Queensland net zero target, and Australia's new National Science and Research Priorities.

Low Carbon Community-Based Energy Production, Conservation and Management

Australia's predominant 'big power' energy model is transitioning towards renewables. This is a critical step, but one that, when considered alone, is insufficient for decarbonisation and demands significant costs in new transmission lines and substations. In parallel, community-based energy systems in tropical regional cities can drive decarbonisation through local supply at the source of consumption (eliminating transmission losses), energy efficiency, community

energy demand management, alternative pricing schemes to reflect demand, and localised storage among other strategies.

Microgrids using energy generation, management and storage, combined with other community-based demand management measures can potentially result in more system efficiencies. They can also enhance local resilience in the face of worsening disaster events. Through cost-effective rooftop solar and more affordable battery storage, communities can also take control of their energy systems and management. This can be enhanced further by establishing community-based infrastructure.

An Integrated Transport and Urban Development Model for Reducing Carbon

Transport emissions are a significant contributor to Australia's overall GHG emissions, with the sector ranking among the highest globally; with Queensland leading the nation on solving this problem. Reducing emissions from private vehicles is therefore a critical priority, particularly through shifting a majority of trips from private vehicles to more sustainable, lower carbon transport solutions such as trackless trams, electric buses/shuttles and electric personal mobility devices. New models of urban development in our regional cities, integrated closely with public transport planning, is essential to supporting this decarbonisation of Queensland transport.

Reducing transport demand can also be achieved by localising essential services and establishing community-based work-from-home hubs. This NGUV pilot project will explore and integrate innovative models including mobility-as-a-service, community based shared car schemes, and micro-mobility services. This can be achieved by creating walkable communities and encouraging active transport such as cycling and personal mobility which reduces transport emissions while enhancing public health and building a sense of community.

Building and Developing Better Sustainable Low Carbon Communities and Dwellings

This NGUV 'living lab' aims to pilot, monitor and improve emerging sustainable low-carbon technologies within a staged master plan with flexibility to adjust plans based on ongoing analysis and feedback. By integrating climate suitable tropical urban design, individuals and communities can simultaneously reduce their GHG emissions, improve liveability, and reduce their cost of living. Developing new housing types that are better suited to changing demographics and smaller households substantially reduces the carbon footprint and costs to occupants. The NGUV aims to trial more compact regional city settlements. This can reduce urban sprawl and its impacts on critical habitat and farmland, each with their own carbon footprint. The carbon embodied within urban developments is a significant source of GHG emissions and a critical area for decarbonisation in Queensland. This project will integrate

leading research and best practice in low carbon construction methods such as lightweight timber construction, green steel, low-carbon cement, and circular economy opportunities (e.g., using recycled content). Construction methods such as mid-rise construction and prefabrication can also reduce waste and lower embodied carbon and lifecycle costs.

Finally, fostering a strong sense of community through good design can provide village centres within our regional cities, where people socialise informally and access basic services within walking distance. Again, this reduces transport emissions while enhancing liveability and community resilience.

Nature Based Landscaping and Water Management for Communities

As mentioned above, to decarbonise our regions, energy and water planning issues cannot be separated. Water is central to life in the tropics and managing it can have a significant impact on emissions. The model of urban development created through the NGUV will reduce energy demand of water systems through localised efficiency, harvesting, storage, treatment, and recycling. These systems also improve the ecological health of local water systems, critical in the Great Barrier Reef catchment.

Many climate impacts are felt primarily through water, such as extreme weather events like cyclones and flooding. By developing flood-resilient communities, the NGUV can reduce the energy spent on reconstruction while enhancing climate resilience of regional communities. Urban habitat will be integrated into NGUVs to provide shade which counters the urban heat island effect and improves the local microclimate. Combined with tropical passive building design, these strategies reduce energy demand to support decarbonisation and affordability. Nature-based landscaping also helps to store carbon through vegetation and soil while enhancing local biodiversity and improving resilience of native ecosystems. Such approaches can sequester carbon and deliver nature positive outcomes.

A Living Lab Approach to Enhance Cross-Sector Learning for Decarbonisation

Developing a viable new model of urban villages within our regional cities requires integration across scales, research themes, and interdisciplinary teams. It also requires close collaboration among researchers, practitioners, government, and community groups. This NGUV proposal will be approached through a ‘Living Lab’ strategy, designing, developing and delivering new low carbon communities. In this way, smaller community sized developments can be trialled, tested, and evaluated at less cost and capital, and lower risk compared to city or regional level decarbonisation. These Living Lab NGUV communities will help to showcase alternative models of development to build community acceptance and stakeholder buy in.

This iterative approach also produces a feedback loop to support continuous improvement of triple bottom line outcomes, including decarbonisation.

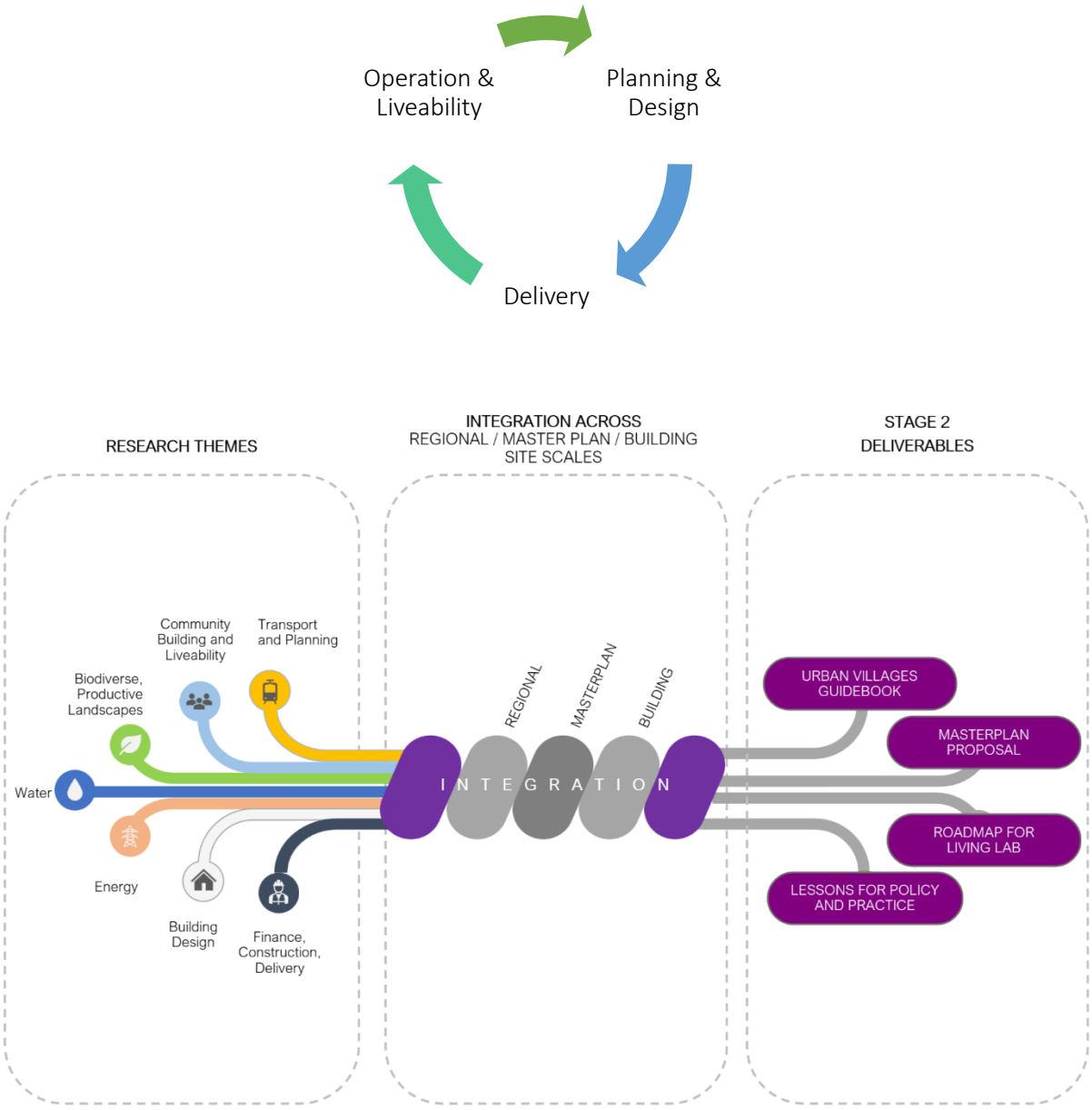

Figure 3: This project will develop a model of Next Generation Urban Villages for Cairns by leveraging iterative design processes, leading research, and best practice for sustainability and liveability.

Recommended Action Moving Forward

Queensland's decarbonisation pathway must engage and transform several carbon-intensive sectors, including our urban environments. However, reshaping regional cities and towns for a low carbon future is very complex. Decarbonising village-size communities within cities and major towns can be studied, improved, and replicated as a system in a relatively short time. It is lower risk and more cost effective than single-sector infrastructure projects and provides

multiple benefits to regional communities and ecosystems. Through this sort of innovative thinking, advances in urban decarbonisation, developed through partnership approaches, can be expanded, reproduced, and tailored to local conditions across regional Queensland and across the wider tropics.

Decarbonising Industry Through SMEs – Nico Adams

Decarbonisation in the industrial sector accounts for about one-quarter of global carbon dioxide emissions. In regional Queensland, the sector is dominated by small to medium enterprises (SMEs). This section reviews the current state of industrial emissions and the drivers and barriers to decarbonisation in different industrial subsectors (e.g., cement, chemicals, etc.). It presents various strategies and technologies that can help reduce the industrial carbon footprint. It also discusses the role of policies, regulations, incentives and stakeholders in facilitating and accelerating the transition to a low-carbon industry. It concludes by highlighting the challenges and opportunities for decarbonisation in the industrial sector and providing recommendations for action.

An Industry Background and Context

Decarbonisation refers to reducing carbon dioxide emissions and transitioning to a low-carbon economy (Assembly UNG, 2015). In regional industry, decarbonisation involves implementing strategies and technologies to minimise the environmental impact of industrial processes and operations by utilising renewable energy sources, improving energy efficiency, adopting carbon capture and storage technologies, and changing production processes. Regional industry decarbonisation, particularly through SME's, is crucial for mitigating climate change and meeting carbon emission reduction targets. Hence, we explore the challenges and opportunities associated with decarbonising the industrial sector while discussing potential solutions and best practices, particularly in relation to Small to Medium Enterprise (SMEs).

Industry is a Significant Emitter of Greenhouse Gases

Climate change is real and caused by human activities (Masson et al., 2021). This includes GHG emissions from industry. Achieving net zero targets will require transformative actions across entire economies, moving towards climate-resilient development. Decarbonisation is closely linked to the UN's SDG 13, which calls for urgent action to combat climate change and its impacts. Fonseca et al. (2020) demonstrate the strong link between industrial decarbonisation and the attainment of SDG 13. According to Krishnan et al. (2022), the vast majority of global GHG emissions are caused by seven energy use systems, which can all be classified as "industrial":

- **Power**. This involves electricity and heat generation. These activities contribute approximately 30% of CO_2 and 3% of nitrous oxide emissions;
- **Industry**. This involves a wide range of processes, including the production of steel, cement, and chemicals and the extraction and refining of fossil fuels. These activities

contribute about 30% of CO_2 emissions, 33% of methane emissions, and 2% of nitrous oxide emissions;

- **Mobility**. This encompasses all forms of transport (e.g., rail, road, maritime, aviation etc.). These activities contribute about 19% of CO_2 emissions and 2% of nitrous oxide emissions;
- **Buildings.** This includes using energy for diverse purposes such as heating, air conditioning, cement manufacturing and cooking, all contributing approximately 6% of CO_2 emissions;
- **Agriculture.** This includes energy use on farms and emissions from fishing and agricultural practices, contributing 1% of CO_2 emissions, 38% of methane emissions, and 79% of nitrous oxide emissions;
- **Forestry and other land use.** This primarily involves land cover changes, contributing 14% of CO_2, 38% of methane emissions, and 5% of nitrous oxide emissions; and
- **Waste.** This includes waste disposal, treatment and incineration and wastewater treatment and contributes 22% of methane emissions and 3% of nitrous oxide emissions.

All these factors are at play in the operation of regional Queensland's industry-based SMEs, as SME's often (through both individual and collective action) have an influence on the supply chains within which they operate. Importantly, regional Queensland's SME-based decarbonisation efforts contribute systemically to achieving other societal SDGs. This can improve air quality, reduce premature deaths and achieve multiple other outcomes. Indeed, achieving successful decarbonisation outcomes always involve a whole-of-system approach within our regions.

Motivation - Net Zero and Decarbonisation Initiatives Create New Business Opportunities

While many SME's may be inclined to think of the need for decarbonisation and net zero compliance mainly as a burden, it can also constitute a significant business opportunity when approached with the right mindset. Embracing sustainable practices will allow SMEs to create new value and differentiate in the marketplace through the development of 'low-carbon' products or services (Mais, 2024). Such products can, for example, be made by considering inputs (e.g., replacing standard steel components with "green steel" manufactured using green hydrogen), innovating in energy-intensive processes, developing product designs with circularity in mind and investing in carbon offsetting (Bocken et al., 2016). Thinking about product development in these terms couples both cost *and* carbon conversations and drives the internal capabilities of SME's (Bland et al., 2022). Green products can also command

premium prices (e.g., green steel), and early market introduction can secure market leadership; a big issue of importance in regions remaining competitive.

Industrial Decarbonisation Trends and Approaches

For SME decarbonisation to succeed in regions, a whole-systems perspective must be taken. Key dimensions that must be addressed and supported include technical, material, economic, societal, governance, institutional and leadership dimensions (Sinclair et al., 2021):

- **Technical and Material Dimensions.** While a technology pathway towards a decarbonised economy is visible, technology translation and adoption are not occurring fast enough. Accelerated innovation is needed to bring new green technologies into production in regions;
- **Economic and Societal Dimensions.** Societal support of decarbonisation, which involves significant human behaviour change, is required to achieve a net zero economy; and
- **Governance, Institutional Support and Leadership Dimensions.** Governance and action by all levels of government and society drives global trends around decarbonisation and can steer policy change, enable systems transformations, and orchestrate low-carbon initiatives.

In regional Queensland, industry decarbonisation needs to embrace the facilitation of SME-level decarbonisation efforts. SMEs represent the largest share of industry-based institutions in most countries globally (Bayraktar and Algan, 2019). In some countries, they account for more than half of overall industrial energy consumption. In Australia, 97.3% of all businesses have less than 20 employees, classifying them as small businesses (FEO, 2023). Queensland mirrors this trend, with 482,836 small businesses making up approximately 99.8% of all businesses (QGSO, 2023).

	Australia		**Queensland**	
	No. businesses	**% total**	**No. businesses**	**% total**
No. of Employees				
Small business (0-19 employees)	2,520,419	97.3%	482,836	97.1%
Medium business (20-199 employees)	64,559	2.5%	13,321	2.7%

Large business (200+ employees)	4,895	0.2%	845	0.2%

Table 1: Number of Australian and Queensland businesses measured by employment size June 2023.

These numbers reflect the importance of SMEs in the Queensland economy. While detailed emissions data by business size is limited, the sheer number and economic significance of SMEs (especially in a decentralised state like Queensland) suggest they are collectively important contributors to energy consumption and, by extension, carbon emissions. This positions them as a critical focus for decarbonisation efforts, particularly through energy efficiency, electrification, and low-carbon practices. They also demonstrate a big potential for driving sustainability and resource efficiency within regions and are essential for regional community building, economic growth, job creation and innovation in the regions, making them an important part of the overall decarbonisation journey.

Because of their small size and lack of dedicated support, SMEs in the regions face significant challenges in transitioning to a net zero economy. The dynamics are intricate and successful decarbonisation will depend on the interplay between an SME's technological capability (e.g., its ability to measure its carbon emissions on an ongoing basis and its ability to create low-carbon processes), its absorptive capacity, its leadership maturity and its connectivity to (global) value chains.

Decarbonisation Frameworks for SMEs

Because SMEs have limited financial and people resources, new investments and initiatives must be carefully planned and evaluated to work within regions. In this context, strategic frameworks are invaluable, as they help businesses clarify priorities, allocate resources effectively, and identify where they can create the most value (Porter, 2018). They help businesses make informed decisions, manage risk and understand competitive advantage. As such, a range of potential decarbonisation frameworks could be targeted for use among SMEs and are also suitable for larger regional enterprises. These frameworks provide structured approaches that businesses can adopt to reduce their carbon footprints effectively. They could include:

- **The GHG Mitigation Hierarchy.** This analytical hierarchy, developed by the Institute of Environmental Management and Assessment (IEMA) is an internationally accepted framework for reducing carbon emissions across organisations of all sizes. It emphasises addressing emissions at their source and prioritises meaningful emissions reductions before considering offsets (IEMA, 2020). For SMEs, the hierarchy offers a

practical and structured approach to decarbonisation, helping to focus limited resources on high-impact actions;

- **SME-Specific Decarbonisation Frameworks.** While the carbon reduction hierarchy provides a useful foundation, SMEs often face additional factors that can limit their ability to implement it effectively. Constrained balance sheets, limited technical capacity to measure carbon emissions, and limited time and staff resources can hinder progress. It is therefore essential that the strategic value of decarbonisation is clearly established from the outset, and the business is aligned with this goal (Van Burg, 2012). A range of organisations have developed playbooks for SMEs to use on their decarbonisation journeys;
- **Digitalisation as an Enabler of Decarbonisation.** Digitalisation is a key technology that can be used to drive rapid decarbonisation. Scaled across industries, it can deliver on major reduction targets in the energy, materials and transport industries (George et al., 2022);
- **Sensing and Control Technologies.** Technologies like the Internet of Things (IoT), automation, robotics, drones and imaging tools are increasingly used to help reduce carbon emissions. These tools provide businesses with visibility into processes in both industrial systems and the natural world and can be used to understand and monitor the behaviour of such systems and enable timely response to change. The use cases that can drive SME decarbonisation include energy efficiency, predictive maintenance, supply chain optimisation, resource management, data-driven decisions and smart grids. In addition to the IoT, automation and control technologies have a substantial role in supporting SME decarbonisation;
- **Decision Making, Analysis and Reporting Technologies.** Artificial Intelligence (AI), Machine Learning, and Digital Twins are decision-making technologies that can assist SME's. All use real-time and historical data to represent the past and present and simulate predicted futures. These can build on data collected by IoT systems and make it actionable. As such, the use cases that can be addressed are like those provided for IoT (Do Amaral et al., 2023); and
- **Enabling Technologies.** In an integrated context, several other digital technologies can support the above, including cloud computing (Acha et al. 2022), 5G telecommunications networks (Lade, 2022), blockchain technologies (Bin et al., 2022), and augmented and virtual reality tools (Bishop, 2022).

Recommended Action Moving Forward

Effectively decarbonising regions requires addressing the challenges of reducing industrial carbon footprints, along with deploying the right strategies and technologies to support this

transition. In regional economies like Queensland's, which are dominated by SMEs, barriers to decarbonisation stem from their limited size, constrained resources, and a lack of supported strategic planning. Various decarbonisation frameworks are available to help regional SMEs initiate this process. A comprehensive support approach encompassing technical, economic, societal, and governance aspects is vital for achieving successful decarbonisation outcomes. Such an approach would sensibly see place-based partnerships developed between governments, regional universities, and industry.

Decarbonising at the Neighbourhood and Household Scale – Mohan Jacob and Bouchra Senadji

Working on decarbonisation efforts at the neighbourhood and household scale in our regions means considering energy innovation, waste related factors, and home to work transport in an integrated way. This section explores opportunities, challenges, and potential solutions in all three areas.

Unlocking Household Decarbonisation Opportunities Through Energy Innovation

Neighbourhood and household energy consumption within the world's regions stands as a significant contributor to carbon emissions, necessitating innovative approaches to mitigate environmental impact while fostering sustainability and resilience. By harnessing renewable energy sources and optimising energy usage, regional households can play a crucial role in advancing decarbonisation agendas. From embracing solar power and battery technologies to implementing smart infrastructure and fostering community resilience, numerous opportunities abound for households to reduce their carbon footprint and transition towards a greener future.

Key opportunities in progressing these agenda within Queensland regions include:

- **Solar PV Systems and Batteries in Residential Complexes**. Exploring the integration of solar photovoltaic (PV) systems with battery storage in residential complexes and holiday resorts can make use of rooftop space and promote local energy consumption. Developing methodologies to assess the health and performance of solar PV systems maximises energy output and longevity;
- **Community Batteries and Local Energy Networks**. Analysing the techno-economic feasibility of community batteries within local energy networks offers a promising avenue for decentralised energy storage and distribution. Stakeholder engagement strategies are key in facilitating the adoption of community batteries and fostering community involvement in initiatives; and
- **Sustainable Building Energy Efficiency and Design.** Sustainable building energy efficiency and design, alongside thermal batteries, presents opportunities for decarbonisation at the neighbourhood and household scale. Central to this is the implementation of sustainable natural ventilation and thermal storage systems driven by solar radiation to regulate indoor thermal comfort and reduce reliance on mechanical cooling systems. This minimises energy consumption from conventional

sources. Additionally, the optimisation of solar absorption systems is being worked on, alongside the adoption of energy-efficient facade designs and the use of sustainable building materials, which minimise heat gain and optimise daylighting, reducing energy consumption for heating and lighting. Similarly, unique opportunities for sustainable energy management can be explored with thermal batteries, particularly in tropical regions, where excess heat can be stored for cooling and where continuous electricity generation is supported.

The challenges in doing this within our regions in Queensland, include:

- **Technological Infrastructure.** Implementing renewable energy systems at the household level requires suitable infrastructure for installation and maintenance, which may not be readily available in all regional areas. Integration of decentralised energy solutions into existing grid infrastructure poses technical challenges related to compatibility and reliability. Additionally, retrofitting existing structures to meet modern energy efficiency and sustainability standards presents another aspect to consider in the implementation of renewable energy systems; and
- **Behavioural Change.** Encouraging households to adopt renewable energy technologies and energy-efficient practices may require long-term and stable education and outreach initiatives to promote behaviour change and engagement. Overcoming inertia and scepticism towards new technologies and alternative energy sources presents a challenge in decarbonising household energy systems.

The expected outcomes from doing things differently in our regions means achieving:

- **Environmental Sustainability.** By transitioning towards renewable energy sources, households can significantly reduce their carbon footprint and help mitigate climate change. Decreased reliance on fossil fuels leads to lower GHG emissions and improved air quality;
- **Energy Security and Resilience.** Diversifying energy sources and promoting decentralised energy generation enhances household energy security and resilience. Renewable energy technologies, coupled with energy storage solutions, provide backup power during grid outages and natural disasters, ensuring continuity of essential services and enhancing community resilience; and
- **Economic Benefits.** Investing in renewable energy technologies and energy efficiency measures not only reduces household energy costs but also stimulates economic growth through job creation and local investment in clean energy infrastructure. The shift creates new opportunities for innovation and entrepreneurship, driving economic development and prosperity.

Recommended actions to drive this agenda forward include:

- **Developing Suitable Infrastructures for Renewable Energy Adoption.** This includes investing in infrastructure development, offering incentives for adoption and upgrading grids to support renewable energy integration. It also includes fostering collaboration between government, utilities, and communities to devise policies and programs for renewable energy and efficiency;
- **Research and Innovation.** This will involve continuing research to develop affordable and renewable energy technologies tailored for households. It also means supporting research institutions and industry partnerships to hasten innovative energy solutions; and
- **Collaborating and Partnering.** This involves forging collaborations between government, utilities, research institutions and communities to tackle regulatory barriers and to streamline permitting processes for renewable energy projects. It also means engaging communities through workshops and education programs to increase awareness about renewable energy benefits.

Unlocking Decarbonisation Opportunities Through Household Waste Utilisation

To support a more circular economy in Queensland's regions, it is important to consider that household waste accounts for approximately 18% of total waste in Australia, around 540 kg per person annually, much of it organic. With proper planning, this waste can be reduced and repurposed into valuable byproducts. Harnessing household waste for energy generation and resource recovery holds immense potential to enhance sustainability, tackle environmental issues, and bolster community resilience. However, overcoming technological, behavioural and regulatory hurdles is crucial to fully unlock the benefits of household waste utilisation initiatives.

Households and communities in Queensland's regions hold untapped potential to support decarbonisation by better managing waste. Using household waste for renewable energy generation, water conservation and wastewater treatment can deliver significant environmental benefits. With innovative waste management practices, communities can play a pivotal role in advancing the decarbonisation agenda. Small-scale waste processing units, like anaerobic digestion or pyrolysis systems, enable renewable energy generation at the grassroots level. Organic waste, such as food scraps, can be converted into biogas and methane through anaerobic digestion and composting. These units offer critical power sources during natural disasters, producing gas for electricity generation. Pyrolysis oil extracted from these systems diversifies the renewable energy portfolio. Additionally, compost used as

fertilizer reduces reliance on chemical fertilizers, promoting sustainable agriculture. Repurposing solid residues minimises waste and supports circular economy principles.

Despite advancements in waste management, water conservation opportunities (such as greywater recycling for irrigation) remain underused. Well-designed water reuse and recycling systems can reduce reliance on freshwater and cut energy use and emissions linked to conventional water supply.

Globally, building construction and ongoing operations account for 39% of total carbon emissions, with 28% coming from energy use during a building's operation and 11% from embodied emissions linked to materials and construction processes across the building's lifecycle. This makes the built environment a key priority for decarbonisation (AECOM, 2024). Design and material selection opportunities exist to reduce the carbon footprint and provide longer lasting, safer buildings that are resilient to severe weather. Furthermore, repurposing buildings can reduce the energy and carbon associated with demolishing a structure and constructing a new one.

Key challenges in achieving this in our regions include:

- **Technological Infrastructure**. Implementing waste-to-energy and resource recovery systems requires suitable infrastructure for collection, segregation and processing, which may not be readily available in all regional areas;
- **Behavioural Change**. Encouraging households to adopt waste segregation practices and to participate in waste repurposing programs may require education and outreach initiatives to promote behaviour change and to foster community engagement; and
- **Regulatory Frameworks.** Regulatory barriers and permitting processes may hinder the implementation of waste-to-energy projects, requiring coordination with local authorities and compliance with environmental regulations.

Expected outcomes that could emerge from adopting this approach regionally could include:

- **Environmental Sustainability**. By diverting organic waste from landfills and reducing methane emissions, household waste use can contribute to climate change mitigation;
- **Resource Efficiency**. Recovering resources from household waste can reduce the demand for virgin materials, conserve natural resources, and promote circular economy principles; and
- **Community Resilience**. Using household waste for energy and resource recovery can enhance community resilience to disasters, providing alternative energy and promoting self-sufficiency.

Recommended actions for moving this agenda forward in our regions include:

- Developing suitable infrastructures for energy and resource development;
- Undertaking research and innovation to develop cost-effective and sustainable technologies;
- Collaborating and partnering with utility providers, government agencies, research institutions, and communities to address waste, water, and energy challenges; and
- Providing education and outreach activities to raise awareness about the importance of sustainable waste management and water conservation among residents and businesses.

Work From Home and Local Transport

In Queensland's regional urban areas, strategies to reduce transport-related energy demand focus on two key approaches: (i) avoiding unnecessary travel by supporting work-from-home options, and (ii) shifting to electric vehicles.

Reducing Unnecessary Traffic

The demand for flexible, work-from-home arrangements is a key societal trend that is likely to influence driving patterns. In Australia, where distances between people and places are vast, the reliance on car travel for daily work significantly contributes to carbon emissions. Enhanced telecommunications serve as a vital lever in altering this pattern by reshaping how we live and work, which leads to the reducing of physical travel, and creating opportunities beyond city limits. Challenges in achieving reductions in unnecessary traffic include:

- **Accessibility and Equity.** Disparities in internet quality and technology access across regions and socio-economic groups can limit the adoption of remote work. To address this, policies should be implemented to provide affordable access to high-speed internet and necessary telecommunication devices. This would improve digital equity, bridge the digital divide, and enhance economic and educational opportunities.
- **Social Isolation and Decreased Community Engagement**. There is a need for virtual and in-person social activities to support mental health outcomes and strengthen community bonds. This requires actions to support community and employer initiatives for virtual and in-person social activities. This can help to increase social cohesion and reduce social isolation.
- **Environmental Impact of Infrastructure Expansion.** The expansion of telecommunication infrastructure can lead to increased energy consumption and landscape disruption. Adopting sustainable development practices and minimising physical disruptions is critical to managing these impacts. Actions needed to resolve

this include allocating funding for R&D in secure, reliable, and efficient telecommunication technologies.

- **Enhanced Network Reliability and Security.** Supporting modern digital demands and safeguarding against disruptions is important. 5G technology enhances mobile network speed, latency, and device connectivity, crucial for efficient remote work through improved video conferencing and collaboration. Future 6G advancements aim to further boost internet reliability and integrate satellite networks for widespread coverage, facilitating more interactive remote work via enhanced virtual environments. Satellite internet from low Earth orbit satellites will provide high-speed access to remote areas, supporting the digital economy, education and healthcare. Additionally, AI and machine learning will improve telecom network efficiency, reliability and security, promoting a sustainable future for remote and regional work, community connectivity and environmental conservation.

The Adoption of Battery Electric Vehicles

In relation to the adoption of battery electric vehicles (BEVs) in our regions, reducing battery waste is crucial to achieving circular economy goals. Improving access to charging and community storage could also enhance social acceptance of energy technologies and further energy justice goals. Opportunities for doing within our regions include:

- **Community Resilience.** Battery storage, at community level, can play a crucial role in facilitating community resilience to climate change by safeguarding access to energy and replacing diesel generators during power outages. Vehicle-to-home technology has the potential to discharge energy and power home consumption. Vehicle-to-grid technology allows people to feed electricity back to the grid when energy is needed;
- **Second-Life Use.** When lithium-ion batteries no longer meet the requirements for automotive use, they may have a second life for stationary storage systems. Due to the high standards for battery performance, security and robustness in automotive applications, the available storage capacities for second-life use in a stationary system is good (Razif et al., 2024); and
- **Energy Justice.** When solar and battery storage is used at the community scale, there may be potential to further energy justice goals, and ensure renters and residents in apartments and multi-unit dwellings can access renewable energy. Currently, barriers to adoption exist since the approval of the body corporate is needed to install rooftop solar panels, batteries and chargers in areas that are considered common property (ECA, 2025).

Key challenges in getting the best outcomes in our regions include:

- **Environmental and Cost Concerns.** Electric vehicle batteries degrade over time and lose capacity after several years of use. Batteries may need to be prematurely replaced if they have minor faults to comply with the terms of the manufacturer's warranty. Strategies to recover and recycle end-of-life batteries and develop second-hand markets, are therefore important to improve customer value, enhance local economies, and reduce environmental harm; and
- **Energy Justice.** Renewable energy technologies have been described as a technology of the middle class and energy justice issues have been raised in relation to low-carbon transitions (Sovacool et al., 2019). Australia is a laggard in terms of supporting the diffusion of electric vehicles and it lacks supportive government policies. As a result, the demonstration of benefits beyond the middle-class is crucial to the social acceptance of electric vehicles, particularly in socio-economically disadvantaged parts of our regions.

Workforce Development for Decarbonising Regions – Hurriyet Babacan, Taha Chaiechi, John Rolfe and Josephine Pryce

Currently, the world is facing major challenges impacted by geopolitical tensions, high global interest rates (including inflation and financial stress), trade fragmentation, and climate change (World Economic Forum, 2024). The global economy is further buffeted by rapid change and transition across a range of areas, including efforts to deal with the impacts of weather extremes, the associated lowering of carbon emissions and the building of resilience and confidence in businesses and communities (Krishnan et al., 2022; World Economic Forum, 2021). Regional and rural economies in Australia have distinct characteristics and diverse strengths and needs. Over the past three decades, these regional economies have undergone significant structural change and adjustments at different magnitudes, speeds and intensities (Chaiechi, 2014a). In parallel, the configuration and maturity of regional financial markets have played a critical role in shaping the success of these transitions and the resilience of employment systems, underscoring the need for robust capital pathways to support decarbonisation (Chaiechi, 2014b). Several factors have driven these major structural shifts, including increasing and rapid exposure to global markets, poor terms of trade and fluctuations in financial markets, technological change, environmental concerns and changing consumer demands (Babacan, 2022a; Babacan 2022b; Babacan et al., 2019; Chaiechi, 2021a).

The adaptive capacity of the workforce in regional/rural areas is also strongly constrained, including: critical challenges of an ageing workforce; mismatch between employer needs and skills; lack of agility in education systems to respond to changing industry needs; barriers to accessing pathways to training education; outmigration of young people for education; and a lower proportion of completion of higher skill qualifications (Rolfe et al., 2020; Babacan et al., 2019). The Senate Select Committee on Jobs for the Future of Regional Areas (2019) noted that “people living in the regions will require an increasing level of technical skills and professional knowledge to take advantage of the jobs that may be available in the regions. As part of this, workers will be expected to be more technologically adept as digital technologies and automation become increasingly integrated into working environments” (Commonwealth of Australia, 2019, p. 23). Digital and technological challenges, however, impinge on the ability of many regions to participate effectively in the digital economy (Babacan et al., 2021).

Climate change and the need to work towards a net zero economy is acknowledged by many industries, governments and businesses (Deloitte, 2024; Krishnan et al., 2022). The Decarbonising Queensland report acknowledges that Queensland’s regions will play a major

role in the transition to decarbonisation and that this change process will involve addressing the challenges and opportunities for the respective industry workforces (Yarnold et al., 2022). For regional Queensland, there is an urgency to address economic and social issues facing the regions to reap the benefits of a decarbonised economy (Cass et al., 2022). Among these urgent issues is addressing regional workforce development and planning for traditional, new, and emerging economies.

Key Regional Workforce Opportunities and Challenges

Decarbonisation and workforce issues are intertwined with a commitment to combat climate change while ensuring economic stability and job creation. Under the Miles Labor Government, Queensland's Clean Energy Workforce Roadmap was touted as allowing for development of a highly skilled workforce while addressing future human capital needs in the transition to net zero (Queensland Government, 2023a). Various reports acknowledge that the transition will create new jobs, have no direct impact on the employment of some workers and cause disruption for other workers through displacement (Cass et al., 2022; Deloitte, 2024). Alongside jobs created and jobs displaced, discussions focus on direct, indirect, induced and evolving employment in relation to the impact of decarbonisation (McCoy et al., 2023). The consequent workforce-related issues around the impacts of decarbonisation on regional areas, economies and communities can be summarised into several areas, including:

- Changes in employment in construction and operation stages and flow through effects;
- Impacts on the cost of energy, including the extent of transformation costs; and
- Approval challenges and impacts of new solar, wind and transmission projects, including community and landholder acceptance of new projects, expenditure in regional economies, impacts on workforce housing and impacts on labour availability and other inputs.

The sectors most likely to be affected by changes in employment are:

- Electricity and gas as workers, with a high exposure to direct impacts;
- The mining sector, primarily due to higher emissions and future policy settings rather than lower demand for coal and gas. Energy versus minerals sector impacts will differ; and
- The manufacturing, agriculture and transport sectors potentially have high emissions, so will be affected by higher energy prices and regulatory mechanisms.

Many of these sectors have high specialisation ratios in regional areas of Queensland, which implies that they are sectors at risk during energy transformations.

Potential Gains in Employment

There are several avenues for increasing employment in regions through decarbonisation projects:

- Construction of new green energy sources (e.g. wind farms, solar farms, roof-top solar);
- The operation of new green energy sources and new manufacturing;
- The expansion of ecosystem services markets; and
- The construction of new manufacturing and more value-rich supply chains.

There is a much wider scope to locate green energy projects geographically compared to fossil fuel sources, so the location of new employment may not directly match existing regional employment patterns. However, there are logistical advantages from situating new generational capacity close to existing infrastructure, and in regions with high energy demands. A starting point is to look at the current structure of regional employment and identifying sectors most at risk of change.

A Case Study: Townsville's Strategic Transformation Toward a Net Zero Economy

The following case study highlights some of the issues and pathways that a major regional town in Queensland is navigating on its journey towards a net zero economy.

Introduction: Townsville, a key player in Queensland's quest for a net zero economy by 2050, is undergoing a profound transformation across its employment and industrial sectors. It is rapidly positioning itself as a leader in the renewable energy sector, particularly in hydrogen production, backed by substantial government investments and collaborative educational initiatives.

Strategic Initiatives and Industry Transformation: The establishment of the Lansdown Eco-Industrial Precinct exemplifies some of Townsville's strategic initiatives, with projections to create approximately 800 construction jobs and 1,700 operational jobs, significantly supporting the region's transition to a green economy (Queensland Government, 2023c).

Employment Trends and Workforce Development: Over the recent five-year period, Townsville's total employment grew by 7,440 jobs, driven by expansions in sectors directly aligned with the city's net-zero goals. The health care and social assistance sector expanded by 2,849 jobs, reflecting a broader trend toward service-oriented roles that contribute to community well-being; a key aspect of sustainable cities. The professional,

scientific and technical services sector increased by 1,419 jobs, highlighting a shift toward knowledge-based, technical roles essential for supporting sustainable technologies and practices (Economy ID Townsville City, nd).

Skill Composition and Development: The Queensland Government's $2 billion Renewable Energy and Hydrogen Jobs Fund is critical in this transformation, enhancing skills to meet the demands of emerging energy technologies. Adding to this, the Albanese Government's commitment of up to $70 million to develop the Townsville Region Hydrogen Hub underscores the national importance of this initiative. This investment is part of a broader strategy that sees Townsville contributing to Australia's stature as a renewable energy powerhouse, leveraging its strategic advantages including a skilled workforce, port facilities, and access to abundant solar resources. In alignment with these developments, Edify and its partners, including Siemens Energy, Queensland TAFE, JCU, and Townsville Enterprise Limited, are proactively working to ensure that the local workforce is adequately prepared (Commonwealth of Australia, 2024). They are focused on providing targeted education and training programs to develop and sustain skills for the burgeoning hydrogen industry.

Innovation and Creative Industries: Townsville is emerging as a hub for advanced manufacturing related to renewable energy. Initiatives such as photovoltaic manufacturing by RTE Energy and the planned green hydrogen production facility by Origin Energy Future Fuels are expected to make substantial economic contributions (City of Townsville, 2024). RTE Energy's project alone is projected to add $1.2 billion to Townsville's gross regional product, underscoring the economic impact of innovative industries in the region (City of Townsville, 2021).

Capacity Building and Education: To facilitate Townsville's transition towards a net zero economy, there is a strong focus on workforce upskilling. In 2022, Queensland launched the Renewable Energy Training Facility and Hydrogen Centre of Excellence, with plans for a new facility in Townsville by 2023. Additionally, over $50 million has been invested in clean energy training infrastructure across Queensland, including in Townsville, to equip students for the hydrogen industry (Queensland Government, 2023a). These initiatives are essential as Townsville gears its workforce for future low-emission challenges. Despite progress, Townsville contends with significant challenges, including a scarcity of local training providers capable of offering advanced skills training for modern industries (Townsville Workforce Development Plan, 2020). To support Townsville's transition to a net zero

economy, strategic efforts are focused on enhancing the manufacturing sector. This involves improving high-level skills, adaptability, and capabilities within the workforce. Addressing gaps in vocational training funding is crucial to prepare for the demands of advanced manufacturing and engineering sectors.

Economic Contributions and Net Zero Transformation Impacts: Projects like the Lansdown Eco-Industrial Precinct and the expansion of the North Queensland Hydrogen Consortium are set to drastically enhance employment and economic output. Emphasising sustainable, high-value jobs, these projects are transforming Townsville into a cornerstone of Australia's renewable energy production and export activities, directly contributing to the city's and Australia's broader environmental targets (City of Townsville, 2021).

Conclusion: Townsville's strategic initiatives have advanced its transformation into a leader in renewable energy, aligning with Australia's net zero goals. The successful integration of government support, industry innovation, and educational programs is setting a model for sustainable development, demonstrating how targeted efforts can effectively drive economic growth and environmental sustainability toward the 2050 net zero target.

Factors Critical to Regional Workforce Development

A number of factors are critical to workforce development for a decarbonising economy in regional Queensland. These include:

- **Investment in Infrastructure for New Industries Such as Renewable Energy.** This transition requires significant investment in place-based infrastructure which can create new job opportunities in construction, engineering, maintenance and so on. There is a need for coordinated infrastructure planning together with investment strategies;
- **Consideration of Impacts on Traditional Industries**. Queensland's regional economies have traditionally relied on mining and agriculture, with some regions heavily dependent on fossil fuel industries (Babacan & Dale, 2019). There is a need for support programs for workers being displaced from existing industries and pathways for entry into new jobs. While much focus has been placed on the clean energy and renewables workforce, there is a need to extend that to industries such as mining, agriculture, tourism, health and construction;

- **Just Transition**. Decarbonisation will involve a variable pace and distribution of change in industries across different regional areas (Rattle et al., 2024). The location of industry and the pace of change may show great variability. New employment may not match existing regional employment patterns. Just transition policies may be needed to mitigate adverse effects on the workforces, incomes and livelihoods in the regions. Research indicates that a transition to net zero will be neither sustainable nor credible if it creates or worsens social inequalities (Abram et al., 2022). Exploring how the workforce opportunities can be shared across regions is needed to ensure the workforce participation of First Nations people, women, people with disabilities and people from culturally and linguistically diverse backgrounds. Cultural norms and behavioural attitudes, such as collectivism and perceived control, can shape how people engage with sustainability transitions, including workforce participation (Zahra et al., 2022);
- **Investment in Education and Skills Development**. Decarbonisation requires workforce with skills in the new jobs (Krishnan et al., 2022). While some skills are transferrable, there is also need for re-training and re-skilling programs in new and emerging industries. Partnerships between government, educational providers and industry are required to develop training programs tailored to the needs of the green economy;
- **Revitalising the Education and Training System**. Decarbonisation offers an opportunity to bring about major reforms in the education and training sectors. There is a need to look at the qualifications framework, pathways between higher and vocational education, and the capacities of the education and training sector to accommodate increased demand. Traditional approaches to sustainability often overlook the structural economic shifts and evolving skill demands that underpin resilient regional economies (Chaiechi, 2022);
- **Industry Specific Workforce Planning**. Clarity is needed regarding which jobs and occupations are emerging at specific industry and sub-industry levels, and in which locations. The net zero economy is emerging with variable clarity on these issues. There is an urgent need to develop workforce plans that are specific to regions and industries, identify transferable skills, highlight new skills and qualifications in demand, and consider the implications of international migration on skill needs;
- **Granular Regional Evidence Base**. While macroeconomic national models offer broad insights, they often overlook the localised dynamics essential for regional planning. Measuring resilience requires disaggregated, data-driven tools that expose underlying economic vulnerabilities (not just surface recovery signals) as

demonstrated in the economic shock analysis of tropical cities (Chaiechi, 2021b; Chaiechi and Nguyen, 2021). There is a need for investment in research and development to produce rich data which is regional and industry specific relating to areas such as regional workforce and occupation projections, skills gaps, employment and job displacement and creation, net employment effects and efficiency/productivity outcomes. Evidence needs to be integrated with other impacts such as accelerating technological innovations and shifting economies and demographics; and

- **Appropriate Policy Development**. Policy uncertainty can create challenges for decarbonisation efforts, investment attraction and workforce development. Notably "places can grow when policy-making is attuned to spatial particularities" (Pugalis & Gray, 2016, p. 181). The challenge for policy makers is how to ensure that workforce needs are identified at the local level and workforce policy innovations can meet the needs of rural Queensland industries and communities. There is a need to develop regional transition strategies and to avoid ad hoc policy interventions which create "engagement fatigue" within regional communities and industries (Yarnold et al., 2022). Long-term and bipartisan policy frameworks are essential for driving workforce development for a low-carbon economy.

Recommended Action Moving Forward

Vibrant and prosperous regional economies rely on industries that can meet their workforce needs. Queensland's regions have their own unique population, economic and workforce characteristics and challenges. Having a well-trained and skilled workforce that allows for adaptive capacity and resilience building in the long-term is critical to the future of Queensland's regions. Queensland's regional universities are well placed to work with governments, industries, regional communities and other sectors (e.g., the vocational and schooling sectors) to build the workforce ecosystem required. The geographic footprint of Queensland's regional universities means that their role in building adaptive workforces should be extensive. Acting as hubs for innovation and research, they can serve as change agents and provide crucial leadership in pioneering the path toward building evidence-based policies and workforce development for a decarbonising economy in regional Queensland.

Maintaining Regional Resilience in the Race to Decarbonising Queensland's Regions – David Phelps

Key Opportunities and Challenges for Regional Resilience

Resilience is the "capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (IPCC, 2014, p. 5). This includes community ambitions to adapt and transform, progressing towards socially desired goals and values (Maru et al., 2014). In lay terms, resilience is 'becoming stronger, better and readier'. Underpinned by social (including cultural), environmental (including built), and economic pillars, resilience includes "the extent to which our regional communities have the capacity, skills and knowledge to prepare, respond and adapt in the face of rapid change" and leads to improved livelihoods and socioeconomic systems (Queensland Government, 2017, p. 4).

Queensland is a highly dispersed state, where each region contributes in unique ways to socio-economic success. Service industries, mining, agriculture and tourism are Queensland's major economic contributors. Its regions underpin economic growth in each of these sectors and maintain critical road and associated infrastructure, providing support for intra and inter-regional long haul road freight and passenger transport. Freight includes agricultural produce and pre-processed foods from regions to capital cities and back again, and all general road freight between capital cities is transported through multiple regions. In some regions, rail infrastructure is crucial for the transport to shipping ports at the start of global manufacturing supply chains.

The role that the regions play in the nation's food security, freight logistics, and as the starting point of global manufacturing supply chains, makes policy for regional decarbonisation of strategic national interest. For example, efficiently transporting fresh Northern Territory mangoes from Katherine to Brisbane markets requires: (i) long-haul freight driver rest and sleep requirements to be met; (ii) their health needs to be met (e.g. through access to nutritious foods, medical clinics, allied health services, pharmacies, and hospitals); (iii) roads to be safely traversable 365 days a year; and (iv) emergency services to be available in the event of accidents. Support from service towns such as Cloncurry, Longreach and Roma makes the delivery of these mangoes possible.

Whilst there is relevant research into livestock transport infrastructure (Higgins et al., 2018), there is a lack of systems-based research to help policy makers understand the interconnections between regional service town size and viability, local government

sustainability, regional resilience and national food security and export market access. At the same time, there is a lack of research that integrates opportunities for new energy sources, such as solar and wind powered EV charging or hydrogen powered long-haul freight throughout the transport, infrastructure and local service town sectors. Equally, there is a lack of whole-of-system research into emissions reduction for rural, regional and remote Australia that also meets community aspirations and improves resilience (Dumbrell et al., 2024). There are examples of carbon markets leading to unintended social, economic and environmental impacts which reduce community and regional resilience (Jassim et al., 2022; Keenan et al., 2019; van Oosterzee, 2012). Such perverse outcomes risk weakening communities which would undermine support for long-haul transport, food production and other essential services.

Systems research into regional resilience is essential to inform effective decarbonisation policies that build capacity and adaptability across Queensland's regions. It will be essential to identify the factors that underpin rural and regional service town viability in a rapidly decarbonising world to underpin effective policy for the future. A key challenge is a lack of institutional research capacity across Queensland's rural and remote regions. To properly understand interactions within such complex socioeconomic systems, it is crucial to combine local knowledge and observations with external skills and expertise, coupled with a longer-term goal to enhance local resilience (Queensland Government, 2017).

New Approaches to Achieving Resilient Change

Research, planning, and policy require a systems approach that fully considers the interactions between local community, regional, state and national socioeconomic systems. All are exposed to a changing climate including risks from extreme weather which can interrupt transport and logistics, and longer-term risks such as declining service provision through depopulation and skilled labour shortages. It is no longer adequate to plan or set policy agendas in isolation from place-based socioeconomic factors. For example, the 2019 Monsoon trough and associated flooding in north-west Queensland cost more than $5.6 billion through infrastructure and environmental damage, lost business income and economic disruption (NEMA, 2019). Both the rail and road systems which link Mt Isa and Townsville were impassible for several weeks. At the local level, fuel supplies were cut off to Richmond and Julia Creek creating difficulties for refuelling helicopters for livestock and human rescue operations. At the global level, the supply chain of critical minerals was interrupted as ore could not be transported from the resource rich north-west minerals province to the Port of Townsville. State Emergency Services volunteers from the small community of Julia Creek were mobilised to attend a rail freight spill, with many members also volunteers in other emergency services or full-time employees of local government. Their attendance at one incident risks capacity to attend other events. Although this didn't happen, extreme weather

events could put lives at risk in small communities where emergency teams share the same volunteers.

The immediate recovery and medium-term resilience building that was implemented following the 2019 Monsoon trough, can be treated as a blueprint for planning, research, and policy. Top-down resources, skills and expertise were married with bottom-up local knowledge, understanding and ambitions to develop a clear strategy. Unfortunately, as is too often the case, only the locally embedded people, businesses and communities have stayed the distance in implementing the plan for longer-term benefits, even though there are obvious strategic national benefits to protecting global supply chains of high-value mining product.

Building resilience in regional areas must go hand in hand with decarbonisation, guided by long-term thinking and a coordinated approach across businesses, towns, communities, and regions—while aligning with state and national priorities. It is important to recognise that what constitutes successful resilience can vary across different levels, from individuals and businesses to towns, states, and the nation. In some instances, these measures may even conflict. For example, adopting labour-saving technology might improve business productivity but might also contribute to town depopulation, reduced volunteer availability and weaken the resilience of emergency response groups.

Investment in understanding these complex systems is needed to genuinely build resilience.

Recommended Action Moving Forward

To help facilitate regional resilience in the face of change across Queensland's regions, it is recommended that more pilot studies be undertaken to develop an improved systems understanding across those regions seeking to decarbonise. Such studies should:

- Analyse the interconnectedness of minerals and livestock production, transport and global supply from the source to the user and local socioeconomic factors;
- Include key elements needed for town and community viability such as identifying strategic linkages within the global supply chain, population and volunteering demographics;
- Consider the opportunities and risks associated with the rapid transition from fossil fuels to EV and hydrogen fuels for the freight sector and local towns and communities;
- Consider the opportunities and risks associated with carbon and environmental markets; and
- Develop recommendations to build remote and rural capacity through research resourcing, including access to communities through regional Universities, bursaries for students, and research sprints in collaboration and codesign with communities.

Finance Brokerage and Closure for Regional Investment – Yvette Everingham, Ana Leite De Almeida and Allan Dale

Key Opportunities and Challenges for Finance in the Regions

Financing decarbonisation within Queensland's regions refers to public and private capital used to help entities reach their net zero or low carbon commitments. Investment into decarbonisation can occur through various channels, such as green bonds (or climate bonds), sustainability-linked loans (such as the one Cairns airport received recently, tied to nature and biodiversity outcomes), and/or investment into funds with net zero or decarbonisation targets. Finance for decarbonisation is not only about investing in actions, projects, or technologies that align with net zero commitments, but also includes divestment from those actions, projects, or companies whose activities do not align with those commitments. At the same time, it also involves engaging with investee companies to change practices and facilitate decarbonisation (known as corporate engagement and stewardship).

The growing investment opportunities on low-carbon transition are becoming more visible. Several public and private sector initiatives have been launched and are currently under development that seek to drive private capital towards a net zero economy. Some of those opportunities include:

- The Australian Government **Treasury's Green Bond Program** is expected to issue its first bonds in the middle of 2024. The Australian Government Green Bond Framework describes eligible green expenditures as those that align with one or more "Green Goals";
- The Australian Government's **Powering the Regions Fund** ($1.9 billion), of which $400 million is part of the Industrial Transformation Stream managed by the Australian Renewable Energy Agency (ARENA) (DCCEEW, 2022; ARENA, 2024). Recently, $330 million was granted to nine projects, including $93 million to upgrade the Queensland Alumina Ltd refinery in Gladstone, as part of an investment stream linked to meeting safeguard mechanisms (Bowen, 2024);
- Established under the *Net Zero Economy Act 2024*, the **Net Zero Authority** will coordinate investment in an orderly transition to net zero, with a focus on supporting affected communities, regions, industries, and workers.
- The UN-convened **Net Zero Asset Owner Alliance** consists of institutional investors committed to transitioning their investment portfolios to net zero by 2050;

- The **Zero Asset Manager's Initiative** has over 315 signatories and covers over USD $57 trillion in assets under management, which includes several Australian managers;
- The **Investors Group on Climate Change (IGCC)** is an Australian not-for-profit organisation that works with institutional investors on better understanding the impacts of climate change. In its most recent study of some 53 investors, the IGCC found that some 70% of respondents have made public commitments to be net zero by 2050; and
- **Individual Asset Owners** are also making public investment commitments, such as Australia's largest super fund, AustralianSuper, which has made a commitment to achieve net zero Scope 1 and 2 emissions by 2050 in its investment portfolio (IGCC, 2023).

Recommended Action Moving Forward

Queensland's regions arguably offer significant investment opportunities to support decarbonisation at all scales. However, more deliberate policy and program design is needed to ensure the right supports are in place to attract and secure this investment. In a related national policy context, Dale (2024) emphasises the importance of adopting a stronger investment pipeline approach when designing investment policy frameworks to resolve potential decarbonisation investment bottlenecks.

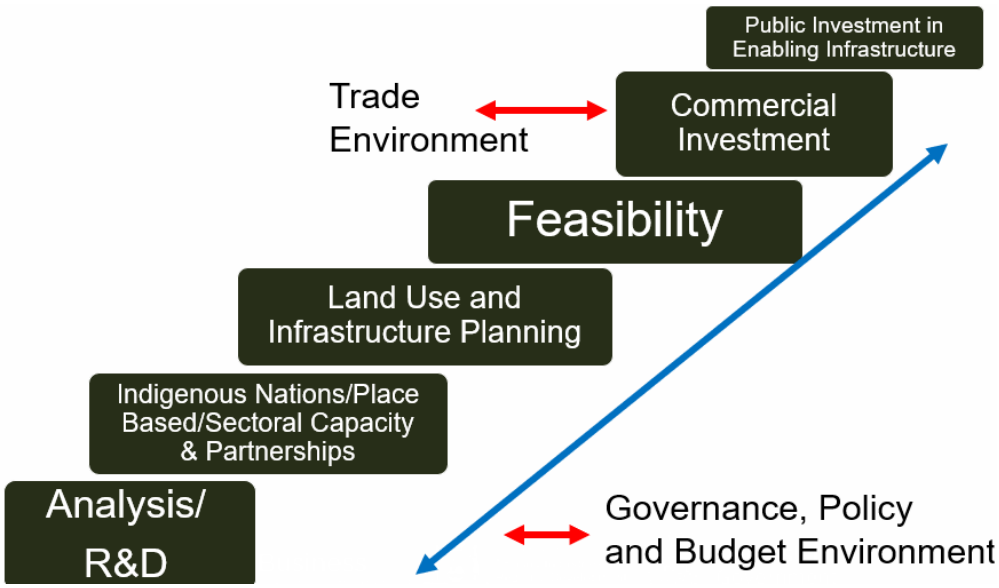

Figure 4: Building a support pipeline to facilitate investment in decarbonising regional Queensland (Dale, 2024).

From a methodological perspective, and in line with global and national development frameworks, attracting decarbonisation investment in regions should prioritise sustainability, inclusivity, and building community and regional resilience. Dale (2024) also highlights the

need for regional development and infrastructure investments to align with well-defined national and state investment principles. In this context, decarbonised development should support businesses of all sizes (large, medium, and small) ensuring that policies foster a diverse and resilient economic future. To achieve this, a well-designed support-based investment pipeline is essential for securing high quality investments that deliver economic, social and environmental benefits across various project proponents drawn from the not-for-profit, private and government sectors.

Dale (2024) argues that achieving genuinely sustainable development through decarbonised investment requires support across several key pipeline stages:

(i) research and development and extension (RD&E);
(ii) human and institutional capacity building;
(iii) strengthening First Nations institutions;
(iv) place-based partnership building;
(v) land use planning and infrastructure planning;
(vi) feasibility and development assessment;
(vii) finance brokerage and closure (from all sectors); and
(viii) public sector investment in major enabling infrastructure.

This pipeline approach to supporting the flow of investment relies on policy efforts focusing attention on the health of the wider trade environment in which the investment occurs, as well as the overall system of governance across regional Queensland. Policy frames to support decarbonisation efforts in regional Queensland need to be able to support all layers across this investment pipeline.

Queensland Regions and Decarbonisation in the Indo Pacific – Hurriyet Babacan and Brian Fairman

The future of regional Queensland is closely tied to the Indo-Pacific, making it essential to identify and pursue the key opportunities emerging in the region as the global economy decarbonises. Although definitions of the "Indo-Pacific" vary, this paper defines it as consisting of 36 diverse countries and over 60% of the world's population - making the region critical to global decarbonisation efforts (NSC, 2024). The Indo-Pacific region includes major economies such as Indonesia (Australia's close neighbour) which has long been projected to become one of the world's largest economies (PWC, 2017), with Goldman Sachs (2022) forecasting it will rank as the fourth largest by 2050. In 2019, the region was responsible for 49% of global carbon emissions, up from 25% in 1997 (International Energy Agency [IEA], 2023). The IEA also forecasts that nearly two-thirds of global energy use growth over the next two decades will come from this region.

While sustainability and low-carbon development have received attention across Indo-Pacific countries in the last decades, climate change is still expected to pose major risks to the region. Without effectively managed transitions to decarbonisation, destabilising social, economic and environmental conditions are real risks (ADB, 2021; UNESCAP, 2022). An important policy agenda has been to converge the interests of growth, climate change, trade, and social inclusion (Anbumozhi, 2023). Initiatives are underway to set low-carbon targets, reduce carbon intensity, and enhance environmental performance, all while ensuring that new growth patterns are inclusive.

The Australian Government funds, and is signatory to, numerous Indo-Pacific agreements via ASEAN, the Pacific Island Forum and bi-lateral agreements. Australia is also a part of a US-initiated Indo-Pacific Economic Framework for Prosperity, an agreement signed in 2022 along with Brunei Darussalam, Fiji, India, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand, and Viet Nam. Pillar 3 in the agreement is "Clean Economy" which aims to take action in line with the Paris Agreement and focuses on accelerating GHG emissions mitigation efforts, enhanced energy security, and climate resilience and adaptation, as well as sustainable livelihoods and quality jobs for our populations (DFAT, 2023).

Key Issues in Decarbonisation in the Indo-Pacific

There are a number of key issues in relation to decarbonisation in the Indo-Pacific of major relevance to regional Queensland. These, in summary, include:

- The Indo-Pacific region is one of the largest contributors to global carbon emissions due to its heavy reliance on fossil fuels for energy generation. Many, particularly ASEAN, nations face significant financial, bureaucratic and socio-economic challenges associated with replacing fossil fuels (Huda, 2023);
- There is increasing demand for critical minerals in the region, with decarbonised economies requiring the supply of scarce metals and minerals in regional Queensland, particularly lithium, nickel, cobalt, rare earth elements, copper and silicon (IRENA, 2023).
- There are high levels of national debt and resultant challenges in attracting investment and incentivising the private sector in decarbonised industries (Abdullah et al., 2023);
- Institutions and regulatory frameworks have major capacity gaps. Regulatory Indicators for Sustainable Energy (RISE) scores across the region have been developed by the World Bank in the area of energy transitions. While difficult to generalise across the Indo-Pacific countries, RISE scores indicate major gaps in institutional policy and regulatory frameworks, including legal frameworks; planning; regulatory support; financial incentives; network connection; risk management; and carbon pricing and monitoring (World Bank & ESMAP, 2022);
- Decarbonisation efforts will have significant implications for Indo-Pacific workforces. While transitions to net zero industries will create new job opportunities in sectors such as renewable energy, sustainable transport, AI and robotics, circular and green economies, there will also be job losses in traditional industries. The adaptive capacity of the workforce within and across Indo-Pacific nations will be challenged. There is potential for displacement of workers and major constraints for the skills transitions, retraining and reskilling programs required to ensure smooth transition (Deloitte, 2024; Babacan, 2022; Babacan et al., 2021);
- A just transition and inclusive growth will be required across the Indo-Pacific. Climate change impacts threaten numerous countries (ADB, 2023) with some Pacific Island countries experiencing up to four times greater sea-level rise than the global average (PISF, 2022). These impacts collectively increase insecurity in accessing clean water, land, food and energy while affecting key industries and infrastructure. There are already major challenges meeting the UN's SDGs across the Indo-Pacific, with unequal access to land, water, energy resource, health and education and participation in the labour market (UNESCAP, 2022). The potential consequences of the energy transition include impacts on food security, livelihoods, poverty, participation in education and training, and worsening health and mental health outcomes (Babacan, 2022a; Babacan 2020; Lau et al., 2021; UNESCAP, 2022). Decarbonising the

economy can also have unintended negative consequences, such as displacement of people from land to make space for green infrastructure or spaces (Barquet et al., 2021).

Implications for Regional Queensland: Towards the Future

In the decades ahead, the Indo-Pacific will face profound challenges to stability, resilience and development - from the planetary scale threat of climate change to intensifying geopolitical contests and disruptive economic transitions. As a close neighbour deeply connected to the region, Queensland will be greatly affected by any major change or instability. Decarbonisation commitments made by governments in the Indo-Pacific, responding to climate change, have crucial implications for Australia's and Queensland's interests. Regional Queensland has deep historical and current relationships in the Indo-Pacific. Addressing common challenges through collaboration and deeper regional integration is the only way forward.

Relationships in the region must be built on inclusive, mutually beneficial terms that acknowledge historical legacies, cultural contexts, and power imbalances, moving beyond transactional or post-colonial models of engagement. Relationships must be built on inclusive and mutually beneficial terms that acknowledge historical legacies, cultural and power differentials in the region and move away from transactional and post-colonial models of integration (Fairman et. al., 2022). Queensland has a well-established industry and innovation ecosystem that can be more actively leveraged to support regional engagement. In parallel, the presence of Indo-Pacific-focused trade commissioners provides a valuable channel for strengthening economic and diplomatic ties across the region.

Queensland is a multicultural state, with 22.7% of the population being born overseas (Queensland Government, 2023d), including an Indo-Pacific diaspora who bring language and cultural skills. The top languages spoken in Queensland at the time of the 2021 Census, other than English, include Mandarin, Vietnamese, and Hindi. Approximately 5% of Queensland's population identify as Aboriginal and Torres Strait Islander, with higher population densities in regional Queensland. Given historical relationships across the region (Queensland Government, 2023d), this presents diplomatic opportunities led by First Nations people. There is geographic proximity, trade and other relationships and easy international access to the Indo-Pacific. These are enabling factors that regional Queensland can take advantage of in a decarbonising economy.

Regional Queensland and Indo-Pacific countries can collaborate on several key aspects of decarbonisation, including:

- **Energy Transition.** Queensland is investing heavily in clean energy and is advantaged with land, sunshine and wind power generation. Queensland can lead the way in initiatives such as developing a dedicated clean energy diplomacy program, providing developing Indo-Pacific countries with support in transitioning to low carbon energy and working towards a multi-lateral framework for meeting regional clean energy needs. Over time, with the right policy and investment levers, Queensland can explore clean energy exports to the Indo-Pacific and support emission reductions in a range of Indo-Pacific industries. Queensland investment in green hydrogen and expertise in renewable energy can also be used to build capacity and technical skills in the region, especially for countries that are in the early stages of transition.
- **Sustainable Critical Minerals.** As Queensland transitions away from fossil fuels, it can support the Indo-Pacific region with the critical minerals needed to shift to a decarbonised economy;
- **Low Emissions Agriculture and Supply Chains.** Queensland is amongst the world leaders in low emissions agriculture and supply chains. Much of the Indo-Pacific region has similar climates to Queensland with sub-tropical to tropical agriculture. The uptake of agricultural technologies, water efficiency, crop varieties, farm and harvest management, livestock management and land management (including carbon farming) are areas in which Queensland has expertise that can be used to develop capacity across the Indo-Pacific region;
- **Workforce.** Despite significant skills gaps in emerging decarbonised industries, Queensland has an opportunity to lead in developing innovative, regionally integrated workforce models with Indo-Pacific partners, creating mutually beneficial outcomes for all involved. Queensland has strong education and training systems which can collaborate with partners in the region to deliver the skills and qualifications needed for emerging industries;
- **First Nations Knowledge.** Indigenous communities have been managing and conserving land, water and sea resources for millennia. This knowledge and expertise can bring important cultural, environmental, social, and economic development outcomes in the Indo-Pacific. There are existing collaborations between Indigenous peoples in Queensland and those in the Indo-Pacific on issues such as carbon farming. These partnerships can be deepened to integrate Indigenous and scientific knowledge, not only to tackle climate change, but also to address related challenges including health, bio-security, livelihoods, and skills development;

- **Innovation in Eco-systems for Businesses**. Regional Queensland has a well-developed innovation eco-system, and this is a critical enabler of industry transition. Supporting enterprise and industry level development to decarbonise requires innovation and knowledge sharing. This can potentially facilitate joint ventures, investments, job opportunities and new markets;
- **Supporting Institutional Capacity.** There are gaps in policy and regulatory frameworks in the Indo-Pacific's decarbonisation efforts. Queensland has well developed policy frameworks which can be tailored to relevant Indo-Pacific countries to help build policy and institutional capacity and capability in the public sector, industry and civil society agencies;
- **Social Protections.** Queensland is a world leader in social protection, offering mechanisms such as basic income, employment transition support, and access to health and education. These systems play a vital role in enabling just transitions by providing essential safeguards. Many Indo-Pacific countries are grappling with the development of such measures and regional Queensland has relevant expertise to support inclusive development; and
- **Research and Evidence.** Queensland has strong research and development capability relating to many aspects of climate change. The Queensland Government has recently funded the Queensland Decarbonisation Hub through a consortium of Queensland universities. This support efforts to develop effective evidence to guide policy making, collection of appropriate data, testing novel ideas and evaluation of what works will be critical in supporting Indo-Pacific decarbonisation efforts.

Recommended Action Moving Forward

While regional Queensland's imperatives to engage better with the Indo-Pacific region are strong, there is a need to examine how this can be best achieved. We need to move away from a transactional business and investment model to a relational model. Building strong relationships is the first step in working across the Indo-Pacific region. Sustainable, long-term funding is needed to support engagement with government, industry, and civil society; focusing on dialogue, relationship-building, and capacity development that extends beyond short-term, project-based initiatives. There is a policy gap at the State level in terms of engagement with the Indo-Pacific region, particularly from both economic and international development perspectives. There is a disconnect between the actions of the Australian Government and how Queensland's frameworks align with them. Currently, many separate initiatives are happening in Queensland regarding the Indo-Pacific, but they need to be better coordinated within a more strategic framework. We must focus on building cultural understanding, leveraging our multicultural population, and strengthening soft power to create

meaningful, culturally responsive relationships. It is crucial that we integrate our efforts across the region to accelerate decarbonisation and climate adaptation, as our futures are closely interconnected.

R&D for Decarbonisation in the Regions – Jenny Seddon

The green energy transition and decarbonisation will require a rapid and collective effort to mitigate the severe impacts of the changing climate. Regional areas are where visible decarbonisation efforts will play out. Renewable energy infrastructure will be constructed, energy-intensive or hard-to-abate industries will be transitioned, and solutions to the challenges of transportation over large geographic distances will be implemented. Regional areas and industries are also those at the frontline of the effects of climate change of more severe weather, including storms, cyclones, floods, and drought.

These opportunities are significant and exciting, offering great potential for our regions. Not only can Queensland's regions contribute to decarbonisation, but they can also use this change to build more diversified and resilient economies, develop new industries, create sustainable cities and towns, and improve livelihoods and overall potential. This shift offers the chance to turn decarbonisation into a competitive advantage for our regions while ensuring equitable development across the state. The green energy transition and broader moves to sustainability must recognise place, taking local context into account. Indeed, the inclusion of regional partners is fundamental to understanding local issues, identifying opportunities and recognising constraints. It is crucial to assess what is feasible and what is acceptable to the community and what is not.

There is a central and significant role for Queensland's regional Universities as anchor institutions within regions, building on their place in their region and long-standing research capacity and partnerships. Universities have a positive effect on their regions through employment in knowledge-intensive or technologically advanced industries, diffusion of innovation through research and industry collaborations, boosting educational levels, and local knowledge spillover (Bunde et al., 2022). In the energy and digital transitions, regional universities are hubs of knowledge, evaluation, engagement, and workforce development.

Key Opportunities and Challenges for Regional Research in a Decarbonising Economy

The green energy transition will touch all areas of our lives and economy, and this is reflected in the breadth and depth of research that will be required. Technological advances are fundamental, including new energy sources, grid stability, efficient green industrial processes and energy efficiencies through digitisation. However, the transition challenge is not merely technical but environmental, economic and social, just as the impacts of climate change are. The technologies available that can underpin full transformation to net zero emissions for

energy-intensive industries (such as green hydrogen and biomass fuels) are not yet commercially viable for deployment at scale (EIB, 2021). Research and development needs to extend beyond the technology to the development of innovative markets, financing and economic incentives modelling, regulatory settings, and the design and implementation of carbon, biodiversity and environmental credits.

In making national, regional, and local changes, it is imperative that we protect biodiversity, Indigenous cultural values and societal values; values that we hold in trust for future generations. Research will be needed to accurately predict the impacts, enabling faster evaluation, and permitting processes that match the urgency of the energy transition. Decarbonisation is an essential response to mitigate the effects of climate change, but the investment is significant and inconvenient while the return is not immediate. The balance sheet is for the benefit of future generations and will not necessarily directly benefit the communities in which the burden of change will occur (EIB, 2021). Securing social license for the decarbonisation agenda and conducting research to understand its social impacts and to identify socially equitable outcomes are just as important as the research and development of the transformative technologies that make it possible. Research will be needed to understand and model the trade-offs that will be necessary in resource allocation and spatial costs and benefits.

Energy justice is a conceptual framework that explores how the costs and benefits of an energy transition are distributed amongst society and how stakeholders are engaged in the decision-making process (Delafield et al, 2021). Frameworks will be needed to assess and balance the local, national and international costs and benefits of the transition, including factors such as impacts on changed land use, cross-sector energy demands, employment and the natural environment (Delafield et al., 2021). There is a need to work out how vulnerable communities or marginalised groups can be engaged in this process, both within our national borders and outside (AbdulRafiu, 2023). Indeed, the real challenge for the energy transition is linking all the systems together, including energy, transport, food, water, health, waste and building systems (AbdulRafiu, 2023; EIB, 2021). This is a whole ecosystem that needs to change, requiring the infusion of systemic research and development to understand the networks of interactions that must be understood and considered.

New Approaches to Achieving Change Through R&D

The size and complexity of the challenges that face us in research and development underpinning the green energy transition means that our approaches must be cross-sectoral, cross-disciplinary, and cross-institutional. Open, inclusive, genuine and mutually beneficial partnerships are the only way forward. The ‘triple helix’ of university, industry, and government

relations was described as a key component of research, innovation, development and diffusion from the last decades of the 20th century (Etzkowitz & Leydesdorff, 1995). This helix has benefits for regional areas. Businesses with less innovative experience and resource constraints can benefit from climate and energy research through collaboration with research institutions (Spanos, 2021). While partnership-building and integrated thinking are essential, they must also include a critical missing strand in the helix: the community. The challenges of the green energy transition will need to engage deeply with Indigenous communities, rural, remote and regional communities and with metropolitan communities.

A key component moving forward is the integrated consideration of place. In the USA, under the Biden administration, there was a move to support networks of universities and investments around a targeted economic opportunity led by a regional entity through the Build Back Better Regional Challenge (USEDA, 2024). In the UK, the Key Cities Innovation Network joins universities working with priority cities for sustainability (see CPINZ, 2024). The 'SuperPlace' concept in the UK's Industrial Decarbonisation Strategy (HMG, 2021) couples a sense of place with the energy transition, often recognising that clusters are in relatively deprived areas but are drivers for their region's prosperity (Devine-Wright, 2022). What these approaches have in common is the spatial ontology, the sense of belonging and identity, and the community engagement with place and identity (Devine-Wright, 2022).

Tackling a problem as significant and complex as the energy transition needs a systems-based approach but at a place-based scale. A place-based approach does two things: it puts the knowledge, engagement and interactions at an achievable scale, and it assists in clarity around the trade-offs, which are an essential component to public acceptance of change. In Australia, we can define the place by region (or lower scales), which might be extensions of those regions defined under the State's Queensland Renewable Energy Zone vision. In Australia, the concentration of research and innovation workforce in metropolitan areas is a challenge that must be addressed, directly through investment or indirectly through effective networks if the regional changes are to be realised.

Recommended Action Moving Forward

Some key recommended actions for moving forward could include:

- Investment in research and innovation hubs with regional universities as anchor institutions;
- Building an approach to RD&E that considers whole of ecosystems unique to each region;
- Tackling green energy transitions as place-based challenges with workable, bite-sized issues;

- Investment in a critical mass of regional research and innovation workforce development across a broad range of expertise that will underpin the research and development required;
- Ensuring support for the full pipeline across fundamental research to innovation to completion of deployment, including de-risking the uptake and building of industries; and
- Research and support must include, but not be limited to, technological advances: the social change and public acceptance of change should be a core consideration and not an add-on.

There is an urgency for action, and so we should be innovative in our frameworks and collaborative models, continuing to trial and improve - not only what we are doing, but the ways in which we are working together. Research should be at the heart of evidence-based decision making in the regions. We need to ensure that there is investment in getting the evidence needed for good decisions and making those decisions at speed. The risks of not responding to current and impending impacts of climate change outweighs the risks of a conservative approach to innovation. We need to come together in new ways and new partnerships to tackle this most complex of challenges, for the good of future generations.

Conclusions and Next Steps – Allan Dale and Liz Young

This policy think piece has aimed to holistically explore what considerations will be most at play as Queensland's regions step up to the global decarbonisation challenge. Most importantly, this work has stressed that Queensland's regions need to be in a stronger economic, social and environmental position at the end to the net zero journey. They will also need to be more resilient. We have examined the challenges, opportunities and necessary actions across multiple scales, exploring sectors such as agriculture, tourism, mining, energy, to regions, communities, First Nations, businesses, neighbourhoods and households. We also recognize that increasing investment at all these levels requires strong foundational supports at every stage of the investment pipeline.

While strong foundations for decarbonisation policy exist at the federal and state levels, further policy attention and thoughtful implementation design are required to address the challenge outlined above. This think piece is aimed at sparking detailed policy dialogue at the state and federal levels for developing the supports needed to achieve these outcomes. It also strongly positions the role of Queensland's regional universities (and the Queensland Decarbonisation Hub) in becoming the logical partner of choice in supporting governments and our regions in this transition.

References

Abdullah I., Warviyan D., Maulana S., Abdullah A., Bilqis A., & Tirta A. (2023). Mobilising finance to ASEAN's low carbon energy transition: Challenges and policy options. *ACE Policy Brief No.3/April.* https://aseanenergy.org/mobilising-finance-to-support-aseans-low-carbon-energy-transition-challenges-and-policy-options/

AbdulRafiu, A. (2023). Policy seduction and governance resistance? Examining public funding agencies and academic institutions on decarbonisation research. *Science and Public Policy, 50*(1), *87–101.* https://doi.org/10.1093/scipol/scac051

Abram, S., Atkins, E., Dietzel, A., Jenkins, K., Kiamba, L., Kirshner J., Kreienkamp, J., Parkhill, K., Pegram, T., & Santos Ayllón, L.M. (2022). Just transition: A whole-systems approach to decarbonisation. *Climate Policy 22*(8), 1033-1049. https://doi.org/10.1080/14693062.2022.2108365

Acha, S., O'Dwyer, E., Pan, I., & Shah, N. (2022). Decarbonisation of the Urban Landscape: Integration and Optimization of Energy Systems. In E. Inderwildi & M. Kraft (Eds.), *Intelligent Decarbonisation: Can Artificial Intelligence and Cyber-Physical Systems Help Achieve Climate Mitigation Targets?* (pp. 133-144). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-86215-2

AECOM (2024). *The carbon and business case for choosing refurbishment over new build.* https://aecom.com/without-limits/article/refurbishment-vs-new-build-the-carbon-and-business-case/

Albanese, A. (2024). A Future Made in Australia. *Address to Queensland Media Club.* https://anthonyalbanese.com.au/media-centre/a-future-made-in-australia-qmc

Anbumozhi, V. (2023). Dealing with climate change: Enhanced opportunities for India-ASEAN's Transition towards Net-Zero Economy. In P. De (Ed.) *Thirty Years of ASEAN-India Relations* (pp. 391-406). Routledge.

Asia Development Bank. (2021). *Climate risk country profile: Indonesia.* https://www.adb.org/sites/default/files/publication/700411/climate-risk-country-profile-indonesia.pdf

Asia Development Bank. (2023) *Asia in the global transition to net zero.* https://www.adb.org/publications/ado-2023-thematic-report

Assembly UNG (2015). *Resolution adopted by the General Assembly on 25 September 2015.* United Nations, Geneva. https://www.eea.europa.eu/policy-documents/resolution-adopted-by-the-general

Australian Government (2017). *Foreign Policy White Paper.* https://www.fpwhitepaper.gov.au/file/2651/download?token=Q5CYuX29

Australian Human Rights Commission and Gooda, M. (2011). *Social Justice Report 2011.* Aboriginal and Torres Strait Islander Social Justice Commissioner, Canberra. https://humanrights.gov.au/our-work/aboriginal-and-torres-strait-islander-social-justice/publications/social-justice-report

Australian Petroleum Production and Exploration Association. (2012). Submission No 28 to the Senate Enquiry. *Environment and Communications Legislation Committee Environment Protection and Biodiversity Conservation Amendment (Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development) Bill*. Commonwealth of Australia, Canberra. https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/Completed_inquiries/2010-13/epbccoalseamgas2012/submissions

Australian Productivity Commission, (2024). *Review of Closing the Gap.* https://www.pc.gov.au/inquiries/completed/closing-the-gap-review/report

Australian Renewable Energy Agency. (2024). *Powering the Regions Industrial Transformation Stream.* https://arena.gov.au/funding/powering-the-regions-industrial-transformation-stream/

Babacan, H. (2022a). Regional/rural workforce transitions for post COVID-19 resilience. *Journal of Resilient Economies, 2*(1), i-ix. https://doi.org/10.25120/jre.2.1.2022.3905

Babacan, H. (2022b). After COVID-19: Building inclusive and sustainable economies for resilience. In T. Chaiechi & J. Wood (Eds.), *Community empowerment, sustainable cities, and transformative economies* (pp. 7-19). Springer Publications. https://doi.org/10.1007/978-981-16-5260-8_2

Babacan, H., and Dale, A. P. (2019). *Emerging rural and regional policy considerations for Queensland: An overview paper*. Rural Economies Centre of Excellence, Toowoomba. https://www.ruraleconomies.org.au/media/1167/recoe-22-policy-issues-overview-paper-march-2019.pdf

Babacan H., Dale A. P., & McHugh H. (2019). *Queensland rural/regional workforce policy analysis* [Policy Working Paper]. Rural Economies Centre of Excellence and James Cook University, Cairns and Toowoomba. https://www.ruraleconomies.org.au/media/1167/recoe-22-policy-issues-overview-paper-march-2019.pdf

Babacan, H., Marshall A., McHugh J., Gopalkrishnan N., & Dale A. (2021a). *TCICA Region Telecommunications and Digital Connectivity Strategy*. Torres and Cape Indigenous Councils Alliance, James Cook University, Queensland University of Technology, Cairns. https://tcica.com.au/wp-content/uploads/2021/08/tcica-digital-connectivity-strategy.pdf

Bailey, M. (2015). *Powerlink propels Surat Basin gas industry* [Press Release]. https://statements.qld.gov.au/statements/75941

Barquet K., Leander, E., Green, J., Tuhkanen, H., Omondi, V., Boyland, M., Fierts, E. K., Escobar, M., Trujillo, M., & Osano, P. (2021). *Spotlight on social equity, finance and scale: Promises and pitfalls of nature-based solutions* [Policy Brief]. Stockholm Environment Institute. https://www.sei.org/wp-content/uploads/2022/12/spotlight-on-social-equity-finance-and-scale-nbs-2021.pdf

Bayraktar, M., & Algan, N. (2019). *The importance of SMES on world economies.* file:///C:/Users/jc170912/Downloads/The_Importance_Of_SMEs_On_World_Economies.pdf

Bedford, T., Catney, P., & Robinson, Z. (2023). Going down the local: The challenges of place-based net zero governance. *Journal of the British Academy, 11*(4), 125–156. https://doi.org/10.5871/jba/011s4.125

Beef Central (2020). *The Australian red meat and livestock industry: State of the industry report*. https://www.beefcentral.com/news/australian-red-meat-state-of-the-industry-report-released/

Bin, C. Y., Yang, W., & Wang, X. (2022). Blockchain for decarbonization. In E. Inderwildi & M. Kraft (Eds.), *Intelligent Decarbonisation: Can Artificial Intelligence and Cyber-Physical Systems Help Achieve Climate Mitigation Targets?* (pp. 61-72). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-86215-2

Bishop, J. D. (2022). Decarbonising transport with intelligent mobility. In E. Inderwildi & M. Kraft (Eds.), *Intelligent Decarbonisation: Can Artificial Intelligence and Cyber-*

Physical Systems Help Achieve Climate Mitigation Targets? (pp. 163-172). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-86215-2

Bland, R., Granskog, A., & Nauclér, T. (2022). *Accelerating toward net zero: The green business building opportunity*. McKinsey & Company, New York. https://www.mckinsey.com/capabilities/sustainability/our-insights/accelerating-toward-net-zero-the-green-business-building-opportunity

Bocken, N., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering, 33*(5), 308-320. https://doi.org/10.1080/21681015.2016.1172124

Bowen, C. (2024). $330 million *investment in Australian heavy industry future* [Press Release]. https://minister.dcceew.gov.au/bowen/media-releases/330m-investment-australian-heavy-industry-future

Bunde, N., Czernich N., Falck O., & Felbermayr, G. (2022). What works? Regional effects of universities. *EconPol Forum 23*(5), 48-55. https://hdl.handle.net/10419/272134

Cahill A. (2022). *What regions need on the path to net zero emissions*. The Next Economy, Brisbane. https://nexteconomy.com.au/work/what-regions-need-on-the-path-to-net-zero-2/

Cantley-Smith, R., Ben-David, R., Briggs, C., Dwyer, S., Hargroves, C., Kallies, A., Khalilpour, K., Kraal, D., & Liebman, A. (2023). *Opportunity assessment - distribution system operator and beyond: Optimising planning and regulation for demand management and distributed energy resources*. RACE for 2030 Ltd. https://racefor2030.com.au/wp-content/uploads/2023/09/N4-OA-Final-Summary-Report-3.pdf

Carbon Market Institute. (2022). *Australian carbon farming industry roadmap* (Version 2.1). https://carbonmarketinstitute.org/wp-content/uploads/2022/08/Australian-Carbon-Farming-Industry-Roadmap-v.2.1.pdf

Cass, D., Connor, L., Heikkinen, R., & Pearse, R. (2022). *Renewables & rural Australia: A study of community experiences in Renewable Energy Zones in NSW and the case for more equity and coordination of the clean energy transformation*. The Australia Institute, Canberra, Australia. https://australiainstitute.org.au/wp-content/uploads/2022/06/P1176-Renewables-and-Rural-Australia-report-FINAL-with-Appendices-20220627.pdf

Cavaye, J., & Kelly, L. (2015). *Agriculture and coal seam gas development in Queensland.* Centre for Coal Seam Gas, Brisbane.

Centre for First Nation Governance (CFNG). (n.d.). *The Five Pillars of Effective Governance*. https://fngovernance.org/five-pillars-of-effective-governance/

Chaiechi, T. (2014a). The economic impact of extreme weather events through a Kaleckian–Post-Keynesian lens: A case study of the State of Queensland, Australia. *Economic Analysis and Policy 44*(1), 95-106. https://doi.org/10.1016/j.eap.2014.01.002.

Chaiechi, T. (2014b). *Post-Keynesian empirical research and the debate on financial market development.* IGI Global. https://researchonline.jcu.edu.au/37843/1/37843%20Chaiechi%202014%20Front%20Pages.pdf

Chaiechi, T. (2021a). *Editorial- The resilience shift: It is all in the partnership. Journal of Resilient Economies 1*(2), 1-3. https://doi.org/10.25120/jre.1.2.2021.3869

Chaiechi, T., Pryce, J., Ciccotosto, S., & Billa, L. (2021b). State-wide effects of natural disasters on the labor market. In T. Chaiechi (Ed.) *Economic Effects of Natural Disasters* (pp. 211-224). Academic Press. https://doi.org/10.1016/B978-0-12-817465-4.00014-5

Chaiechi, T. and Nguyen, T. (2021). Measuring urban economic resilience of two tropical cities using impulse response analysis. *Bulletin of Applied Economics 8*, 59–79. https://doi.org/10.47260/bae/814

Chaiechi, T. (2022). Foreword-Sustainable and resilient economies, theoretical considerations. In *Community Empowerment, Sustainable Cities, and Transformative Economies* (pp. 1-5). Springer Nature Singapore. https://doi.org/10.1007/978-981-16-5260-8

City of Townsville (2021). *Eco-industrial precinct strides ahead with four new proponents signing on to Lansdown.* https://www.townsville.qld.gov.au/about-council/news-and-publications/media-releases/2021/december/eco-industrial-precinct-strides-ahead-with-four-new-proponents-signing-on-to-lansdown

City of Townsville (2024). *Recommendations made to ensure renewable energy success in the North.* https://www.townsvilleenterprise.com.au/recommendations-made-to-ensure-renewable-energy-success-in-the-north/

Civic Partners in Net Zero (CPINZ). (2024). *Innovative approaches to universities working with their places to achieve net zero.* https://keycities.uk/2024/04/23/civic-partners-in-net-zero/

Clean Growth Choices Consortium (CGCC). (2020). *Clean Growth Choices for Communities in Transition Pilot Program. Final report*. University of Southern Queensland and JCU, Cairns. https://research.usq.edu.au/item/z7yv0/clean-growth-choices-for-communities-in-transition-pilot-program-final-report

Climate Change Authority (CCA). (2023) *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

Commonwealth of Australia (2019). *Senate Select Committee on Jobs for the Future of Regional Areas*. Australian Government, Canberra. https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Jobs_for_the_Future_in_Regional_Areas

Commonwealth of Australia (2023). *National statement on climate change and agriculture*. Department of Agriculture, Fisheries and Forestry, Canberra. https://www.agriculture.gov.au/sites/default/files/documents/national-statement-on-climate-change-agriculture.pdf

Commonwealth of Australia (2024). *Joint media release: Renewable hydrogen hub for north Queensland.* https://minister.dcceew.gov.au/bowen/media-releases/joint-media-release-renewable-hydrogen-hub-north-queensland

Energy Consumers Australia (ECA). (2025). *Consumer energy report card.* https://energyconsumersaustralia.com.au/consumer-energy-report-card

Cornell, S. and Kalt, J. P. (2007). Two approaches to economic development on American Indian reservations: One works, the other doesn't. In M. Jorgensen (Ed.). *Rebuilding native nations: Strategies for governance and development* (pp. 35–52). University of Arizona Press. https://www.tribalyouth.org/wp-content/uploads/2021/08/111_imgimgjopna_2005-02_Approaches.pdf

Currey P., Lyons B., & De Daunton, F. (2024). *Family farm economic diversification. Too hard and risky or an opportunity overlooked?* The University of Southern Queensland. Toowoomba, Queensland.

https://www.ruraleconomies.org.au/media/1458/family-farm-economic-diversification-too-hard-and-risky-or-an-opportunity-overlooked.pdf

Dale, A. P. (2024). *Creating a pipeline for sustainable and inclusive development: A research synthesis for developing new pathways for the northern Australian refresh.* A joint report for the Cooperative Research Centre for Northern Australia (CRCNA), Townsville and Reef and Rainforest Research Centre (RRRC), Cairns. https://www.nespmarinecoastal.edu.au/publication/creating-a-pipeline-for-sustainable-and-inclusive-development/

Dale, A. P., Sheppard, M., Burrows, D., & Williams, Y. (2022). *Supporting regional planning in northern Australia: A scoping study.* Report to the RRRC, Cairns, Queensland. https://www.nespmarinecoastal.edu.au/publication/supporting-regional-planning-in-northern-australia-a-scoping-study/

Delafield, G., Donnison, C., Roddis, P., Arvanitopoulos, T., Sfyridis, A., Dunnett, S., Ball, T., & Logan, K.G. (2021). Conceptual frameworks for balancing society and nature in net-zero energy transitions. *Environmental Science & Policy, 125*, 189–201. https://doi.org/10.1016/j.envsci.2021.08.021

Deloitte (2024). *Work toward net zero report.* https://www.deloitte.com.au/en/issues/climate/worktoward-net-zeor.html

Denis A., Jotzo F., Ferraro S., Jones A., Kautto N., Kelly R., Skarbek A., Thwaites J., Adams P., Graham P., & Hatfield-Dodds S. (2014). *Pathways to deep decarbonization in Australia.* Climate Works and Australian National University, Canberra. https://nla.gov.au/nla.obj-2995835047/view

Department of Agriculture, Fisheries and Forestry. (2025). *Agricultural and land sectoral plan.* Accessed at: https://www.agriculture.gov.au/agriculture-land/farm-food-drought/climatechange/ag-and-land-sectoral-plan

Department of Climate Change, Energy, the Environment and Water. (2022). *Powering the Regions Fund: Consultation overview*. Australian Government. https://www.energy.gov.au/sites/default/files/2022-12/Powering%20the%20Regions%20Fund%20Consultation%20Overview.pdf

Department of Climate Change, Energy, Environment and Water. (2023). *Quarterly update of Australia's National Greenhouse Gas Inventory: September 2023*. Australian Government, Canberra.

https://www.dcceew.gov.au/sites/default/files/documents/nggi-quarterly-update-sept-2023.pdf

Department of Climate Change, Energy, the Environment and Water. (2024a). *Carbon Farming Outreach Program.* https://www.dcceew.gov.au/climate-change/emissions-reduction/agricultural-land-sectors/carbon-farming-outreach-program

DCCEEW (2024b). *Reducing methane emissions from livestock.* https://www.dcceew.gov.au/climate-change/emissions-reduction/agricultural-land-sectors/livestock

DCCEEW (2024c). *Improving soil carbon storage and measurement*. https://www.dcceew.gov.au/climate-change/emissions-reduction/agricultural-land-sectors/soil-carbon-storage-measurement

DCCEEW (2025). *Methods for the Australian Carbon Credit Units (ACCU) Scheme*. https://www.dcceew.gov.au/climate-change/emissions-reduction/accu-scheme/methods

Department of Foreign Affairs and Trade (DFAT). (2023). *Indo-Pacific Economic Framework: IPEF Clean Economy Agreement*. https://www.dfat.gov.au/sites/default/files/ipef-clean-economy-agreemen.pdf

Department of State Development, Infrastructure, Local Government and Planning. (2023). *Queensland New Industry Development Strategy.* Queensland Government, Brisbane. https://www.statedevelopment.qld.gov.au/__data/assets/pdf_file/0027/80766/queensland-new-industry-development-strategy.pdf

Devine-Wright, P. (2022). Decarbonisation of industrial clusters: A place-based research agenda. *Energy Research and Social Science, 91,* Article 102725. https://doi.org/10.1016/j.erss.2022.102725

Do Amaral, J. V. S., Dos Santos, C. H., Montevechi, J. A., & de Queiroz, A. R. (2023). Energy digital twin applications: A review. *Renewable and Sustainable Energy Reviews, 188,* Article 113891. https://doi.org/10.1016/j.rser.2023.113891

Dumbrell, N., Robinson, C., Ricketts, K., Urzedo, D., Walker, L. and Bond, A. (2024). Toward land restoration transitions: Elevating regional voices and the provenance of co-benefits in Queensland rangelands. *The Rangeland Journal, 46*(1), Article RJ23045. https://doi.org/10.1071/RJ23045

Economy ID Townsville City. (n.d.). *Townsville City Council, Employment by industry (FTE).* https://economy.id.com.au/townsville/employment-by-industry-fte

Etzkowitz, H., & Leydesdorff, L. (1995). The triple helix - University-industry-government relations: A laboratory for knowledge based economic development. *EASST Review, 14*(1), 14-19. https://ssrn.com/abstract=2480085

European Investment Bank. (2021). Climate action, environmental sustainability and innovation for decarbonisation. *EIB Impact Report 2020.* https://doi.org/10.2867/51049

Fabre A., Howes M., & Deweerdt, T. (2023). Best practice in urban transport decarbonisation: A case study of three initiatives in Brisbane. *Australian Planner, 59*(1), 64-85. https://doi.org/10.1080/07293682.2023.2190143

Fairman B., Voak A., & Babacan H. (2022). Human mobility and dismantling cultural dominance: Creating collaborative conversations to secure talent in a Post-COVID world. *Journal of Resilient Economies, 2*(1), 96-101. https://doi.org/10.25120/jre.2.1.2022.3917

Family Enterprise Ombudsman. (2023). *Number of small businesses in Australia*. *In* Ombudsman, A. 2023. *Australian Small Business and Family Enterprise*. https://www.asbfeo.gov.au/sites/default/files/2023-10/Number%20of%20small%20businesses%20in%20Australia_Aug%202023_0.pdf.

First Nation Clean Energy Network (n.d.). *Queensland policy overview: First Nations and clean energy*. https://www.firstnationscleanenergy.org.au/

Fonseca, L., Domingues, J., & Dima, A. (2020). Mapping the Sustainable Development Goals relationships. *Sustainability 12*(8), Article 3359. https://doi.org/10.3390/su12083359

Gawara Baya, (n.d.). *Leading-practiceresponsible development*. https://www.gawarabaya.com/

George, M., O'Regan, K., & Holst, A. (2022) *Digital technologies can cut global emissions by 20%. Here's how*. World Economic Forum. https://www.weforum.org/agenda/2022/05/how-digital-solutions-can-reduce-global-emissions/.

Gertz, J. (2022). *Gugu Badhun sovereignty, self-determination and nationhood.* [PhD thesis, James Cook University, Townsville]. ResearchOnline. https://doi.org/10.25903/abhm-4m07

Gertz, J., Petray, T., Jorgensen, M., Vivian, A., & Achterberg, C. (2025). For the good of the Gugu Badhun people: Indigenous nation building, economic development and sharing as sovereignty. *Thesis Eleven, 187*(1), 145-163. https://doi.org/10.1177/07255136241308886

Goldman Sachs Global Investment Research (2022). *The Path to 2075 - Slower Global Growth, But Convergence Remains Intact*. https://www.goldmansachs.com/pdfs/insights/pages/gs-research/the-path-to-2075-slower-global-growth-but-convergence-remains-intact/report.pdf.

Her Majesty's Government (HMG). (2021). *Industrial decarbonization strategy.* https://assets.publishing.service.gov.uk/media/605110228fa8f55d37fca6e5/6.7279_BEIS_CP399_Industrial_Decarbonisation_Strategy_FINAL_PRINT_FULL_NO_BLEED.pdf.

Higgins, A., McFallan, S., McKeown, A., Bruce, C., & Chilcott, C. (2018). Informing major government programs for rural transport infrastructure in northern Australia. *The Rangeland Journal, 40*(4), 341-351. https://doi.org/10.1071/RJ18008

Huda, M.S. (2023). *The geopolitics of energy transition in ASEAN.* Fulcrum. https://fulcrum.sg/aseanfocus/the-geopolitics-of-energy-transition-in-asean

Hunt, J., Smith, D. E., Garling, S., & Sanders, W. (Eds.). (2008). *Contested governance: Culture, power and institutions in Indigenous Australia*. ANU Press, Canberra. http://doi.org/10.22459/CAEPR29.08.2008

Indigenous Carbon Industry Network. (2022). *Mapping the opportunities for indigenous carbon in Australia: Identifying opportunities and barriers to indigenous participation in the Emissions Reduction Fund*. Indigenous Carbon Industry Network, Australia. https://assets.nationbuilder.com/icin/pages/182/attachments/original/1664240300/Mapping_the_opportunities_ABRIDGED_WEB.pdf?1664240300

Institute of Environmental Management and Assessment. (2020). Pathways to net zero: Using the IEMA GHG Management Hierarchy. https://www.iema.net/resources/reading-room/2020/11/26/pathways-to-net-zero-using-the-iema-ghg-management-hierarchy-november-2020

Intergovernmental Panel on Climate Change. (2014). *Climate change 2014 - Impacts, adaptation, and vulnerability: Summary for policy makers.* World Meteorological Organisation, Geneva. https://www.researchgate.net/publication/272150376_Climate_change_2014_impacts_adaptation_and_vulnerability_-_IPCC_WGII_AR5_summary_for_policymakers

International Energy Agency. (2023). *World energy outlook 2023.* https://www.iea.org/reports/world-energy-outlook-2023

International Renewable Energy Agency. (2023). *Geopolitics of the energy Transition: Critical materials.* https://www.irena.org/-/media/Irena/Files/Technical-papers/IRENA_Critical_Materials_2021.pdf

Investor Group on Climate Change. (2023). *The state of net zero investment: Analysis of $2.1 trillion managed in Australia*. https://igcc.org.au/wp-content/uploads/2023/03/IGCC-The-State-of-Australian-Net-Zero-Investment_March2023.pdf

Jabalbina Yalanji Aboriginal Corporation. (2022). *Bamangka Kaban: Powering our future*. https://www.jabalbina.com.au/wp-content/uploads/2022/12/12-0922-Bamangka-Kaban.pdf

Jassim, D., Witt, B., & Evans, M. (2022). Community perceptions of carbon farming: A case study of the semi-arid mulga lands in Queensland, Australia. *Journal of Rural Studies, 96,* 78-88. https://doi.org/10.1016/j.jrurstud.2022.10.010

Keenan, R., Pozza, G., & Fitzsimons, J. (2019). Ecosystem services in environmental policy: Barriers and opportunities for increased adoption. *Ecosystem Services, 38*, Article 100943. https://doi.org/10.1016/j.ecoser.2019.100943

Kelly, D., & Phelps, D. G. (2019). Looking beyond the DUST: Building resilient rangeland communities. *The Rangeland Journal, 41*, 233–250. https://doi.org/10.1071/RJ18047

Krishnan, M., Samandari, H., Woetzel, J., Smit, S., Pacthod, D., Pinner, D., Nauclér, T., Tai, H., Farr, A., Wu, W., & Imperato, D. (2022). *The net-zero transition: What it would cost, what it could bring*. https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/the%20net%20zero%20transition%20what%20it%20would%20cost%20what%20it%20could%20bring/the-net-zero-transition-what-it-would-cost-and-what-it-could-bring-final.pdf

Lade, O. (2022). Green, lean and digital transformation for decarbonisation of chemical industries. In O. Inderwildi & M. Kraft (Eds.), *Intelligent Decarbonisation: Can Artificial Intelligence and Cyber-Physical Systems Help Achieve Climate Mitigation Targets?* (pp. 91-104). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-86215-2

Lau J., Kleiber D., Lawless S., & Cohen P. (2021). Gender equality in climate policy and practice hindered by assumptions. *Nature Climate Change, 11,* 186-192. https://doi.org/10.1038/s41558-021-00999-7

Lockie, S., Fairley-Grenot, K., Ankeny, R.A., Botterill, L.C., Howlett, B.J., McBratney, A.B., Probyn, E., Sorrell, T.C., Sukkarieh, S., & Woodhead, I. (2020). *The future of agricultural technologie*s. Report for the Australian Council of Learned Academies, Melbourne. https://acola.org/wp-content/uploads/2020/09/hs6_agricultural-technologies_acola_report.pdf

Mais, F., & Bauernhansl, T. (2024). Decarbonization drivers and their impact on business models in the energy-intensive manufacturing Industry. *Sustainability, 16*(11), Article 4836. https://doi.org/10.3390/su16114836

Maru, Y. T., Stafford Smith, M., Sparrow, A., Pino, P. F., & Dube, O. P. (2014). A linked vulnerability and resilience framework for adaptation pathways in remote and disadvantaged communities. *Global Economic Change, 28*, 337–350. https://doi.org/10.1016/j.gloenvcha.2013.12.007

Masson-Delmotte, V. P., Zhai, P., Pirani, S. L., Connors, C., Péan, S., Berger, N., Caud, Y., Chen, L., Goldfarb, M., & Scheel Monteiro, P. (2021). Summary for policymakers. *In Climate change 2021: The physical science basis. contribution of the working group to the sixth assessment report of the intergovernmental panel on climate change.* UN, Geneva. https://www.ipcc.ch/report/ar6/wg1/chapter/summary-for-policymakers/

McCoy, J., Davis, D., Mayfield, E., & Brear, M. (2023). *Downscaling: Employment impacts*. Net zero Australia. https://www.netzeroaustralia.net.au

National Emergency Management Agency. (2019). 2019 Queensland Monsoon Trough: After the flood: A strategy for long-term recovery. https://ncq.org.au/wp-content/uploads/2019_AG_QueenslandMonsoonTrough-ActionStatement.pdf

National Farmers Federation. (2024). *Climate change report highlights challenges for agriculture in reaching net zero*. https://nff.org.au/media-release/climate-change-report-highlights-challenges-for-agriculture-in-reaching-net-zero/

National Security College. (2024). *Indo Pacific regional order: Elusive equilibrium*. National Security College, Futures Hub. https://futureshub.anu.edu.au/the-indo-pacific-regional-order-elusive-equilibrium/

O'Neill, L., Thorburn, K., Riley, B., Maynard, G., Shirlow, E., & Hunt, J. (2021). Renewable energy development on the Indigenous Estate: Free, prior and informed consent and best practice in agreement-making in Australia. *Energy Research & Social Science, 81*, Article 102252. https://doi.org/10.1016/j.erss.2021.102252

Pacific Security Outlook Report. (2022). *The Pacific security outlook report 2022-2023*. Pacific Islands Forum Secretariat, Suva. https://forumsec.org/sites/default/files/2024-03/Pacific-Security-Outlook-Report-2022-2023.pdf

Porter, M. (2008). The five competitive forces that shape strategy. *Harvard Business Review, 86*(1), 78-93.

Price Waterhouse Coopers. (2017). *The long view: How will the global economic order Change by 2050?* https://www.pwc.com/gx/en/world-2050/assets/pwc-the-world-in-2050-full-report-feb-2017.pdf

Pugalis L., & Gray N. (2016). New regional development paradigms: An exposition of place-based modalities. *Australasian Journal of Regional Studies, 22*(1), 181–203.

Quail, K., Green, D., & O'Faircheallaigh, C. (2023). Getting it right: What needs to be done to ensure First Nations' participation and benefit from large-scale renewable energy developments on country? In S. A. Crate & M. Nuttall (Eds.), *Anthropology and Climate Change* (pp. 117-130). Routledge. https://doi.org/10.4324/9781003242499

Queensland Farmers Federation. (2021). *Agriculture needed to achieve new zero.* https://www.qff.org.au/presidents-column/agriculture-needed-achieve-net-zero/

Queensland Government (2017). *Queensland strategy for disaster resilience 2017: Making Queensland the most disaster resilient state in Australia.* https://www.qra.qld.gov.au/sites/default/files/2018-10/queensland_strategy_for_disaster_resilience_2017_0.pdf

Queensland Government (2022a). *Resource Industries Development Plan*. https://www.resources.qld.gov.au/qridp

Queensland Government (2022b). *Queensland Energy and Jobs Plan.* [No longer available online due to website update; archived copies may be available].

Queensland Government (2023a). *Queensland's Clean Energy Workforce Roadmap*. https://desbt.qld.gov.au/employment/strategies/clean-energy-workforce

Queensland Government (2023b), *Land Restoration Fund: Priority Investment Plan*. Department of Environment and Science (DESI). https://www.data.qld.gov.au/article/assets/pdf_file/0024/116547/lrf-priority-investment-plan.pdf

Queensland Government (2023c). *Mission 2050: How Townsville is becoming a global renewable energy hub.* https://www.statedevelopment.qld.gov.au/news/mission-2050-how-townsville-is-becoming-a-global-renewable-energy-hub

Queensland Government (2023d). *Diversity figures 2021.* Queensland Government Statistician's Office, Queensland Treasury, Brisbane. https://www.dcssds.qld.gov.au/resources/dcsyw/multicultural/communities/diversity/diversity-figures-report-2021.pdf

Queensland Government (2024a). *Queensland 2035: Clean economy pathway*. https://www.epw.qld.gov.au/__data/assets/pdf_file/0028/48493/queensland-2035-clean-economy-pathway.pdf

Queensland Government (2024b). *Renewable Energy Zone Roadmap*. https://statements.qld.gov.au/statements/99982

Queensland Government (2024c). *Miles more protections for Great Artesian Basin.* Media Statement. Accessed at: https://statements.qld.gov.au/statements/100453.

Queensland Government (2025a). *Media Statement: Energy Roadmap to deliver affordable, reliable and sustainable electricity.* Accessed at: https://statements.qld.gov.au/statements/102355

Queensland Government (2025b). *A fresh start for Queensland: Communities empowered on renewables* [Media Statement]. https://statements.qld.gov.au/statements/102492

Queensland Government Statistician's Office. (2023) *Small business in Queensland: A statistical snapshot, June 2023*. Queensland Treasury. https://www.qgso.qld.gov.au/issues/2881/small-business-qld-202306.pdf

Queensland South Native Title Services. (n.d.). *People, place and partnerships framework.* https://qsnts.com.au/?qsnts=Services

Queensland Treasury (2025a). *Net Zero Roadmap.* https://www.energyandclimate.qld.gov.au/climate/net-zero-roadmap

Queensland Treasury (2025b). *Priority transmission investments.* https://www.energyandclimate.qld.gov.au/energy/energy-system-planning/priority-investments

Rattle, I., Gailani, A., & Taylor, P.G. (2024). Decarbonisation strategies in industry: Going beyond clusters. *Sustainability Science, 19*, 105–123. https://doi.org/10.1007/s11625-023-01313-4

Razif, A., Aziz, N., Kadir, M., & Kamil, K. (2024). Accelerating energy transition through battery energy storage systems deployment: A review on current status, potential and challenges in Malaysia. *Energy Strategy Reviews, 52,* Article 101346. https://doi.org/10.1016/j.esr.2024.101346

Rolfe, J. C., Kinnear, S. H., & Borg, D. T. (2020). Factors affecting population and workforce mobility in Australia: A future of declining regional affinity? *Rural Society 29*(1), 1-15. https://doi.org/10.1080/10371656.2020.1761599

Sinclair, L., & Coe, N. M. (2024). Critical mineral strategies in Australia: Industrial upgrading without environmental or social upgrading. *Resources Policy, 91,* Article 104860. https://doi.org/10.1016/j.resourpol.2024.104860

Sinclair, M., Henshaw, M., & Henshaw, S. (2021). On building sustainable communities: A perspective for HFE practitioners. *Applied Ergonomics, 96,* Article 103476. https://doi.org/10.1016/j.apergo.2021.103476

Smith, D. E., & Field, J. (2024). *People, place and partnerships: A model for reclaiming indigenous self-determined governance of development* [Discussion Paper No. ##/2024]. Centre for Aboriginal Economic Policy Research, Australian National University. https://aigi.org.au/wp-content/uploads/2024/03/People-Place-and-Partnerships-A-Model-for-Reclaiming-Indigenous-Governance-of-Development-PAPER-TO-AIGI.pdf

Sovacool, B., Lipson, M., & Chard, R. (2019). Temporality, vulnerability, and energy justice in household low carbon innovations. *Energy Policy, 128*, 495-504. https://doi.org/10.1016/j.enpol.2019.01.010

Spanos, Y. E. (2021). Exploring heterogeneous returns to collaborative R&D: A marginal treatment effects perspective. *Research Policy, 50,* Article 104223. https://doi.org/10.1016/j.respol.2021.104223

Standing Council on Energy and Resources. (2012). *Review of limited merits regime*. https://www.aer.gov.au/publications/reports/submissions/scer-expert-panel-review-limited-merits-review-regime

Sustainable Minerals Institute (2024). *Resourcing decarbonisation*. https://smi.uq.edu.au/strategic-programs/resourcing-decarbonisation

Townsville Workforce Development Plan (2020). *Townsville Workforce Development Plan 2020-2025*. State of Queensland, Jobs Queensland. https://jobsqueensland.qld.gov.au/wp-content/uploads/2020/09/townsville-workforce-development-plan.pdf

Turnour, J. P. (2022). *Indigenous economic development and sustainable livelihoods for northern Australia* [Doctoral dissertation, James Cook University]. https://doi.org/10.25903/srmz-b347

United Nations Economic and Social Commission for the Asia and the Pacific. (2022). *2022 review of climate ambition in Asia and the Pacific.* https://www.unicef.org/eap/media/12896/file/ESCAP-2022-RP-2022-Review-Climate-Ambition-Asia-Pacific.pdf

United Nations. (2007). *UN Declaration of the Rights of Indigenous Peoples*. https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf

United States Economic Development Administration. (2024). *Supercharging local economies*. https://www.eda.gov/funding/programs/american-rescue-plan/build-back-better

Van Burg, E., Podoynitsyna, K., Beck, L., & Lommelen, T. (2012). Directive deficiencies: How resource constraints direct opportunity identification in SMEs. *Journal of Product Innovation Management, 29*(6), 1000-1011. https://doi.org/10.1111/j.1540-5885.2012.00976.x

van Oosterzee, P. (2012). The integration of biodiversity and climate change: A contextual assessment of the carbon farming initiative. *Ecological Management and Restoration, 13*(3), 238-244. https://doi.org/10.1111/emr.12001

Wood, K., Markham F., Smith D., Taylor J., Burbidge B., & Dinku Y. (2021). *Towards a perpetual funding model for Native Title Prescribed Bodies Corporate* [Commissioned Report No. 7]. Centre for Aboriginal Economic Policy Research.

https://cipr.cass.anu.edu.au/files/docs/2025/6/CAEPR_CR_7_Woods_et_al_2021_Towards_a_perpetual_funding_model.pdf

World Bank & Energy Sector Management Assistance Program (2022*). Regulatory indicators for sustainable energy 2022: Building resilience*. https://www.esmap.org/esmap-RISE

World Economic Forum (2021). *This is how climate change could impact the global economy*. https://www.weforum.org/agenda/2021/06/impact-climate-change-global-gdp/

World Economic Forum (2024). *Global Economy nears soft landing says IMF*. https://www.weforum.org/agenda/2024/02/imf-world-economic-outlook-report-soft-landing/

Yarnold, J., Marston, G., Mackey, B., McVeigh, J., Rolfe, J., Dale, A., Babacan, H., Lyons, B., Deane, F., Newlands, M., Plint, N., Molyneaux, L., Keenan-Jones, D., Birch, J., Maguire, R., Quiggin, J., Buleer, D., Lovelock, C.E.., Doran-Browne, N., & Ashford, G. (2022). *Decarbonising Queensland*. Queensland Universities Vice Chancellors Forum. https://www.ruraleconomies.org.au/media/1404/decarbonising-queensland.pdf

Zahra, S., McCarthy, B., & Chaiechi, T. (2022). Exploring sustainable meat consumption intentions in a Pakistani collectivist culture: Utilising the theory of planned behaviour. In T. Chaiechi & J. Wood (Eds.), *Community empowerment, sustainable cities, and transformative economies* (pp. 417–436). Springer Singapore. https://doi.org/10.1007/978-981-16-5260-8

Zero Net Emissions Cooperative Research Centre. (2024) *Delivering value from net zero*. https://zneagcrc.com.au/our-approach/

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