SUBMISSION

Submission to the NSW Net Zero Commission

Submission to the Call for Evidence on pathways

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The Australian Academy of Technological Sciences and Engineering (ATSE) is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.

New South Wales has a significant opportunity to accelerate the transition to a low-emissions economy while strengthening economic resilience, energy security and industrial competitiveness. Achieving the state's emissions reduction targets will require a coordinated, systems-based approach that supports innovation, investment and the conditions needed to enable the widespread adoption of low-emissions technologies across all sectors of the economy. Further opportunities exist to reduce emissions from hard-to-abate sectors, strengthen the research and commercialisation pipeline, and ensure the infrastructure, workforce and governance arrangements are in place to deliver the transition. Realising these opportunities will require strategic investment in renewable energy systems, emerging technologies and enabling infrastructure, alongside stronger collaboration across government, industry, research organisations and communities. ATSE's submission responds to the Net Zero Commission's questions regarding priority emission reduction opportunities, including electrification, available and emerging sector-specific technologies needed to achieve net zero and the enabling systems required to support their successful implementation.

ATSE makes the following recommendations:

Recommendation 1: Accelerate emissions reduction by prioritising investment in renewable electricity generation, transmission, storage and digital grid technologies to deliver a reliable, resilient and low-emissions electricity system.

Recommendation 2: Support the uptake of distributed energy resources, demand-side management and energy-efficient technologies to improve grid flexibility, reduce energy costs and enable economy-wide electrification.

Recommendation 3: Increase investment in research, development, demonstration and commercialisation to accelerate the deployment of emerging low-emissions technologies, particularly for hard-to-abate sectors.

Recommendation 4: Strengthen the enabling systems for the transition through coordinated governance, streamlined planning processes, workforce development and meaningful community and First Nations partnerships.

Decarbonising the electricity system

Decarbonising the electricity sector represents the single largest opportunity to reduce emissions in NSW and is the foundation of the state's broader transition to a net zero economy. A low-emissions electricity system not only reduces emissions from power generation but also enables emissions reductions across transport, industry, buildings, mining and parts of agriculture through the electrification of energy-intensive activities. As more sectors transition away from fossil fuels, electricity demand is expected to grow significantly, making a reliable, affordable and resilient renewable electricity system essential to achieving long-term emissions targets (IRENA 2026). The transition will require coordinated investment across the entire electricity system, including renewable generation, transmission, distribution, storage and digital technologies. ATSE's position statement, Pathways to Australian decarbonisation, further outlines a pathway to accelerate the electrification of Australia's domestic energy systems, including by expanding transmission, interconnection and digital management tools to balance supply and demand across regions(ATSE 2026).

The transition to a renewable electricity system will also require a smarter and more flexible grid. Consumers are increasingly relying on distributed energy resources, including rooftop solar, household batteries and electric vehicles. These resources represent a significant opportunity to improve grid flexibility while reducing energy costs (Walker and Kuiper 2026). The electrification of heating and hot water systems also provides more efficient alternatives to gas heating systems (Rey-Costa et al. 2025). Better integration of these assets through virtual power plants and smart energy management systems can reduce peak demand, improve system reliability and defer costly network upgrades. ATSE's Power to the people explainer outlines the benefits of demand side management for both consumers and the broader energy system, including grid stabilisation and lower capital and consumer costs (ATSE 2025a). Continued investment in energy efficiency across homes, businesses and industry will further reduce electricity demand while improving productivity and reducing electricity prices.

The growth of artificial intelligence, cloud computing and quantum computing is expected to drive considerable increases in electricity demand from data centres. However, opportunities exist to integrate data centres into existing electricity systems as a valuable source of demand flexibility. Computing workloads such as AI model training can be shifted to periods of high renewable energy generation or lower system demand, which can help to absorb renewable electricity excess and improve overall grid stability. Data centres can also be encouraged to invest in additional renewable energy generation and storage to meet the growing demand, which can assist in reducing pressures on the electricity system while supporting overall emissions reduction (Tao and Gadh 2025).

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Investing in R&D to drive net zero innovation

Achieving net zero emissions will require both the deployment of commercially available low-emissions technologies and continued innovation in sectors where current solutions remain technically or commercially constrained. Decarbonisation pathways can distinguish between commercially deployable technologies and those that will require further development before widespread adoption is possible. Mature technologies including renewable electricity, distributed energy resources, EVs, heat pumps and energy efficiency measures have the potential to deliver significant emissions reductions in the short term. However, they will not be sufficient to eliminate emissions across all sectors of the economy, particularly in hard-to-abate sectors such as agriculture, mining, heavy industry, built environment, wastewater and waste management. Hard-to-abate sectors currently make up about 19% of New South Wales's emissions due to chemical, technical or practical limitations (NSW DCCEEW 2025). Many decarbonisation technologies in these sectors, including renewable fuels for heavy transport and advanced recycling systems, require further technological development or cost reductions. Others, such as recycled concrete, low-carbon binders and digital lifecycle management technologies for the built environment sector, are commercially available but face barriers to widespread uptake, including infrastructure requirements, regulatory settings, standards and high upfront costs.

Technology readiness and deployment challenges can vary significantly across sectors, particularly those with hard-to-abate emissions. In agriculture, innovations such as methane-reducing feed additives, livestock genetics and precision agriculture can reduce emissions while maintaining productivity (Ghavi Hossein-Zadeh 2026). Challenges remain in scaling and applying these technologies. For example, while methane-reducing feed additives are promising, gaps remain in the technologies needed to deliver these additives, particularly for large-scale and distributed farms. Freight and mining also require continued innovation. Electrified vehicles can reduce emissions at short distances, but advances in battery technology are still needed for long-haul freight and heavy mining equipment. Biofuels also represent an opportunity for the mining, freight and agricultural sectors but require further R&D and commercialisation before they can be deployed at scale. ATSE's report, Decarbonising diesel industries, further explores emerging technologies in freight, agriculture and mining and the solutions and barriers to their implementation (ATSE 2025b). Heavy industry will similarly need sector-specific innovation to achieve net zero. Industries including ammonium nitrate, aluminium, steel and cement production will require further R&D to develop and commercialise lower emissions technologies such as renewable hydrogen integration in ammonium nitrate production, alternative anode technologies in aluminium production, scrap recycling, direct reduced iron and electric arc furnaces for steel, alternative cementitious materials, oxy-firing and carbon capture for cement.

Further research and innovation will also be essential to ensuring the transition to net zero is itself sustainable. Renewable energy technologies rely on significant quantities of critical and strategic minerals and materials such as aluminium, copper, lithium, rare earth elements and silver. However, increasing

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deployment of these technologies also raises questions about how these materials will be managed at the end of their operational lifespans. Without investment in advanced recycling, resource recovery and circular manufacturing technologies, these valuable materials risk becoming future waste streams rather than strategic resources (International Energy Agency 2022). This is particularly relevant for solar photovoltaic systems, where increased deployment today will lead to large numbers of retired panels in the future (Rodrigues et al. 2026). Developing technologies to recover and reuse these materials will improve supply chain resilience, reduce future resource constraints and strengthen Australia's sovereign capability in critical mineral processing and advanced manufacturing. R&D can also support the development and scaling of negative emissions technologies that remove carbon dioxide from the atmosphere or permanently sequester it from industrial processes. For example, mineral carbonation, including the potential for in situ carbonation of naturally occurring silicate rock formations, could provide a pathway for the permanent storage of carbon dioxide at significant scale (Al Kalbani et al. 2024; Iyare et al. 2025).

The NSW Government has an important role in supporting technologies through the innovation pipeline, from early-stage research through to demonstration and commercial deployment, where private investment alone is often insufficient. While New South Wales has internationally recognised universities, research organisations and innovation hubs, many promising technologies fail to progress beyond the research phase due to the high cost and risk of demonstration and initial deployment (Universities Australia 2025). Pilot facilities, demonstration projects and early commercial applications are often too capital-intensive for private investors, despite their importance in proving technologies and reducing costs for wider adoption. Strategic government investment at these stages can accelerate commercialisation, attract private capital and position New South Wales as a leader in emerging low-emissions industries. The NSW Government should maintain a technology-neutral and adaptive approach to emerging low-emissions technologies. This should include monitoring developments in emerging technologies such as fission and fusion nuclear technologies, carbon capture and storage and other low-emissions technologies, while recognising that their suitability for NSW will depend on future performance, costs, environmental impacts, regulatory settings and social licence.

Recommendation 3: Increase investment in research, development, demonstration and commercialisation to accelerate the deployment of emerging low-emissions technologies, particularly for hard-to-abate sectors.

Enabling decarbonising pathways through governance, workforce and community partnerships

Delivering the scale of transformation required across all pathways will depend on the economic, social and governance systems that enable these technologies to be deployed effectively. Coordinated investment in governance, planning, workforce capability and community partnerships will be essential to ensure the transition occurs efficiently, equitably and at the pace required to meet New South Wales's emissions reduction targets.

Building and maintaining social licence will be a critical challenge for decarbonisation pathways. New renewable energy generation, transmission infrastructure and industrial developments will increasingly be located within regional communities, requiring meaningful engagement with landholders, local governments, Aboriginal and Torres Strait Islanders and broader communities. Projects that do not establish and maintain community trust or demonstrate clear local benefits may face delays and increased costs or may fail to proceed altogether (Wright 2024). Embedding early, transparent and ongoing community engagement throughout project planning, benefit-sharing arrangements and opportunities for local employment and investment can improve project outcomes while strengthening public confidence. Supporting Aboriginal and Torres Strait Islander communities through partnerships, co-investment opportunities and asset ownership can further ensure that the benefits of the transition are shared equitably while contributing to regional economic development (Norman 2024).

The transition will also require significant investment in workforce capability, with Australia estimated to need an additional 42,000 energy trade workers by 2030 (Powering Skills Organisation 2025). Delivering renewable energy infrastructure, electrifying industrial processes and deploying emerging technologies will require skilled workers across engineering, construction, advanced manufacturing, and digital technologies. At the same time, existing industries will require support to transition their workforces and adopt new technologies. Strengthening education, vocational training and workforce planning will be essential to ensure that skills shortages do not become a barrier to decarbonisation while creating new employment opportunities across urban and regional New South Wales.

Recommendation 4: Strengthen the enabling systems for the transition through coordinated governance, streamlined planning processes, workforce development and meaningful community and First Nations partnerships.

ATSE thanks the NSW Net Zero Commission for the opportunity to respond to the Call for Evidence on pathways. For further information, please contact academypolicyteam@atse.org.au.

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