CLIMATE CHANGE AUTHORITY

2023 ANNUAL PROGRESS REPORT

October 2023

4 Cross-Cutting issues

Key information about Chapter 4

Carbon markets are poised to play a vital role in realising Australia's net zero ambitions.

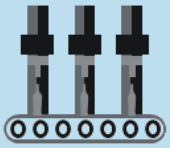
As the emphasis in the market for Australian Carbon Credit Units switches from Government purchasing to private demand, driven by the Safeguard Mechanism reforms, ensuring the carbon market is functioning well with high integrity is crucial.

Limiting warming to the Paris Agreement temperature goals will require both deep emissions reductions and an increase in carbon removals from the atmosphere. Time has run out to rely on reductions alone.

Australia needs to better understand its carbon sequestration potential and plan to significantly scale-up deployment of sequestration solutions to support the transition to net zero and ultimately net negative emissions in Australia. Carbon removed from the atmosphere will need to be stored in biological or geological 'sinks,' or used in long-lived products.

Australia should aggressively pursue opportunities for electrification of and improved energy efficiency in the built environment.

There are barriers to overcome to ensure the opportunities and benefits are widely available, including to low-income households, renters and small businesses.



A research, development & demonstration (RD&D) strategy should feature as part of the government's Net Zero Plan.

The technologies and solutions available today will underpin achievement of Australia's 2030 target, while emerging technologies can complete the net zero emissions picture. A RD&D strategy should promote innovation, safeguard competitiveness, and amplify co-operation between the government and private sector, while tracking progress towards goals.

The urgency, scale and importance of the response to climate change calls for much greater involvement of and cooperation and coordination between the Australian and state and territory governments.

A new agreement, or set of agreements, on reducing emissions, climate adaptation and the net zero transition will help drive the outcomes and behaviours Australia needs to be prosperous and resilient in a net zero world.

4.1 Domestic carbon markets

Australia's domestic carbon market is undergoing major change. The Safeguard Mechanism reforms commenced on 1 July 2023. The government has responded to the Independent Review of Australian Carbon Credit Units (ACCU) (Australian Government, 2023c) and is currently implementing the recommendations (DCCEEW, 2023u). The authority is also currently undertaking its review of the ACCU scheme which it is required to complete by the end of the year. Among other issues, the authority's review will build on the Chubb Review and consider the role of the government within the ACCU scheme in its 2023 review of the *Carbon Credits (Carbon Farming Initiative) Act 2011*.

The private sector, particularly facilities covered by the Safeguard Mechanism, will become the primary buyer of Australian carbon credit units (ACCUs) (CER, 2023c). Until recently, the Australian Government was the primary purchaser of ACCUs. The Clean Energy Regulator reported some Safeguard Mechanism entities are accumulating ACCUs, with Safeguard Mechanism account holdings increasing from 2.2 million over the financial year to 3.1 million by 30 June 2023 (CER, 2023c). Intermediaries, such as carbon traders, are also increasing their participation in the market – accounting for 35% of private ACCU holdings indicating potential liquidity of the market in future years (CER, 2023c). The government will continue to purchase under the ACCU scheme including to support the cost containment measure under the Safeguard Mechanism.

The supply of ACCUs in the next several years is forecast to be sufficient to meet expected Safeguard Mechanism compliance demand (CER, 2023c). The amount and type of supply of ACCUs available in the market will be heavily dependent on factors such as price, available methods under the ACCU scheme and available land for sequestration projects. The government also plans to launch the Australian Carbon Exchange in 2024 which will provide a platform for the purchase of ACCUs (CER, 2023i).

The authority's view is that the government should undertake and release analysis as part of its Net Zero Plan that outlines:

- anticipated emissions reductions from each sector in sectoral plans
- demand for offsets and parameters for their use
- potential realisable supply of both biosequestration offsets and geological sequestration.

The authority will support this analysis as part of its work on sectoral pathways. As mentioned in the discussion of the agricultural and land sector in this report (Chapter 3), there is significant pressure on the land sector to supply offsets while farmers must also look to sequestration to address the emissions from their own operations.

The authority has previously called for such analysis as part of a National Carbon Market Strategy (CCA, 2022b). Such a strategy could clarify the role of high integrity domestic and international units in the mix of voluntary and compliance related mitigation action, and help build confidence and trust in the markets that are essential to supporting Australia's transition to net zero.

32. RECOMMENDATION

Develop and publish a National Carbon Market Strategy.

4.2 Sequestration

Time has run out to achieve agreed limits to warming by reducing emissions alone. In addition to the rapid reductions of emissions, deployment of carbon dioxide removal (CDR) technologies is unavoidable if net zero CO_2 or net-zero GHG emissions are to be achieved (IPCC, 2022d). The authority's insights paper on carbon sequestration (CCA, 2023) calls for the scaling up of sequestration in Australia through a portfolio of approaches, as no single technology can achieve the scale of sequestration needed.

4.2.1 What is sequestration?

Carbon sequestration is the capture and storage of CO_2. It can be captured either through removal from the atmosphere (whether through photosynthesis or engineered technologies such as direct air capture (DAC)), or through separation from other gases at the point of origin, such as from industrial smokestacks. Carbon can then be stored in biological materials such as trees, in geological formations, minerals, long-lived products, or oceans (CCA, 2023). While sequestration may be associated with offsetting of carbon emissions, it is essential in itself for the long-term necessity to achieve net negative emissions by the second half of this century through drawdown and storage of carbon dioxide from the atmosphere.

In Australia, demand for sequestration is likely to grow. Not only is the demand for offsets likely to increase as industries such as cement pursue decarbonisation targets (Australian Government, 2021a), but Australia will require sequestration to meet its current emissions reduction targets, including net zero emissions by 2050 (CCA, 2023).

4.2.2 Recent developments

4.2.2.1 International policy developments

International support for sequestration has increased substantially in the past year, with a step change in government investment. Some of the most significant developments have been:

- The United States' *Inflation Reduction Act 2022* (IRA) raising the '45Q' tax credit to USD85 per tonne sequestered and to USD180 per tonne for DAC for facilities that meet specific eligibility criteria (The White House, 2023a), while USD2.54 billion has been allocated to the Carbon Capture Demonstration Projects Program (US DoE, n.d.). In August 2023, funding was announced for two DAC facilities which together are intended to remove more than 2 Mt CO_2 a year from the atmosphere, 250 times more than the largest DAC facility currently operating globally (US DoE, 2023).
- The European Union, through its Carbon Removal Certification Framework, proposes to establish a voluntary framework to certify high quality carbon removals and to monitor, report and verify the authenticity of these removals (European Commission, n.d.).
- The private sector is providing significant financial support to meet global sequestration goals. Examples include Microsoft's USD1 billion Climate Innovation Fund and the XPRIZE Foundation's USD100 million Prize for Carbon Removal, which aim to drive both commercialisation and scale (Microsoft, n.d.; XPrize, 2023).

4.2.2.2 Developments in Australia

In Australia, 64 Mt CO_2-e was sequestered in the land sector in 2022–23 (unpublished data provided by DCCEEW) (in net terms, see Chapter 3), while in 2020–21 slightly over 2 Mt CO_2-e was sequestered through carbon capture and storage or 'CCS' by the Gorgon offshore LNG project in Western Australia (DCCEEW, 2023c). The Gorgon project committed to sequestering at least 80% of the CO_2 from gas processing operations that would otherwise have been vented over the period 2016 to 2021, an amount estimated to total 12.3 Mt CO_2-e (IEEFA, 2022)). However, the project fell well short of this target, reporting a shortfall of 5.23 Mt CO_2-e over the period (Chevron, 2021).

The Department of Climate Change, Energy, the Environment and Water (DCCEEW) has released projections for the rates of sequestration in 2030. If realised, the rate of sequestration would decline to 38 Mt CO_2-e by 2030, comprising net removals of 33 Mt CO_2-e from the land sector and 5 Mt CO_2-e from CCS from the Moomba and Gorgon projects (DCCEEW, 2022a). Even by 2050, Australia is projected to produce around 87 Mt CO_2-e per year of 'non-technologically abatable' emissions, indicating an ongoing demand for offsets (Australian Government, 2021a).

A recent report by the CSIRO, commissioned by the authority and the Clean Energy Regulator, provided detailed information on the state of and potential for sequestration in Australia (CSIRO, 2022b). The report found that Australia has good potential to sequester carbon, but that no single technology would be sufficient to deliver sequestration at the necessary scale. A portfolio of approaches will be needed. The report found that Australia's realisable sequestration potential is unknown as there are substantial knowledge gaps, but that sequestration is a resource limited by inputs such as competition for land, water, energy and capital.

4.2.2.3 Develop a sophisticated modelling capability on sequestration

The realisable scale of sequestration in Australia is currently uncertain. Australia needs to rapidly build analytical capabilities, including modelling, to assess its sequestration potential. This analytical capability must take into account factors such as economic and environmental trade-offs in relation to land-use, energy and water availability. This analytical capability could be built through partnerships between government, industry and academia.

33. RECOMMENDATION

Develop a sophisticated modelling capability to analyse and forecast sequestration, for example through a partnership between the government, industry, and academia.

4.2.2.4 Ramp up investments in long-lived and engineered forms of sequestration

Significantly more investment is needed in long-lived sequestration. The engineered removal industry is currently in its infancy. Research, development and demonstration (RD&D) projects are needed to enable the rapid scaling up of engineered forms of carbon removal (CCA, 2023). Initiatives like the Future Energy Exports Cooperative Research Centre (Fenex CRC), the CO2CRC and CSIRO's CarbonLock Future Science Platform, are well placed to support the development of engineered sequestration.

The government could help build a market for currently high-cost engineered forms of sequestration by incentivising net-zero and carbon capture-derived products in compliance markets and Commonwealth procurement policies. This could gradually lead to lower costs as market demand increases. The government could also draw on market mechanisms including advance market commitments, contracts for difference and concessional loans to promote engineered sequestration. The authority intends to examine the role of the ACCU scheme in supporting long-lived and engineered forms of sequestration in its review due later this year.

34. RECOMMENDATION

Incentivise the development of long-lived and engineered forms of sequestration by supporting research and development and as technologies develop, through carbon markets or other financial instruments.

4.2.2.5 Ensure that fossil emissions are increasingly offset by long-lived forms of sequestration

The authority's insights paper noted that biological and geological sequestration are currently treated as equivalent in carbon markets, where no distinction is made between the carbon credits issued for the sequestration. The insights paper argued that for emissions to be counterbalanced by sequestration, carbon should be stored in a quantity and for a duration equivalent to the nature of the emissions (CCA, 2023). Geological sequestration can last thousands or even millions of years, but the vulnerability of biological sequestration (for example to droughts and bushfires, exacerbated by climate change) means it may only last decades to centuries unless continually renewed (CSIRO, 2022b; IPCC, 2022d).

In addition, where fossil emissions are offset by biological sequestration, the Earth's natural carbon cycles are altered through the transfer of carbon from the geosphere (the inactive geological fossil carbon cycle) to the biosphere, atmosphere and hydrosphere (the active carbon cycle) (Bellona Foundation, 2022). A 2022 study argues that offsetting emissions from fossil fuels in the biosphere at best provides only temporary stabilisation of the global temperature. For long-term climate stability, 'geological net zero' is required, namely, that geological emissions are matched by geological sequestration and biological emissions are matched by biological sequestration (Allen, 2022).

To address these problems, and in line with the Oxford Offsetting Principles and the ISO's Net Zero Guidelines, Australia should increasingly shift towards offsetting fossil fuel emissions in long-lived forms of storage that permanently remove CO_2 from the atmosphere (University of Oxford, 2020; ISO, n.d.). This would be particularly applicable to facilities covered under the Safeguard Mechanism. It means that over time, they would need to increasingly offset their emissions with long-lived, in most instances geological, forms of sequestration.

4.2.2.6 Address regulatory barriers to enable greater uptake of sequestration

A range of barriers to the rapid uptake of sequestration currently exists, both domestically and internationally. In the domestic context, engineered forms of sequestration are currently not financially incentivised, such as through the *Carbon Credits (Carbon Farming Initiative) Act 2011*, which only includes sequestration via living biomass, soil, or dead organic matter, and does not cover engineered. This means that engineered technologies are unable to generate funds through the creation of ACCUs. In addition, these technologies are currently not distinctly covered in Australia's national inventory and the IPCC has not developed new reporting guidelines, where CDR could be treated as a distinct category alongside traditional sectoral categories found within greenhouse gas inventories (DCCEEW, 2022g).

The authority's insights paper suggested removals could be a distinct category in national decarbonisation plans, emissions reporting, projections and the authority's annual progress reports (CCA, 2023). There are also opportunities for Australia to work with like-minded countries and the IPCC to update international inventory reporting rules. In relation to onshore and offshore geological storage, legislative and regulatory environments can be complex, including containing duplications, uncertainties, and inconsistencies in the application of state and territory and Commonwealth legislation and regulations. These complexities should be assessed and streamlined to ensure regulatory objectives are achieved while also creating an enabling environment for the deployment of sequestration.

35. RECOMMENDATION
Take a leading role to reduce the domestic and international regulatory barriers preventing the uptake of engineered sequestration and carbon dioxide removal technologies.

4.2.2.7 Establish separate targets for emissions reduction and removals

The authority's insights paper argued that carbon dioxide removal (whether by biological or engineered forms) should be a distinct category in national decarbonisation plans, and that separate targets for emissions reduction and removal should be set to incentivise future demand (CCA, 2023). This concept is being discussed around the world. For example, responses to recent public consultation on the European Union's 2040 climate target found that 'most respondents advocated for three separate targets for GHG emission reductions, nature-based carbon removals, and industrial removals' (European Commission, 2023d). Academic research has also highlighted the need to guard against removals being used to delay emissions reductions (McLaren, 2019; Dooley, Nicholls, & Meinshausen, 2022). The authority will continue to work on these issues.

4.2.2.8 Other measures

Other measures proposed in the insights paper, which could assist in the rapid growth of sequestration, include:

- Australia should work with like-minded countries and the IPCC on the development of a science-based sequestration taxonomy and terminology, through the development of national standards and international guidelines.
- Sectoral pathways and targets for decarbonisation could help build a more rigorous framework for anticipating future sequestration demand.
- Carbon dioxide removal should be included as a distinct category in national decarbonisation plans, emissions reporting, projections, and the authority's annual progress reports.
- Separate targets for emissions reduction and removal should be set to help incentivise future demand and help guard against sequestration being used to delay emissions reductions.

4.2.3 Indicators of progress

Progress on scaling up sequestration in Australia could be measured through the following indicators. The authority will look to report against these in future annual progress reports:

- Annual expenditure on RD&D for engineered sequestration
- Policies to encourage fossil fuel emissions to be offset through geological forms of sequestration, while biological sequestration is increasingly used to offset land-based emissions.

4.3 Electrification of the built environment

4.3.1 Issues, context and trends

Greenhouse gas emissions associated with Australia's built environment, including commercial and residential structures, were 97 Mt CO_2-e in 2020–21, or 21% of Australia's total emissions that year.[23] This figure includes 18 Mt CO_2-e of emissions associated with direct combustion including gas combustion for space and water heating and cooking, and 79 Mt CO_2-e associated with the generation of electricity to supply these buildings.[24] The built environment also contributes indirectly to emissions, for example through embedded emissions in purchased materials such as concrete, steel and glass (UNEP, 2022b).

In this section, the authority focuses on the electrification of the built environment as it presents a significant opportunity for decarbonisation towards 2030. The authority will consider the issues relating more broadly to the contribution of the built environment to reducing Australia's emissions in its future work, in particular as one of the sectors in the authority's review of sectoral technology transition and emission pathways.

Decarbonisation of Australia's built environment will depend upon the decarbonisation of electricity supply and electrification to address the emissions associated with gas combustion in buildings. Opportunities for electrification include transition from gas to electricity for heating, hot water and cooking (AEMO, 2023f).

The pace of rooftop solar installations needs to continue to meet modelled outcomes for the high shares of renewables in electricity supply consistent with Australia's emissions reduction targets, and household battery installations need to accelerate. However, the government's subsidy for small scale solar installations (the Small-scale Renewable Energy Scheme) is progressively reducing each year as it moves towards its close in 2030 (CER, 2023k). In the lead up to 2030, incentives will also likely be needed to ensure that small-scale batteries are installed in much greater numbers to assist with grid stability challenges. The government should consider what measures for rooftop solar installations and complementary small-scale battery storage will be required to maintain the required pace of installations.

If Australia follows international trends, buildings will be the location of most of the recharging infrastructure needed for electric vehicles (ChargeUp Europe, 2022; Blonsky, Munankarmi, & Balamurugan, 2021). The roll out of this infrastructure needs to be monitored and supported through the removal of unnecessary regulatory barriers. Technological innovations should be prioritised such as vehicle to grid, where electric vehicles can provide stability to the grid (ARENA, 2021).

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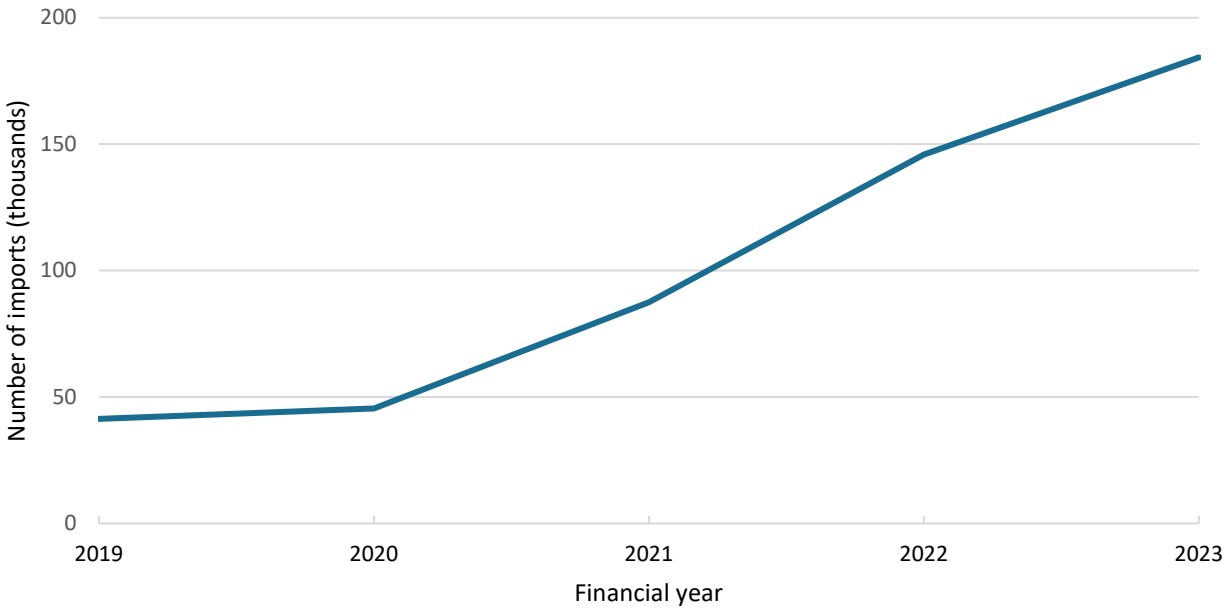
23 This figure includes emissions from direct fuel combustion under IPCC sectors 1.A.2.g.iv Construction, 1.A.4.a Commercial/Institutional and 1.A.4.b Residential; 2 Mt, 5 Mt and 11 Mt respectively in 2020–21 (DCCEEW, n.d.). This figure also includes emissions relating to the purchase of electricity from ANZSIC economic sectors DIV E Construction, DIV F-H, J-S Commercial Services and Residential; <1 Mt, 37 Mt, and 42 Mt respectively in Data Table 2 (DCCEEW, n.d.). Australia's total emissions in 2020–21 were 465 Mt (DCCEEW, n.d.). This is the latest data available for built environment emissions as this data is not included in the DCCEEW National Greenhouse Gas Inventory: Quarterly updates.

24 See previous footnote.

4.3.2 Leading indicators

Efficient electrification will be essential for the built environment to deliver its fair share of emissions reductions to 2030. Heat pumps (for example to heat water) are a ready technology. Imports of heat pumps have been growing rapidly over the last few years, however from a relatively low base (see Figure 4.1). One of the barriers to accelerated uptake of heat pumps is the difference in cost between gas and electric appliances (Grattan Institute, 2023). Grattan Institute analysis of retail data found that heat pump hot water heaters were approximately $1,550 more expensive than instantaneous gas hot water heaters (Grattan Institute, 2023).

Figure 4.1: Heat pump imports, 2019–2023



Notes:

- Number of heat pump imports includes domestic heat pump hot water systems and domestic heat pump air conditioners.
- Source: Unpublished ABS data

Submissions suggested leading indicators relevant to electrification, including specific indicators on people changing their gas stoves to electric ones (Individual submission); and solar panels being placed on roofs (Individual submission). GreenPower suggested tracking the number of household and business gas connections. The authority considers that the number of rooftop solar PV installations and numbers of household and business gas connections are important historical indicators, rather than leading indicators.

Other submissions suggested broader themes for indicators, such as household and business decline in gas use (Climate Council), electrification (Australian Conservation Foundation) and increasing energy efficiency (Australian Conservation Foundation, Climate Council). The authority will consider how to use these themes to build on leading indicators for the 2024 Annual Progress Report.

4.3.3 Innovations and developments

4.3.3.1 Distributed energy resources

As at 30 June 2023, there was 18,043 MW of small-scale solar PV installed in the NEM under the Small-scale Renewable Energy Scheme.[25] It is difficult to find data on actual installed capacity of distributed storage and coordinated DER storage in the NEM as small-scale batteries are not an eligible technology under the Small-scale Renewable Energy Scheme, the main mechanism for data collection on small scale installations. The 2023 AEMO Inputs Assumptions and Scenarios Workbook estimated that in 2022–23 there was 786 MW of embedded small-scale battery storage and 139 MW of aggregated (e.g., in a Virtual Power Plant) small-scale battery storage in the NEM (AEMO, 2023j).

Distributed energy resources such as rooftop solar PV units, battery storage, electric vehicles and chargers and smart meters are changing Australia's electricity grid. ARENA has noted that 'rather than electricity being generated by big, centralised power stations, it is now starting to come from many places, including millions of homes and businesses' (ARENA, 2023b). ARENA is providing over $18 million in funding across seven current distributed energy resources projects. These include the Smart CER Consumer Uptake Tool project which commenced during 2022–23, to develop an online consumer Smart Energy Tool to provide households with an economic assessment of DER options (ARENA, 2023d); (ARENA, 2023e).

ARENA is also investing in demand response projects to help facilitate the voluntary reduction or shift of electricity use by customers to support grid stability, including providing $16.5 million across four current projects which commenced in 2022–23 (ARENA, 2023a); (ARENA, 2023d). ARENA should continue to support DER and demand response projects as more DER resources enter the grid. The Clean Energy Finance Corporation has been allocated an additional $19 billion to help deliver the Rewiring the Nation program, with investments expected to include distributed energy resources (CEFC, 2023c).

In developing the National Energy Performance Strategy, the government should have regard to AEMO's Integrated system Plan and coordinate with AEMO, ARENA and CSIRO to incentivise the best mix of distributed energy resources for a stable grid. The Strategy should also support continued investment in distributed energy resources and demand response.

The submission from Greenpower suggested the 'Australian Government could provide funding for significant public awareness and education campaigns which highlight some of the most impactful practical actions that households and businesses can take to reduce their carbon footprint and save money', including as examples, installing rooftop solar, buying or leasing an electric vehicle, and insulating and electrifying homes and businesses. In the authority's view, the National Energy Performance Strategy could also include education campaigns about electrification and load shifting.

[25] Calculated by adding the installed capacity in the Australian Capital Territory, New South Wales, Queensland, Tasmania, South Australia and Victoria in the CER Postcode data for small-scale installations (CER, 2023c).

4.3.3.2 Data gaps

Electrification opportunities for the built environment include the installation of heat pumps and solar water heaters, rooftop PV and batteries and electric vehicle chargers. Heat pumps, solar water heaters and rooftop PV are eligible technologies under the Small-scale Renewable Energy Scheme (CER, 2023k). Under this scheme, the Clean Energy Regulator collects and publishes monthly installation numbers for eligible technologies, and monthly installed capacity in kilowatts for rooftop solar. Data is available from 2001 onwards and is disaggregated by postcode. The Clean Energy Regulator does not collect or publish data on installations by electricity grid.[26] An additional limitation on this data is that the Small-scale Renewable Energy Scheme is planned to end in 2030 (CER, 2023k), which presumably will halt data collection for eligible technologies.

Tracking the progress of household batteries and electric vehicle chargers is more challenging as these are not eligible technologies under the Small-scale Renewable Energy Scheme. The Clean Energy Regulator provides data on the number of rooftop PV installations under the Small-scale Renewable Energy Scheme which include a battery (CER, 2023e). Battery data is reported to the Clean Energy Regulator on a voluntary basis, typically when eligible Small-scale Renewable Energy Scheme installations occur. The Clean Energy Regulator does not collect or publish data on the installed capacity of household batteries, or numbers of electric vehicle charger installations.

The National Energy Performance Strategy consultation paper states that meeting the future needs of the energy market requires strengthening the role of demand-side considerations in energy system planning (DCCEEW, 2022h). Improved data collection and reporting for distributed energy resources would assist AEMO in modelling energy demand and developing system plans. For example, expanding the scheme to include household batteries or electric vehicle chargers would incentivise the installation of these technologies and facilitate data collection on their installation and capacity numbers. Continued and more detailed data collection would also provide important information to the government in tracking progress towards the 2030 emissions reduction target.

4.3.3.3 Heat pump and solar water heater installations

In 2022–23, 110,000 air source heat pumps were installed in Australia that were eligible to generate certificates under the Small-scale Renewable Energy Scheme, a significant increase from 71,880 installed in 2021–22 (CER, 2023c). Only 30,476 solar water heaters were installed in 2022–23[27] (CER, 2023j) down from 36,360 in 2021–22 (CER, 2021).

System owners typically assign the right to sell small-scale technology certificates on their behalf to an agent (i.e. their installer) in return for a lower upfront purchase price (CER, 2023k). The upfront financial benefit received is generally based on the market price of the small-scale technology certificates at the time of installation (CER, 2019), which was $37.10 per small-scale technology certificates on 5 October 2023 (Greenbank, 2023). This benefit could equate to a reduction of approximately $864 on the price of a heat pump hot water heater (SolarHub, 2023).

Some state and territory governments have also offered rebates for the installation of heat pumps and solar hot water systems. For example, the Victorian Government offers owner-occupiers a rebate of up to $1,000 on eligible heat pumps and solar hot water systems (Victorian Government, 2023a). The New South Wales Government Energy Savings Scheme also incentivises hot water system upgrades (NSW Government, 2023d).

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[26] Postcode data can be used to disaggregate installations by grid, by correlating postcodes with maps of electricity grids, however this is a time-consuming process.

[27] CER website data for small-scale installations is current as at 31 August 2023.

Even with discounted costs, it may be difficult for low-income households to afford the installation cost of these technologies. Two additional components of the cost of transitioning away from gas appliances include fees to disconnect or remove a gas connection, and the potential cost of upgrading to three-phase power due to the increased electricity load (Grattan Institute, 2023). Costs for abolishing gas supply vary, for example $770–$800 in the Australian Capital Territory, and approximately $1,150 in New South Wales (ACT Government, 2023b); (Jemena, 2023). The Australian Energy Regulator issued a decision in June 2023 to cap certain gas abolishment tariffs over the 2023−28 period in Victoria (AER, 2023b). Renters can also face the barrier of not having permission to electrify certain appliances.

4.3.3.4 Rooftop solar photovoltaic (PV) and batteries

In 2022–23 3,046 MW of small-scale solar was installed in Australia[28] (CER, 2023c). Of the small-scale solar systems installed in the 2022 calendar year, approximately 7% included battery storage (CER, 2023d); for the calendar year up to 30 June, 2023, this figure amounted to only 2% (CER, 2023e). A scenario modelled by AEMO of greater than 80% renewable energy generation indicates the quantity of small-scale solar and battery storage needed to be deployed on average per year to 2030 (Table 4.1). This scenario shows that, approximately one MW of small-scale battery storage is needed for every 3 MW of rooftop PV installed in the NEM by 2030[29] (AEMO, 2022g).

Table 4.1: Installed rooftop solar PV in the NEM, MW

	Total capacity in June 2022	Capacity required by June 2030	Annual increase required to 2030	Increase in capacity in 2022–23	Difference between required and actual increase
Rooftop solar PV	15,410	30,396	1,873	2,632	+759

Source: (AEMO, 2022g); (CER, 2023j).

The 2022–23 GenCost report noted that the COVID-19 pandemic has led to higher capital costs for all technologies considered (including rooftop solar PV) (CSIRO, 2023d). The Small-scale Renewable Energy Scheme discount could equate to a reduction of up to $408 per kw[30] in a moderately sunny area of Australia (Greenbank, 2023). However, the total subsidy provided by the Small-scale Renewable Energy Scheme will reduce towards 2030 as the number of years during which a system can generate small-scale technology certificates will diminish under the rules of the scheme.

The Guarantee of Origin Scheme, if enacted, would operate past 2030 and in the lead up to 2030, would operate alongside the Renewable Energy Target (Australian Government, 2022d). Eligible participants could generate a tradable certificate representing one megawatt hour of eligible renewable electricity generation (Australian Government, 2022d). However, it is unclear how certificates would be priced by the market, and whether the scheme would offer the same reduction in upfront cost as the Small-scale Renewable Energy Scheme.

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28 Calculated by adding the installed capacity in NEM postcodes.

29 The Rooftop PV sheet of AEMO's Inputs assumptions and scenarios workbook shows 30 gigawatts (GW) of rooftop PV installed cumulatively across NEM states by 2030 under the 'Step Change' scenario, and the Embedded energy storage sheet shows 9 GW of small-scale batteries in 2030 under the same scenario.

30 Based on an installation date of 1 October 2023, system capacity of 1 kW, postcode of 2601 and small-scale technology certificate price of $37.10. According to the Greenbank calculator, this would equate to 11 small-scale technology certificates.

The authority is of the view that the government should consider extending the Small-scale Renewable Energy Scheme deeming period past 2030 and expanding the types of technologies eligible for support. If the scheme is extended past 2030, the authority considers that it would be useful for data to be collected on installations by grid as well as by postcode to help track the decarbonisation of each grid. Expanding eligible technologies to include household batteries and electric vehicle chargers would incentivise their deployment and provide valuable data on the roll-out of these technologies.

36. RECOMMENDATION

Extend the Small-scale Renewable Energy Scheme post-2030 to ensure continued support for electrification and expand the scheme to include household batteries and private electric vehicle chargers.

If the Small-scale Renewable Energy Scheme ends as planned in 2030, the government should consider alternative options to continue incentivising small-scale installations and maintaining safety and quality standards. For example, expanding the Community Battery scheme and Solar Banks program discussed below or developing new incentives.

Even with discounted costs under the Small-scale Renewable Energy Scheme, it may be difficult for all stakeholders to have equitable access to rooftop PV. Barriers identified in First Nations consultations included lack of access to rooftop solar for renters, housing standards (as some dwellings could not support rooftop solar), lack of information on diesel subsidies making it difficult to make an informed decision about switching to solar and a lack of a skilled workforce in remote areas for installing and maintaining systems. First Nations stakeholders suggested a mandate for government to support rooftop solar on social housing and ensure that tenants benefit from rooftop solar as well. The submission from the Committee for Sydney recommended mechanisms to encourage property owners to install rooftop solar in rented properties, expanding solar for low-income housing and updating strata rules to make it easier to install apartment solar systems.

The authority is of the view that the National Energy Performance Strategy should give particular consideration to supporting low-income households, renters, public housing tenants, apartments and regional, remote and First Nations communities.

4.3.3.5 Electric vehicle charging

Chapter 3, Electricity provides commentary on the growth of publicly available electric vehicle chargers. However, private vehicle chargers (such as household chargers) will be an important part of the infrastructure required for electric vehicles. Over 80% of charging in the European Union and in the United States of America occurs at home or at work (ChargeUp Europe, 2022; Blonsky, Munankarmi, & Balamurugan, 2021) and a similar trend might be expected in Australia. There are currently no statistics for private charger installations in Australia despite their role in supporting the transition to electric vehicles and effect on grid stability (CSIRO, 2022a). Understanding the numbers, location and speed of private vehicle chargers will be relevant for managing the grid in the future (AEMO, 2021b). As more behind-the-meter solar PV is installed, and more batteries and electric vehicles charge and discharge, the demand profiles for grid-supplied energy shifts (AEMO, 2022a). For example, if electric vehicles are charged during the day, they could potentially store excess solar generation, while charging at night would increase evening peaks (AEMO, 2022a).

If the recommendation to extend and expand the Small-scale Renewable Energy Scheme is adopted, installation numbers would be reported to the Clean Energy Regulator and published. If this recommendation is not adopted, the authority recommends the government establish methods to track figures instead under the Electric Vehicle Strategy, to inform the metrics to monitor the progress of charging infrastructure.

37. RECOMMENDATION

Establish methods to track the numbers, locations and speed of private electric vehicle charger installations, to inform metrics on the successful roll-out of charging infrastructure. The government should publish these figures each year, and ensure the data is available to AEMO for grid management purposes.

The National Electric Vehicle Strategy indicates that the government will undertake research to inform and enable electric vehicle uptake for residents of existing multi-residential buildings (DCCEEW, 2023e). This research should be complemented by actions to track private charger installations and to identify and remove barriers to the roll out.

4.3.4 Policy opportunities and recommendations

4.3.4.1 Energy performance

The government is investing $15.2 million to develop a Commonwealth-led National Energy Performance Strategy (DCCEEW, 2023bb). The Strategy will provide a national plan to accelerate demand-side action, including energy efficiency and electrification (DCCEEW, 2023bb). The National Energy Performance Strategy Consultation Paper released in November 2022 anticipated that the Strategy would be delivered in mid-2023 (DCCEEW, 2022h). As at 10 October 2023 the Strategy has not been released.

In the authority's view, the Strategy should provide a framework for action that encompasses the electrification of the built environment, behaviour change, load shifting and energy efficiency. The authority recently advised, in its submission to the Fuel Efficiency Standards consultation, that the impacts of an increase in transport electrification be considered in energy transition policy development processes, such as the post-2025 electricity market design project and the development of the National Energy Performance Strategy.

4.3.4.2 Electrification

Many submissions supported measures for the uptake of electrification technology in residential or commercial buildings (Australian Energy Council, EnergyAustralia, Committee for Sydney, Australian Conservation Foundation, Beyond Zero Emissions, Doctors for the Environment, Grattan Institute, Council of Capital City Lord Mayors, individuals) such as water heating, cooking, space heating, cooling, electric vehicle charging, rooftop solar and distributed battery storage. Several submissions supported incentives to decrease the upfront installation costs of electric appliances (EnergyAustralia, Australian Institute of Landscape Architects).

The authority has provided commentary on the Small-scale Renewable Energy scheme above, which is currently the most significant mechanism to encourage electrification through the installation of heat pumps, solar hot water heaters and rooftop solar PV.

In the May 2023 budget, the government announced $1.3 billion in funding for a Household Energy Upgrades Fund to support home upgrades that would improve energy performance and save energy (Treasury, 2023a). This included $1 billion for the Clean Energy Finance Corporation to provide low-interest loans for energy-saving home upgrades (Treasury, 2023a). The Household Energy Upgrades Fund also includes $300 million to support upgrades to social housing (Treasury, 2023a).

The government has committed $200 million for the Community Battery scheme to 'deploy 400 community-scale batteries for up to 100,000 Australian households' (DCCEEW, 2022f).

In 2022, the government announced the Community Solar Banks program with investments of $102 million targeting 25,000 recipients living in apartments, rental accommodation or low-income households (DCCEEW, 2022f). At June 2022, there were 418,400 households in the four main social housing programs: public housing, community housing, Indigenous community housing and state-owned and managed Indigenous housing (AIHW, 2023). The Community Solar Banks program would need to be scaled up significantly to ensure access to the benefits of rooftop solar for residents in public housing alone.

Stakeholders expressed support for government measures to electrify social, community and Indigenous housing (Grattan Institute, Doctors for the Environment, Committee for Sydney). Some submissions specifically noted difficulties for renters or low-income households to shift away from gas (Brotherhood of St Laurence, Beyond Zero Emissions, Melbourne Climate Futures). Submissions recommended introducing tax incentives for landlords (Grattan Institute), or more generally, actions towards landlords and investors so renters don't miss out (Melbourne Climate Futures).

The authority is of the view that the National Energy Performance Strategy should give particular consideration to supporting low-income households, renters, public housing tenants, apartments and regional, remote and First Nations communities.

4.3.4.3 Energy efficiency and affordability

The cost of energy is increasing. To protect customers from high energy prices, the Australian Energy Regulator (AER) has maintained a default market offer since 2019, which acts as a safety-net price cap (AER, 2023a). However, the default market offer must be set to allow retailers to cover their costs. As a result, residential customers in Queensland, New South Wales and South Australia on standard plans could still face price increases of between 19.6% to 24.9% in the next financial year (AER, 2023a). Victoria's regulator has also proposed an increase of around 25% for customers on default offers, with typical bills increasing from $1,403 to around $1,829 per year (Essential Services Commission, 2023).

Rising energy bills disproportionality impact low-income households with those in the National Energy Market consistently paying approximately double what an average income household pays as a proportion of household income (AER, 2022). The rising cost of energy and overall cost of living has contributed to one in five Australians surveyed by the Melbourne Institute reporting not being able to afford to adequately use their heating or cooling, with the disadvantage being more pronounced for those who are financially stressed. Further, 12% reported having skipped a meal or eaten less to be able to pay their energy bills (Melbourne Institute: Applied Economic & Social Research, 2023).

The implications of rising costs of energy consumption are increased by energy inefficient housing. Several submissions to the authority's issues paper (Planning Institute of Australia, Greenpeace Australia Pacific, Joint submission from 19 built environment peak bodies, Council of Capital City Lord Mayors, Australian Institute of Landscape Architects) recognised this and supported further investment in energy efficiency measures, or energy saving mechanisms (ARENA, the Australian Conservation Foundation). The Energy Efficiency Council indicated that energy efficiency opportunities are available for immediate deployment. However, there are persistent barriers preventing a market and/or regulatory environment that improves the energy performance of Australia's residential building stock. Key barriers include:

- a lack of data on a home's energy performance
- market environment for energy efficiency options
- access to energy efficiency options.

4.3.4.4 Lack of data on a home energy's performance

Most home occupiers are not equipped with information on the energy performance of their home, which includes information on their appliances and the thermal shell of their home. As part of the National Household Energy Rating Scheme (NatHERS) energy performance ratings for 15,658 class 1 homes has been recorded (as of 5 October 2023). It is important to note that, 97% these homes were in Victoria. The average energy performance rating for homes within the NatHERS database is a very low score of 2.2 NatHERS stars out of 10 (CSIRO, 2023b). This indicates very poor energy performance for the homes included in the database.

At the national scale there is little to no information on the performance of the 6 million class 1 dwellings built prior to the introduction of minimum energy efficiency standards 2003 (NatHERS, 2022). Updates to the National Construction Code in 2022 included a requirement that all new homes have a minimum star rating of 7 (ABCB, 2022).

There have been regulatory challenges that have driven this data gap. In 2009, the Council of Australian Governments agreed to phase in mandatory disclosure of residential building energy performance at the point of sale or lease (COAG, 2009). As of October 2023, this had not been implemented. Another challenge is technical; there is currently no NatHERS-accredited tool to rate existing homes. In May 2023, the Australian Government announced $36.7 million in funding to deliver NatHERS-accredited ratings for existing homes (Australian Government, 2023d). This is a promising development and the authority will monitor the implementation of the commitment.

Disclosing energy performance information is not likely to deliver notable energy efficiency improvements on its own. A market environment for energy efficiency upgrades must accompany this information to motivate home occupiers to invest in energy performance.

4.3.4.5 Market environment for energy efficient upgrades

The upfront cost of investment in energy performance is a challenge for many property owners. Exemplifying this, Sustainability Victoria found that an average energy efficiency upgrade cost of $2,809 reduced a household's energy cost by approximately $87 over the measured winter period and a modelled cost of $124 over a calendar year (Sustainability Victoria, 2022), resulting in an estimated 22.6-year payback period. However, electricity and natural gas prices along with cost-of-living increases are shifting the economics of decarbonisation options and make the issue of energy affordability a top priority in the short term (AER, 2022).

4.3.4.6 Access to energy efficient upgrades

The 31% of Australians that rent their home face barriers to accessing energy efficiency improvements and are likely to live in energy inefficient homes (ABS, 2022c) (O'Neill, 2020). Renters are largely unable to replace fixtures and fittings or the thermal shell without landlord permission, and a split-incentive exists in which renters are unlikely to be tenanting a property long enough to recoup expenditure on energy efficient upgrades. Landlords are unlikely to experience material benefits from energy efficient upgrades and, aside from minimum requirements in the Australian Capital Territory (ACT Government, 2023c) and Victoria (Consumer Affairs Victoria, 2023), are not required to invest in upgrades to property energy performance to lease a property. Providing tax incentives to landlords to invest in energy efficient upgrades was suggested by the Grattan Institute in response to the authority's issues paper.

Poor energy performance producing unhealthily cold homes is a prevalent issue for Australia's renters. In a 2022 study, 74 rental properties, tracked using smart thermometers, failed to reach the World Health Organisation's recommendation of a minimum 18°C indoor temperature to protect health during 75% of a recorded winter period (Dignam & Barrett, 2022). This problem is not just impacting renters; another study of 100 homes between June and August 2022 found that 81% of the homes surveyed failed to meet an 18°C average indoor temperature (Barlow, Daniel, & Baker, 2023).

38. RECOMMENDATION

Implement policies to increase the accessibility of electrification options. This includes, for example, through provision of zero interest financing to reduce up-front costs and provision of funding for public and Indigenous housing to convert to all-electric.

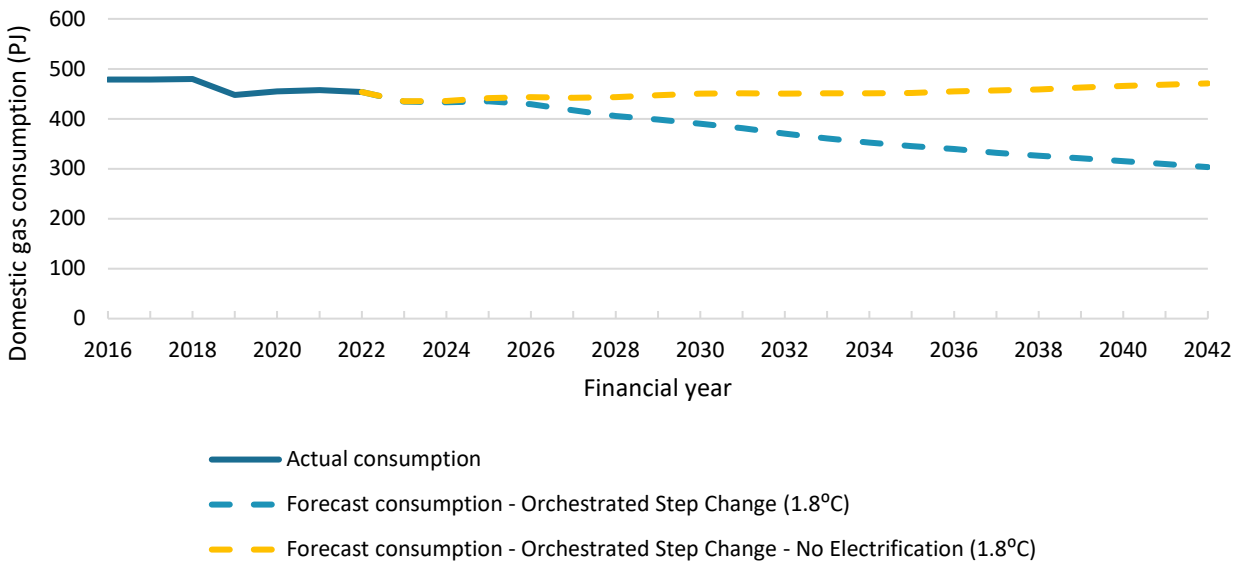
4.3.4.7 The role of gas

Chapter 3 – Electricity provides commentary on the role of gas in the National Electricity Market and the importance of maintaining adequate domestic supply.

According to AEMO, there were 4,691,013 household and commercial gas connections in the NEM in 2020–21. AEMO modelling of a scenario most closely aligned with the 82% renewable energy target includes the removal of 801,548 gas connections by 2029–30 (AEMO, 2023k). This equates to the electrification of 89,061 connections per year. AEMO revised forecasts of residential and commercial gas consumption due to a slower pace of electrification than was previously forecast in the 2022 Gas Statement of Opportunities (AEMO, 2023f).

AEMO's 2023 Gas Statement of Opportunities notes the uncertainties in the speed and extent of gas sector transformation and uses scenarios and sensitivities to explore the needs of gas consumers and the adequacy of gas infrastructure to meet those needs (AEMO, 2023f). Figure 4.2 below shows the forecast of domestic gas consumption under the Orchestrated Step Change (1.8°C) scenario (the scenario most closely aligned to the Step Change scenario), and the Orchestrated Step Change (1.8°C), No Electrification scenario assumes a halt on electrification (AEMO, 2023f). A clear phase out of new connections and plans for the electrification of existing connections would provide more certainty on future demand for generators and the market operator in anticipating domestic gas consumption needs.

Figure 4.2: Domestic gas consumption, 2019–2042



Source: (AEMO, 2023k)

State governments have taken different approaches to phasing out gas. For example, the Australian Capital Territory Government's *Climate Change and Greenhouse Gas Reduction Act 2010* (ACT) was amended in June 2023 to prohibit gas distributors from providing new gas connections for natural gas (see Section 13A(1)). This Act includes setting targets to reduce greenhouse gas emissions in the Australian Capital Territory as one of its objects in Section 5 and implements measures to meet these targets. In July 2023, the Victorian Government announced that from 1 January 2024, new homes and subdivisions requiring a planning permit will only be able to connect to electric networks (Victorian Government, 2023b), drawing on the role of states and territories in the planning and permitting of buildings.

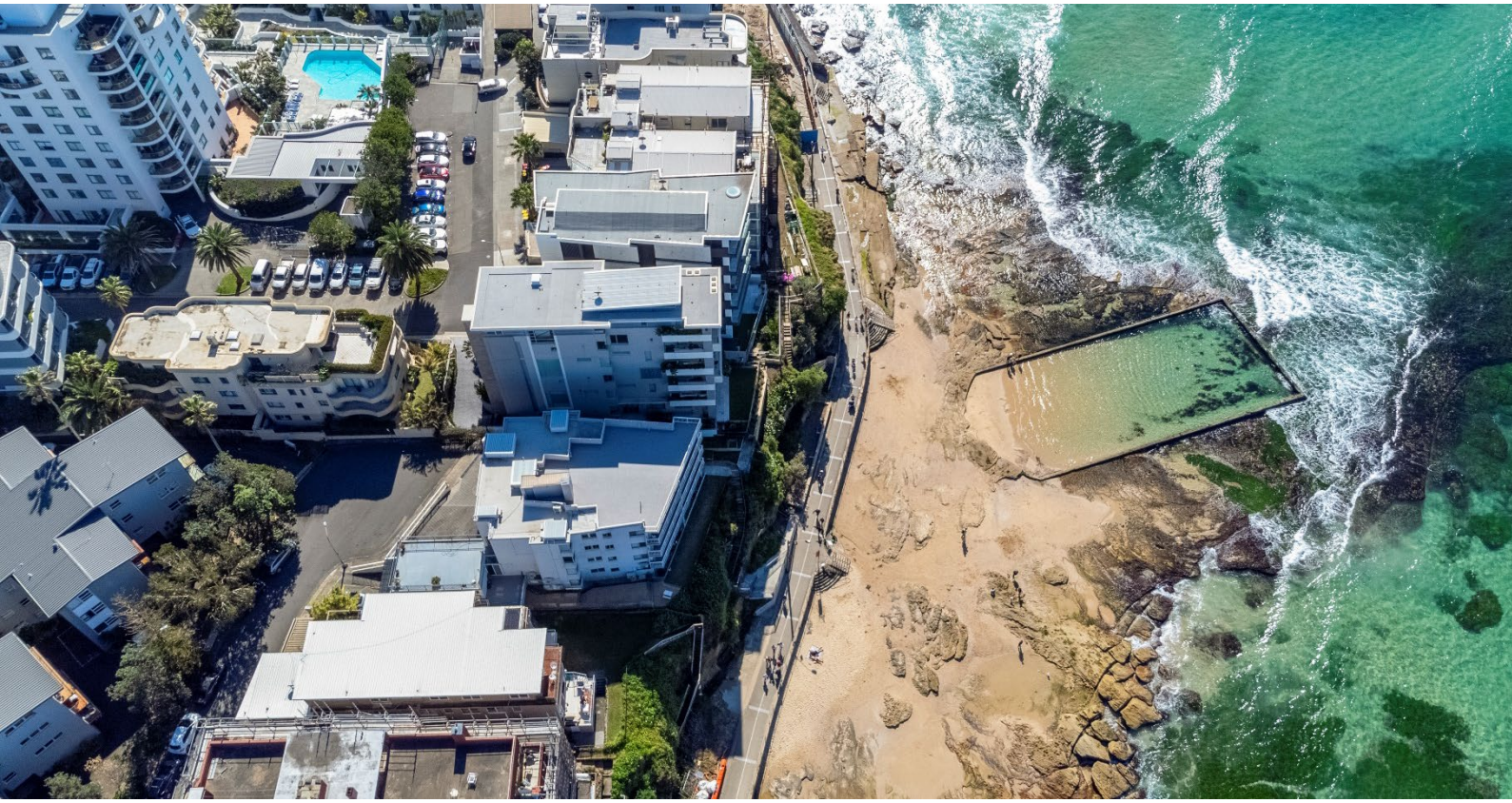
The City of Sydney has passed a motion requesting the Council's CEO investigate the opportunities and challenges with amending the City of Sydney's planning controls to require all new residential developments to be all electric, and report back to Council (City of Sydney Council, 2023). Several submissions supported banning new gas connections (Grattan Institute, Planning Institute of Australia, Greenpeace Australia Pacific, Australian Institute of Landscape Architects) or setting dates for banning connections in new buildings (Committee for Sydney).

The authority is of the view that the phase out of gas should be coordinated between the Australian Government and state and territory governments. Where states and territories do not take action to set clear dates on gas phase-out, it is likely that local Councils will take on this role leading to an inconsistent approach.

39. RECOMMENDATION

Work with state and territory governments to agree on a coordinated, nationally consistent approach to phasing out new gas connections for residential and small commercial buildings and phase-out of existing gas connections.

Some submissions further supported phasing out or banning the sale of gas appliances (Grattan Institute, Australian Institute of Landscape Architects, Committee for Sydney). The authority is of the view that there are still significant barriers for some households in transitioning from gas to electric appliances. The authority has made a recommendation above supporting mechanisms to increase the accessibility of electrification opportunities.



4.3.4.8 Electric vehicle charging infrastructure

There are opportunities to improve the regulation of electric vehicle charging infrastructure for which the Australian Government could coordinate a national approach. States and territories have differing service and installation rules (EVC, 2022a) (EVC, 2022a), allowing different amp and phase chargers to be installed. It would be beneficial to have a clear and consistent approach to charging installations nationally where possible.

Certain electric vehicle chargers can return electricity back to the grid when paired with a compatible vehicle (vehicle to grid technology). This technology has the ability to deliver lower priced charging, reduced residential electricity costs to electric vehicle users and support stability of the electricity grid (ARENA, 2023c; ARENA, 2021). In 2022–23, South Australia became the first jurisdiction to approve this technology across pilot sites (SA Power Networks, 2022). Appropriate national regulation for this technology could help increase the uptake rate of vehicle to grid chargers and increase the interest from car manufacturers to incorporate the technology into a wider range of vehicles. The authority received 2 submissions (EnergyAustralia, individual) that discussed the benefits of emerging technology like bidirectional electric vehicle charging (Vehicle to Grid or Vehicle to Load) and smart charging.

4.3.4.9 Private electric vehicle charging and multi-dwelling housing

The transition to electric vehicles may be held back by barriers to the roll out of private electric vehicle chargers including homes with no off-street parking, dwellings that require strata approval (e.g. apartment buildings) and the lack of incentives for chargers to be installed in rental properties (ARENA, 2022b).

There is anecdotal evidence of barriers to installing electric vehicle chargers in buildings with strata or owners corporation arrangements (Sydney Morning Herald, 2022) (Terzon, 2022), and homes with no off-street parking (The Age, 2022). Updates to the National Construction Code in 2023 to make new buildings ready for electric vehicle charging (Australian Building Codes Board, 2023) is a welcome announcement, but more work is needed to remove barriers for existing buildings (Sydney Morning Herald, 2023) (Bleby, 2023). The authority also received submissions (Planning Institute of Australia, individual) that discussed the need for policies to increase charging access in offices, multi-unit housing and for renters.

There are still some safety concerns about charging electric vehicles in large apartment blocks in the rare instance there is a fire (strata community association, 2023). Fire and Rescue NSW is currently leading a collaborative research program on the Safety of Alternative and Renewable Energy Technologies (Fire and Rescue NSW, 2023). Relevant learnings from this research could be incorporated into clear national advice on safety protocols for buildings with strata or owners corporation arrangements.

40. RECOMMENDATION

Identify and remove barriers to installing private vehicle chargers and vehicle-to-grid capability, while ensuring building codes adequately mitigate safety risks.

4.4 Sustainable finance and corporate action

4.4.1 Corporate action and sustainable finance

Corporate action is crucial to shift investment away from high-emitting sectors and projects, and towards growing net-zero-aligned industries (World Economic Forum, 2022). This includes:

- improving how corporations understand, manage, value and disclose climate-related risks
- standardising how corporations measure and report their emissions
- aligning domestic practices with international standards to build long-term, sustainable trading relationships
- ensuring corporations deliver on their public commitments and comply with new standards and regulations.

4.4.2 Disclosure regime developments

In June 2023, the Australian Government released its second consultation paper on the design and implementation of the Government's commitment to standardised, internationally-aligned requirements for disclosure of climate-related financial risks and opportunities in Australia (Treasury, 2023c). The consultation paper proposed a phased approach, which by 2027–28 would require entities that lodge financial reports under Chapter 2M of the *Corporations Act 2001* to make climate-related financial disclosures if two of the following criteria are met:

- the consolidated revenue of the company for the financial year and any entities it controls is $50 million or more
- the value of the consolidated gross assets at the end of the financial year of the company and any entities it controls is $25 million or more, or
- the company and any entities it controls have 100 or more employees at the end of the financial year.

The disclosure regime will be finalised following the release of draft legislation and the release of the final International Sustainability Standards Board framework (Treasury, 2023c).

4.4.3 Net Zero claims

Alongside mandatory disclosure regimes, there is increasing guidance available on substantiating net zero claims. For example, in 2022 the United Nations' High Level Expert Group on Net Zero Emissions of Non-State Entities (UN, 2022b) launched a report into net zero commitments by businesses, financial institutions, cities and regions, which set out ten recommendations focusing on establishing standards of integrity, transparency and accountability for pledging, planning and transitioning to net zero.

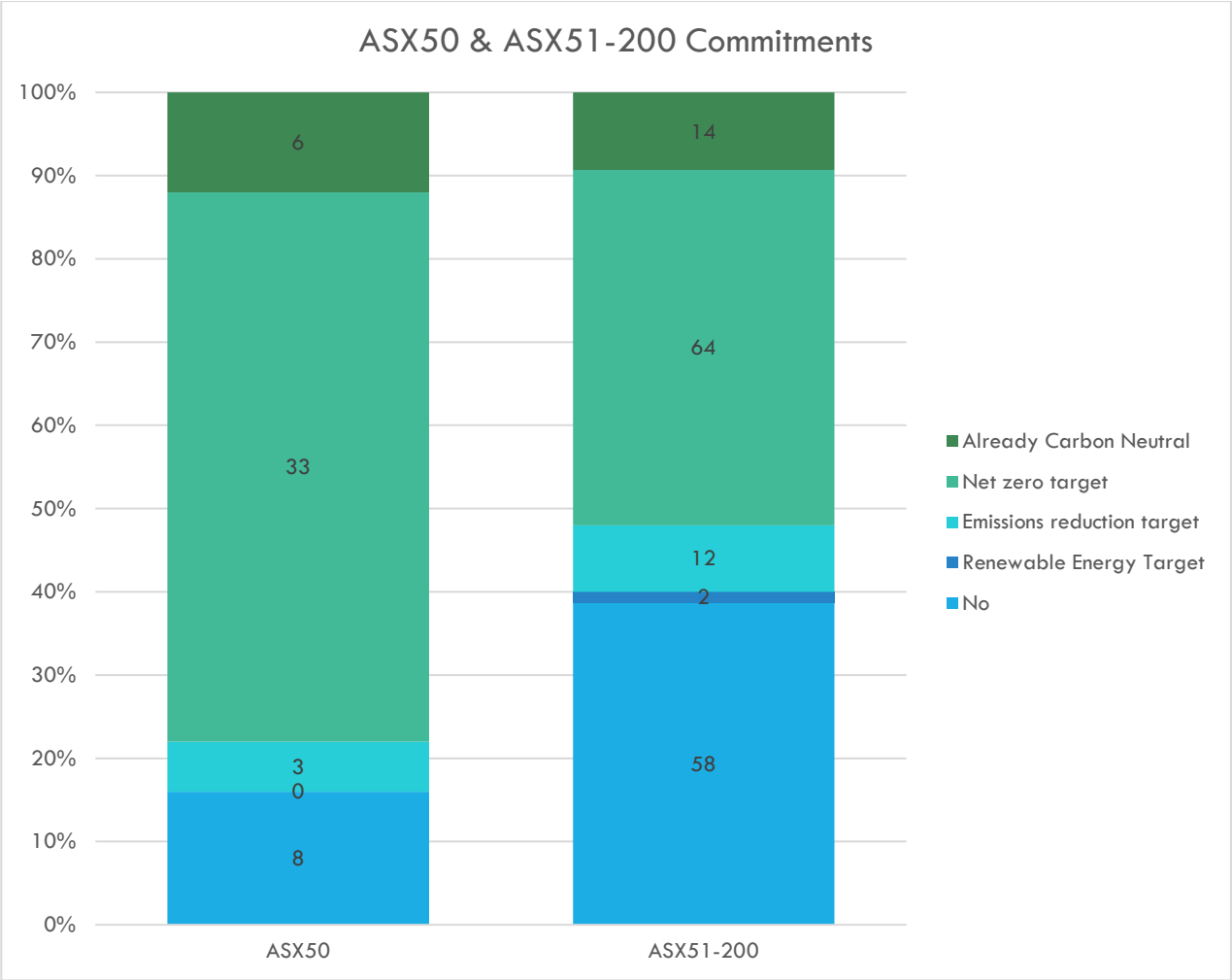
Some Australian corporates are engaging in voluntary verification of their net zero plans through the Corporate Emissions Reduction Transparency (CERT). The CERT has participants from a broad cross-section of the economy, and participating companies represented 21% of scope 1 emissions and 8% of scope 2 emissions in the 2021–22 financial year (CER, 2023l).

There are a growing number of Australian entities committing to net zero emissions, carbon neutrality and other kinds of climate commitments and targets. The authority's research indicates that as at July 2023, 97 companies in the ASX200 have net zero targets that capture scope 1 and 2 emissions, and 20 report they are carbon neutral (Figure 4.3). This is an increase from Climateworks' findings of 84 out of 187 ASX200 companies reporting net zero scope 1 and 2 emissions targets in December 2022 (Climateworks, 2022), and ASCI's findings of 49 ASX200 companies reporting these targets in August 2021 (ACSI, 2021). However, over 35% of ASX200 listed corporations with net zero targets or carbon neutral status are in the software, communications, financial services, or real estate investment trusts (REITs) sectors. Corporations within these sectors typically have lower scope 1 and 2 emissions when compared to Australia's highest emitters, but have potentially significant scope 3 emissions as a result of upstream and downstream activities along value chains that are not captured in net zero scope 1 and 2 emission targets (Klaaßen & Stoll, 2021).

The credibility of these commitments and claims has been questioned by several experts and research groups. Climate Action 100+ noted that net zero targets are not often supported by strategies to deliver them, with only 19% of assessed companies quantifying key elements of their decarbonisation strategies with respect to the major sources of their emissions (Climate Action 100+, 2022). Policies, frameworks and regulations are needed to ensure that markets can trust the commitments and claims of corporations, and that those companies who are delivering on their commitments are not unfairly disadvantaged by the lack of integrity of claims made by others.

More transparent reporting on climate transition plans and emissions would help to improve corporate accountability and investor confidence. Enhanced corporate ambition in line with Treasury's proposed climate-related financial risk disclosure policy would improve the clarity and robustness of corporate commitments.

Figure 4.3: Proportion of ASX50 and ASX51–200 companies with net zero commitment as of end of 2022–23 Financial Year



Source: Climate Change Authority analysis. ASX200 as of June 30, 2023. Net zero commitments retrieved from publicly available company documents. Net zero target defined as a target of net zero scope 1 and 2 emissions.

4.4.4 Sustainable finance

The government has taken a positive step in supporting scalable sustainable finance architecture, committing $1.6 million in 2023–24 to support the initial development of a sustainable finance taxonomy in partnership with the Australian Sustainable Futures Institute (ASFI) (The Treasurer, 2023) (Treasury, 2023a). Sustainable finance taxonomies are important tools for market transparency and the development of sustainable assets. These can provide a set of common definitions and criteria that enable a shared understanding between investors, companies, government and other stakeholders of what economic activity is considered sustainable and in support of the transition to net zero (CCA, 2021). When appropriately designed, sustainable finance taxonomies can facilitate investment and supporting policy action and enable easier tracking of sustainable finance flows (OECD, 2020).

Internationally there is growing standardisation of green taxonomies (OECD, 2020), including through platforms such as International Platform on Sustainable Finance (IPSF) which aims to exchange best practice approaches and enhance international coordination where appropriate (European Commission, 2021). Australia is not a member of the IPSF. However, the design of Australia's taxonomy will need to account for shared understanding internationally to take advantage of cross-border financial opportunities.

The government has also committed $8.3 million over four years from 2023–24 to establish a sovereign green bond program, to raise capital for environmental and climate change related programs, although insufficient detail has been published on the design of the program to enable the Authority to evaluate its effectiveness in this report (Treasury, 2023a). The Australian green bond market is small but is growing quickly. In the first half of 2023 approximately $13 billion in green bonds were issued, which is higher than the annual amount of any previous year on record. Green bonds are also important drivers of Australia's net zero transition; proceeds from Green Bonds have been used to fund over $50 billion in clean transport, energy efficiency, green buildings and climate change adaptation projects (Armour, Hunt, & Lwin, 2023). The CEFC has been heavily involved Australia's green bond market to date, investing more than $900 million in green bonds across its first decade of investment, which have raised almost $6 billion in investment (CEFC, 2023a).

The CEFC's role was expanded in June 2023 with the government allocating an additional $20.5 billion to it for three programs: the Rewiring the Nation program, the Household Energy Upgrades Fund and the Powering Australia Technology program (CEFC, 2023d). This is on the back of private sector leverage for CEFC investment commitments reaching an all-time high in 2022–23, with each $1 in finance provided by the CEFC attracting $5.02 of additional private sector capital (CEFC, 2023b). The authority advised in its 2020 report, Prospering in a low-emissions world: An updated climate policy toolkit for Australia, to expand the remit of the CEFC to allow it to invest in emissions reduction technologies in all sectors to help overcome barriers to finance (Recommendation 32) (CCA, 2020).

4.4.5 Regulation

Beyond reporting, in 2022–23 Australian competition and financial regulators are also stepping up monitoring and enforcement action with respect to sustainability-related claims through their existing powers. In February 2023, the Australian Securities & Investment Commission (ASIC) announced its first court action against alleged greenwashing conduct, commencing civil proceedings against Mercer Superannuation (Australia) Limited for allegedly making misleading statements about the sustainable nature and characteristics of some its superannuation investment options (ASIC, 2023).

The Australian Competition and Consumer Commission[31] has also completed a stock take of environmental

[31] Misleading and deceptive conduct under Australian competition and consumer law protects against false or misleading sustainability claims.

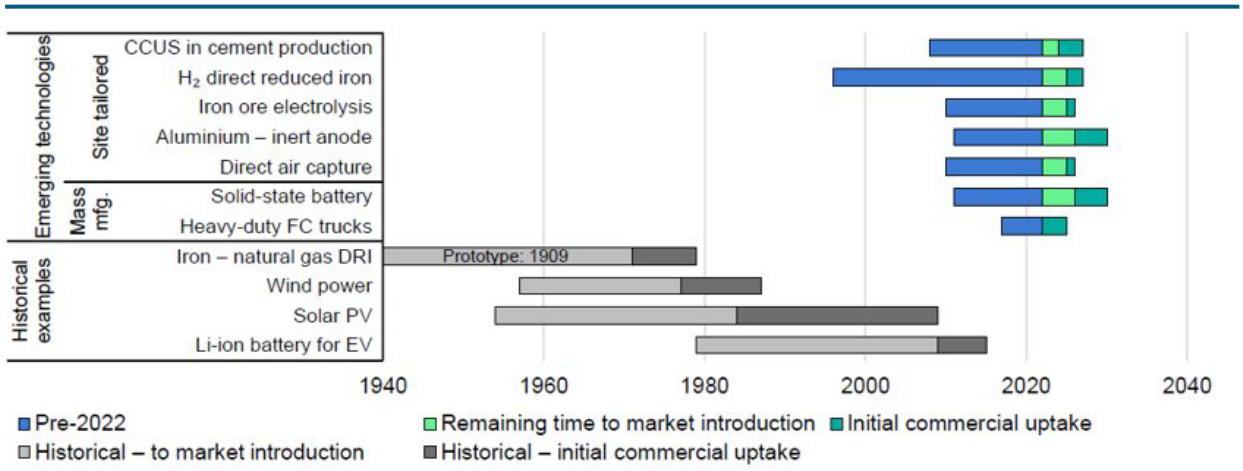
claims, finding 57% of businesses reviewed made concerning sustainability claims that lacked clarity, without sufficient evidence, unsupported goals and/or used third-party certifications in confusing ways to support the claim (ACCC, 2023). Other regulators such as the ASIC and Australian Prudential Regulation Authority are engaging in educational functions to support compliance. APRA conducted a Climate Vulnerability Assessment for of Australia's five largest banks with climate scenario analysis finding a measurable impact on lending losses, but likely to be absorbed by lenders (APRA, 2022).

4.5 Research and development, technology and innovation

Technologies and solutions are available today to immediately reduce emissions, while emerging technologies will be required to achieve the longer-term goal of reaching net zero emissions. While the emissions reductions to 2030 can be delivered with existing technologies, the IEA concludes that about half of the emissions reductions in 2050 will come from technologies at prototype or demonstration stages today (IEA, 2023a). Reliance on technologies still under development is higher for harder-to-abate activities, such as aviation and heavy industry (IEA, 2023a).

The time available to bring emerging technologies to market to meet net zero targets is much shorter than was the case previously (see Figure 4.4). For example, 15–30 years for technologies such as green steel, heavy duty fuel cell trucks and CCUS in cement production. This compares to existing technologies, including solar, where the innovation process has taken 20 to 70 years from prototype to commercialisation (IEA, 2023a).

Figure 4.4: Time frame for prototype to market introduction and early adoption for selected clean energy technologies in the past and the NZE Scenario



Notes: mfg. = manufacturing; DRI = direct reduced iron; H_2 = hydrogen; FC = fuel cell; Li-ion = lithium-ion. Initial commercial uptake is defined as the time until take-up in 1% of the market and market introduction as when the first commercial model is available on the market. Direct air capture is assumed to reach initial commercial scale at 1 Mt of CO_2 per year and market introduction at 1% of the market. Historical figures are calculated for selected market-leading countries (Norway for Li-ion batteries; Germany for solar PV; Denmark for wind power; and the United States for natural gas DRI).

Sources: IEA analysis based on Gross et al. (2018); Worldsteel Association (2020); Comin & Hohjin (2004). Also see IEA (2020a).

The IEA has highlighted the importance of shortening of innovation cycles and recommended that this be supported by improving the commercial advantage of clean energy technologies; increased global co-operation and international knowledge transfer; as well as the importance of tracking progress towards goals (IEA, 2023a).

4.5.1 Innovation – through deployment at scale

Australia has long been at the forefront of solar PV innovation and deployment. Innovations in PV panel technology and manufacturing, and the increasing scale of solar farm installations have contributed to cutting the cost of solar PV generation by 85% over the past ten years, and it is already mature and sufficiently cost effective to deploy at scale (ARENA, 2023f). It requires no significant technology breakthroughs to achieve Australia's 2030 goals. (ARENA, 2023f).

Nevertheless, there are ongoing innovations emerging through deployment at scale that can provide benefits and savings to new projects. In particular, the development of modular, prefabricated and pre-configured solar panel products that enable rapid deployment in a range of location types. The prefabricated, compact design improves efficiencies in procurement, transport and installation. For example, in transport the design allows for an increase in the number of panels per load, improving logistics and reducing costs in remote locations. The modular design also enables rapid installations which can be disassembled and redeployed for new projects, contributing to sustainable practices at the end of operations.

NSW-based company 5B has been able to demonstrate installation rates of its modular PV technology at 1.1 MW per day of solar power capacity with 20 people (PV Magazine, 2023a). A development from a UK company has now also included solar tracking systems in prefabricated modules, which maximise energy yield while at the same time reducing construction time and costs, improving the overall business case. These units were recently installed in a pilot project, a 2.3 MW system to provide power to a gold field operation in Kalgoorlie. The design and innovative anchoring system also eliminates the need for piles and concrete (PV Magazine, 2023b), providing a reduced carbon footprint.

4.5.2 Innovation – emerging and needing development

Decarbonisation of electricity generation together with electrification of many end-use activities is necessary to achieve net zero emissions. Electricity storage plays a critical role in balancing electricity supply and demand and can provide other services needed to keep decarbonised industrial systems reliable and cost-effective (MIT, 2022).

Battery technologies with high energy density are suited for use in electric vehicles and mobile electronics. The private sector has provided significant venture capital for storage technologies generally, and for lithium-ion batteries, particularly in vehicles (MIT, 2022).

Technologies with lower energy density can be used for storage in electricity system applications where space is less important. Technologies such as pumped storage hydro and some thermal storage options are proven and available for commercial deployment (MIT, 2022). However, there are a wide range of emerging technologies, particularly in thermal storage, requiring further research, development, and demonstration to be commercially available at scale in the 2030s or 2040s (MIT, 2022).

Recent developments in Australia include the release of the 2023 CSIRO Renewable Energy Storage Roadmap (CSIRO, 2023a) which identifies a mix of technologies across sectors to meet Australia's energy storage needs. Higher levels of renewables in Australia's energy system will result in a greater role for renewable energy storage technologies. The report advises that Australia will need to rapidly develop a pipeline of projects across a portfolio of energy storage technologies to address key technology challenges across different end-use applications and geographical locations (CSIRO, 2023a).

Emerging applications of thermal storage include for electrification in sectors using gas for heat production, allowing replacement of fossil fuels with renewable energy and recycling of waste heat. A food and beverage manufacturer in the Netherlands has launched a pioneer installation to replace gas heating with electrification and heat storage provided by Kraftblock net-zero heat system (Eneco, 2023). Using excess renewable energy, the unit heats air up to 800 degrees celsius, which can then be stored in heat-retaining pellets which use 85% recycled material (Koolen Industries, 2022). The heat can then be accessed when needed in the production process. The first phase is expected to provide a 50% emissions reduction, with future expansion targeting a 98% reduction (Eneco, 2023).

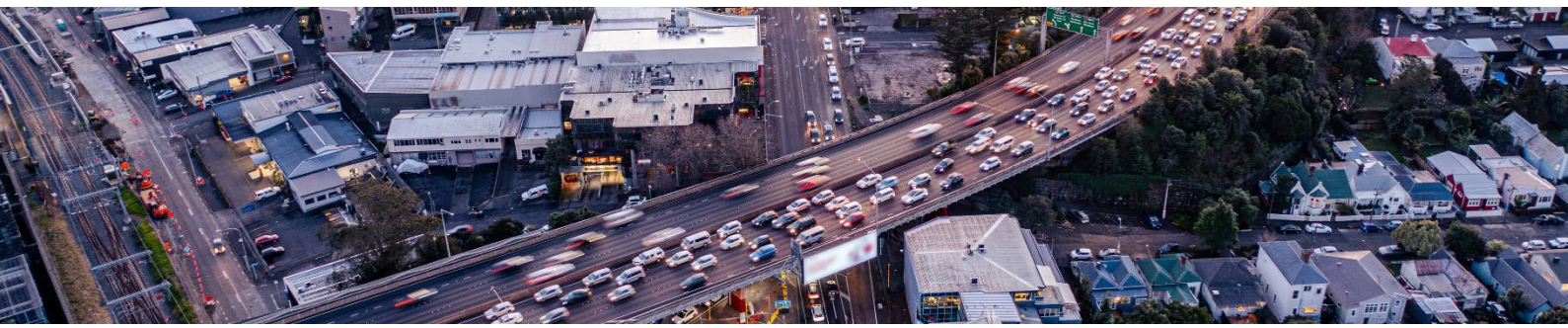
Another technology being developed is superconducting transmission lines aimed at distributing electricity with lower losses. Nexans has deployed superconducting cables in the US and Germany and is participating in the National Grid Superconductor Applications for Dense Energy Transmission project to identify applications for superconductors in cities (Nexans, 2022). US-based company Veir has suggested that existing High Temperature Superconductors (HTS) perform well over short distances in dense urban centres, but that deployment costs have proven too high for HTS to meet its potential for providing long-distance transmission (Veir, 2023). Veir has developed a cooling system with the aim of enabling long-distance HTS transmission (Veir, 2023).

4.5.2.1 Decarbonising heavy industries

In the near to medium term, decarbonisation pathways are less certain for hard-to abate sectors such as cement, steel and chemicals. Emissions come from necessary chemical reactions (such as calcination of limestone for cement) or because zero emissions versions of industrial equipment (such as high temperature furnaces) are ineffective and/or costly. Innovation has driven down costs and introduced new technologies and this must accelerate with significant technological and financial investment to deliver solutions to 2030 and beyond.

The decarbonisation of cement production, one of the most energy intensive materials, is another example of the ongoing need for innovation. Around 60% of emissions come from chemical reactions, the majority of the rest is produced by fuel combustion. Production facilities are capital intensive and are generally long-term assets which creates a barrier to timely response to energy or emission related priorities. Demand for cement is growing, and emissions reduction strategies, such as novel/substitute materials that require less heat to produce and the potential for carbon capture and storage located within cement manufacturing facilities are being explored but are not fully mature and need large scale demonstration projects to develop further (VDZ, 2021).

Technologies and solutions are available today that can kickstart the transition while emerging ones can complete the process – solutions can utilise new production methods, alternative energy sources and feedstocks, emissions-abatement technologies e.g. CCS and circular/recycling practices. Combined together across the production chain these innovations can collectively deliver to net zero goals.



4.5.3 Investment finance - strategies now and in future

A complete picture of recent government research, development and demonstration (RD&D) funding relevant to climate change is complex to collate, however a snapshot of funding for energy, which is reported regularly to the IEA, suggests funds are increasing, with a strong focus on clean energy transition. Australia's RD&D spend relative to GDP remains comparatively low amongst OECD economies (IEA, 2023f); (IEA, 2023c).

The government is considering the broader research and development (R&D) and innovation environment in Australia through the *Australian Universities Accord* process, scheduled to report at the end of 2023, which will make recommendations on the university research system's ability to meet Australia's current and future needs (Department of Education, 2023). The Australian Council of Learned Academies (ACOLA), has a focus on energy transition. In 2021 they developed a comprehensive research agenda, the *Australian Energy Transition Research Plan* as a pathway to net-zero by 2050 (ACOLA, 2021).

Public spending on research and development has been on a steady upward trend, as has corporate spending (IEA, 2023f). Public spending on research and development has been on a steady upward trend, as has corporate spending (IEA, 2023f). The IEA reported that globally, estimated public spending on energy R&D grew by 10% in 2022 to USD44 billion, with around 80% (USD35 billion) directed to clean energy (IEA, 2023f). In addition, early-stage Venture Capital (VC) reached a new high of USD6.7 billion in 2022 (IEA, 2023f).

The IEA also noted that corporate R&D budgets of companies in energy-related sectors had risen to an estimated USD120 billion (IEA, 2023f). Growth in 2022 was high relative to recent years despite higher cost of capital and economic uncertainty, this is interpreted as a response to the threats and opportunities of the energy transition (IEA, 2023f). R&D is a central strategy for growing or maintaining market share, for example in the automotive market, where growth in R&D impacts the overall trend. Outside the energy sector corporate R&D is also rising in the related hard-to-decarbonise sectors (IEA, 2023f).

Corporate venture capital (CVC) funding for emerging clean energy technologies also reached a high of USD 8 billion in 2022, growing quickly since 2015. CVC can provide a company with a lower-cost and quicker means of acquiring new knowledge, new technologies and business models in an energy sector facing disruption from modular and quick-to-scale technologies.

The OECD reports an increase in flows to investment funds that are mandated to invest in green or sustainable investments (RBA, 2023). Data compiled by the OECD show global sustainable funds at around USD3 trillion in 2022, (OECD, 2023).

The Reserve Bank of Australia has reported that Australia is very much part of the global increase in clean energy investment, including wind and solar renewable energy where investment has already grown strongly in recent years (RBA, 2023).

Green bonds are bonds issued to fund projects beneficial to the environment or climate. In Australia the main uses of green bonds to date have been for the deployment of clean transportation solutions, energy efficiency and green construction. To date issuers and investors have used voluntary guidelines for classification such as the Climate Bonds Initiative's 'Climate Bond Standard'. Bonds issues into the Australian market by a non-resident organisation – Kangaroo green bonds – make up around one-third of total issuance (RBA, 2023). In Australia, the green bond market has grown quickly since 2014.

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In Australia, the green bond market has grown quickly since 2014. Over $10 billion of green bonds were issued in 2022. In the first 6 months of 2023 alone, that amount was exceeded as new issuers continued to enter the market.

IEA global analysis has highlighted that for clean energy alone, by 2030 annual investment will need to be three times the current rate, which has already increased substantially in recent years (IEA, 2023f). As well as further rapid deployment of available technologies to 2030, reaching net zero by 2050 requires widespread use of technologies that are currently not yet on the market. Major innovation efforts must occur in order to bring these to market in time (IEA, 2021).

The authority will further consider technology and innovation, including the role for public and private finance, in its work on sectoral pathways, and in developing its advice on emissions targets in 2024.

Given the critical importance of technology in achieving Australia's emissions reduction targets, the government should incorporate a Research, Development & Demonstration (RD&D) Strategy as a key feature of its Net Zero Plan. The strategy should consider the need for dependable framework conditions that promote innovation, safeguards competitiveness, and amplifies co-operation between government and private sector, as well as tracking progress towards goals.

41. RECOMMENDATION

Include a Research, Development & Demonstration (RD&D) Strategy as a key feature of Australia's Net Zero Plan. The strategy should consider the need for dependable framework conditions that promote innovation, safeguards competitiveness, and amplifies co-operation between government and private sector, as well as tracking progress towards goals.

4.6 Federal, state and territory government cooperation

The changes needed in the Australian economy and in society for meeting our emissions reductions targets, and ensuring our future prosperity and resilience, are immense and urgent.

Given the many overlapping and complementary responsibilities held by the Australian and the state and territory governments, a successful net zero transition will require much greater levels of government intervention, coordination and cooperation than currently exist, to drive the decisions and behaviours by governments, businesses and households towards the outcomes required. And the approach will need to be flexible and adaptive, given the inherent uncertainties of the future.

Many of the authority's recommendations in this report call on the Australian Government to work with the states and territories to achieve a range of policy objectives. A disjointed approach runs the risk of much less timely and effective policy responses, and unnecessarily adding to regulatory costs and burdens for businesses and consumers.

The authority's views is that the time is right for a new, Commonwealth-State reform agreement (or set of agreements) on climate change mitigation, adaptation and the net zero transition.

Developed in parallel to the work on sectoral plans, the 2035 target and the Net Zero Plan, the agreement would provide a framework for cooperation on the response to climate change, including principles and actions on a range of matters where consistent and/or coordinated action is in the national interest. However, Australia cannot afford protracted negotiations to delay action – the focus should be on areas where agreement can be reached quickly important areas, with the agreement reviewed and expanded regularly as appropriate.

4.6.1 Mitigation

The federal and all state and territory governments have adopted the target of achieving net zero emissions by 2050 or earlier. There is an enormous amount of work already underway, but also considerably more to be done to ensure we are on a trajectory to net zero, meeting our 2030 and subsequent interim targets. Emissions reduction targets and other climate change and related policies across jurisdictions are not yet fully aligned with Australia's Paris Agreement targets, and likely future targets.

A new agreement, or set of agreements, could establish a framework that includes a commitment to work together to meet Australia's 2030 and subsequent interim Paris Agreement targets, as well as net zero by 2050, and identifies key mitigation policy goals (e.g. for sector plans), and specific policy approaches to achieving those goals where appropriate, including roles and responsibilities.

Major policy reforms are required in areas where the Commonwealth and the states share responsibilities and/or in areas where cross-cutting issues arise – such as electricity supply, environmental protection and approvals and land use, and reforms to revenue raising and sharing to both drive and respond to the transitioning economy. Without collaborative and coordinated approaches on the big issues, failure is likely.

There is a need for a comprehensive review of, and response to, unnecessary regulatory barriers to effective mitigation and adaptation action across the economy. And there is a need to ensure that where new regulations are introduced, nationally consistent approaches are adopted wherever appropriate, to avoid the imposition of unnecessary regulatory burdens and costs on businesses and consumers.

With respect to government operations, there is an opportunity to develop agreed principles and guidelines for consistent and robust approaches to the valuation of carbon for government planning and decision-making, for climate related financial disclosures and risk management across government agencies, and for government procurement policies that are 'net zero consistent'.

Taking an integrated, place-based approach to the challenges and opportunities of the net zero transition will enhance Australia's prospects for success. For example, identifying regional 'zones' or 'precincts' where facilitating projects in renewables generation, hydrogen production, critical minerals extraction and carbon capture and storage creates the ingredients for decarbonising existing activities and facilitating new, green industries. Coordinating across levels of government will be essential, including for successful workforce and community transitions.

A new agreement could also provide the framework under which emerging policy challenges and opportunities are identified and responded to. For example, the net zero transition raises significant implications for tax bases and revenue sharing between the Commonwealth and the states and territories. As an example, significant taxation revenue is currently raised from activities associated with high levels of emissions (extraction and use of fossil fuels such as coal, oil and gas) and these will decline over time. Analysing and planning for these changes should commence sooner rather than later.

4.6.2 Adaptation

Adaptation is an issue of national significance – vital for economic performance and the wellbeing of Australians generally. The Australian Government is developing its National Climate Risk Assessment and National Adaptation Plan.

The Australian Government will have a key role as a provider of information on climate trends and risks to assist others make informed decisions to adapt to global warming. The physical impacts of climate change have specific consequences for the Australian Government in terms of its role as the 'lender of last resort' for the costs of extreme, climate-related events and as a significant funder of Australia's health system. The Australian Government is also responsible for commitments made on adaptation in our Nationally Determined Contributions under the Paris Agreement.

State and territory governments deliver a broad range of services and are primarily responsible for service delivery and infrastructure, such as emergency management, transport infrastructure, land-use planning, health and education services and public housing. Local governments have an important role to play through local planning and regulations and managing the risks and impacts of climate change on local service delivery.

With respect to government operations generally, there is an opportunity to develop agreed principles and guidelines for consistent and robust approaches to the valuation of carbon for government planning and decision-making, for climate related financial disclosures and risk management across government agencies, and for government procurement policies that are 'net zero consistent'.

Ensuring clarity and agreement on the respective roles of the three tiers of government will be crucial for crucial to ensuring Australia effectively manages the risks and impacts of climate change. A new agreement on adaptation roles, responsibilities and implementation, updating a decade old COAG agreement, would complement the National Adaptation Plan currently under development by the Australian Government, and provide a vehicle for an agreement to incorporate climate change in all government decision-making, as recommended in Chapter 2.

4.6.3 Further considerations

A successfully negotiated agreement would send a strong signal to the Australian community, and the rest of the world, about the net zero emissions path we are on, and contribute to a virtuous cycle already established as a result of legislating Australia's emissions reduction targets. A more unified approach will help build the necessary levels of 'social licence' that are essential for a successful transition, by supporting a consistent, overarching narrative from governments.

The agreement would need to respect the different circumstances of each state and territory and not get in the way of early, no regrets actions to respond to climate change. The Prime Minister, Premiers and Treasurers, supported by their departments, should drive the agenda, given the national significance, whole-of-economy and whole-of-society nature of responding to climate change.

The agreement could include a framework for consistent reporting on progress with, and outcomes from, the implementation of climate change measures, which is necessary for ensuring transparency and accountability in relation to the achievement of emissions reduction and adaptation targets.

42. RECOMMENDATION

As part of development of its Net Zero Plan, the government develop a set of agreements with the state and territory governments for coordination and cooperation on change mitigation, adaptation and resilience and Australia's transition to a net zero economy.

For more information about the work of the Climate Change Authority, visit our website at https://www.climatechangeauthority.gov.au/.

You can also contact us at: mailto:enquiries@climatechangeauthority.gov.au