RACE for 2030
RELIABLE AFFORDABLE CLEAN ENERGY

Opportunity Assessment

Smarter planning for the energy transition

Final report

Australian Government
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Final Report

Theme E2: Innovative foresighting and planning

Opportunity Assessment

Smarter planning for the energy transition

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What is RACE for 2030?

Reliable, Affordable Clean Energy for 2030 (RACE for 2030) is an innovative collaborative research centre for energy and carbon transition. We were funded with $68.5 million of Commonwealth funds and commitments of $280 million of cash and in-kind contributions from our partners. Our aim is to deliver $3.8 billion of cumulative energy productivity benefits and 20 megatons of cumulative carbon emission savings by 2030.
racefor2030.com.au

Acknowledgement of Country

The authors of this report would like to respectfully acknowledge the Traditional Owners of the ancestral lands throughout Australia and their connection to land, sea and community. We recognise their continuing connection to the land, waters, and culture and pay our respects to them, their cultures and to their Elders past, present, and emerging.

Executive Summary

As the Australian energy system continues its transition towards a zero-carbon future, numerous uncertainties make planning and decision-making difficult. The politics of energy transition, uncertainty about future customer choices and practices, the rate of uptake of technologies, and concerns about the resilience of infrastructure as the climate changes make transition pathways and endpoints unpredictable. New ways of anticipating and responding to possible futures are needed that go beyond traditional forecasting approaches. This is the focus of RACE for 2030's Research Theme E2: Innovative Foresighting and Planning.

This Opportunity Assessment evaluates the current anticipatory planning capacity of the Australian energy system and looks for opportunities for improvement. This Final Report summarises findings from the literature review and stakeholder consultation and presents a comprehensive multi-year "Research Roadmap" for this research theme.

Anticipatory activity in the Australian energy system

The terms used to describe future-focused activity are contested and confusing. We have followed the lead of UNESCO[1] in using the term *anticipation* to refer to all the different ways we explore and use the future in the present. There are three types of anticipation: forecasting, exploratory foresighting and normative foresighting.

- ***Forecasting*** aims to identify and characterise the most likely or probable future, usually through quantitative modelling.

Typical methods of forecasting include: extrapolation; econometric modelling; trend analysis; and megatrend analysis. Forecasting was used in almost all the publications reviewed for this Opportunity Assessment (see Table E1) but was frequently used in a supporting role alongside exploratory or normative foresighting. There is long experience in the energy sector with sophisticated quantitative modelling of demand trends, econometrics, technology uptake and grid performance. However, accurate forecasting has become significantly more difficult due to decentralisation, changing customer behaviour and behind-the-meter participation. Even the most sophisticated forecasting approaches struggle to accurately predict the future behaviour of complex energy systems. As such, the dominance of forecasting methods has declined.

- ***Exploratory foresighting*** maps the range of possible futures that could emerge, either qualitatively or quantitatively, to challenge decision-makers to consider other possibilities.

Typical methods of exploratory foresighting include: scenarios; "futures wheel"; environmental scanning; strategic interviews/Delphi; weak signals; wild cards; causal layered analysis. Exploratory foresighting is the least common anticipation type in Australia (see Table E1). However, it is used in some high-profile publications such as AEMO's Integrated System Plan (ISP), which defined, modelled and published multiple scenarios that were developed in consultation with stakeholders. The Optimal Development Path proposed in the plan considers all scenarios, but much of the ISP is illustrated with details from the Step Change scenario, which a (small) majority of stakeholders saw as most likely. This makes the exploratory dimension of the ISP less prominent than its normative dimension.

[1] https://en.unesco.org/futuresliteracy

Other examples of exploratory foresighting include the multiple scenarios presented in Western Australia's Whole of System Plan and various 'think pieces' developed by research organisations or consultants. Western Power's Grid Transformation Engine also supports exploratory foresighting through its ability to investigate different future grid configurations at different periods of time. The use of 'least regrets analysis' in work led by Energy Networks Australia and the flexible and modular approach to the future adopted in the ACT Climate Change Strategy are also forms of exploratory foresighting.

- *Normative foresighting* identifies or imagines a desirable future, analyses pathways to navigate towards that future and develops plans or roadmaps to guide action.

Typical methods of normative foresighting include: visioning; Three Horizons; Backcasting; Roadmaps; and multi-criteria analysis. Normative foresighting is the most common type of anticipation in the Australian energy sector (see Table E1). Many of the anticipatory publications reviewed for this Opportunity Assessment were plans or roadmaps designed to make progress towards a vision of the future that the authors saw as desirable.

All three types of anticipation are within the scope of this Opportunity Assessment. Table E1 summarises and evaluates representative anticipatory activities in the Australian energy system.

All types of anticipation are potentially useful in the right circumstances. Forecasting is useful in situations where the systems being studied are stable and continuous. It can also support detailed descriptions of scenarios by showing what would happen if the assumptions of that scenario hold true. However, with increasing uncertainty in energy systems, forecasting is not a fit-for-purpose decision-making tool on its own. The future is emergent and cannot be fully predicted. Forecasting needs to be complemented by exploratory foresighting to expand the range of possible futures that are considered when making decisions. Exploratory foresighting can deliver a more complete perception of the strategic options available[2] and is particularly valuable in situations where there is rapid change, complexity, and uncertainty. These conditions clearly apply to the Australian energy system. Once the range of possible futures is clear, normative foresighting can be used to develop plans to steer towards preferred futures.

As such, the combination of forecasting, exploratory foresighting and normative foresighting is a powerful one that captures the strengths and overcomes some of the weaknesses of each approach. "*Anticipatory planning*" uses all three types of anticipation together to develop plans that take possible and desirable futures into account. The evaluation in Table E1 demonstrates that some key publications, such as AEMO's ISP, do powerfully combine forecasting, exploratory foresighting and normative foresighting. However, considered in its entirety, the energy system uses exploratory foresighting significantly less than the other types of anticipation.

The evaluation in Table E1 also indicates that anticipatory publications do not give equal consideration to all the different types of drivers that can shape future developments. Thinking about the future is dominated by technological drivers, and to a lesser extent, economic drivers. Environmental and social drivers receive more moderate attention, whereas political drivers and values receive the least attention. It is undoubtedly difficult to predict how politics, governance and customer values will evolve in the future, but these drivers can play a key role in how the future unfolds. The value of exploratory foresighting is that it provides methods to help us to imagine how these less predictable drivers might shape the future.

[2] Voros, J. (2003). A generic foresight process framework. Foresight, 5(3), 10-21. https://doi.org/10.1108/14636680310698379

In addition to these gaps in the type of anticipatory methods used and the drivers considered, there are other shortfalls in Australia in the availability and use of data to support anticipation, stakeholder consultation methods, and integration of net zero carbon outcomes in future scenarios. These shortfalls are considered further below in 'Gaps in anticipatory capacity'.

International best practices

Our review of international anticipatory activity found that exploratory foresighting is more common internationally and is often taking place at the heart of government. Australia lacks institutions of foresight within government that routinely take on the task of exploring and communicating different possible futures. Instead, there is a strong normative focus on planning for political goals. This is a risky approach that fails to consider surprises and lacks flexibility to respond if the future heads in a different direction. If the COVID-19 pandemic has taught us anything, it should be that we need to be better prepared for surprises and wild cards that may come to shape the future.

There are interesting examples of international approaches to energy system planning that have been more successful at planning for the whole system and involving customers in the planning process. In the United States, 36 states engage in integrated resource planning (IRP)[3], which is an approach to energy system planning that aims to be truly 'whole of system', considering all possible options to meet the energy service needs of customers. IRP considers a full range of power sector investment options. It takes into account bottom-up load forecasting, generation costs, demand-side management options and costs, transmission and distribution costs, risks of fuel price volatility, drought and carbon taxes, and social and environmental 'externalities'. It requires detailed studies of the potential of demand-side responses to support identification of a genuinely least-cost energy strategy.

In the Australian context, the idea of an IRP raises questions of responsibility, as no single entity currently has regulatory or planning oversight of the entire energy system. In the absence of regulatory reform, this points to the need to create spaces for cross-industry collaboration and coordination to develop least cost models. Currently, such spaces are insufficient, so demonstration projects (including via RACE for 2030) can help to illustrate how stakeholders from across the energy system can come together to do whole-of-system planning.

Compared to what we see internationally, it is evident that the methodological palette of Australian energy stakeholders is limited when it comes to engaging stakeholders. International innovations in public participation, such as the UK Climate Assembly, have yet to make much of a mark in the Australian energy sector. The most common anticipatory methods are quantitative modelling and stakeholder consultation. The latter generally follows a standard approach to consulting on public policy matters, where a view is formed internally, a document is published and input is sought from stakeholders, sometimes with workshops included to allow more interaction. Stakeholders are informed or consulted but rarely engaged in more collaborative or empowering ways. Exceptions include the stakeholder dialogue forums held by CSIRO and the Foresighting Forums held by Energy Consumers Australia, which gather diverse energy sector stakeholders to explore issues in a more open-ended way.

At the same time, the methods used to think about the future are less diverse than those used internationally. The lack of exploratory foresighting in Australia was already noted. There is also very little apparent use of

[3] Also called "Least Cost Planning".

specialised anticipatory methods and tools, such as environmental scanning, weak signal analysis, Three Horizons[4], or causal layered analysis.[5] Instead, there is heavy use of forecasting and backcasting to model likely or desired futures. While useful, these approaches risk reinscribing ideas that are prevalent in the present, rather than stimulating creativity and imagination to consider and better prepare for different futures. There are exceptions to build on. AEMO used a Delphi method in the development of its draft 2022 ISP and innovative approaches to future grid planning are starting to emerge that provide accessible, location-based data about current network assets and possible futures.

Gaps in anticipatory capacity

To evaluate current anticipatory capacity, it is useful to have some idea about the kind of futures that lie ahead for the Australian energy system. These futures are clearly uncertain, but there is near consensus that the energy system must reach net zero carbon emissions before 2050. Most stakeholders consulted to date anticipate a future energy system that is more holistic, integrated, and decentralised. They also anticipate an energy system that is people-centred, resilient and flexible.

The literature review and stakeholder consultation identified the following gaps in the anticipatory capacity of Australia's energy system:

1. A lack of high-level (government-led) institutional support and leadership for comprehensive anticipatory planning and action (identified in international best practice comparison). Limited leadership from the Australian Government in committing to, and planning for, a transition to a zero-carbon system over the past decade has led to decision-making and incentives focusing on short-term cost reduction and risk mitigation, to the detriment of long-term energy system performance.

   This applies particularly to demand management opportunities (including energy efficiency, load management, price reform and distributed storage), which could reduce costs and improve customer comfort and health. In this context, few organisations have felt confident to invest in the development of anticipatory capacity.

2. Absence of integrated resource planning (least-cost planning) for the whole energy system (identified in international best practice comparison). Even where exploratory modelling exists in Australia, such as in AEMO's ISP, it generally makes assumptions about uptake of demand-side and distributed energy resources and then optimisation calculations are performed on the supply side only, rather than including the demand-side in the optimisation process. Energy market rules and separation of responsibility mean that no single entity has responsibility for the whole energy system and collaborative approaches that would support holistic planning are not yet adequate.

3. Insufficient quantitative and qualitative data to support anticipatory action. This applies to: the costs, benefits, and capacity of demand-side options; global technological and other trends; and the value and types of employment in a DER future (identified through stakeholder consultation). Some of these data are not collected, while some are not accessible due to privacy or commercial concerns that hinder data sharing.

[4] See Sharpe, B. (2020). *Three horizons*. Triarchy Press.

[5] See Holmberg, J., & Robèrt, K. H. (2000). Backcasting—A framework for strategic planning. *International Journal of Sustainable Development & World Ecology*, *7*(4), 291-308.

4. Limited understanding of current and future customer needs and aspirations, and how these can be expected to evolve in the future. Table E1 indicates that change in future customer values is a driver that is frequently neglected in anticipatory publications. This is particularly important considering the increasing number of customer-owned distributed energy resources, and the implications of interactions between different investments (for instance, energy efficiency improvements, electric vehicles, behind-the-meter battery systems, remote load control/Internet of Things capability). Some stakeholders have a tendency to assume customers want to engage with energy use more than they actually do, and tend to view customers as a homogenous group rather than a segmented group with differences in attributes and energy use intentions.

5. Low familiarity with, and use of, innovative anticipatory methods to support decision-making under uncertain conditions. Separate from an absence of Government leadership and capacity building in foresighting for the future, there has also been an absence of application of truly innovative anticipatory methods that are expansive enough to consider a range of possible futures and open new thinking. This leaves the Australian energy system poorly prepared for disruptions, trend breaks and 'wild card' events that are becoming more common.

6. Failure to comprehensively plan for a rapid transition to net zero carbon futures. While net zero carbon targets are increasingly adopted by both governments and corporate entities, practical plans for achieving these targets are rare and those that exist are often contradictory, favouring particular technological solutions. There is a need to comprehensively and equitably explore all options for a rapid transition to net zero, while taking into account cross-sectoral implications for supply chains, workforces etc.

7. Few spaces where genuine, diverse stakeholder dialogue about the future of the energy system is encouraged and influential. Stakeholder consultation is ubiquitous in the energy sector but it frequently has narrow terms of reference that do not encourage open thinking about possible and preferable futures and is dominated by those with the resources to participate. In anticipatory processes, ensuring representation of voices from the margins of the system and niche projects is crucial, as these may come to shape the future much more than incumbent regime participants.

E2 Research Roadmap

Responding to the gaps identified above, the E2 Research Roadmap proposes four primary research projects:

1. A **Decentralised Energy Data Inventory** to fill data gaps relating to current uptake of decentralised energy products and services – addressing Gap 3 (insufficient data) and Gap 4 (understanding customer needs)

2. A **Least-Cost Energy Strategy** to identify an optimal mix of centralised and decentralised energy opportunities to meet customer needs while transitioning to a net zero world – addressing Gap 2 (least cost resource planning) and Gap 6 (net zero planning)

3. An **Australian Energy Futures report series** to support more robust and informed decision-making by reviewing and publicising possible futures for the Australian energy system – addressing all gaps

4. A **Decentralised Energy Statement of Opportunities** to draw attention to opportunities to deliver energy services through actions in distribution networks and behind the meter – addressing Gaps 3, 4, 6 and 7 (a consultative process, including with customers, to determine the opportunities to access customer-focused data and develop a decentralised energy net zero plan).

These four core research projects are supported by additional capacity building and doctoral research projects. The Roadmap is summarised in Table E2. A more detailed version with accompanying rationale is available in Section 7.

Table E1: Evaluation of anticipation type, drivers considered and key methods in Australian anticipatory energy publications. See legend following table for assessment criteria.[6]

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Australian Government										
Australia's Emission Projections										Quantitative modelling, sensitivity analysis, roadmap
Australia's Long-term Emission Reduction Plan										Quantitative modelling, scenarios (BAU and Plan), roadmap
Technology Investment Roadmap										Environmental scanning, technology assessment, roadmap
2021 Australian Infrastructure Plan										Visioning, scenarios, no regrets analysis, multi-criteria analysis, theory of change
State and Local Governments										
NSW Net Zero Plan										Quantitative modelling, roadmap
WA Whole of System Plan										Quantitative modelling, scenarios
WA Distributed Energy Resources Roadmap										Technology assessment, visioning, roadmap
SA Government Climate Change Action Plan										Projections, visioning, roadmap
Darwin-Katherine Electricity System Plan										Scenarios, least regret analysis, roadmap
ACT Climate Change Strategy										Visioning, roadmap, projections

[6] All listed publications are discussed and referenced in Section 4 of the report.

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
City of Sydney Environmental Strategy										Visioning, scenarios, roadmap, quantitative modelling
Regulators / market bodies										
AEMO Integrated System Plan 2022										Quantitative modelling, scenarios, roadmap, Delphi, least regrets analysis
AEMO Electricity and Gas Statement of Opportunities										Quantitative modelling, projections, scenarios
ESB Post-2025 Electricity Market Design										Quantitative modelling, roadmap
Industry										
Ausgrid DTAPR										Quantitative modelling, least regrets analysis, GIS
ENA Electricity Network Transformation Roadmap										Quantitative modelling, no regrets analysis, scenarios, roadmap
ENA Network Opportunity Maps										GIS
ENA Energy Vision										Visioning
ENA Gas Vision 2050										Visioning, quantitative modelling, pathway analysis
Western Power Grid Transformation Engine										Quantitative modelling, GIS, scenarios
Customer advocates										
ECA Foresighting Forum										Forecasting, visioning, scenarios

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Research										
CSIRO Change and Choice (Future Grid Forum)										Quantitative modelling, scenarios
CSIRO Low Emissions Technology Roadmap										Quantitative modelling, technology assessment, pathway analysis, roadmap
Monash Digital Energy Futures										Environmental scanning, trend analysis, scenarios
Summary	2.0	1.5	2.3	2.1	2.9	2.5	1.9	1.4	1.1	

Legend

	Score	Type of anticipation	Drivers considered
	0	No evidence of this type of anticipation	No explicit mention of this category of drivers
	1	Some use of this type of anticipation	Some consideration of this category of drivers
	2	Moderate use of this type of anticipation	Moderate consideration of this category of drivers
	3	Strong use of this type of anticipation	Strong consideration of this category of drivers

Social	Technological	Economic	Environmental	Political	Values
Ways of life (e.g. use of leisure time, family living patterns), demographic structures, social inclusion and cohesion issues (fragmentation of lifestyles, levels of (in)equality, educational trends).	Rates of technological progress, pace of diffusion of innovations, problems and risks associated with technology (including security and health problems)	Levels and distribution of economic growth, industrial structures, competition and competitiveness, markets, and financial issues	Pressures connected with sustainability and climate change, more localised environmental issues (including pollution, resource depletion, and associated biodiversity, and welfare concerns)	Dominant political viewpoints of parties, political (in)stability, regulatory roles and actions of governments, political action and lobbying by non-state actors (e.g. pressure groups, paramilitaries)	Attitudes to working life (e.g. entrepreneurialism, career aspirations), deference to authority, demands for mobility (across jobs of places, etc), preferences for leisure, culture, social relations, etc.

Table E2: Summary of E2 Research Roadmap.

Project	Activities	Gap addressed	Timing	Priority
Core Projects				
1 Decentralised Energy Data Inventory	• Assess available datasets on decentralised energy solutions; undertake surveys if required to fill gaps • Build comprehensive database on decentralised energy options	3, 4	Immediate start, with first inventory complete by 30 June 2023 Subsequent survey to be completed by 30 June 2024	High
2 Australian Least Cost Energy Strategy	• Using an Integrated Resource Planning (IRP) framework, identify the optimal mix of centralised and decentralised energy opportunities to meet customer needs at least cost over the next decade • Update regularly to incorporate new data	2, 6	FY22/23 start, first Least Cost Energy Strategy by 30 June 2023, then update every two years Engage with existing system planning processes, such as AEMO ISP and WA WOSP, throughout to seek improvements	High
3 Australian Energy Futures Report series First Foresighting Report: *The future of Australian energy system planning: Towards whole-of-system and zero-carbon planning* Later reports will update the first report and add scope based on stakeholder consultation	• Qualitative review of possible futures for the Australia energy system to support more robust and informed decision-making • Summarise energy megatrends to set the context for energy planning • Evaluate current energy system planning • Participatory process to develop a shared vision for the future of energy system planning • Explore alternative pathways for achieving the vision	All	FY22/23 start, with completion of first report by 30 June 2023. Subsequent reports every two years.	High
4 Decentralised Energy Statement of Opportunities	• Stakeholder consultation to design the DESOO process, map interaction with other similar reports and identify research needs • Research on selected decentralised energy options to fill gaps • Review other initiatives that are pursuing better coordination of decentralised energy • Provide a roadmap for integrating DESOO innovations into market institutions	3, 4, 6, 7	First DESOO Report by 30 June 2024, second DESOO Report by 30 June 2026.	High

Table E2: Summary of E2 Research Roadmap (cont.)

Project	Activities	Gap addressed	Timing	Priority
Supporting Projects				
5 Australian Energy Foresight Portal	• Scope, establish and maintain the Australian Energy Foresight Portal as a live online resource curating publications and data relevant to energy futures. • Run regular future-focused events and stakeholder dialogues. • Track and publicise 'weak signals' and 'wild cards' through an ongoing environmental scanning process.	1, 3, 5, 7	Establish in 2024 when first rounds of above projects are complete, then ongoing maintenance for life of RACE for 2030	Medium
6 Roadmap for open data sharing to support energy planning	• Develop a roadmap to provide a curated, close to real-time source of data to support anticipatory planning • Curate and publish available data needed to anticipate the future of the energy system • Establish pilot projects to test ways of overcoming commercial and privacy barriers to sharing other data	3	Engage with existing data portal providers during 2023 with a view to portal establishment in 2024	Medium
7 Short course on anticipation for zero carbon futures	• Design and develop short course • Offer short course	1, 5	Course to launch alongside first Foresighting Report	Medium
8 Doctoral research	• PhD on institutional change to support anticipation	1, 5	Seek student immediately to inform mid-term review (30 June 2025)	Low
	• PhD on strategic foresight and policy planning for net zero energy systems	1, 2, 5, 6	Seek student immediately to inform mid-term review (30 June 2025)	
	• Doctoral research project on how to evaluate anticipation	1, 3	Seek student immediately to inform mid-term review (30 June 2025)	
	• Doctoral research evaluating RACE for 2030 from a transition management perspective	5, 6	Seek student to commence by 30 June 2026	

Contents

Glossary

AAS - Australian Academy of Science

ACARD - Advisory Council for Applied Research and Development

ACOLA - Australian Council of Learned Academies

ACOSS - Australian Council of Social Services

ACT - Australian Capital Territory

AEMC - Australian Energy Market Commission

AEMO - Australian Energy Market Operator

AER - Australian Energy Regulator

AI – Artificial Intelligence

ALGA - Australian Local Government Association

ASX – Australian Stock Exchange

BAU – Business as usual

CEFC - Clean Energy Finance Corporation

COAG - Council of Australian Governments

CSIRO - Commonwealth Scientific and Industrial Research Organisation

DER – Distributed Energy Resources

DESOO - Decentralised Energy Statement of Opportunity

DR – demand response

DSR – Demand side response

E2 – RACE for Everyone Theme

EE – energy efficiency

EMM - Energy Ministers' Meeting

ENA – Energy Network Australia

ENCRC - Energy National Cabinet Reform Committee

ENTR - Electricity Network Transformation Roadmap

ESB - Energy Security Board

ESOO - Electricity Statement of Opportunities

ESPAS - European Strategy and Policy Analysis System

EU - European Union

EV - Electric vehicle

FCAS - Frequency control ancillary services

FFR – Fast frequency response

GPG - Gas-powered Generation

GTEng - Grid Transformation Engine

GW - gigawatt

GWh – gigawatt per hour

HVAC - Heating ventilation and air conditioning

IAP2 - International Association for Public Participation

IoT - Internet of Things

IPCC -Intergovernmental Panel On Climate Change

IRG – Industry Reference Group

IRM – Interim Reliability Measure

IRP - Integrated Resource Planning

ISF - Institute for Sustainable Futures

ISP – Integrated System Plan

MLP - multi-level perspective

MW - megawatt

NARUC - National Association of Regulatory Utility Commissioners

NEM – National Electricity Market

NEMDE - NEM dispatch engine

NEO - National Electricity Objective

NISTEP - National Institute of Science and Technology Policy

NOM - Network Opportunity Maps

NSP – Network Service provider

NSW – New South Wales

OA – Opportunity Assessment

ODP - Optimal Development Path

OECD - Organisation for Economic Co-operation and Development

OpEN - Open Energy Networks

P2P - Peer-to-peer (energy)

PIAC - Public Interest Advocacy Centre

PM - Prime Minister

RACE for 2030 CRC - Reliable, Affordable, Clean Energy (RACE) for 2030 Cooperative Research Centres (CRC)

REZ – Renewable Energy Zones

RIT-D - Regulatory investment test for distribution

SEI - Solar Enablement Initiative

SWIS – South West Interconnected System (Western’s Australia’s electricity grid)

UK - United Kingdom

US - United States

USA - United States of America

USE - Unserved Energy

UTS - University of Technology Sydney

V2X –Vehicle-to-everything

VaDER - Value of Distributed Energy Resources

VPP - Virtual Power Plant

VRE - Variable Renewable Energy

WA - Western Australia

WOSP - Whole of System Plan

WW2 – World War II

1 Introduction

1.1 RACE for 2030

The Reliable, Affordable, Clean Energy for 2030 Cooperative Research Centre (RACE for 2030) is a 10-year, $350 million Australian research collaboration involving industry, research, government and other stakeholders. Its mission is to drive innovation for a reliable, affordable, clean energy future. RACE for 2030 undertakes research to support market transformation that will:

- Reduce energy costs
- Cut carbon emissions
- Increase customer load flexibility to allow increased penetration of renewables in the grid and increased reliability.

RACE for 2030 research is organised under four programs:

- RACE for Business
- RACE for Homes
- RACE for Networks
- RACE for Everyone (covering cross-sectoral issues).

The RACE for Everyone program focuses on building industry capacity and developing skills for service providers, customers, and suppliers to better address rapid change. It has three research themes:

- Theme E1: Trust building for collaborative win-win customer solutions
- Theme E2: Innovative foresighting and planning
- Theme E3: Developing the future energy workforce

This Opportunity Assessment is for Theme E2.

1.2 Theme E2: Innovative foresighting and planning

The future of the energy sector has never been less certain. At the first stakeholder consultation workshop for this Opportunity Assessment, we asked participants to share their biggest sources of uncertainty about the future of the Australian energy system. Responses are grouped and summarised in Table 1.

Climate change, accelerating technological development and changes in customer roles and expectations are breaking down old models of energy supply and forcing an energy transition, but outcomes remain highly uncertain. Stakeholders shared uncertainties about the rate of uptake of technologies, the ability of the grid to accommodate those technologies and the role that government policy and market reform will play in energy transition.

As a result of these uncertainties, energy transition pathways and endpoints remain unclear. How fast will decarbonisation take place? What mix of technologies will emerge? How will supply and demand be balanced? To what extent will consumers participate in this energy transition? And how can the work of RACE for 2030 best contribute to the emergence of a future characterised by deep electricity decarbonisation and a low emissions economy – whilst ensuring reliability and affordability in electricity supply?

Table 1: Stakeholder views on the biggest sources of uncertainty about the future of the Australian energy system.

Category	Sources of uncertainty
Policy and politics	• Government policy (listed twice) • Political ideology • Shifts in government leadership (federal and state) • Regulatory inertia or bravery • The level of leadership from government • Climate policy ambition • Governance at local level • Policy of state and federal government • Slow pace of planning and especially regulatory process to new innovation
Customer choices and practices	• Customer preferences • Customer behaviour with respect to new technologies • Overall demand forecast • Device and premise level usage profiles • Willingness in people to let energy companies control when they can charge things • Degree of flexibility in energy demand • Demand and variable renewable energy resource yields
Infrastructure resilience	• Maintaining grid reliability in our energy transition • Climate change impacts on physical infrastructure and networks • Voltage management • Network buildout • Cyber-security related disruptions to network operations and integrity • Incorporation of DER into the grid • Role of electric vehicles (EVs) • Population movement (from coast inland with planned and unplanned retreats) - associated infrastructure disruptions
Rate of uptake of technologies	• Rate and pace of electrification • The degree to which energy efficiency and load management will be fully recognised and utilised in the electricity system • Pace of technology adoption • DER uptake • Batteries and EVs • New technology impacts • Uptake of new technologies - magnitude and how users will adopt them - EVs, behind the meter batteries, and also investment in large scale infrastructure, e.g. transmission and wind and solar projects • Scenario for 3-10 years of a solar dominated grid • Pace of electrification • Batteries • EV • Technology costs
Market and pricing reform	• Market design • Prices • Impact of price reform • Tariffs • Incorrect net present value of coal fired power
Transition pathways	• The pace at which things change

Category	Sources of uncertainty
	• Decarbonisation of the transport sector • Pace and timeline of the coal fired power station closures • Demand for gas and potential transition fuels e.g. hydrogen, electrification

Many of the forecasting and planning practices in the energy sector were developed in a time when planning for supply-side investment to meet ever-increasing electricity demand was the norm. They are not adequate to the task of responding to the questions raised above. Disruptive processes associated with the rise of distributed energy resources, including solar PV, EVs, and smart energy management, require a new planning approach that is still emerging.

Theme E2 promotes innovative foresighting and planning as a response to these challenges. It seeks to blend traditional forecasting with more innovative foresighting and comprehensive distributed energy resource (DER) potential assessment to consider not just what trends suggest, but also what is possible and desirable.

1.3 E2 Opportunity Assessment

The E2 Opportunity Assessment assesses how industry, government and NGO participants in the Australian energy sector currently plan for the future and examines the potential for new foresighting approaches that can support the transition to a net-zero carbon future. The Opportunity Assessment is led by the Institute for Sustainable Futures (ISF) at the University of Technology Sydney (UTS), in partnership with University of New South Wales, Curtin University and Monash University.

This Final Report from the Opportunity Assessment includes a summary of findings from the literature review and stakeholder consultation, and a Research Roadmap that will guide the future work of RACE for 2030 under Theme E2. It scopes out four major research projects:

- A **Decentralised Energy Data Inventory** to fill data gaps relating to current uptake of decentralised energy products and services
- A **Least-Cost Energy Strategy** to identify an optimal mix of centralised and decentralised energy opportunities to meet customer needs while transitioning to a net zero world
- An **Australian Energy Futures report series** to support more robust and informed decision-making by reviewing and publicising possible futures for the Australian energy system
- A **Decentralised Energy Statement of Opportunities** to draw attention to opportunities to deliver energy services through actions in distribution networks and behind the meter.

It also identifies several supporting projects that would assist the delivery of these four primary projects and build capacity for anticipatory whole-of-system planning in the Australian energy sector.

2 Research approach

This section summarises our approach to the Opportunity Assessment. Section 2.1 starts by defining how foresighting, planning and other key terms are used in the report. Section 2.2 outlines the energy transitions framework that guides the Opportunity Assessment and the way we organised the work. Finally, Sections 2.3 and 2.4 discuss the two methods used in the Opportunity Assessment - literature review and stakeholder consultation.

2.1 Anticipatory planning in the energy system

RACE for 2030 has named Theme E2 'Innovative Foresighting and Planning'. This creates some challenges, because foresighting means very different things to different people. Scholars and practitioners with a focus on exploring and understanding the future have introduced many terms over the years to describe their work: futurology, futures studies, forecasting, foresight, strategic foresight and futures thinking, to name a few. This has created much confusion. Since 2012, UNESCO has sponsored efforts to clear up this confusion by building futures literacy and establishing a new 'discipline of anticipation'.[7]

Anticipation refers to all the ways we explore and use the future in the present. It is intended as a comprehensive term that captures diverse ways of thinking about the future. Anticipation occurs when the future is used to plan and guide action. We interpret our scope in this Opportunity Assessment as covering the full range of anticipation in the Australian energy system - what is currently being done to anticipate and plan for the future of the energy system, and how could current practice be improved.

Within the broad framework of anticipation, terms such as forecasting and foresighting have specific meanings, as summarised in Table 2. We adopt these meanings in this Opportunity Assessment.

Table 2: Types of anticipation and associated methods.[8]

Type of anticipation	Goal and characteristics	Typical methods
Forecasting	Identify and characterise the most likely or probable future, often quantitatively; predictive; assumes that the system under study will continue to work more or less as it has been working so far	Quantitative modelling; extrapolation; trend and megatrend analysis; technology assessment; GIS
Exploratory foresighting	Explore or map the range of possible futures that could emerge; qualitative or quantitative; introduces and often focuses on discontinuities; used to challenge the mindset of decision-makers	Scenarios; sensitivity analysis; no or least regrets analysis; futures wheel; Three Horizons; environmental scanning; strategic interviews / Delphi; weak signals; wild cards; causal layered analysis
Normative foresighting	Identify or imagine desirable futures; often qualitative; introduces discontinuities; used to identify preferred futures	Visioning; Three Horizons; backcasting; roadmapping; multi-criteria analysis; pathway analysis

All types of anticipation are potentially useful in the right circumstances. Forecasting is useful in situations where the systems being studied are stable and continuous. It can also support detailed descriptions of scenarios by showing what would happen if the assumptions of that scenario hold true.

[7] https://en.unesco.org/futuresliteracy

[8] After Poli, R. (2019). Introducing Anticipation. In R. Poli (Ed.), Handbook of anticipation: Theoretical and applied aspects of the use of future in decision making (pp. 3-16). Springer International Publishing. https://doi.org/10.1007/978-3-319-91554-8_1

Exploratory foresighting practices are useful for facilitating imaginative thinking about future possibilities. As the OECD points out, exploratory foresighting 'does not attempt to offer definitive answers about what the future will hold'.[9] The future is emergent and cannot be fully predicted. Instead, exploratory foresighting is about expanding the range of possible futures that are considered when making decisions. It aims to deliver a more complete perception of the strategic options available.[10] Exploratory foresighting is particularly valuable in situations where there is rapid change, complexity and uncertainty. These conditions clearly apply to the Australian energy system. Normative foresighting is used for imagining, identifying pathways to, and planning actions to achieve, preferred futures within the range of possibilities.

Anticipatory planning draws on forecasting, foresighting and other practices to identify the best actions to take in response to anticipated futures. The term 'anticipatory planning' emphasises the crucial need to integrate best-practice anticipatory practices into energy system planning. It is possible, and unfortunately common, to develop plans without a sophisticated exploration of what the future might bring. Such plans are less likely to plot an efficient and effective path towards agreed goals; they are rapidly overtaken by events. We use the term anticipatory planning throughout this report to advocate for a type of planning that is more comprehensive in its consideration of future possibilities.

2.2 Energy transitions

Energy systems around the world are currently in transition, under pressure to reduce greenhouse gas emissions, respond to new customer priorities and accommodate associated technological developments. Governments around the world, including in Australia, now agree on a goal of net zero carbon, even if debate still rages over the timing and pathways for achieving that goal. The pace of transition, and the pathways it will take, is a key source of uncertainty that anticipatory systems seek to address.

In Australia's electricity system, a rapid influx of intermittent renewable energy generation, combined with an increasingly decentralised electricity system, is creating both supply and demand challenges for an electricity grid that has historically been comprised of a one-way flow of dispatchable energy sources. The grid is increasingly hosting small-scale renewable energy, storage and load management systems throughout its network, generally called Distributed Energy Resources (DERs). The Australian Energy Market Operator (AEMO) defines DERs as consumer-owned devices that, as individual units, can generate or store electricity or have the ′smarts′ to actively manage energy demand.[11] They include rooftop solar photovoltaic (PV) units, battery storage systems, hot water systems, pool pumps, air conditioners, smart appliances, and electric vehicles. Other definitions, such as from the American Council for an Energy Efficient Economy, expand the list of DERs beyond devices to include energy efficiency initiatives.[12]

The growth in DERs is creating a need to manage the grid in new ways to maintain the quality of electricity supply. A key uncertainty is how quickly DER uptake will proceed and what balance of decentralised and centralised energy resources will emerge.

[9] https://www.oecd.org/strategic-foresight/whatisforesight/

[10] Voros, J. (2003). A generic foresight process framework. Foresight, 5(3), 10-21. https://doi.org/10.1108/14636680310698379

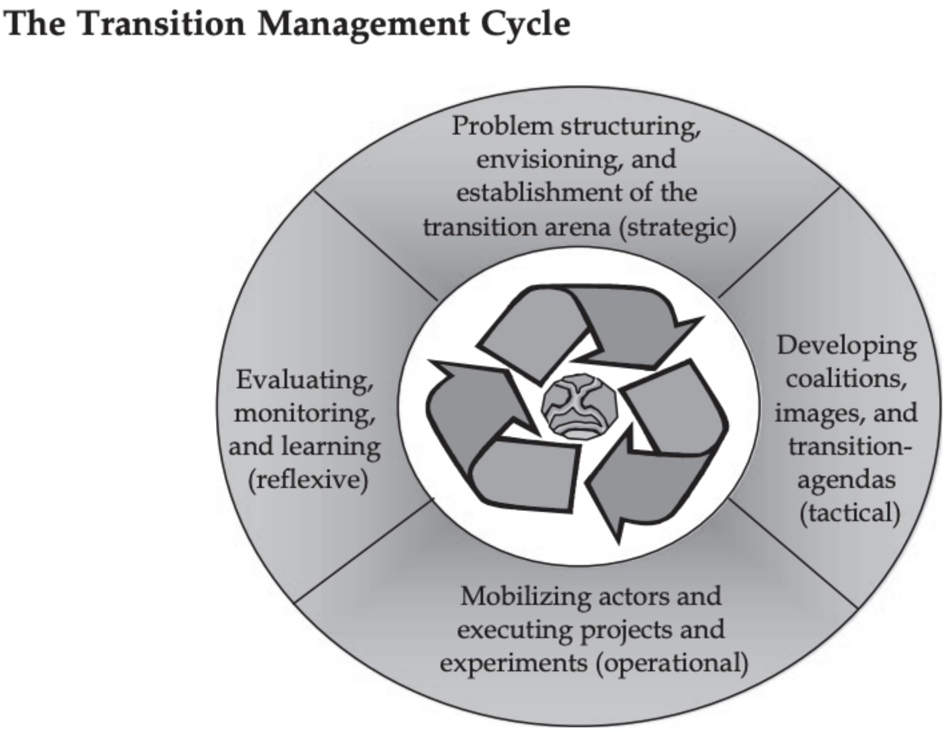
[11] https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/about-the-der-program

[12] https://www.aceee.org/topic/distributed-energy-resources

Research on sociotechnical transitions, much of it focused in the energy sector, has provided us with several tools to help understand energy transitions and the potential role of anticipation. Primary among these is the framework of transition management. Derk Loorbach developed the idea of transition management to guide policy makers seeking to shape transitions through four sequential steps, as shown in Figure 1.[13] Loorbach defines an anticipatory process with four stages:

1. Strategic activities to define the problem, identify visions for success and establish a 'transition arena'
2. Tactical coalition and agenda-building
3. Operational tasks of mobilising actors and taking action
4. Reflexive evaluation, monitoring and learning.

Figure 1: The Transition Management Cycle.[14]



The scope of this Opportunity Assessment primarily covers the strategic and tactical stages in Figure 1, as these are the stages where actors are anticipating the future, before moving on to action. But for a comprehensive view of anticipation, we do touch on the operational and reflexive stages in this Opportunity Assessment.

The other transitions theory tool we use in the Opportunity Assessment is the multi-level perspective (MLP), shown in Figure 2. There are two key ideas we take from MLP. The first is the idea that the energy system is a

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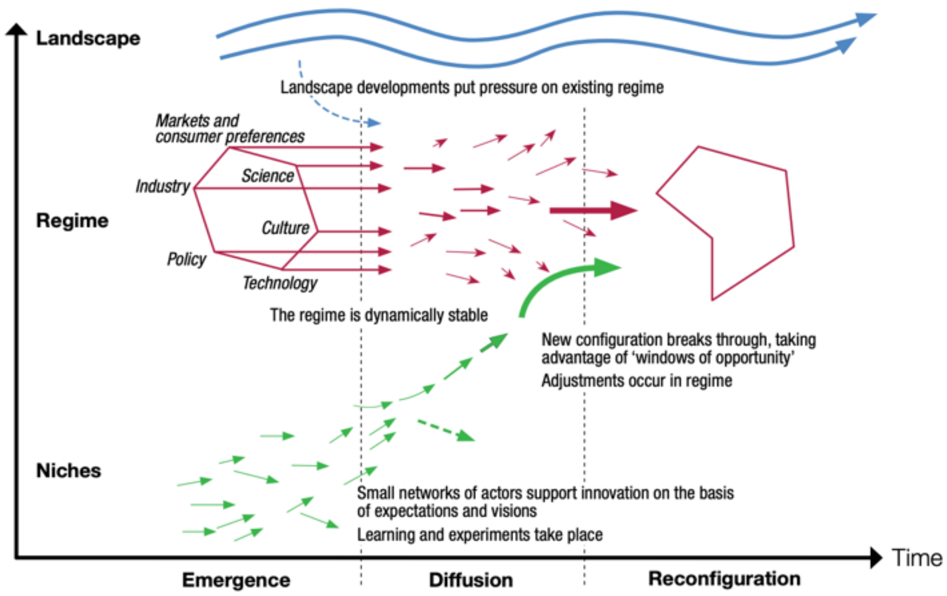
[13] Loorbach, D. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. Governance, 23(1), 161-183.
[14] Loorbach, D. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. Governance, 23(1), 161-183.

dynamically stable[15] regime made up of: markets and consumer preferences; industry; policy; technology; science; and culture. These are key elements to pay attention to when considering how the regime might transition to another state in the future.

Second, MLP contains a theory about how change happens in the energy system that defines two levels of activity in addition to the regime: the landscape and niches. Landscape developments create pressure on the existing regime that could lead to change. For the energy system, current pressures include the global drive to reduce greenhouse gas emissions, geopolitical changes affecting access to and prices of energy resources, the ongoing expansion of digital technologies and networks, and culture-wide shifts in customer aspirations. Niches are innovative spaces where new ideas, technologies and practices can develop without pressure from the regime. When the conditions are right in the regime, usually due to landscape pressures, niches can break into the regime, or even replace it entirely in some cases. We use these concepts throughout the Opportunity Assessment to frame how anticipation can drive system-level changes towards a zero-carbon energy system.

Figure 2: The multi-level perspective from transitions theory. Image by International Science Council based on Geels.[16]



Given all of the above, a more suitable name for the RACE for 2030 Theme E2 would be 'anticipatory planning for the energy transition' - the title we have used for this Final Report.

2.3 Literature review

One of the two methods used for the Opportunity Assessment was a review of academic and industry publications on the broad topic of anticipation in Australia's energy system. There were three phases to the literature review:

1. Review and document the current state of anticipation in the Australian energy system
2. Review international best practice in anticipation, relevant to energy

[15] In transitions theory, 'dynamically stable' captures the idea that regimes have some inertia or 'lock in' that makes them resist change in their overall structure, even while they contain dynamic processes of change within that structure.
[16] Geels, F. W. (2019). Socio-technical transitions to sustainability: a review of criticisms and elaborations of the Multi-Level Perspective. Current Opinion in Environmental Sustainability, 39, 187-201. https://doi.org/10.1016/j.cosust.2019.06.009

3. Additional literature review to explore opportunities for improvement emerging from the first two stages and stakeholder consultation.

The literature review is a narrative review that does not aim to be comprehensive or systematic but does aim to cover the key literature identified by stakeholders and known to our team. We have sought guidance during stakeholder consultation (see the next section) on material to include but also conducted targeted database searches to fill gaps in knowledge.

2.4 Stakeholder consultation

The other primary method used in the Opportunity Assessment was stakeholder consultation. We established an Industry Reference Group (IRG), listed in Table 3, to provide guidance throughout the project. Members were chosen based on interest in the topic and to give good coverage of stakeholder types with an interest in energy futures. The IRG met twice during the project, on 6th December 2021 and 26th May 2022. The meetings sought input on scope, key questions to cover in the Opportunity Assessment, and current practice in anticipation, as well as reviewing draft findings. IRG members have also participated in consultation workshops and interviews, outlined below.

Table 3: Industry Reference Group membership, in alphabetical order

Name	Position	Organisation
Monaaf Al-Falahi	Technical Program Coordinator	Energy Networks Australia
Greg Appleby	Senior Resource Management Advisor, Environment and Heritage	Sydney Water
Gabrielle Breen	Senior Policy Officer, Energy Demand and Efficiency Policy	Department of Environment, Land, Water and Planning (Victoria)
Daniel Collins	Specialist	Australian Energy Market Operator
Alan Dormer	Managing Director	Opturion
Paul Graham	Chief Economist	CSIRO, Energy Business Unit
Brian Innes	Technical Director and Founder	Starling Energy
Christopher Lee	CEO	Climate-KIC Australia
Arianwyn Lowe	Director Energy Programs, Energy, Climate Change and Sustainability	Department of Planning, Industry and Environment (NSW)
Nik Midlam	Manager, Carbon Strategy	City of Sydney
Brian Spak	Director, Energy System Transition	Energy Consumers Australia
Holly Taylor	Head of Projects	Energy Efficiency Council
Caitlin Trethewy	Strategy Manger, Corporate Strategy	AGL
Craig Tupper	Manager, DM and Forecasting	Ausgrid

In addition to the IRG meetings, we held two Consultation Workshops in February and May 2022, which were open to the IRG and other interested parties. The first workshop shared preliminary literature review findings, sought input on a vision of success for Theme E2 and gathered feedback on the role of key Theme E2 commitments such as the Foresighting Report. The second Consultation Workshop used the 'Three Horizons' anticipatory method to identify project ideas for potential inclusion in the E2 Research Roadmap.

Finally, interviews with key stakeholder representatives have been a valuable source of information. Workshops allow feedback to be gathered quickly from many people, but it can be difficult to go deep into issues of interest to participants. Interviews allow for a richer conversation on specific topics. Interview participants to date are listed below.

Table 4: Interview participants.

Name	Position	Organisation
Monaaf Al-Falahi	Technical Program Coordinator	Energy Networks Australia
Brian Spak	Director, Energy System Transition	Energy Consumers Australia
Chris Dunstan	Chief Research Officer	RACE for 2030 CRC
Craig Tupper	Manager, DM and Forecasting	Ausgrid
Daniel Collins	Specialist	Australian Energy Market Operator
Douglas McCloskey	Program Director, Energy + Water Consumers' Advocacy Program	Public Interest Advocacy Centre

3 Future expectations for the Australian energy system

The main focus of this Opportunity Assessment is on understanding *how* actors in the energy system prepare for the future, and whether these practices can be improved. *What* the future will be like is not a key focus for the Opportunity Assessment but offers important context. To judge whether the anticipatory capacity of the Australian energy system is sufficient, we need to have some sense of the kind of futures we need to be preparing for.

3.1 Uncertain futures

The clearest message from the research to date is the high degree of uncertainty about the future of the Australian and international energy systems. As summarised in Table 1, participants in our first Consultation Workshop identified six key sources of uncertainty: government policy and politics; customer choices and practices; infrastructure resilience; rate of uptake of new technologies; market and pricing reform; and transition pathways.

Aurecon has done stakeholder engagement on the future of energy in Australia that found a similar level of uncertainty.[17] In their research with over 100 industry participants, stakeholders asked:

- Where will the energy come from? What will be the future fuel and technology mix?
- How will decentralisation shape the future energy system?
- How fast will we reduce greenhouse gas emissions and through what technologies?
- What role will electrification play in the future of the energy system?
- What will happen to energy demand?
- Which stakeholders will lead policy development? What policy settings will there be in the future?

With all this uncertainty, and the changes observed in the energy system in recent history, few would argue that the future trajectory of the energy system will be steady and continuous. Foresighting methods that go beyond forecasting and projection will be needed to cope with uncertainty, discontinuity and surprises.

3.2 Zero carbon and beyond

Despite this uncertainty, there is a near-consensus that a future energy system will at some point need to achieve zero carbon, and perhaps move beyond that to sequester greenhouse gases that have already been emitted. When we asked our IRG to describe their vision for the future of the energy sector in just three words, some of the most popular choices were renewable, clean and decarbonised, as shown in Figure 3. In the Aurecon research mentioned above, stakeholders did not ask *whether* we would reduce greenhouse gas emissions but *how fast* it would happen and through which technologies.

While the technology mix to achieve zero carbon and the pace of change is fiercely contested, there is little doubt that anticipatory systems will need to provide guidance on how to navigate the transition to a zero carbon future. This means having the capacity to imagine, model and compare alternative pathways for achieving that goal. Global investors with trillions of dollars of assets are increasingly ready to commit funding to projects that can demonstrate net zero outcomes[18].

[17] https://www.aurecongroup.com/markets/energy/transforming-energy-market-australia
[18] https://www.climateaction100.org/

Figure 3: Word cloud summarising IRG visions for the future of the Australian energy system.

3.3 Holistic, integrated and decentralised

For decades, before decarbonisation became a shared agenda, the goal of energy system actors was to plan sufficient centralised energy supply to meet steady growth in energy demand - keeping the lights on. Practices for anticipating the future in that context included forecasting, modelling and projections, which worked well in a stable energy regime. But once the energy transition kicked off, these practices were no longer sufficient. Now, stakeholders agree that the future of the energy system needs to be more holistic and integrated, treating demand-side and supply-side options equally. In Figure 3, words like integrated, decentralised, optimised and least-cost capture this expectation.

This means that practices for anticipating the future need to be able to see the whole system and the full set of opportunities for intervening in the system, including supply-side and demand-side responses, or centralised and decentralised options.

3.4 People-centred

In Figure 3, stakeholders captured the need for the future energy system to be people-centred, user centric and low cost. Human behaviour is notoriously hard to predict. Faster than anticipated customer uptake of particular technologies, such as air-conditioning and rooftop solar, has created past and current challenges for the Australian energy system. Customers now have easy access to vast amounts of information and actively seek opportunities to obtain better energy services, reduce their energy bills and consume in ways they see as ethical.

In the past, customer preferences and practices were either left out of forecasting or reduced to simple price-based behaviours, which do not match observed reality. Anticipatory practices need to develop a much clearer view of possible futures on the customer side, which will have a huge impact on the uptake of distributed energy resources.

3.5 Resilient and flexible

Finally, given all of the above, we can anticipate that the future energy system will need to be resilient and flexible, to cope with the uncertainty described above, but also to weather the increasing impacts of climate change. Keeping the energy system functioning through storms, fires and floods will be an inevitable part of our future. Flexibility is also needed to avoid stranded assets and be able to move in new directions as technology advances.

For anticipatory systems, this means being able to develop least-regret pathways and options that are robust across multiple possible futures.

4 Anticipatory activity in the Australian energy system

This section summarises the current state of anticipation in the Australian energy system, drawing on the literature review and stakeholder consultation to date. Where appropriate the following guiding questions have been considered:

- What are governments, regulators, industry, customer groups and researchers doing to engage with the future of the Australian energy system and plan for energy transition?
- What are the key future-focused publications produced by these groups, what are their aims, and how are they used?
- What methods are used to anticipate the future? How prevalent are forecasting, exploratory foresighting, normative foresighting and anticipatory action?
- For each of the groups, what is being done well, and what could be improved?

Each organisational group is considered in turn below, followed by a summary of findings in Section 4.8.

4.1 Australian government

While many other national governments have institutionalised foresighting capability (see Section 5), the Australian Government does not have a recognised 'institution of foresight'[19] as part of its policy or decision-making structure. There have been some attempts to develop such capacity in the past. The Australian Commission for the Future was established in 1985 to raise public awareness and stimulate debate about future issues, and report to Parliament. It lasted for 13 years in various forms before its closure in 1998. In 2001, the Australian Parliamentary Library produced a research paper *Australia 2020: Foresight for our Future*, outlining how formal foresighting methods could be used for policy development[20], however there is no evidence these recommendations were adopted.

At the highest federal level, the Department of Prime Minister and Cabinet recently published the *Blueprint for Critical Technologies*, which specifically calls for using an advanced foresight capability (set up within the Defence Science and Technology Group) to identify critical technologies and notes that this capability is one where Australia has taken the lead in the Quad Leaders Dialogue.[21] Visibility at this level may mean that exploratory and other formal foresighting methods may be more widely applied across the Australian Government in future, which would be important for resilience as forecasting and normative foresighting alone may not prepare us well for unexpected disruption.

Despite the lack of a formal foresighting function, the Australian Government does engage in anticipatory activity. It is responsible for Australia's greenhouse gas emission projections[22], which are required to demonstrate progress towards international emission reduction commitments. These projections are based on quantitative forecasts but do include some sensitivity analysis (exploratory) and policy statements (normative).

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[19] Slaughter, R. A. (1999). Lessons from the Australian Commission for the Future: 1986–98. Futures, 31(1), 91-99. https://doi.org/10.1016/s0016-3287(98)00114-1

[20] https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp0001/01RP18

[21] https://www.pmc.gov.au/resource-centre/domestic-policy/blueprint-critical-technologies

[22] https://www.dcceew.gov.au/sites/default/files/documents/australias_emissions_projections_2021_0.pdf

In the context of energy, the key policy is Australia's Long-Term Emissions Reduction Plan, developed by the Department of Industry, Science, Energy and Resources, which sets out an approach for achieving net zero emissions by 2050.[23] Its approach to the future is primarily driven by this normative goal. It draws on economic modelling and limited scenario analysis (BAU and Plan) to identify priority technologies and policies.

The key initiative in Australia's Long Term Emission Reduction Plan is a Technology Investment Roadmap[24], started in 2020. The Roadmap is an overarching strategy to accelerate the development and commercialisation of new and emerging low emissions technologies. It adopts a staged approach of identifying priority technologies to support, based on abatement potential, comparative advantage, scale of economic benefit and technology readiness, then planning pathways to invest in their development. Through annual Low Emission Technology Statements[25], the Australian Government has narrowed in on seven priority technologies: clean hydrogen; ultra low-cost solar; energy storage; low emissions steel; low emissions aluminium; carbon capture and storage; and soil carbon. It has set economic stretch goals for each.

The Roadmap and Statements were developed through a consultative process, led by the Technology Investment Advisory Council. This group is chaired by Dr Alan Finkel with membership from science, business, technology and government organisations. Interested parties were able to provide written submissions to the original Discussion Paper and similar consultation approaches were used for development of the Statements. The anticipation approach taken here is normative foresighting. The Australian Government established a vision of a 'prosperous Australia, recognised as a global low emissions technology leader'. Drawing on a standard government consultation process, it has put in place a roadmap to build its leadership in these key technologies.

The Roadmap is important for the future of the energy sector because it guides the direction of government policy and substantial government investment, which will shape which technologies are prioritised and their rate of uptake. The approach could be criticised for 'picking winners', which reduces the flexibility to respond to an uncertain future and unforeseen disruptions. This is partially addressed by revising the Low Emission Technology Statements each year, using a consultation hub to accept submissions. Ultra low-cost solar was added to the priority list in this way. There does not seem to be a process in place for renewing the vision at this stage; however, in the Low Emissions Technology Statement 2021[26] there is an Emerging Technologies section which identifies high potential technologies at an early stage. The process for identifying these is not described.

Other future-focused activity relevant to the energy system takes place in Australian Government agencies, including the Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation (CEFC) and Infrastructure Australia.

ARENA's objective is improving the competitiveness of renewable energy technologies and increasing the supply of renewable energy in Australia by investing in pre-commercial innovation.[27] It pursues this goal mainly through provision of funding and sharing knowledge from funded projects. It complements the Australian Government's support for innovation and energy sector reform by collaborating with organisations such as the

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[23] https://www.industry.gov.au/data-and-publications/australias-long-term-emissions-reduction-plan

[24] https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-first-low-emissions-technology-statement-2020/technology-investment-roadmap

[25] https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-first-low-emissions-technology-statement-2020

[26] https://www.industry.gov.au/data-and-publications/technology-investment-roadmap-low-emissions-technology-statement-2021

[27] https://arena.gov.au/

Clean Energy Finance Corporation (CEFC), CSIRO, Australian Energy Market Operator (AEMO), Australian Energy Market Commission (AEMC), Australian Energy Regulator (AER), Energy Security Board (ESB) and innovators in industry. ARENA also stays connected with all state and territory governments.

- ARENA's General Funding Strategy and Investment Plan[28] are key documents shaping the future of the energy sector, as they have a significant influence on which technologies receive funding support. The view of the future presented in these documents largely reflects the Australian Government policy priorities in the Low Emissions Technology Roadmap, discussed above, although ARENA also seeks stakeholder views in developing its investment strategies and plans. ARENA's extensive knowledge base and deep engagement with other organisations raises the possibility that it could take a stronger role in synthesising and publishing future-focused perspectives.
- The Clean Energy Finance Corporation[29] has $10 billion to invest in 'clean energy technologies, projects and businesses, to accelerate Australia's transition to a low emissions economy'. The main document guiding investment is the CEFC Investment Mandate Direction[30] which is updated annually and signed by the Minister for Energy and Resources. This document is very specific in directing the kinds of technologies and outcomes where investments can be made. CEFC must also align investments with the Technology Investment Roadmap. There is no further indication of how CEFC anticipates trends or emerging investment opportunities, but it does work with other bodies such as AEMO which use foresighting methods. However, CEFC's rich interactions with industry and the business community would give it access to those stakeholder's future-focussed thinking. Its investment board includes ARENA representatives.
- Infrastructure Australia also considers the future of the energy system as part of its brief on infrastructure more generally. An *Assessment of Australia's Future Infrastructure Needs* released in 2019 used strategic foresighting to move beyond simple extrapolation and consider different possible futures.[31] That document formed part of the foundation for the *2021 Australian Infrastructure Plan* which sets out recommendations for transition to a smart, affordable and reliable grid and low-emission energy sources.[32] It draws on a 'theory of change' methodology to identify the actions required to deliver desired outcomes.[33] The actions recommended are largely incremental, as would be expected for a 5 year planning horizon.

The most common method used in Australian Government foresighting and planning is stakeholder engagement. Table 5 summarises stakeholder engagement methods used by various Australian Government agencies and the scope of stakeholders involved. Input from such engagement is used in policy development, however formal foresight practice is only mentioned in CSIRO, AEMO and Infrastructure Australia documents. There is little explanation of how visioning is done, goals set, or how themes are developed. Sharing and describing that initial process may improve how we develop (and revise) visioning processes.

[28] https://arena.gov.au/about/publications/funding-investment-plan/
[29] https://www.cefc.com.au/
[30] https://www.legislation.gov.au/Details/F2020L00552
[31] https://www.infrastructureaustralia.gov.au/sites/default/files/2020-09/2019_AIAudit_may2020_update.pdf
[32] https://www.infrastructureaustralia.gov.au/publications/2021-australian-infrastructure-plan
[33] https://www.infrastructureaustralia.gov.au/sites/default/files/2021-11/Theory of Change Guidance 20211123.pdf

Table 5: Stakeholder engagement methods used by the Australian Government.

	Methods			Consultations															
	Communication	Feedback for draft plans	Workshops	Stakeholders		Industry			Government			Consumer groups		Other organisations		Environmental groups		Community	
	Web and social media	Feedback for draft plans	Industry workshops	Individual consultations	Landholder consultations	Technology developers	Investors	Advocacy groups	Federal	State	Local	Customers	Consumer representatives	Research organizations	Unions	Environmental organisations	NGOs	Community information sessions	Communities
AEMO		*	*	*	*				*										
AER		*					*		*	*		*	*						*
ARENA	*	*	*	*					*	*	*			*			*		
CEFC		*	*	*					*	*				*	*		*		
CSIRO		*	*	*		*			*	*			*	*			*		
DISER		*	*	*					*				*	*			*		
ESB		*	*						*	*			*	*					

4.2 State and territory governments

Responsibility for the energy system(s) in Australia sits largely with states and territories, and future-focused activity in Australia's energy sector is strongly influenced by the stakeholder consultation approaches undertaken by these jurisdictions. All state governments have developed plans for managing the energy transition and aim to receive stakeholder feedback and establish ongoing collaboration with groups deemed relevant to their plan. However, feedback and collaboration methods, and groups selected for ongoing collaboration differ between states. Table 6 summarises the predominant approaches to stakeholder engagement about the future of energy in the States and Territories.

Table 6: Stakeholder engagement approaches in States and Territories.

	Methods			Consultations															
	Communication	Feedback for draft plans	Workshops	Stakeholders		Industry			Government			Consumer groups		Other organisations		Environmental groups		Community	
	Web and social media	Feedback for draft plans	Industry workshops	Individual consultations	Landholder consultations	Technology developers	Investors	Advocacy groups	Federal	State	Local	Customers	Consumer representatives	Research organizations	Unions	Environmental organisations	NGOs	Community information sessions	Communities
Victoria		*	*	*	*						*	*							*
Western Australia		*	*	*		*	*	*				*							
New South Wales	*	*	*	*	*													*	*
Capital Territory	*	*	*	*							*			*					*
Queensland		*	*	*				*						*	*	*			*
Tasmania			*							*	*			*		*			
South Australia			*										*						
Northern Territory												*							

The state government energy plans all have ambitions to lower the carbon emissions of electricity supply, while also achieving energy security and affordability. Their use of foresight varies. Most states have some level of planned or completed action to improve forecasting ability by improving data collection and sharing, as in the more centralised effort of AEMO's national DER Register. However, the states are not yet seeing how proper land-use planning can expedite the safe integration of DERs, which will happen once the frameworks for assessing these projects are made available, and partnerships with local governments are created to do demonstrations. Both scales of approaches are needed.

The sections below provide more detail on anticipatory activity by each jurisdiction.

4.2.1 Australian Capital Territory

The ACT Climate Change Strategy 2019–2025 is a roadmap for reducing emissions by 50–60% (below 1990 levels) by 2025 and establishing a pathway for achieving net zero emissions by 2045.[34] It was developed by consulting academics, businesses and advocacy groups via meetings, invitations for written feedback, establishment of online forums, and reaching out to individuals at community events. The strategy considers incremental targets for emissions in the future towards the stated goals. The strategy also aims to be flexible, recognising that a successful transition to net zero will require iterative learning and dynamic methods to ensure flexibility and adaptability, as technologies mature, and interim solutions are made in progress towards the ultimate goal. This intended adaptability applies to all aspects of the process, including technology selections and engagement with evolving parties of stakeholders. The Strategy is supported by plans and roadmaps relating to specific aspects of energy, such as a Zero Emission Vehicles plan.

4.2.2 New South Wales

NSW has established a Net Zero Plan to reach net zero emissions by 2050.[35] The Net Zero Plan Stage 1: 2020-2030 is a roadmap for the first part of the journey to net zero emissions. Its main aims are a 50 percent reduction of 2005 emission levels by 2030 and improving the sustainability of the economy and communities. The NSW Government considers decentralised solar generation in supporting these aims. Potential for large scale renewables – especially for primary industry – is examined through forecasting and the potential market value of Large-Scale Generation Certificates. There does not seem to be consideration of how the installation of small scale DERs may impact the existing grid infrastructure or demand profiles as part of such forecasting. The NSW Government intends to encourage and support DER uptake (including batteries) however there does not seem to be a roadmap for the development of supporting services. Regarding EVs, a form of DER that may cause significant disruption to the energy system, the NSW Government forecasts the rates of uptake, but only briefly considers how uptake may affect the wider generation system.

The NSW Government intends to review progress of the Net Zero Plan and improve forecasting by: periodically assessing the plan's environmental impacts and updating forecasts; seeking recommendations for reducing emissions and improving economic performance; reviewing biannually emerging technologies; and the establishment of a Bilateral Implementation Committee to facilitate jointly-funded programs.

In recent consultation on Promoting Innovation for NSW Energy Customers, the NSW Government expressed its intent to deliver an energy system that puts the customer at the centre of policy and program design.[36] It is seeking input on barriers experienced by customers and industry.

The NSW Electric Vehicle Strategy projects that EV uptake will rise to over 75 percent of new car sales by 2036 with successful implementation of the strategy. In this strategy, the NSW government recognises the importance of supporting a bottom-up approach for improving uptake numbers and functional facilitation, with fiscal support of new EV customers and engagement of local government in orchestrating charging networks. The strategy will be reviewed for its methods and relevance in mid-2023 and then every three years.

The NSW Government Net Zero Plan details a general approach of consultation and ongoing partnership solely with relevant industry members (see Net Zero Plan Stage 1: 2020-2030). However, smaller-scale

[34] https://www.environment.act.gov.au/cc/act-climate-change-strategy

[35] https://www.environment.nsw.gov.au/topics/climate-change/net-zero-plan

[36] https://www.energy.nsw.gov.au/government-and-regulation/energy-customer-policy-reform

engagement occurs in transmission development for renewable energy zones (REZs) - of which five are proposed in the state. In this case, consultation processes include personal communication with landowners (emails, phone updates, letters), distribution of information via meetings, community information sessions, and establishing a website and a social media platform for development plan updates and feedback.

Case Study: Transgrid in NSW

NSW Government and Transgrid has been developing engagement methods for its work in Central-West Orana Renewable Energy Zones (REZ). It collected community feedback for visual impacts, compensations and property values, biodiversity, impact on farming, corridors and easements on transmission structures, access to properties, and health and safety (for example, bushfire ignition). Between December 2020 and September 2021, the engagement program spoke with over 900 people and groups, including landowners, communities and other stakeholders who may be directly and indirectly impacted by the Transmission project.

The methods used were landowner and community consultation using a variety of methods: phone number and email provided, email/phone updates, letters sent to landowners, website established, interactive map, meetings and community information sessions held, fact sheets, advertisements and social media used to distribute information, community events held and attended. Engagement covered Indigenous groups and local councils.

Stakeholders gave feedback on the engagement process by stating that they would have liked to have been consulted earlier on in the selection of a region for new transmission lines so they could give feedback and raise concerns earlier in the process.

Source: https://www.transgrid.com.au/media/wzpd25g1/cworez-community-engagement-feedback-report.pdf

4.2.3 Northern Territory

The Northern Territory Government has been focusing on supplementing remote community diesel power stations with large solar generation. Their forecasting is conducted by the Utilities Commission of the

Northern Territory and these forecasts were used for three modelling scenarios in the Darwin-Katherine Electricity System Plan, shown in Figure 4.[37]

Figure 4: Key scenarios of the Darwin-Katherine electricity system.

The first scenario, "From Little Things", investigates a natural uptake in rooftop solar; the second scenario, "Seek Different", and third scenario, "Sunshine for Sale", are based on significant investment in large scale solar plants connected to an expanded central grid. Scenario three also considers the impact of additional demand due to heavy EV uptake. The Northern Territory Government commissioned an expert panel in 2017 to produce a renewable energy roadmap proposal, recognising a "*lack of forecasting data*" as a restriction "*that could impede the uptake of renewable energy*" and hence recommends requiring system control and power networks to publish forecasting data. The Northern Territory aims to produce a plan which is accessible and transparent to consumers when discussing renewable technologies and potential pathways in the energy transition, as detailed in Darwin-Katherine Electricity System Plan.

It seems that the main mechanism to support the development of the scenarios has been stakeholder engagement with the plan stating: "*A range of external experts and local industry have informed understanding of technology, system limits, and emerging innovations*". The government recognises that changes in energy behaviour and the emergence of a 'low-emission economy' will require updates to the plan biennially, in order for current and future initiatives to be future-proof. For example, the current planning of thermal generation will act as a 'stepping-stone' towards lower emission generation systems, with compatibility for an energy

[37] https://territoryrenewableenergy.nt.gov.au/__data/assets/pdf_file/0011/1056782/darwin-katherine-electricity-system-plan-web.pdf?v=0.1.1

supply of renewable hydrogen. In addition, broader system integration of thermal generation with solar is necessary with 'smart' architecture for orchestrating renewable generation, including DERs of solar and batteries.

4.2.4 Queensland

The Queensland Government's ambition is 50 percent renewable energy generation by 2030 – using both large scale and DERs – with a report into renewable energy markets commissioned in June of 2021, awaiting publication.[38] The most recent renewable energy plan published by the state government is dated back to 2009. The government recognises there is no ambition or forecasting beyond the 2030 target. The Queensland Government recognises the importance that EVs will have on electricity forecasting, but have not made any public efforts to determine how changes might occur or how to adapt for them.

The Queensland government details an engagement approach in its 'Powering Queensland Plan: an integrated energy strategy for the state', by the Department of Energy and Public Works,[39] which is focused on consulting community members, unions, environmental organisations, educational institutions and advocacy groups as well as industry members. Consultation approaches include invitations for written feedback and organisation of individual meetings, aiming to conduct ongoing consultation with the groups consulted and to hold public hearings to update stakeholders on progress made.

4.2.5 South Australia

The South Australia Government is one of the more ambitious jurisdictions in terms of a commitment to renewable energy, with 60% of its electricity coming from renewable energy.[40] South Australia's action on climate change is guided by the South Australian Government Climate Change Action Plan 2021-2025, which includes clean energy transformation as one of its seven focus areas.[41] South Australia also has a series of specific plans and projects related to DER, electric vehicles and renewable energy and a plan for a secure transition to affordable renewable energy – many of which include elements of normative foresighting.[42] The role of exploratory foresighting in the development of these plans is not well documented.

South Australia's consultation approach involves customer representatives as well as industry members, and collaborations with these groups in future system planning development.

4.2.6 Tasmania

The Tasmanian Government is already close to Net Zero electricity generation due to large scale hydro generation and wind power contributing 80 and 10 percent of state generation respectively, and hence the state does not consider the role of DERs for major electricity service in their Tasmanian Renewable Energy Action Plan[43] or other statements - although Tasmania is increasing considerations for DERs in communities, and has passed legislation to support behind the meter energy investments such as rooftop solar, batteries and electric vehicle chargers. However, Tasmania has established Renewables Tasmania to advise the Government in energy, climate change and emissions reduction, including devising strategies for achieving

[38] https://www.epw.qld.gov.au/about/initiatives/renewable-energy-targets
[39] https://www.epw.qld.gov.au/about/initiatives/powering-queensland
[40] https://www.energymining.sa.gov.au/growth_and_low_carbon/leading_the_green_economy
[41] https://cdn.environment.sa.gov.au/environment/docs/climate-change-action-plan-2021-2025.pdf
[42] https://www.energymining.sa.gov.au/__data/assets/pdf_file/0009/364266/200615_Energy_Solution_Action_Plan_final_spreads_rs.pdf
[43] https://recfit.tas.gov.au/renewables/tasmanian_renewable_energy_action_plan

sustainability goals with high renewable energy utilisation. Renewables Tasmania is responsible for managing the Renewable Energy Action Plan, which will be dynamic, responding to community and stakeholder consultation.

While Tasmania has achieved the capacity for 100 percent renewable energy generation, and net generation and exchange into the NEM will be at least 100 percent renewable, there will be periods where gas generated electricity will complement low hydropower. Conversely to DERs, Tasmania is focusing on doubling its installed renewable generation capacity, with a target of 200 per cent of their current electricity needs by 2040 - largely via hydropower - and exporting via Bass Link and the future Project Marinus underwater cables, providing a pumped hydro battery for the NEM, referred to as 'Battery of the Nation'.[44] Doubling baseline renewable energy is the most ambitious generation aim of any state globally. Over 80% of Tasmania's electricity is generated by centralised hydroelectric plants, resulting in high levels of stable renewable energy and less incentive to transition to fluctuating DERs. While there is some adoption of photovoltaics (PVs) – the Australian Photovoltaic Institute states 16 percent of Tasmanian dwellings in 2020 – it is not forecast to impact the wider transmission system significantly. The Government is anticipating positive results for EV uptake and will support the transition by shifting all state government vehicle fleets to EVs by 2030.

Tasmania details a consultation approach in the 'Tasmanian Renewable Energy Action Plan' focused on developing a plan which presents benefits to local communities and establishes good environmental practices. Government-owned energy businesses, wind farm operators, research institutions, community groups, businesses and the community are stakeholders of interest for ongoing collaboration and will be updated on the progress of the plan via annual progress reviews and information published on the Renewables Tasmania website. The Draft Renewable Energy Coordination Framework[45] released in 2021 sought to consult with communities about DER installation and establishment of REZs after recommendations from AEMO.

4.2.7 Victoria

The Government of Victoria has a Net Zero strategy[46] that mostly plans for large-scale renewables but also has a relatively strong understanding of the need to improve information and investment strategies regarding the implementation of DERs – although currently there is limited understanding of how these changes are likely to occur, due to a lack of forecasting. There are various substantiated plans to conduct further research and planning to inform forecasting, such as the foundation of the Centre for New Energy Technologies.[47] There are plans for various DER projects, such as a digital platform that will foster the ability for electricity distribution companies, distributed generators and third parties to engage in open trading to overcome grid constraints and assist integrating renewable energy into the network. Victoria details an engagement approach in its Climate Change Strategy where community members, businesses and industry members are consulted via invitations for written feedback, stakeholder workshops, individual consultations, and surveys of residential and industrial consumers.

The Strategy highlights that governance and its strategic planning should engage all portfolios in addressing climate issues, to improve adaptation and deliver a safe transformation via best-practices by authorities and

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[44] https://www.hydro.com.au/clean-energy/battery-of-the-nation

[45] https://www.stategrowth.tas.gov.au/recfit/consultation_and_community/recent_closed_consultation/draft_renewable_energy_coordination_framework

[46] https://www.climatechange.vic.gov.au/victorias-climate-change-strategy

[47] https://c4net.com.au/

implementing supportive legislation. However, specific details for this mission are to be determined with consultation between governing agencies and stakeholders. In addition to governance and strategic planning, the Strategy outlines other key enablers for Victoria's energy forecasting: collaborative capacity building and partnerships, financing, leadership and innovation. These functions require elaboration and detailing for successful forecasting and planning.

4.2.8 Western Australia

The Western Australian Government has released a Climate Policy with an aspiration to achieve net zero emissions by 2050.[48] Western Australia faces the challenges of one of the highest penetrations of rooftop solar, considerable wind generation, an isolated grid, and a vast land area which is difficult to maintain with a centralised grid approach. This has led to an accelerating deployment of distributed energy resources. In response, the Western Australian government developed the 'Distributed Energy Resources Roadmap'[49], which was developed by the WA government's Energy Transformation Taskforce, with broad engagement with industry and consumer advocates; and in close consultation with Horizon Power, Synergy, Western Power and the AEMO. Ongoing engagement will continue through Energy Policy WA and will include forums, education and public consultation.

Western Australia has also developed a Whole of System Plan (WOSP) for the South West Interconnected System (SWIS).[50] The WOSP does not lock planning into one path, but anticipates four potential scenarios for energy service evolution - including 'Cast Away' (lower growth of energy demand and increased decentralisation), 'groundhog day' (increased DER and high network reliance), 'techtopia' (more stable energy demand profile via technology balance) and 'double bubble' (high growth of energy demand). The WOSP examines each to understand common challenges and opportunities which can be engaged immediately as potential actions, as in the WA Electric Vehicle Action Plan[51] which designates actions and deliverables to agencies and utilities.

Like other states, Western Australia engages with stakeholders via stakeholder workshops, individual consultations and industry forums. There is an additional focus on consulting with technology developers, investors and advocacy groups as well as industry members. There is also an effort to engage customers to deliver education on the changing energy industry and receive ongoing feedback.

A particularly important project in Western Australia is Project Symphony, a major pilot project in orchestration and integration of DER like rooftop solar, batteries and selected household appliances as part of a Virtual Power Plant (VPP), as shown in Figure 5. All of this innovation has flowed from the DER Roadmap, and was informed by consultation during the state's widely supported 'Parliamentary Inquiry into Microgrids and Associated Technologies', a foresight-oriented public process.

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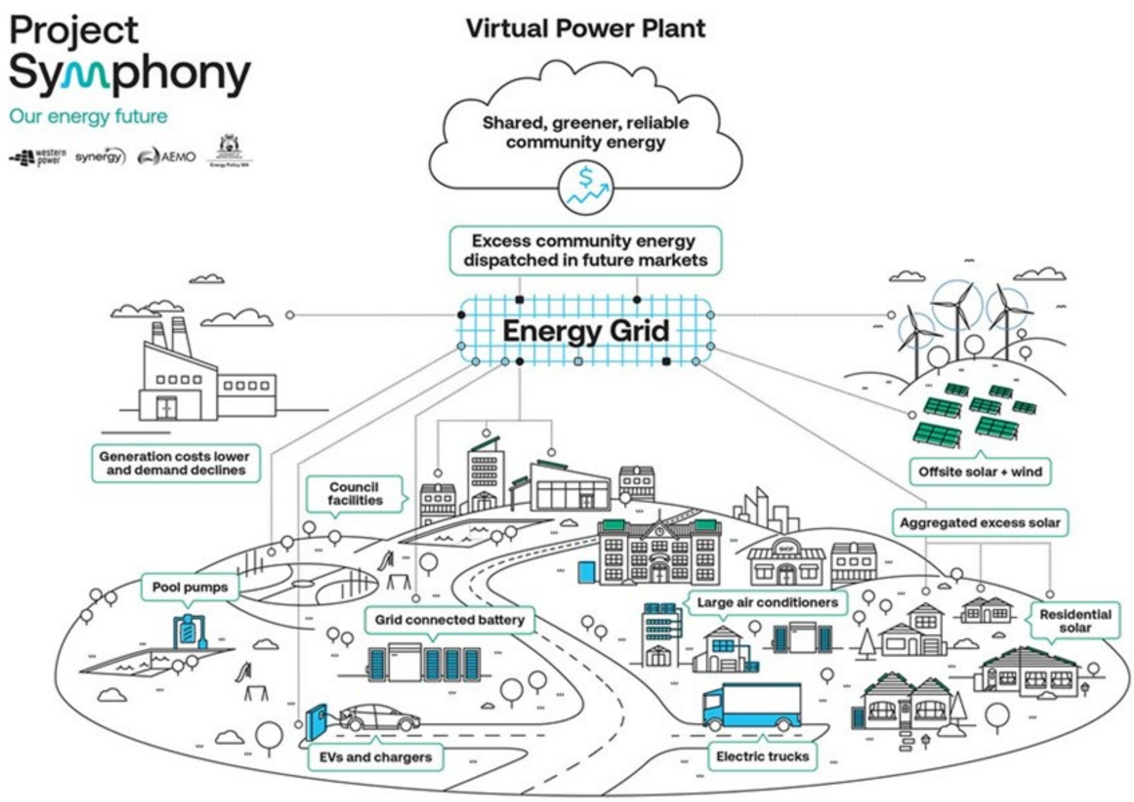
48 https://www.wa.gov.au/system/files/2020-12/Western_Australian_Climate_Policy.pdf
49 https://www.brighterenergyfuture.wa.gov.au/distributed-energy-resources/
50 https://www.brighterenergyfuture.wa.gov.au/whole-of-system-plan/
51

Figure 5: Diagrammatic representation of Project Symphony.



4.3 Local governments

Many local governments have well-established plans for Net Zero transition, which will necessarily involve a major shift in how energy is sourced. Climateworks Net Zero Momentum tracker[52] records that for local governments in Australia:

- 37% have target or aspiration to reach net zero emissions by or before 2050 for all, or the majority, of their community emissions
- 58% have a target or aspiration to reach net zero by 2050 for their operational emissions
- All of the local governments assessed are taking steps to reduce their operational or community emissions.

The Australian Local Government Association (ALGA) notes that local governments have a fundamentally important role to play in emissions reduction.[53] Specifically "new research launched during the National Assembly of the Australian Local Government Association (ALGA), shows that, if all the targets set by Australian local governments were met, an incredible 88,200 kt CO2e emissions would be reduced. This is equivalent to taking 20,511,627 petrol cars off the road per year". The Australian Government is contributing through ARENA's Cities Power Partnership[54] which "is the largest local government climate program, with 100

[52] https://www.climateworksaustralia.org/resource/net-zero-momentum-tracker-local-government-report/

[53] https://www.icleioceania.org/icleioceanianews/2021/6/18/cities-are-australias-secret-net-zero-weapon

[54] https://arena.gov.au/projects/cities-power-partnership/

councils representing almost 11 million Australians." Created by the Climate Council, this national program aims to accelerate the pollution reduction and clean energy successes of Australia's towns and cities. Those who join the partnership, pledge to take five key actions across renewable energy, energy efficiency, sustainable transport and working together. Through this program local governments will have access to the consolidated knowledge and future-focussed thinking available to ARENA.

How foresighting is used by local governments to develop their energy transition goals and strategies varies across a very large number of local jurisdictions. Selected local government examples will be discussed following.

4.3.1 City of Sydney

The City of Sydney is a leading example of how local governments can anticipate and respond to energy transition. The City of Sydney achieved the goal of carbon neutrality for its own operations in 2007 and supplied 100% of operational electricity requirements from renewable sources from 2021. The City's new 2021-25 Environmental Strategy[55] sets targets for the whole local government area:

- Net zero emissions by 2035
- 90% diversion from landfill of residential, commercial and construction waste by 2030
- 50% of electricity demand met by renewable sources by 2030.

It also sets targets for City of Sydney operations

- 80% reduction in emissions generation by end June 2025, from 2006 baseline
- Zero fleet emissions by 2035 or sooner
- Zero increase in potable water use annually until 2025, from 2006 baseline
- 90% diversion from landfill from City-managed properties by end June 2025.

While there was extensive consultation on this Strategy, the methods used to define the goals and anticipate future scenarios are not publicly communicated, as seems to be the case across government at all levels.

Further, as part of the development of "City of Sydney 2050" a process to investigate a range of trends was undertaken, with the following related to the energy system: expected population growth, a reduction in cars in neighbourhoods, and electric vehicles charging facilities. The process appears to have been to gather technical and other data on these trends to better identify landscape conditions and technology trends to inform the 2050 visioning process with extensive consultation across a diverse range of communities within the City of Sydney population.[56]

4.3.2 City of Melbourne

In 2018, City of Melbourne consulted with climate change experts and the community to develop a Climate Change Mitigation Strategy to 2050.[57] The strategy is "a major commitment to action that aims to reduce the largest source of greenhouse gas emissions in the municipality". The City of Melbourne has taken care to align its strategy with international targets from the Paris Climate Agreement and so its foresighting draws on international work in the field.

[55] https://www.cityofsydney.nsw.gov.au/strategies-action-plans/environmental-strategy

[56] https://www.cityofsydney.nsw.gov.au/vision-setting/planning-sydney-2050-what-we-heard

[57] https://www.melbourne.vic.gov.au/about-council/vision-goals/eco-city/Pages/climate-change-mitigation-strategy.aspx

For example, when the IPCC indicated stronger emissions reduction pathways were required, the City of Melbourne responded by designing an accelerated pathway to zero emissions by 2040 for the municipality in response to these revised guidelines on emissions, responding through a number of prioritised actions[58] while noting that one of the most important factors influencing whether targets are reached is action from the State and Federal governments[59], and the City of Melbourne intends to request more from these levels of government.

The City of Melbourne also has an ambitious Emissions Reduction Plan[60], set out by the Emissions Reduction Plan for Council Operations. It builds on a 76 percent reduction in 2011-12 emissions to 2019-20 and highlights eight key priorities towards net zero:

- Carbon Neutral Events
- Zero carbon for our buildings
- Measure and minimise embodied carbon in design and construction
- Carbon neutral goods and services
- Zero carbon corporate transport
- Towards Zero Waste for council operations
- Low emissions subsidiaries
- Tell City of Melbourne's Climate Change Story.

The thinking behind devising this plan is not explained, however the city does review its emissions annually, and aligns its goals with international guidance (as noted, in the case of the IPCC's revised advice). In the previous ERP 2016-21 only operational emissions were considered, whereas the current plan examines whole-lifecycle emissions.

More broadly, fragmentation is a problem across local government and can often lead to duplication and difficulty sharing best practice. The 'Sustainable Cities and Regions' work by Future Earth and the Australian Academy of Science (AAS) discusses a 10 year strategy to enable transformation of urban systems, summarising capital city foresighting and other regional initiatives.

The AAS highlights collaboration as an enabler of greater foresighting, as no stakeholder or interested group can respond to sustainability challenges and opportunities alone. Hence it recommends establishing a national framework with embedded stakeholder participation in development and bridging of knowledge and foresight into policy and actions. An example is in the Newcastle 2030 Community Strategic Plan. The plan includes a multi-modal engagement of communities for improved plan consultation, and measurement of the plan's success, with progress reported every four years.

4.4 Regulators and market bodies

Australian regulators are actively planning for a future energy system and zero-carbon transition. While traditional forecasting practices and stakeholder consultation processes are still prevalent inputs to this planning, there have been recent efforts to incorporate foresighting practices, such as scenarios. Specific activities are outlined below.

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[58] https://www.melbourne.vic.gov.au/about-council/vision-goals/eco-city/climate-change/Pages/taking-action-climate-change.aspx
[59] https://www.melbourne.vic.gov.au/about-council/vision-goals/eco-city/climate-change/Pages/action-needed-victorian-australian-governments.aspx
[60] https://www.melbourne.vic.gov.au/about-council/vision-goals/eco-city/Pages/emissions-reduction-plan.aspx

The Energy National Cabinet Reform Committee (ENCRC) and the Energy Ministers' Meeting (EMM) are Ministerial forums for the Commonwealth, Australian states and territories, and New Zealand to work together on priority issues of national significance and key reforms in the energy sector, following the disbandment of Council of Australian Governments (COAG) Energy Council in May 2020. Energy Ministers work closely with Energy Consumers Australia, and have oversight of the energy market institutions responsible for the operation of national energy markets, including The Energy Security Board (ESB), Australian Energy Market Commission (AEMC), The Australian Energy Market Operator (AEMO) and The Australian Energy Regulator (AER).

The Energy Security Board (ESB) was established under COAG in 2017, and its role is to coordinate the implementation of the reform blueprint produced by Australia's Chief Scientist, Dr Alan Finkel AO. The ESB comprises the heads of the Australian Energy Market Commission (also as Chair), the Australian Energy Regulator and the Australian Energy Market Operator. In October 2021, energy ministers endorsed a package of reforms proposed by the ESB on resource adequacy mechanisms and retirement of ageing power stations, essential system services, integration of DER, and transmission and access. The ESB is currently establishing a program of work to deliver these reforms.[61]

The Australian Energy Market Operator (AEMO) was established by the Council of Australian Governments in 2009 and operates the energy markets and systems, and also delivers planning advice in supporting the industry to deliver a more integrated, secure, reliable and cost effective national energy supply. It manages the National Electricity Market (NEM), the Wholesale Electricity Market (WEM) and the Victorian gas transmission network. AEMO publishes a suite of key future-focused planning reports on a regular basis, including Integrated System Plan, Electricity Statement of Opportunities, Gas Statement of Opportunities, Victorian Annual Planning Report (AEMO is responsible for planning of the Victorian transmission network), Energy Adequacy Assessment Projection, Quarterly Energy Dynamics, Medium Term Projected Assessment of System Adequacy (MT PASA) etc.

The Australian Energy Regulator (AER) regulates wholesale and retail energy markets, and energy networks to work better for consumers, under national energy legislation and rules in eastern and southern Australia. AER performs three key regulation functions: 1) Wholesale energy market regulation - monitors participant bidding and rebidding, market dispatch and prices, network constraints and outages, demand forecasts and forecasts of production and capacity; 2) Energy networks regulation - regulates electricity networks and natural gas pipelines by setting the maximum amount of revenue they can earn; 3) Retail energy market regulation - regulates retail electricity and gas markets in jurisdictions that have commenced the National Energy Retail Law. It also provides a price comparison website, Energy Made Easy, to help customers find the best energy offers for their needs.

Australian energy institutions are actively planning for a reliable, low-cost, consumer focused future energy system and zero-carbon transition. Despite this commitment, current methodologies heavily rely on past experiences, and conventional forecasting, stakeholder consultation processes and optimisation modelling techniques that overlook temporal evaluation and behaviour. To be ready for further disruption, more emphasis can be placed on more robust and future proof foresighting and modelling processes at the whole-of-economy level that anticipate more structural changes in future energy systems and their connection with built environment, transport, industry, and agriculture etc. To enable further analysis and assessment, we have provided an overview of key current forward-looking initiatives and reports by these institutions.

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[61] https://esb-post2025-market-design.aemc.gov.au/

4.4.1 AEMO Integrated System Plan

The Integrated System Plan (ISP) is described by AEMO as ‘a whole-of-system plan that provides an integrated roadmap for the efficient development of the National Electricity Market (NEM) over the next 20 years and beyond.[62] According to AEMO, ‘its primary objective is to optimise value to end consumers by designing the lowest cost, secure and reliable energy system capable of meeting any emissions trajectory determined by policy makers at an acceptable level of risk’.[63] Through transparent consultation processes, AEMO seeks to determine an Optimal Development Path (ODP) that maximises benefits to consumers and provides guidance to investors and policy-makers on prudent investments in energy supply, transmission and storage.

Despite this positioning, stakeholders consulted during this Opportunity Assessment argued that the ISP is not yet a whole-of-system plan and may not be a least cost plan. Its focus is on large-scale generation and transmission, and it does not yet optimise at the distribution scale, nor does it fully incorporate decentralised energy options in its optimisation process. For example, the extent of energy efficiency improvement is an input assumption rather than something that is optimised in the modelling, which potentially leads to under-investment in energy efficiency options. The same applies to most DERs, which are specified in scenarios rather than being optimised in modelling. While AEMO continues to improve its process and scope with each biennial iteration of the ISP, there is still work to do to deliver a truly whole-of-system plan that considers all options in its optimisation.

It is important to also recognise that it is not currently AEMO’s regulatory function to provide a holistic least-cost plan that incorporates demand opportunities. Following the AER’s Forecasting best practice guidelines[64], the AEMO is required only to develop demand forecasts, supply forecasts and develop an assessment of the demand and supply balance that determines whether the reliability standard will be met. Further moves towards holistic planning will require either regulatory changes or a broader, collaborative approach.

Prevailing AEMO anticipation methodology is forecasting, a combination of scenario building (usually four to five), input/output analysis, simulation, prediction & roadmaps. Its principles for forecasting cover accuracy (continuous improvement of data/model), transparency (methods shared with stakeholders), and engagement (consultation with stakeholders in forecast development). The accuracy of forecasts is assessed annually. AEMO convenes a forecasting reference group of AEMO and industry forecasting experts that meets monthly to validate assumptions, share expertise and explore new approaches to addressing the challenges of forecasting in a rapidly changing energy industry.

Long term aspects are reflected in input projections and assumptions and capacity outlook modelling to explore how the energy system would develop in each ISP scenario, and reveals long-term outcomes for generation expansion and retirement, transmission expansion, storage, and dispatch options, in all ISP scenarios, while minimising capital expenditure and operational costs of the entire NEM.

Five scenarios are incorporated in the draft ISP 2022, as shown in Figure 6, namely Slow Change, Steady Progress, Step Change, Net Zero 2050, and Hydrogen Superpower. These scenarios mostly differed in the underlying demand and the degree of decentralisation, as shown in the graph below. At one spectrum, Slow Change and Steady Progress see slow demand growth, while at the other Hydrogen Superpower see multi-fold

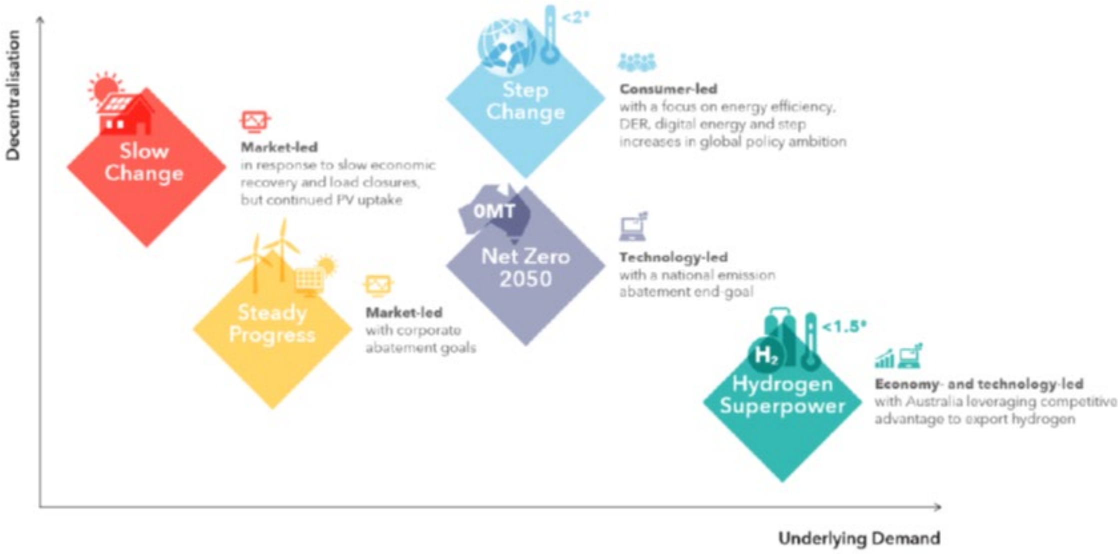
[62] https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/integrated-system-plan-isp

[63] Ibid

[64] https://www.aer.gov.au/system/files/AER%20-%20Forecasting%20best%20practice%20guidelines%20-%2025%20August%202020.pdf

increase in underlying demand to meet Australia's green hydrogen export and green industry expansion. The Step Change scenario was considered by a small majority of industry stakeholders to be the 'most likely' scenario, representing a future with rapid consumer-led transformation of the energy sector, based on a balanced level of electrification, energy efficiency, DERs, and a gradual growth of green hydrogen and industry in the economy.

Figure 6: Scenarios considered in the Draft ISP 2022.



4.4.2 AEMO Electricity and Gas Statement of Opportunities

The Electricity Statement of Opportunities (ESOO) provides technical and market data for the National Electricity Market (NEM) over a 10-year period to inform the planning and decision-making of market participants, new investors, and jurisdictional bodies. Despite different focuses, both ESOO and ISP are developed using the same set of inputs, assumptions and scenarios. In addition, the NEM ESOO incorporates a reliability assessment - a five-year reliability forecast and five-year indicative reliability forecast for each NEM region identifies a material reliability gap three years ahead. These reliability assessments are based on a full time-sequential model that simulates each interval of the modelling horizon. The model replicates the NEM dispatch engine (NEMDE) to the extent possible by minimising cost of dispatch per interval subject to a number of physical constraints. Reliability in the medium to long term is assessed by determining a statistical expectation of Unserved Energy (USE), capturing impacts of future uncertainties using the Monte Carlo simulation approach.

GSOO focuses on Australia's gas markets and infrastructure services, helping to support its efficient decision-making and long term investment. GSOO 2021 applied three scenarios as well as additional sensitivities that provided a range of forecast outcomes, in alignment with scenarios in the 2021 ISP. These are the central scenario, Slow Change, and for the first time included a Hydrogen scenario in which hydrogen could provide a potential substitute for gas use in certain applications. Gas demand forecasts are impacted by a number of industrial activities, including industry consumption, LNG export, Gas-powered Generation (GPG), and growth in hydrogen. Its industrial sector modelling uses an integrated, bottom-up sector modelling approach to industrial forecasts to capture the structural change effect in the Australian economy. Residential and commercial sector consumption modelling mostly uses econometric models to develop forecasts, and GPG gas consumption were derived from Capacity Outlook model and Time-sequential model used in the ESOO.

The mostly bottom-up forecasts linking to short term parameters in these modelling can also lead to path-dependent pathways and options that potentially fit ill to a disruptive future. A coherent whole-of-economy planning approach is needed, explicitly incorporating the development of energy efficiency, load management, price reform, green hydrogen and electric vehicles (including two-way smart charging), and other cross-sectorial developments such as built environment, transport and industry, so as to enable better resource allocation efficiency across sectors and systems.

4.4.3 ESB Post-2025 Electricity Market Design

The objective is to deliver a stronger, lower emissions power system for Australians, by addressing essential change in a world of expanding consumer choices, new technologies, and large-scale capital replacement as old thermal power stations leave the market. A program of work to deliver an agreed suite of reforms is currently under development. The reforms include setting up technical standards for new technologies/devices, enabling policy framework and market reforms for flexible demand and consumer choices of technologies and easy entry of service providers; delivering on governments' policy commitments including emissions reduction. The initiative includes extensive industry and public consultations, and a stakeholder steering group is being formed to bring multiple stakeholder interests together, and to build an evidence base of customer insights to inform reforms (and related activities).

The set of policy and market reforms aim to bring in stronger focus on consumer and environmental objectives that are lacking in the current planning practice, and are likely to have material impacts on the demand side and consumer behaviours through implementation, therefore a significant factor to be considered in forecasting and foresighting processes. One important area of focus in on the potential for two-sided markets, where all types of energy users actively buy and sell electricity.[65]

4.4.4 AER Value of Distributed Energy Resources (VaDER) project

A process is being developed to provide stakeholders with guidance on how the AER will assess distributors' expenditure proposals for DER integration programs. The project also includes identifying a framework and establishing a methodology to reflect the benefit or value of DER when considering the value that DER can provide through access to markets or via autonomous functions, to accurately signal networks to support DER connection and access to markets.

The current methodology however excludes some of the customer benefits of DER integration, such as "intangible" benefits (for example customers' fulfilment from locally produced power), customer willingness to cover the costs of DER integration, individual customer desired level of reliability, or the value of avoided carbon emissions in their investment decisions. Consequently, assumptions of DER adoption may be underestimated, which can lead to under-investments on DER integration from distribution network providers.

4.4.5 AER Network Business Regulatory Determinations

The monopoly energy networks are regulated in all Australian jurisdictions (with networks regulated by the Economic Regulation Authority in WA). AER sets the amount of revenue that network businesses can recover from customers for using these networks. Regulated network businesses must periodically apply to the AER to assess their revenue requirements (typically, every five years). The revenues or prices that a network business can charge are determined by forecasting how much revenue a business needs to cover its efficient costs

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[65] https://www.aemc.gov.au/news-centre/media-releases/what-next-two-sided-energy-market-implications-venturing-behind-meter

(including operating and maintenance expenditure, capital expenditure, asset depreciation costs and taxation liabilities) and providing a commercial return on capital.

Its five-year cycle has a rather short-term view built on existing asset bases, and it does not evaluate the long-term needs in system requirements from supply and demand changes and decarbonisation goals, such as Net Zero by 2050. The degree and quality of customer participation in the development of regulatory proposals varies depending on the NSP. The AER is seeking to address this last issue with the recent release of its Better Resets Handbook, which aims to incentivise NSPs to develop high quality proposals which are driven by genuine engagement with consumers.[66] The intention is that this will lead to regulatory outcomes that better reflect the long-term interests of consumers.

4.4.6 AER State of the Energy Market Report

The report highlights trends and issues across the industry, consolidating material from sources including the AER's market performance reports, data monitoring and regulatory reviews of energy networks, and external resources, taking a long-term view. It covers all sectors of the energy market, including Australia's wholesale electricity and gas markets, the transmission and distribution networks, and energy retail markets.

The report examines the energy system from operational, investment and consumer perspectives, however does not incorporate the net zero goals. It does not address long term planning and forecasting options or provide advice on pathways going forward.

4.4.7 AEMO NEM and DER Data Dashboards

AEMO NEM Dashboards show real-time data (5-minute) for each region including current dispatch price, scheduled demand, scheduled generation, semi-scheduled generation and flows (and limits) across each interconnector connected to the region. The sources of generation including wind and solar for each state. The dashboards are set up to provide real-time operational parameters, which has little effect or consideration to support foresighting or long term planning needs.

4.4.8 Clean Energy Regulator

The CER administers schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions, determined by Climate Change Law. Its administrative responsibilities include National Greenhouse and Energy Reporting Scheme, Emission Reduction Funds, Renewable Energy Target, Australian National Registry of Emissions Units. The CER plays a significant role in administering the operation and performance of emission reduction schemes, as well as reinforcing their compliance, whilst little involvement or influence in the decision making or planning processes of the energy system or energy market.

4.5 Industry

The Australian energy industry is diverse. Deregulation of electricity supply means that different players are involved in generation, transmission, distribution, retailing and support services. While all engage in some anticipatory activity, it is generally only the larger businesses that do so formally and publish the outcomes. As a result, this section is inevitably biased towards anticipation by the larger businesses in the energy industry. It is also not feasible to provide a comprehensive overview of anticipatory activities, given the large number of

[66] https://www.aer.gov.au/node/79496

industry participants. Instead, we have focused on high profile initiatives and publications at each stage of the energy supply chain.

4.5.1 Generation and supply

The Australian Energy Council represents 20 major electricity and downstream natural gas businesses that generate most of the electricity in Australia. Our review of their recent publications did not identify any that used forecasting or foresighting methods. Most publications were very much focused on present policy discussions in the energy sector.

Similarly, the Clean Energy Council representing renewable energy generators and the energy storage industry is largely focused on present policy debates. Its flagship Clean Energy Australia report is a snapshot of the current state of the clean energy industry. While it does include some sections labelled as 'industry outlooks' these are summaries of recent developments rather than forward-looking.

Individual generation-owners do engage in foresighting, although it is not always publicly released. An example is AGL's scenario analysis as part of its reporting to the Task Force on Climate-Related Financial Disclosure.[67] This report modelled future emissions under four scenarios, taking into account future power station closures at end of life.

4.5.2 Network Service Providers

In contrast to the lack of evident anticipatory activity from generators, network service providers are actively engaged in forecasting and foresighting. Network service providers (NSPs) include both distribution and transmission networks. They are a key part of the energy system as the owners and operators of the 'poles and wires' of the electricity network. Planning and foresighting is an integral part of their business as they need to ensure their network can reliably meet demand.

NSPs Plans & Statements

NSPs are required to submit Regulatory Proposals and undertake annual planning reviews for transmission and distribution. When the NSPs for distribution and transmission are distinct, there is an element of joint planning between the transmission review and the distribution NSPs in the jurisdiction.

The Annual Planning Reports from these reviews serve to identify the level of investment needed to deliver services to customers, and to inform stakeholder groups of: the identified future network needs (network capacity limitations, asset renewal, power quality and reliability); proposed and committed network solutions (upgrades, replacements); and the potential opportunities for non-network solutions (including embedded generation and demand-side management) to meet these needs. In addition to the planning reviews, NSPs also

[67] https://www.agl.com.au/-/media/aglmedia/documents/about-agl/investors/webcasts-and-presentations/2020/200529-draft-tcfd-scenario-analysis-presentation-v7-for-webcaster_updated.pdf?la=en&hash=B7FEA34D17E6AEFD6624D90479B65C56

publish Tariff Structure Statements that provide customers with information about current network tariffs and how these may change in the future.

Case Study: Innovative spatial tools to help NSPs and energy stakeholders in planning

Industry and research have highlighted concerns around data access and visibility on distribution networks. Increasing visibility and transparency is an enabler for trust between customers and other energy stakeholders and can facilitate innovative energy solution development. There have been some initiatives by NSPs and Energy Networks Australia (ENA) to improve spatial visibility and enable stakeholder interaction with data about the distribution and transmission network. Enhanced planning and information systems like these are essential to enable the full benefits of DER to be realised.

The Network Opportunity Maps (NOM) (https://www.energynetworks.com.au/projects/network-opportunity-maps/), developed by UTS and supported by ENA provide consistent, transparent annual planning data to identify opportunities for distributed generation, energy storage and other non-network solutions to address network capacity constraints and reduce costs for customers. NOM provides spatial data on network constraints, planned investment and the potential value of distributed energy resources to provide network services across the NEM based on data provided by NSPs in their annual planning reviews. While the NOM itself does not undertake any foresighting or planning, it provides data as input to stakeholders planning their energy futures. The latest maps were released in June 2021 and are annually updated.

Similarly, in 2021, Ausgrid published a web-based mapping portal (https://dtapr.ausgrid.com.au/) where participants can see emerging limitations in Ausgrid's zone-substation and sub-transmission network layers, to allow market participants to determine where they can help Ausgrid address those limitations.

In Western Australia, Western Power has developed its own Network Opportunities Map process, and the Grid Transformation Engine (GTEng) spatial modelling system to forecast economic, demographic and technology changes over time (https://www.westernpower.com.au/community/news-opinion/the-tool-changing-our-energy-future/). The GTEng tool has created scenarios about what the future grid looks like, including an autonomous grid for rural areas and a mesh grid for metropolitan areas, based on population and demographic predictions, economic forecasts, customer needs and profiles, energy generation and loads, energy use and location mapping. The tool allows Western Power to adopt a more modular approach to analyse where new infrastructure or services might be needed in the future. It asks what customers will want in the future, how the network can meet those needs at least cost, and what pathways can get us there.

ENA's Solar Enablement Initiative (SEI) was established to implement state estimation at a distribution level for historical and near real-time applications and provide complete visibility of medium voltage distribution

Taking Ausgrid's Distribution and Transmission Annual Planning Report[68] as an example, there is a strong focus on the next five years, but charts and projections extend as far as 2040. The report identifies a series of upcoming challenges, such as DER uptake, management of ageing network assets and extreme weather. These read as 'megatrends' to use a term common in foresighting practice. There is usually some limited exploratory

[68] https://www.ausgrid.com.au/Industry/Regulation/Network-planning/DTAPR

foresighting involved, in the form of multiple forecasts using different assumptions. Many NSPs are also starting to experiment with the use of innovative spatial tools to support network planning, as described in the case study below.

Stakeholder engagement in Regulatory Proposals and Annual Planning Reports varies, but is often excellent. For example, Essential Energy has developed a Stakeholder Engagement Framework that adopts the seven core values of the International Association for Public Participation.[69] Its current consultation on the 2024-2029 Regulatory Proposal has seen executive, senior leaders, customer teams, asset management and operational team members meet with nearly 500 customers, small and medium businesses; Councils; young people, and CALD and indigenous groups.

Alongside the more formal process of Annual Planning Reports, some NSPs have released other anticipatory documents. For example, SA Power Networks developed a Distributed Energy Transition Roadmap for 2020-2025, with a vision that looks ahead to 2030.[70]

Energy Networks Australia

Energy Networks Australia (ENA) is the peak industry association for NSPs. ENA works with different stakeholders to provide research and advice on key technical, operational and policy issues. Key anticipatory initiatives include the Net-Zero Energy Vision, Electricity Network Transformation Roadmap and OpEN project.

In March 2022, ENA launched Australia's Energy Vision[71] that describes how energy networks will work together and with customers to enable Australia's net-zero energy future. The Vision recognises that pathways to net-zero are still emerging but describes potential use cases for different customer groups and what net-zero networks will look like in these scenarios. The Vision presents a normative view of the future roles of transmission, distribution and renewable gas networks to allow networks to act proactively towards net-zero emissions. Its vision is for a network that is clean, customer-centric, equitable, integrated, resilient and investable. To achieve this vision, ENA intends to work together with government, customers and other stakeholders.

The Electricity Network Transformation Roadmap (ENTR)[72] developed by CSIRO and ENA provides a guide to an efficient and timely transformation over the 2017-27 decade. The roadmap recognises that there are many potential futures for the Australian energy networks, but seeks to promote those with demonstrably better customer outcomes than others and thus has developed a balanced scorecard of customer outcomes. It is supported by modelling of scenarios developed by Energia and CSIRO out to 2050. The modelling tests the impact of various policy scenarios on the efficient uptake of microgrids, and the associated impact on customer bills and equity. The two scenarios – The roadmap and the counterfactual – are evaluated on three key elements:

- Pricing and incentives: Residential electricity bills
- Efficient capacity utilisation: Electricity system total expenditure
- Electricity sector decarbonisation: Greenhouse gas emissions .

[69] https://engage.essentialenergy.com.au/our-engagement-process
[70] https://www.sapowernetworks.com.au/future-energy/
[71] https://www.energynetworks.com.au/resources/reports/2022-reports-and-publications/energy-vision-networks-delivering-net-zero/
[72] https://www.energynetworks.com.au/projects/electricity-network-transformation-roadmap/

The ENTR calls for more sophisticated short- and long-term forecasting (energy and demand) to account for the increasingly dynamic nature of the distribution network. It argues for more forecasting that focuses on different time scales and different levels of network (voltage) to facilitate accurate matching of supply and demand. One of the milestones in the ENTR is to develop a range of new analytical tools to extend current power system forecasting and planning approaches, that will enable networks to work with all key stakeholders to undertake robust and comprehensive long term regional planning for transmission infrastructure.

In 2018, ENA and AEMO launched the Open Energy Networks (OpEN) Project[73], seeking stakeholder input on how best to integrate Distributed Energy Resources (DER) into Australia's electricity grid. The project proposed four potential new market frameworks and examined how well they allow DER to operate efficiently with other elements of the network and system. The frameworks are based on AEMO's forecasts i.e. exploratory forecasts using scenarios that are regularly updated. Frameworks represent a rigorous way of testing various options for integrating DER into wholesale markets and the response of DER to distribution network constraints. Initially, three frameworks were proposed, however, following discussions internally and with stakeholders, a fourth framework was developed. Stakeholders created an independent distribution system operator (DSO) – Hybrid framework to overcome problems identified with the other options. In this scenario, the DSO relies on technical capability forecasts to provide DER with static operating envelopes and subsequently develops dynamic operating envelopes based on market bids and network constraints. Thus, forecasting systems are expected to be a key function of the DSO.

The OpEN project is interesting for its use of 'least regrets analysis' as a way of thinking about the future. The project recognises that the four frameworks will lead to diverging futures, but there is a period of 'common functionality' when 'least regrets' actions can be taken that are unlikely to be wasted in any of those futures. This thinking has been influential and the idea of 'least regret' pathways is prevalent in other anticipatory work by NSPs.

One of the key issues addressed by OpEN is around increased visibility and monitoring to collect data to support modelling and forecasting. Data from DER and network assets facilitates forecasting of the need for network services, the delivery of dynamic connection arrangements and active network management to support increased hosting capacity. An OpEN report on Required Capabilities and Recommended Actions[74] highlighted that aggregators, retailers and market customers provide improved load and generation forecasts. As aggregators and retailers amass portfolios of customers who own DER to provide distribution market services and products, there will be a new obligation to collaborate with networks and the system operator to ensure long-term and short-term forecasts are updated. This is being explored in the ESB NEM 2025 Two-Sided Market design initiative (see Section 4.4.3).

Similar to the ENTR for electricity, ENA's Gas Vision 2050[75] analyses different scenarios to achieve net-zero emissions and projected costs for gas networks. It is supported by analysis undertaken by Frontier Economics to investigate and evaluate costs of three decarbonisation scenarios for gas - blue hydrogen, green hydrogen and electrification. These scenarios are in many ways simplifications of the future energy system but are useful representations to compare different technology options. The base case had the electricity sector reach net zero emissions in 2050 while unabated gas use continued to supply heat and feedstock to industry.

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[73] https://www.energynetworks.com.au/projects/open-energy-networks/
[74] https://www.energynetworks.com.au/assets/uploads/open_energy_networks_-_required_capabilities_and_recommended_actions_report_22_july_2019.pdf
[75] https://www.energynetworks.com.au/projects/gas-vision-2050/

4.5.3 Retailers and aggregators

Customer-facing businesses are much less active in publishing future-focused work than network businesses but there are some examples. Origin Energy produces an annual Future Energy Report[76] that is squarely focused on customers. It draws on survey research with consumers to explore current customer practices and future customer expectations. EnergyAustralia has also written about the megatrends shaping the future of energy.[77]

Innovative energy businesses like Starling Energy Group use 'the future of energy'[78] as a selling point for new technologies and practices, like virtual power plants. Starling Energy Group provides DER services and has created Plico to provide a co-operative of up to a thousand homes and small businesses (not linked geographically) with solar and batteries shared in a Virtual Power Plant. This produces 7.5MW of power but as they say '*the real value is about supporting local infrastructure reliability, voltage issues and reducing energy peaks*'.

4.5.4 Industry support

There are numerous industry publications that discuss the current state of the energy sector, such as the Business Renewable Centre Australia State of the Market Report that provides key trends in the Corporate Renewable Power Purchase Agreements sector; Electric Vehicle Council's State of Electric Vehicles Report that presents market data on EVs and the Australian EV industry; ARENA's State of DER technology integration report that assesses DER integration in Australia; and APVI's solar data and market analysis on solar installation trends over time. There are also statistical publications like AEC's Electricity Gas Australia on shifts in electricity and gas retail and generation data and the ASXEnergy DataCenter on market data for ASX Energy Australian Electricity Futures, Caps and Options products. These publications do not explicitly engage with the future, but they do shape industry expectations about current trends that may continue into the future.

In addition to peak bodies and industry associations, consulting firms have also published think pieces on the future of energy. Aurecon conducted a survey with over 100 Australian business executives from the Energy industry and Government asking about shaping Australia's energy future.[79] The two biggest opportunities identified were renewables and improved policy and regulation. PWC's paper on 'The Future of Energy' presents a detailed analysis on the financial , environmental and economic impacts of four different energy scenarios for Australia through to 2040.[80] Three of the four scenarios are based on AEMO forecasts and thermal power plant closures in line with company announcements. The renewables case assumes replacing these plants with renewables and the Coal case assumes replacing them with High Efficiency Low Emissions Coal technology. The Accelerated Renewables case assumes all thermal power plants shut by 2040 and are replaced by renewables.

4.5.5 Energy sector media

Another avenue for informing stakeholder views and shaping expectations are media and news sources. Energy sector media can have an important influence on how industry participants view the future. Key among these

[76] https://www.originenergy.com.au/about/investors-media/reports-and-results/future-energy-report.html
[77] https://www.energyaustralia.com.au/about-us/media/news/share-or-perish-megatrends-shaping-energy
[78] https://www.starling.energy/future-of-energy/
[79] https://www.aurecongroup.com/markets/energy/future-of-energy
[80] https://www.pwc.com.au/power-utilities/future-of-energy/future-of-energy.pdf

are media publications like the Conversation and RenewEconomy. While reporting on current affairs, they also bring out a nuanced analytical approach to energy sector news and sometimes point to likely or possible futures. RenewEconomy also runs a podcast 'Energy Insiders', which discusses current developments and trends in the energy space through interviews and expert analysis. Organisations like ARENA and ENA also publish newsletters (Insights, Energy Insider respectively) and blogs (ARENAWIRE) that are widely read by the industry and keep readers updated on latest trends in the sector. ARENA's Insight forums bring together industry stakeholders to share project insights and discuss key emerging themes in the energy sector.

4.6 Customer advocacy organisations

While customers clearly represent one of the priority stakeholder groups in the consideration of energy futures, the amount of foresighting undertaken by consumer groups on their behalf has been relatively limited. Perhaps the most prominent foresighting activity has been the planning undertaken by Energy Consumers Australia (ECA) which has adopted a range of approaches in considering the impact on consumers across a range of future scenarios. One such approach is ECA's annual Foresighting Forum which brings together a broad range of stakeholders from the entire energy sector 'to work collaboratively on key issues affecting the long term interests of customers'.[81]

The most recent forum in 2021 was conducted online for one day in each of July, August and September and explored how the shocks of bushfire, COVID-19 and floods from the previous year might inform futures thinking in the energy sector. Key themes included social practice and consumer behaviour, system resilience and system design. Key outputs included a review of consumer practices and behaviours during the crises; an examination of changes required by network providers to enhance network resilience and empower vulnerable local communities; and consideration of technical changes required to ensure consumers are supported and protected when playing an active part in the future grid. The 2022 forum (date and format to be confirmed) was intending to explore what the energy future will look like in 2040 and undertake backcasting to identify pathways to achieve an affordable, abundant and clean energy future that consumers expect.[82]

To complement the forum, ECA also commissions research into energy futures, such as its recent survey into consumer expectations of a future energy vision[83] as well as utilising research to inform submissions to government and other key energy bodies such as the AER, NEO and ESB.

Other organisations in Australia that represent consumers' interests in the energy market include the Australian Council of Social Services (ACOSS), the Energy and Water Customer Advocacy Project at the Public Interest Advocacy Centre (PIAC) as well as groups associated with governments (such as the Western Australian Advocacy for Consumers of Energy Forum), and energy retailers and network service providers (such as Essential Energy's Customer Advocacy Group).[84] There is little evidence of these other consumer organisations undertaking any substantial foresighting work involving consumers. Instead PIAC focuses on a narrower agenda of lowering household energy bills by 25%, while ACOSS advocates for low income and disadvantaged households.

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[81] https://energyconsumersaustralia.com.au/projects/foresighting-forum

[82] https://energyconsumersaustralia.com.au/projects/foresighting-forum

[83] https://energyconsumersaustralia.com.au/publications/a-future-energy-vision-consumer-expectations-research-household-findings

[84] https://www.essentialenergy.com.au/about-us/customer-advocacy-group

4.7 Research organisations

4.7.1 RACE for 2030 Research Roadmaps

The RACE for 2030 Cooperative Research Centre (CRC) is in the process of developing research roadmaps as part of Opportunity Assessments for each of its 17 research themes.[85] The roadmaps are future-oriented, in the sense that they set out future research opportunities through to 2030 for each theme. The approach taken across all the roadmaps is fairly consistent, given that they all have a common scope. Most review the technologies, current market status and research opportunities relevant to that theme, before identifying a goal and the research stages required to achieve that goal through to 2030. However, there is some variation in how different assessments approach these tasks.

One source of variation is the extent to which different possible futures were explored when assessing options available in each research theme. Some take a forecasting approach of projecting a single future, while others use scenario modelling to explore different possible futures. For example, the RACE for Everyone E1 roadmap on trust-building for collaborative win-win solutions did not explore alternative futures to any significant extent, focusing instead on a single normative goal of building trust in the energy sector. In contrast, the RACE for Business B3 roadmap on process heats used in the commercial and industrial sectors modelled technology uptake using future scenarios, including a BAU and future economic growth (positive, negative) scenario. This informed a target of reducing emissions from process heat by 50% by 2035. The roadmap then identified short-, medium- and long-term actions to meet the target. The RACE for Networks N1 opportunity assessment on electric vehicles and the grid went even further, exploring five modelled scenarios: Slow Change, Central [moderate], Fast Change, High levels of DER, and Step Change, based on the accessibility of EV charging infrastructure (private, public).

The other key source of variation was the extent to which the staging of future research projects in the roadmap was based on a theory of change. Some roadmaps classified proposed research projects as high, medium or low priority without articulating how those projects would build on each other to create change. Others used a defined theory of change to sequence the projects. For example, the RACE for Business B1 roadmap on transforming energy productivity proposes a sequence of feasibility studies and situation analysis as the first step through to 2023, transition studies to 2025, and expansion and adaptation studies to 2030 and beyond. These steps are proposed across priority areas, such as food systems and shelter. Finally, the RACE for Everyone E3 roadmap on developing the future energy workforce had a strong focus on understanding the current energy workforce, recognising that the present data is not yet sufficient to allow reliable anticipation of the future.

4.7.2 CSIRO

The CSIRO has a long history of future-oriented work in the energy sector. From the early 2000s, CSIRO pioneered a series of ‘future forums’ focusing on topics relevant to the energy sector. These processes brought industry stakeholders together in structured workshops to work collaboratively on scenarios, which were modelled and quantified by the CSIRO team. These were exploratory foresighting exercises, aiming to draw out and understand possible futures, rather than select a preferred future. Separate forums were held on the future of energy, fuels, aviation fuels and the grid over the course of several years.

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[85] https://www.racefor2030.com.au/opportunity-assessment-reports/

It has been almost a decade since the last of these forums, the Future Grid Forum, in 2012.[86] That forum asked:

- What might Australia's electricity system look like in 2050?
- What are the issues and options that might arise along the way?
- What can the electricity sector and its stakeholders do to most effectively plan and respond?

It modelled four scenarios: Set and Forget; Rise of the Prosumer; Leaving the Grid; and Renewables Thrive. These scenarios anticipated many drivers that are apparent in the energy system today, such as active engagement of residential customers in electricity supply, reduced battery costs and fast uptake of renewable energy. The process was notable for its whole-of-system perspective and the breadth of stakeholder input, involving more than 120 representatives of every segment of the electricity industry, as well as government and community.

More recently, CSIRO has produced technology roadmaps for the Australian Government (the Low Emissions Technology Roadmap) and Energy Networks Australia (Electricity Network Transformation Roadmap - see Section 4.5.2). These are examples of normative foresighting, where a vision is established and plans are established to achieve that vision.

The Low Emissions Technology Roadmap used a bottom-up analysis of technological options to identify technologies that could achieve 2030 emission reduction goals and realise economic value and job creation. It constructed four different pathways (scenarios) combining those technologies: Energy Productivity Plus; Variable Renewable Energy; Dispatchable Power; and Unconstrained. These differ in their assumptions about energy productivity improvements, uptake of hydrogen and availability of different new build generation options.

The pathways outlined in the Roadmap were used to point out key strategic decisions that policy makers needed to consider, including whether policy should be technology neutral or technology specific, and whether a national or jurisdiction-specific approach should be adopted. On the former question, the Australian Government chose to adopt a technology specific approach with its Technology Investment Roadmap, discussed in Section 4.1.

Continuing this thread of work, CSIRO and AEMO commissioned Strategen to produce a report on power systems architecture as part of Australia's contribution to the Global Power Systems Transformation project.[87] The report proposes an Action Research Plan over 18 months that would use a process inspired by previous CSIRO future forums to produce a Future Options and Transition Pathways Report on power system architecture.

These diverse foresight projects from CSIRO demonstrate the value of scenario-based approaches for drawing out key drivers for possible futures and highlighting pathway-related decisions that need to be made in the present.

4.7.3 Digital Energy Futures

Digital Energy Futures is a 3-year research partnership between the Australian Research Council, Monash University, AusNet Services, Ausgrid and Energy Consumers Australia. The project is interdisciplinary and brings together concepts and practices from the disciplines of design, anthropology, sociology and geography.

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[86] CSIRO. (2013). Change and Choice: The Future Grid Forum's analysis of Australia's potential electricity pathways to 2050. CSIRO.
[87] https://www.strategen.com/gpst-psa-report

The project applies a social-science approach to improve our understanding of the emerging technology-consumer nexus and explores how changing social trends and consumer behaviour impact the energy sector. It involves the following stages:

- Desktop literature review on how household practices are likely to change in the future,
- Ethnographic research on practices and expectations from digital technology (households)
- Surveys supplementing ECA's annual Energy Consumer Sentiments Survey
- Stakeholder workshops on scenario innovation: participants "make scenarios", i.e. rethink/ imagine the future (residential electricity users)
- Industry stakeholder workshop to test visions with energy sector stakeholders
- Review of findings and implementations i.e. identification of disruptive technologies and future developments.

The scenario innovation workshops with residential consumers are exploring practices in 5, 10 and 30 year intervals, covering the years 2025, 2035 and 2050.

The future behaviour of customers is widely recognised as a key source of uncertainty in the Australian energy sector, which makes this project particularly important as one of the few that is squarely focused on this topic.

4.7.4 Australian Council of Learned Academies

The Australian Council of Learned Academies (ACOLA) developed the Australian Energy Transition Research Plan to establish a coherent research agenda to support the transition to zero carbon by 2050.[88] It was developed through stakeholder consultation with the Australian energy sector. The objective of the Research Plan is to identify research gaps and subsequently promote research priorities for a successful Australian energy transition to net-zero carbon emissions by 2050. A key research theme on Transition Pathways (Energy System Dynamics) explores the main feasible transition pathways, and the greatest uncertainties, based on current knowledge and forecasts. The Policy and regulation topic under Social Engagement dynamics looks at the best mix of market and government planning to facilitate the transition.

4.7.5 Centre for New Energy Technologies

The Centre for New Energy Technologies (C4NET)[89] is a collaboration between six Victorian universities, industry and government. It has recently announced a new flagship program of work on Enhanced System Planning for Victoria (ESP-V) to help prepare and plan for the significant shifts in energy systems. The ESP-V proposes a systematic study to assess the impacts of electrification of heating and electric vehicles on the Victorian electricity network. The program will involve detailed modelling of high voltage and low voltage networks.

4.8 Discussion

Table 7 summarises and evaluates key anticipatory publications in the Australian energy system, identifying the type of foresighting used, the extent to which different types of drivers that shape the future are considered, and the methods used. While it is clear that there is a lot of anticipatory activity happening, there are some

[88] https://acola.org/australian-energy-transition_research-plan-2021/
[89] https://c4net.com.au/

evident gaps. These are discussed below, followed by a section identifying some of the positive things to build on.

4.8.1 Lack of exploratory foresighting

Table 7 evaluates each publication to identify the extent to which the three types of anticipation – forecasting, exploratory foresighting and normative foresighting – feature in each publication. Based on a subjective assessment, each type of anticipation was scored from zero (no evidence of that type of anticipation) to three (strong use of this type of anticipation). Across the Australian energy system, all types of anticipation are in use and some key publications (e.g. AEMO's ISP) make strong use of all three. However, looking at the average across the sector, it is clear that exploratory foresighting is significantly less common than the other types of anticipation. It is entirely absent from seven publications and not used to its full potential in another 11. Strong use of exploratory foresighting, where multiple scenarios are considered and actions are chosen to be robust across the scenarios, is relatively rare.

As noted above, the most high-profile exception is AEMO's Integrated System Plan, which defined, modelled and published multiple scenarios, developed in consultation with stakeholders. The Optimal Development Path proposed in the plan takes into account all scenarios, but much of the ISP is illustrated with details from the Step Change scenario, which was the most popular with stakeholders. This somewhat reduces the prominence of the exploratory work, focusing attention back on a single scenario.

Western Australia's Whole of System Plan also explored multiple scenarios. In this case, no attempt was made to choose a preferred or most likely scenario, making this a more genuinely exploratory approach. Western Power's Grid Transformation Engine also supports exploratory foresighting through its ability to investigate different future grid configurations at different periods of time.

Other exploratory foresighting tends to sit outside the core policy-making structure of the energy system, positioned as a 'think piece' for stakeholders to consider. It is notable that all the work listed by research organisations included exploratory foresighting but it is unclear how much influence this work has on industry practice.

Anticipation is most effective when it combines forecasting, exploratory foresighting and normative foresighting, taking advantage of the strengths and reducing the weaknesses of each. This does not mean that every anticipatory publication needs to include all three types of anticipation. Rather, the energy system as a whole needs to do all three well and have ways of integrating the outcomes. Our evaluation points to the need for more exploratory foresighting and creation of opportunities to collaboratively integrate the outcomes of anticipatory publications.

4.8.2 Customer blind spots

Table 7 also evaluates the coverage of different drivers of the future in key anticipatory publications, across six categories: social; technological; economic; environmental; political; and values. The drivers considered in each category are shown at the bottom of Table 7 and the scoring system is the same as for the types of anticipation. The evaluation indicates that anticipatory publications do not give equal consideration to all the different types of drivers that can shape future developments. Thinking about the future is dominated by technological drivers, and to a lesser extent, economic drivers. Environmental and social drivers receive more moderate attention, whereas political drivers and values receive the least attention.

The lack of a bipartisan political approach to climate change and energy transition in Australia has made consideration of the impact of political processes on the energy sector extremely challenging. Nevertheless, few could argue that changes in government and policy shifts do not matter when planning for the future. Most publications have opted to take current policy settings as given and not explore alternatives. This constrains thinking about the future and may leave us ill-prepared for some possible futures.

Similarly, although consumer practices and choices are increasingly recognised as a key source of future uncertainty, there have been few attempts to explore how changes in customer values might shape the future of the energy system. Given the important role that customer choice has played in the uptake of rooftop solar and batteries, this is clearly a gap. Forecasting customer behaviour is undoubtedly difficult, which makes it problematic to include in traditional energy sector forecasts. Typically, customer behaviour is reduced to a set of assumptions about future collective energy demand, without much analysis of the complex social trends underlying those assumptions.

There are some promising attempts to develop a more sophisticated understanding of possible consumer futures, including the Digital Energy Futures project at Monash University and Western Power's use of customer profiling in its Grid Transformation Engine.

Nevertheless, customer values are neglected as a driver of the future. One of the great opportunities of exploratory foresighting is that it provides methods to help us to imagine how these less predictable drivers might shape the future and to prepare for different possibilities.

4.8.3 Methodological gaps

Table 7 also lists the core anticipatory methods used in the reviewed publications. Almost all publications also included some form of stakeholder consultation, however we have not listed this in the table. Stakeholder consultation generally follows a fairly standard approach to consulting on public policy matters, where a view is formed internally, a document is published and input is sought from stakeholders, sometimes with workshops included to allow more interaction.

The most common forecasting method is quantitative modelling, which includes highly sophisticated economic, power system modelling and technology modelling, which has long been a strength of the energy sector.

Scenarios are also relatively common although the methods used to develop them are frequently opaque. There is very little apparent use of specialised anticipatory methods and tools, such as Three Horizons[90] or backcasting.[91] One exception is the use of a Delphi approach by AEMO in the development of its draft 2022 ISP. The value of these specialised tools is that they have been developed to support participants to broaden their perspective and imagine possible futures that might be quite different to the assumptions currently prevailing in the sector. This imaginative dimension is crucial to exploratory foresighting and allows users to better prepare for uncertain futures.

Roadmaps are also very common, where a goal is established, and modelling or pathway analysis is used to identify steps required to reach that goal. Those steps typically relate to technology and policy development.

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[90] See Sharpe, B. (2020). *Three horizons*. Triarchy Press.

[91] See Holmberg, J., & Robèrt, K. H. (2000). Backcasting—A framework for strategic planning. *International Journal of Sustainable Development & World Ecology*, *7*(4), 291-308.

Least or no regrets analysis is starting to receive greater attention, as are GIS-based methods that allow spatial exploration of data. However, the palette of methods used is still significantly narrower than the range listed in Table 2, pointing to the possibility of introducing additional methods to support more diverse and imaginative thinking about the future of the energy system.

4.8.4 Partial and conflicting perspectives

Despite claims of 'whole of system' planning, future-focused publications and projects mostly take a partial view. For example, AEMO's ISP has very little visibility of the distribution network or distributed energy resources and ENA's Open Networks Project (see Section 4.5.2) has pointed to the need for better, more accessible data on distribution networks.

With many different actors publishing their conflicting perspectives on the future, there is a great deal of complexity and competition for attention. An integrated, whole-of-system approach is not yet evident.

4.8.5 Things to build on

While the above discussion focuses on gaps in anticipatory capacity, it is important to recognise the things that are working well in the Australian energy system and should be retained or strengthened. These include:

- Sophisticated quantitative modelling of technology uptake and grid performance that supports development of detailed roadmaps and scenarios about the future
- Transparency of the market operator's future planning and consistent timing of key documents such as AEMO's Integrated System Plan, allowing stakeholders to plan around them
- Growing awareness of the limitations of forecasting and use of multiple forecasting scenarios to 'stress test' decision making
- Substantial experience in roadmapping and normative foresighting
- The use of exploratory foresighting in the development of AEMO's draft 2022 Integrated System Plan
- The flexible and modular approach to the future adopted in the ACT Climate Change Strategy
- A strong focus on stakeholder consultation and some use of stakeholder dialogue processes, for example in CSIRO's Future Grid Forum, and more recently the Foresighting Forums held by Energy Consumers Australia
- The use of 'least regrets analysis' in work led by Energy Networks Australia and through WA's Whole of System Plan. This is a key element of exploratory foresighting, which aims to uncover actions that will be robust across multiple possible futures.
- The recent emergence of innovative approaches to future grid planning that provide accessible, location-based data about current network assets and possible futures.

Table 7: Evaluation of anticipation type, drivers considered and key methods in Australian anticipatory energy publications. See legend following table for assessment criteria.

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Australian Government										
Australia's Emission Projections	Black	Light grey	Light grey	Light grey	Black	Black	Black	Light grey	White	Quantitative modelling, sensitivity analysis, roadmap
Australia's Long-term Emission Reduction Plan	Dark grey	Light grey	Black	Light grey	Black	Black	Black	Dark grey	White	Quantitative modelling, scenarios (BAU and Plan), roadmap
Technology Investment Roadmap	Light grey	White	Black	White	Black	Black	Dark grey	Light grey	White	Environmental scanning, technology assessment, roadmap
2021 Australian Infrastructure Plan	Light grey	Dark grey	Black	Black	Black	Black	Black	Black	Dark grey	Visioning, scenarios, no regrets analysis, multi-criteria analysis, theory of change
State and Local Governments										
NSW Net Zero Plan	Dark grey	White	Black	Dark grey	Black	Black	Black	Dark grey	Light grey	Quantitative modelling, roadmap
WA Whole of System Plan	Light grey	Black	White	Dark grey	Black	Black	Dark grey	Light grey	Dark grey	Quantitative modelling, scenarios
WA Distributed Energy Resources Roadmap	Light grey	White	Black	Black	Black	Dark grey	White	Dark grey	Dark grey	Technology assessment, visioning, roadmap
SA Government Climate Change Action Plan	Light grey	White	Black	Light grey	Black	Black	Black	Dark grey	White	Projections, visioning, roadmap
Darwin-Katherine Electricity System Plan	Dark grey	Dark grey	Black	Light grey	Black	Dark grey	Light grey	Dark grey	White	Scenarios, least regret analysis, roadmap
ACT Climate Change Strategy	Dark grey	Light grey	Black	Dark grey	Dark grey	Dark grey	Black	Black	Light grey	Visioning, roadmap, projections
City of Sydney Environmental Strategy	Dark grey	Dark grey	Black	Black	Dark grey	Dark grey	Black	Dark grey	Dark grey	Visioning, scenarios, roadmap, quantitative modelling

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Regulators / market bodies										
AEMO Integrated System Plan 2022										Quantitative modelling, scenarios, roadmap, Delphi, least regrets analysis
AEMO Electricity and Gas Statement of Opportunities										Quantitative modelling, projections, scenarios
ESB Post-2025 Electricity Market Design										Quantitative modelling, roadmap
Industry										
Ausgrid DTAPR										Quantitative modelling, least regrets analysis, GIS
ENA Electricity Network Transformation Roadmap										Quantitative modelling, no regrets analysis, scenarios, roadmap
ENA Network Opportunity Maps										GIS
ENA Energy Vision										Visioning
ENA Gas Vision 2050										Visioning, quantitative modelling, pathway analysis
Western Power Grid Transformation Engine										Quantitative modelling, GIS, scenarios
Customer advocates										
ECA Foresighting Forum										Forecasting, visioning, scenarios
Research										
CSIRO Change and Choice (Future Grid Forum)										Quantitative modelling, scenarios

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
CSIRO Low Emissions Technology Roadmap										Quantitative modelling, technology assessment, pathway analysis, roadmap
Monash Digital Energy Futures										Environmental scanning, trend analysis, scenarios
Summary	2.0	1.5	2.3	2.1	2.9	2.5	1.9	1.4	1.1	

Legend

	Score	Type of anticipation	Drivers considered
	0	No evidence of this type of anticipation	No explicit mention of this category of drivers
	1	Some use of this type of anticipation	Some consideration of this category of drivers
	2	Moderate use of this type of anticipation	Moderate consideration of this category of drivers
	3	Strong use of this type of anticipation	Strong consideration of this category of drivers

Social	Technological	Economic	Environmental	Political	Values
Ways of life (e.g. use of leisure time, family living patterns), demographic structures, social inclusion and cohesion issues (fragmentation of lifestyles, levels of (in)equality, educational trends).	Rates of technological progress, pace of diffusion of innovations, problems and risks associated with technology (including security and health problems)	Levels and distribution of economic growth, industrial structures, competition and competitiveness, markets and financial issues	Pressures connected with sustainability and climate change, more localised environmental issues (including pollution, resource depletion, and associated biodiversity, and welfare concerns)	Dominant political viewpoints of parties, political (in)stability, regulatory roles and actions of governments, political action and lobbying by non-state actors (e.g. pressure groups, paramilitaries)	Attitudes to working life (e.g. entrepreneurialism, career aspirations), deference to authority, demands for mobility (across jobs of places, etc), prferences for leisure, culture, social relations, etc.

5 International best practice in anticipation

Having reviewed the current state of anticipation in the Australian energy sector, we now examine international best practice. Given the vast scope of international anticipatory activity, our review is necessarily high-level and guided by stakeholder advice on countries and jurisdictions that are using innovative approaches that could address gaps and limitations in Australia. Section 5.1 considers key international organisations with a focus on energy. The sections that follow take a country or regional focus. Section 5.6 discusses and summarises findings.

5.1 International organisations

High-profile international organisations play an important role in shaping energy industry expectations about the future and normalising specific anticipatory practices. The Intergovernmental Panel on Climate Change (IPCC)[92] is responsible for assessing the science relating to climate change, issuing regular reports on the state of the climate and exploring possible future scenarios. Its latest report was issued in February 2022 and makes for grim reading, again pressing for an even faster transition to a low carbon future, particularly in Australia. In addition to providing the impetus for energy transition, the IPCC's reports have normalised the practice of modelling exploratory future scenarios to understand possible futures under conditions of deep uncertainty.

In the specific area of energy, the International Energy Agency (IEA) shapes future expectations through the annual release of its World Energy Outlook.[93] For many years, the IEA World Energy Outlook remained optimistic about the future of fossil fuels and relatively unresponsive to the challenge of emission reduction, but this has changed radically in recent years. In 2021, the IEA released a roadmap for the global energy sector to reach zero emissions by 2050.[94] The roadmap sets milestones every five years and identifies priority actions for industry, buildings, power and transport, based on detailed modelling of a single normative scenario. The International Renewable Energy Agency (IRENA) has done similar work in its World Energy Transitions Outlook, which provides a roadmap for keeping global warming below 1.5°C based on a theory of change.[95] The IEA World Energy Outlook now compares three main scenarios – the normative Net Zero Emissions by 2050 Scenario, a scenario based on pledges announced through the UNFCCC process, and a scenario based on stated policies of nations. It highlights the gap between likely futures and the net zero trajectory.

Global energy scenarios are not only the purview of these large international agencies. The World Energy Council has produced exploratory long-term world energy scenarios.[96] The Council describes itself as an impartial network of energy leaders, pioneers and practitioners. Its scenarios are described as plausible futures through to 2060, and include:

- Modern Jazz: a market-led, digitally disrupted world with faster-paced and more uneven economic growth. Recent signals suggest that this entrepreneurial future might accelerate clean energy access on both global and local scales, whilst presenting new systems integration, cyber security and data privacy challenges.
- Unfinished symphony: A strong, coordinated, policy-led world, with long-term planning and united global action to address connected challenges, including inequitable access and affordable decarbonisation. Recent

[92] https://www.ipcc.ch/
[93] https://www.iea.org/reports/world-energy-outlook-2021
[94] https://www.iea.org/reports/net-zero-by-2050
[95] https://irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook
[96] https://www.worldenergy.org/transition-toolkit/world-energy-scenarios

signals suggest increased activism and commitment to addressing climate change at the sub-national level, and an expansion of the focus from climate change mitigation to a broader, socially inclusive and economically affordable sustainable development agenda.

- Hard rock: A fragmented world with inward-looking policies, lower growth and less global cooperation. Recent signals, such as the rise of populist leaders and uncertainty about the outlook for international cooperation, imply that this scenario is also evolving into a story of regionally firmer security foundations rather than total fragmentation and "harder rocks."

These scenarios take an exploratory approach, intended to trigger thinking about possible futures.

Beyond scenario development, the IEA has also supported the development of new energy technologies through its Technology Collaboration Programmes (TCP). These collaborations bring together experts from around the world to address issues relating to specific technologies. The Demand Side Management TCP ran from 1993 to 2019 and played a key role in helping to facilitate emergence of demand-side technologies. It was relaunched in 2019 as a new TCP on User-Centred Energy Systems that aims to provide evidence from socio-technical research on the design, social acceptance and usability of clean energy technologies to inform policy making for clean, efficient and secure energy transitions.[97]

Multinational companies like Shell have a long history of producing energy scenarios. The most recent version is Shell's Energy Transformation Scenarios: Waves, Islands and Sky 1.5.[98] International consultancies such as KPMG, McKinsey and Arcadis have also published net zero roadmaps and transition pathways in 2021 to promote their own vision and advisory capabilities. Resources for the Future publishes a Global Energy Outlook that aims to review and compare many of the other global energy projections.[99] All of these documents potentially shape expectations about futures of the Australian energy system.

5.2 United States

Foresighting in the United States grew out of the post-WW2 activities of the RAND Corporation, which takes credit for many foresighting research techniques, including computer-assisted games involving role playing, computer simulations, and technological forecasting methods including the Delphi technique.[100] Herman Kahn used fiction to create scenarios of highly unlikely situations to determine whether there was a need to prepare for them. His report "Thinking about the Unthinkable: Scenarios and Metaphors" in 1962 stands as a classic.

For the big picture, in the US the National Intelligence Council produces the Global Trends analysis, the most recent being Global Trends 2040[101] which examines a range of possible trajectories including the optimistic 'Renaissance of Democracies' through to 'Tragedy and Mobilization'. The report examines the pathways to how the scenarios came to be, the underlying forces, and what decisions in the present resulted in those pathways. The reports consider drivers for energy system transition (emission reduction targets) and broad technology trends, but do not get into detail on how energy systems will evolve in the different scenarios.

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[97] https://userstcp.org/

[98] https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html#iframe=L3dlYmFwcHMvU2NlbmFyaW9zX2xvbmdfaG9yaXpvbnMv

[99] https://www.rff.org/publications/reports/global-energy-outlook-2021-pathways-from-paris/

[100] https://www.rand.org/

[101] https://www.dni.gov/index.php/global-trends-home

The United States has been a pioneer in energy system planning. As early as 1979, Roger Sant proposed the application of least cost planning, arguing that energy services could be met at lower cost by considering demand-side strategies alongside supply-side strategies.[102] Many states pursued least-cost planning, which later evolved into integrated resource planning (IRP) (see the case study box). At the state level, the US has some of the most progressive energy and emission reduction targets, including in California where, since 2015, energy utilities have been required to submit Integrated Resource Plans (IRPs). In all, 36 states currently require submission of IRPs.[103]

While the IRP process is an improvement on traditional supply-side planning, it does not solve all the challenges associated with integration of DER into the grid. In part, the challenge is about goal setting. IRP can identify the least cost way to achieve a goal, but the goal may not be aligned with the needs of the zero-carbon transition. For example, in privatised energy markets, the direction of the sector is driven by a number of individual investment decisions by the utilities, each of which is designed to maximise profit within the regulatory limitations. These decisions, in aggregate, may fall well short of the optimal system as the decisions do not take into account all sectors (e.g. transmission operators may not be aware of the long-term generation plans, generation companies may not have vision of the potential changes for energy end users such as rooftop PV and behind the meter batteries). Broad stakeholder and public participation in goal-setting is needed to address this challenge, and is generally recommended as part of IRP processes.

A specific initiative that responds to the challenge of goal-setting in complex energy markets is the creation of the Comprehensive Taskforce on Electricity Planning by the National Association of Regulatory Utility Commissioners (NARUC).[104] NARUC is working with fifteen US states to develop new, more comprehensive approaches to electricity system planning and a more holistic analysis of system and customer needs and solutions. The aim is to improve grid reliability and resilience, optimise use of new and existing resources, avoid unnecessary costs to ratepayers, support state policy priorities, and increase the transparency of grid-related investment decisions. NARUC has developed five idealised visions of the planning process to suit the differing market conditions that exist across the US, each expressed as a detailed roadmap. For example, the Amber roadmap is for states where there are organised markets, utilities own the generation assets and there is a desire to align planning for transmission, distribution and resources. It defines a four-phase planning process of establishing system status assumption, identifying forecast scenarios to consider, detailed planning and holistic review, and formal regulatory approval. There appears to be opportunities to learn from this process for Australia.

[102] Sant, R., 1979, *Least Cost Energy Strategy: Minimizing Consumer Costs through Competition, Arlington,* VA: Energy Productivity Center, Mellon Institute. Sant, R., Bakke, D., Naill, R. F., and Bishop, J., 1984, *Creating abundance: America's least cost energy strategy*, New York : McGraw-Hill.
[103] https://blog.aee.net/understanding-irps-how-utilities-plan-for-the-future
[104] https://www.naruc.org/taskforce/

Case Study: Integrated Resource Planning in the United States

Integrated Resource Planning is an approach to energy system planning that aims to be truly 'whole of system', considering all possible options to meet the energy service needs of customers. It is an advancement on conventional 'least-cost' generation planning, which focuses on new generation sources. Instead, IRP considers a full range of power sector investment options. It takes into account bottom-up load forecasting, generation costs, demand-side management options and costs, transmission and distribution costs, risks of fuel price volatility, drought and carbon taxes, and social and environmental 'externalities'.

The IRP process is also public, involving diverse stakeholders in all stages of the planning phases. It also includes scenario and sensitivity analysis to test costs under different assumptions. IRP plans typically use 20 to 30 year time horizons.

In states with multiple utility businesses, the IRPs from each utility are combined by the central regulator to check that the aggregated plans are on track to meet the state targets. The process is repeated every two years so that utilities can adjust their trajectories.

To provide the data needed to include demand-side investment options in IRPs, 'potential studies' are commonplace in the United States. An example is the California Demand Response Potential Study, released by Berkeley Lab in 2020, which assessed the scale of the opportunity for enabling load shifting as a form of demand response (DR) in California, as part of the renewable energy transition. Such studies are particularly important when new 'resources' are being considered for inclusion in IRP.

The IRP process represents best practice forecasting for large utility companies. However, the numerical methods are built on past and present data so are unable to foresee events which lie outside statistical extrapolations. Therefore, the planning process should be complemented by exploratory foresighting techniques which can account for events which lie outside the modelled domain.

Source: https://www.internationalrivers.org/resources/reports-and-publications/an-introduction-to-integrated-resources-planning/; https://emp.lbl.gov/publications/california-demand-response-potential

5.3 United Kingdom

Foresight has a 50-year history in the UK, where it has developed in tandem with other European countries. In 1983, the Advisory Council for Applied Research and Development (ACARD, an advisory body reporting to the UK Cabinet Office) created a group 'to survey current scientific developments and advise the Council on work which showed commercial and economic promise for the medium to long term'. The group benchmarked France, Germany, USA and Japan to learn how they conduct prospective studies. It found a considerable amount of work was going on in these countries and began to adopt the term 'foresight' as a convenient shorthand for efforts to identify which research areas are likely to lead to the greatest economic and social benefits'.

Currently, the UK organises its future-oriented activities under the Government Office of Science[105]. A Horizon Scanning Programme Team coordinates horizon scanning work between departments, develops networks and aims to bring emerging issues to a senior-level audience. Horizon scanning is about exploring what the future might look like to understand uncertainties better, helping governments to analyse whether they are prepared for potential opportunities and threats.

The Office is currently working on a scenario and pathway study of net-zero society, due to report in late 2022.[106] The project aims to support the resilience of government net zero policies by understanding how different social and behavioural changes will affect the path to net zero. It intends to examine trend data on consumer behaviours that drive energy demand, explore how they may change in the future, and develop holistic scenarios that consider potential impacts on society and technology. Previously, the UK Foresight Programme has produced similar innovative exploratory scenarios, for example looking at the future of cities.[107]

Focusing specifically on energy, National Grid ESO (the energy system operator for Great Britain) produces Future Energy Scenarios outlining plausible pathways for the future of energy through to 2050.[108] The four scenarios are Falling Short, Consumer Transformation, System Transformation and Leading the Way. They were developed through stakeholder engagement, research and modelling. Importantly, these are exploratory scenarios – none is selected as the preferred or most likely future.

The UK is also the home base for Forum for the Future, which curates the Futures Centre, an open, participatory futures community, tracking signals of change to create a more just and regenerative future.[109] It looks for signals of how the world is changing and two of its key categories are energy and just transition. The Forum also produces exploratory scenario reports, such as its report on four pathways to stay below 2°C global warming by 2040.[110]

5.4 Europe

Strategic foresight is a central element of strategic planning in the European Union (EU). The EU has recently established several foresight units, as shown in Table 8. They are led by a member of the EU Commission (in 2022 Maroš Šefčovič). EU's key term is 'strategic foresight' that seeks to 'embed foresight into European Union policy-making', and the EU defines foresight as 'the discipline of exploring, anticipating and shaping the future to help building and using collective intelligence in a structured, and systemic way to anticipate developments'.

Out of these organisations, the Competence Center on Foresight has recently released a document that explores decentralisation of energy and its implications to the Union.[111] The document is still in the making, but its focus will be specifying possible futures decentralisation creates. The main trend it explores is how energy becomes interactive by creating proactive consumers, and its purpose is to prepare the Union to

[105] https://www.gov.uk/government/collections/foresight-projects
[106] https://www.gov.uk/government/publications/net-zero-society-scenarios-and-pathways
[107] https://www.gov.uk/government/collections/future-of-cities
[108] https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021
[109] https://www.thefuturescentre.org/
[110] Forum for the Future. (2018). <2°C Futures: 2040 worlds on a trajectory to stay below two degrees centigrade of warming above pre-industrial levels. https://www.forumforthefuture.org/2c-futures
[111] https://www.europarl.europa.eu/RegData/etudes/ATAG/2020/651944/EPRS_ATA(2020)651944_EN.pdf

avoid hasty decisions (an example is Spain's "sun tax"). Technologically, it looks at energy storage, interconnectivity, P2P, blockchains and off-grid applications as well as energy communities. Its uncertainties are regulation, price hikes, and interoperable smart grids enabled by AI and the Internet of Things (IoT). Its disruptions are Covid-19 induced reduction of economic activity and natural disasters.

Table 8: Foresight in the European Union.

Body	Status/purpose	Links
Strategic Foresight and Capabilities Unit	Under the EU Parliament's Secretariat-General and its Directorate-General for Parliamentary Research Services	The main outcome is an annual Strategic Foresight Report (2021: https://ec.europa.eu/info/strategy/strategic-planning/strategic-foresight/2021-strategic-foresight-report_en)
Competence Center on Foresight (est. 2018)	Fosters a strategic, future-oriented and anticipatory culture in the EU policy making process." It consults in methodologies such as horizon scanning, megatrend analysis, and scenario exploration system.	https://knowledge4policy.ec.europa.eu/foresight/about_en
The European Strategy and Policy Analysis System ESPAS	Coordinates key European institutions from the Parliament and the Commission to its funding, security and auditing mechanisms.	https://espas.eu/

The EU Commission also produces an annual Strategic Foresight Report. In 2021 it explored key global megatrends that will impact the EU in the future, including climate change.[112]

Like England, several European countries have used futures research in planning since the sixties. In Europe, France became the main incubator of the modern futurist movement. Bertrand de Jouvenel studied alternative futures in the 1960s and the French organization DATAR applied scenarios for government planning. The first significant commercial use of future scenarios was at Royal Dutch Shell in the early seventies. Pierre Wack with his colleagues presented two scenarios relating to the price of the oil. In one scenario the price of the oil increased dramatically, which was not expected at that time. However, when in 1973 the price of the crude oil did indeed increase dramatically, leading to the oil crisis, Shell was the only company in the oil industry prepared for the disruption.[113]

To give two examples of the best-known current cases, we can look at France and Finland. In France the Senate Delegation of Foresight (Délégation sénatoriale à la prospective)[114] was established in 2009 to explore different future scenarios based on social, technological, and economic data to aid the senate in decision making especially with regards to technological advancement. France also uses foresighting techniques to reduce inequalities within France.

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[112] https://ec.europa.eu/info/strategy/strategic-planning/strategic-foresight/2021-strategic-foresight-report_en

[113] Wilkinson, A., & Kupers, R. (2013). Living in the futures. Harvard business review, 91(5), 118-127.

[114] http://www.senat.fr/commission/prospective/index.html

Finland has three foresight bodies. The Government Foresight Group was founded in 2015. It has a staff of 11 members and coordinates foresight activities and merges them to decision-making. The group is headed by a professor of futures research. It has proposed a program of Cooperative and Continuous Foresight.[115] Sitra[116] is a major think tank under the Parliament. It was established in 1967, and it has coordinated foresight since 1977, currently through a Foresight and Insight Team. Since 1993, the Parliament has also had a committee that is to respond to the Prime Minister's Report on the Future.

5.5 Asia

Due to language barriers, our review of best practice foresight in Asia is limited, but some key initiatives are identified below. The Asian Development Bank provides a useful summary of futures thinking in Asia and the Pacific.[117]

5.5.1 Japan

The National Institute of Science and Technology Policy (NISTEP) publishes reports using the Science and Technology Foresight technique.[118] Its work started in 1971 and it has inspired foresight practices in many European countries. Japan's foresight process looks 30 years ahead. It uses four complementary methodologies: Delphi surveys, scenarios, literature searches and societal searches. The Delphi method is a structured survey of expert views. The most recent report consulted 4,309 experts, drawn from universities, the private and public sectors. The survey has multiple rounds, and participants can modify their answers based on the results of the previous round; this encourages convergence towards a consensus. The reports initially focused specifically on technology, but this changed with the ninth report in 2012. This edition addressed urgent social and global issues, including climate change, energy and the aging population.

5.5.2 China

The European Institute for Security Studies describes China's foresighting capability as striking in its absence.[119] It would appear that, in Chinese culture, to be uncertain of the future is a weakness, and to commit funds and time to question the grand plan is frowned upon. China of course has a long history of long-term planning, more so than most Western countries, but that planning is rigid and reactionary to changes in global circumstances rather than being accommodating.

That being said, China has lofty ambitions and plans for the future that are aspirational and difficult to achieve. An example in the energy space is the plan for a global interconnected electricity network (GEIDCO).

5.5.3 Singapore

In Singapore, Ministry of Defence spearheaded the government's focus on future planning in the eighties. The Prime Minister's office set up the Scenario Planning Office in 1995. It became Strategic Policy Office in 2003. Currently, Strategy Group in the PM's office coordinates the foresight activities of the ministries, and Centre for Strategic Futures (est. 2009) is a competence center. Foresight has been integrated to the government's strategic planning cycle and Singapore has a process for creating national scenarios. Singapore works with

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[115] https://vnk.fi/documents/10616/1098657/R0214_Cooperative+and+continuous+foresight.pdf/ef7078ee-8e53-47b6-bf8d-7dd180d2b0d8
[116] https://www.sitra.fi/en/
[117] https://www.adb.org/publications/futures-thinking-asia-pacific-policy-makers
[118] https://www.nistep.go.jp/en/?page_id=56
[119] https://www.iss.europa.eu/content/strategic-foresight-china

ESPAS, OECD's Government Foresight Community, Japan's NISTEP, Canada's Policy Horizons and USA's National Intelligence Council. Its methods are consultations, workshops, study trips and conferences.[120]

5.6 Discussion

5.6.1 Exploratory foresighting and innovation

One thing that is abundantly clear from the review of international best-practice is the substantial focus on exploratory foresighting, which is relatively lacking in Australia. As noted in Section 4.8.1, exploratory foresighting is rare in Australia's energy system but it is commonplace internationally, and is often taking place at the heart of government. Australia lacks institutions of foresight within government that routinely take on the task of exploring and communicating different possible futures. Instead, there is a strong normative focus, with a great deal of roadmapping and planning for particular goals.

This is a risky approach that fails to take into account surprises and lacks flexibility to respond if the future heads in a different direction. If the COVID-19 pandemic has taught us anything, it should be that we need to be better prepared for surprises and wild cards that may come to shape the future. In the academic literature, McCollum et al. argue explicitly that energy modellers need to explore extremes more systematically in their scenarios.[121]

5.6.2 Methodological best-practice

Another observation is that the methodological palette of Australian energy stakeholders is fairly limited when it comes to engaging stakeholders and exploring future possibilities. The International Association for Public Participation (IAP2) developed a well-known spectrum of public participation that categorises engagement approaches in terms of the impact the engagement has on the final decision.[122] Most engagement in the Australian energy sector is towards the left-hand side of the spectrum, where stakeholders are informed or consulted. International best-practice moves towards the right-hand side of the spectrum, taking a more collaborative or empowering approach. An example is the UK Climate Assembly.[123]

At the same time, the methods used in Australia to think about the future are less diverse than those used internationally. The lack of exploratory approaches was already noted above. There is also limited evidence of the use of key foresighting approaches such as environmental scanning, weak signal analysis[124], Three Horizons analysis, or causal layered analysis. Instead, there is heavy use of forecasting and backcasting to model likely or desired futures. While useful, these approaches risk reinscribing ideas that are prevalent in the present, rather than opening up creativity and imagination to consider different futures.

5.6.3 Considering the customer

International approaches aligned with Australian in recognising the future behaviour of customers as a key unknown that needs further consideration. There are initiatives underway, for example in the UK, that might

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[120] https://dpmc.govt.nz/sites/default/files/2019-05/CSF Sharing May 2019.pdf

[121] McCollum, D. L., Gambhir, A., Rogelj, J., & Wilson, C. (2020). Energy modellers should explore extremes more systematically in scenarios. Nature Energy, 5(2), 104-107. https://doi.org/10.1038/s41560-020-0555-3

[122] https://iap2.org.au/resources/spectrum/

[123] https://www.climateassembly.uk/

[124] The World Energy Council's World Energy Transition Radar is a great example of tracking weak signals: https://www.worldenergy.org/transition-toolkit/world-energy-scenarios/covid19-crisis-scenarios/world-energy-transition-radar.

provide inspiration for how Australia can approach this challenge. There are also planning approaches, such as IRP in the United States, that give customers a much stronger role in the planning process.

5.6.4 Holistic, integrated and decentralised

Finally, the widespread practice of IRP in the United States, and the 'potential studies' that support such planning, offer a template for Australia to follow to move towards genuinely 'whole of system' planning. Australian researchers have already explored how the practice of IRP, originally developed within integrated utilities, could be adopted within Australia's market-based electricity system.[125] The E2 Research Roadmap could potentially draw on methods from these established IRP processes to identify a genuine least-cost energy strategy for Australia.

[125] See Dunstan, C, 2018, *In the Balance: Electricity, Sustainability and Least Cost Competition*, PhD Thesis, University of Technology Sydney, https://opus.lib.uts.edu.au/handle/10453/131582.

6 Gaps in anticipatory capacity

What emerges from the literature review and stakeholder consultation is a series of gaps in the anticipatory capacity of Australia's energy system, summarised in this section. These gaps come with opportunities to improve anticipatory capacity, which will be proposed in the Research Roadmap in Section 7.

6.1 Lack of institutional support and leadership

In many countries, anticipatory capacity is built into key decision-making institutions and routinely applied to challenges in diverse sectors, including energy. Stakeholders indicated that the lack of such capacity within Australian governments is a key gap that is experienced in the energy sector as a lack of vision and leadership to drive innovation. It has been left to individual agencies such as AEMO and Infrastructure Australia, research organisations such as CSIRO, and consultants to develop anticipatory capacity without coordination. While their efforts are valuable, implementation of insights from foresighting is difficult without sufficient institutional support.

Stakeholder consultation indicated that the situation has been exacerbated over the last decade by the lack of leadership from the Australian Government in committing to and planning for a transition to a zero-carbon energy system. Without a long-term national vision for the future of Australia's energy system, decision-making frameworks and incentives naturally focus on short-term cost reduction and risk mitigation, to the potential detriment of long-term system performance.

In this context, few organisations have invested in the development of broad anticipatory capacity (beyond forecasting) and the potential benefits of such investment remain little known. To be clear, this is not a gap that RACE for 2030 can address alone. However, it is listed as important context and does shape some of the opportunities identified in the Research Roadmap. The next decade of collaborative action in the energy sector needs to build institutional support to look ahead and plan for uncertain futures.

6.2 Least-cost, whole-of-system planning

While AEMO's Integrated System Plan and Western Australia's Whole of System Plan are welcome steps in the right direction, most stakeholders indicated that genuine least-cost, whole-of-system planning is not yet a reality for the electricity system. The ISP, for example, currently makes assumptions about uptake of demand-side options and only then seeks to determine an optimal strategy, rather than including the demand-side in the optimisation process. This means that the potential of demand-side options to contribute towards a least-cost energy strategy may not be fully realised.

Further, while there is extensive stakeholder consultation during the development of the ISP, there is no public participation in establishing energy system objectives. The ISP optimises for net market benefits rather than total resource cost or customer bills. In addition, important environmental and social costs are neglected. The result of this is that, despite getting a great deal of attention, demand-side options such as energy efficiency, load management, price reform and demand management are not yet treated equally with supply-side options. This is partly due to a lack of data, but is more broadly a reflection of the institutional rules and norms that has historically interpreted 'energy system planning' as being passive in relation to optimisation of customer-side energy solutions (even if this would reduce whole of system costs). Historically, energy utilities were strongly focused on planning energy supply to meet ever-growing demand, and something of this organisational culture remains. Decentralised opportunities are neglected in system planning and investment decisions are not based on whole-of-system least-cost principles – although we note that implementation of the ESB's post-2025 market reforms and implementation of a two-sided market could go a long way towards addressing this shortfall in the distributed electricity space.

There is also a tendency to develop roadmaps for isolated technologies, such as gas or hydrogen, that take a narrow perspective and fail to consider what would be best for the system as a whole. True integrated resource planning across the energy sector, incorporating electricity, gas, and transport, was the eventual goal for many stakeholders. This raises questions of responsibility, as no single entity currently has regulatory oversight of the entire energy system. In the absence of regulatory reform, this points to the need to create spaces for cross-industry collaboration and coordination. Currently, such spaces are insufficient. Further, more demonstration projects are needed that show how stakeholders from across the energy system can come together to do whole-of-system planning.

6.3 Lack of data to support anticipatory action

The quality of our anticipation of possible futures is always limited by the available data. Possible futures can be routinely overlooked if nobody is collecting the appropriate data to see those futures beginning to emerge. An example raised frequently by stakeholders is the rapid uptake of air conditioners by Australian households, creating a future where rapid grid investment was needed to meet peak demand on hot days. Anticipating this future would have required some entity to collect and make sense of data on climate trends, thermal efficiency of housing, customer aspirations and air conditioner retailer intentions.

Stakeholders made it clear that there continue to be important gaps in the available data to support anticipatory action. The most prominent gap relates to current and future customer needs and aspirations. This is discussed in Section 6.4. However, stakeholders also noted:

- Limited awareness of broader global trends that will apply pressure to Australia's energy system
- Lack of forecasting of the value and types of employment in a DER future
- Poor understanding of the realisable potential of decentralised energy options, due to lack of data on the costs, benefits and capacity of such options.

Stakeholders were concerned that the long timeframes of regulatory processes and barriers to data access due to privacy and commercial concerns prevent timely open access to strategic data needed to anticipate the future. They drew attention to the need for real-time, responsive forecasting to support agile participation of distributed energy resources.

6.4 Anticipating customer needs and aspirations

Given that the purpose of the energy system is to meet people's needs for energy, remarkably little is known about customer needs and aspirations and how these shape the energy system. Even less is known about how these needs and aspirations might evolve in the future. There is already work underway to address this gap. For example, Energy Consumers Australia undertakes regular sentiment surveys about customer preferences, RACE for 2030 Theme E1 on trust building for collaborative win-win solutions will investigate current customer priorities and Monash University's Digital Energy Futures Project is exploring future customer scenarios. However, gaps in understanding will likely remain.

Customers are continuously navigating social and cultural change and pursuing aspirations that they do not connect with the energy system, but which might have significant implications for energy use. This creates quite a broad scope for understanding customer practices and aspirations.

Even limiting the focus to the energy system, many new technologies are emerging at this time of transition, and it is unclear how customers will respond to these technologies. Some technologies (e.g. electric vehicles) will require significant direct participation by customers: how rapidly will customers take up electric vehicles and what charging practices will they adopt? Or, will customers abandon private vehicle ownership in favour of subscribing to on-demand self-driving vehicle services? Other technologies, such as remote load control, require explicit acceptance by customers in a context of concerns about data privacy and distrust of institutions. Yet most customers have little interest in becoming deeply engaged with their energy use and just want it to be something they don't have to worry about.[126] During consultation for this Opportunity Assessment, stakeholders identified a tendency in the energy sector to assume customers want to engage with energy use more than they actually do.

Further, customers are diverse, with different needs and aspirations. There are many different approaches to segmenting the customer base, drawing on demographics, values, intentions and so on. It is not always clear which approach is best suited to understanding current and future customer intentions in relation to specific technologies, pricing mechanisms or practices.

These challenges lead to poor understanding of customers and their future practices, resulting in ongoing disconnects between the predicted and actual futures of emerging technologies, pricing mechanisms and practices. The lack of knowledge about customers means that there is also little understanding about possible consequences of energy system transformation for equity and inclusion, as we have little sense how vulnerable groups will respond to changes. These gaps will not be addressed by one-off studies but require systematic ongoing monitoring of customer intentions.

6.5 Innovative anticipatory methods to support decision-making under uncertain conditions

While the Australian energy sector routinely uses forecasting methods, sensitivity analysis and normative foresighting, there is significantly less use of exploratory foresighting methods. Stakeholders also described anticipatory methods as unimaginative, or lacking innovation. There is little use of methods developed by foresighting practitioners to stimulate imagination about possible futures and open new thinking. Further, anticipatory thinking is dominated by imagined technological and economic trajectories that only include customer values and political developments as an afterthought. The kind of interdisciplinary input needed to comprehensively explore possible futures is missing. This leaves the Australian energy system poorly prepared for wild cards, disruptions, and trend breaks, which are becoming more and more common.

It is important to note that what is needed is to develop system-wide capacity for anticipatory planning. This does not mean that every single anticipatory publication needs to integrate forecasting, exploratory foresighting and normative foresighting. Rather, there is a need to increase access to exploratory foresighting so that it is available to decision-makers and integrated into their decisions. RACE for 2030 can potentially play a role here by undertaking and publicising exploratory scenarios that complement existing work.

There is also scope for further innovation in established anticipatory methods, such as forecasting. AEMO's Forecasting Reference Group is a welcome development but more work is needed to shift from static

[126] See the report from the RACE for 2030 Theme E1 Opportunity Assessment: https://www.racefor2030.com.au/opportunity-assessment-reports/#3

forecasts to dynamic, real-time forecasting and to explore ways to integrate insights from qualitative foresighting into quantitative forecasting.

6.6 Planning for zero carbon futures

Closely related to the above gap is the lack of anticipation and planning that considers the most effective ways to deliver a zero-carbon future for the energy system, at least by 2050, but ideally sooner. The Net Zero Carbon agenda is firmly established in financial and political systems but to deliver it will require whole-of-system planning that sets out a fully integrated approach. Rather than roadmaps for specific technologies, what is needed is the formal establishment of net zero carbon as one of the primary regulatory objectives for the sector, and development of a comprehensive energy transition agenda that considers all options for a rapid transition to net zero.

6.7 Stakeholder participation

While many stakeholders were positive about the range of opportunities available to provide input to industry planning processes, such as AEMO's ISP, there is still room for improvement. There are relatively few spaces where genuine, diverse stakeholder dialogue about the future of the energy system is encouraged and influential. In anticipatory processes, ensuring representation of voices from the margins of the system and niche projects is crucial, as these may come to shape the future much more than incumbent regime participants.

7 Research Roadmap

The E2 Research Roadmap proposed here aims to address the gaps in anticipatory capacity identified in Section 6 and integrate the RACE for 2030 milestones agreed with the Commonwealth Government. Several principles guided our thinking on what to include and how to define the scope of key deliverables.

First, we are conscious that RACE for 2030 is a research organisation, and this is a Research Roadmap. Some of the gaps in anticipatory capacity identified in Section 6 can only be resolved with significant political and industry leadership to set a policy direction for the energy sector. RACE for 2030 can lead research that enables and supports institutional change, and it can pilot and demonstrate approaches, but building the anticipatory capacity of the energy system requires industry-wide action that is beyond the scope of research projects.

Second, stakeholders were largely unanimous in their advice to avoid 'doubling up' and creating yet more documents about the future of the energy system. Most felt that existing planning processes were moving in the right direction, albeit too slowly. As such, they encouraged RACE for 2030 to explicitly connect proposed projects to those existing processes. Ideally, this would mean a proposed project like the Least-Cost Energy Strategy would be part of the development of the ISP and WOSP, rather than something separate. And the proposed DESOO would ultimately be integrated with, or sit alongside, the ESOO and GSOO. While we have proposed separate publications, we have also proposed pathways for inclusion of their content and methods in existing processes.

Finally, the structure of the roadmap took guidance from established practices of transition management used widely in energy systems around the world. We categorised project ideas emerging from the stakeholder consultation and project team according to the transition management cycle shown in Figure 1 (Section 2.2). This provided a valuable check that key stages in the process of anticipatory planning for energy transition were considered when identifying research project ideas.

The E2 Research Roadmap is summarised in Table 9. Sections 7.1 to 7.6 provide the rationale and scope for the proposed research projects. We anticipate that most projects listed in the roadmap would be pursued via Standard Track Projects, although some doctoral research projects are also included. Significant commitments of funds from Partner Attributed Cash Contributions would be essential for most projects to proceed.

Table 9: E2 Research Roadmap.

Project	Activities	Gap addressed	Milestone	Outputs	Outcomes	Timing	Cost	Potential partners
Core Projects								
1 Decentralised Energy Data Inventory	• Assess available datasets on decentralised energy solutions; undertake surveys if required to fill gaps • Build comprehensive database on decentralised energy options	6.3, 6.4	E2.2	Comprehensive database on the current status of decentralised energy options for use in anticipatory planning; improved data	Energy sector anticipation is better informed by high-quality data	Immediate start, with first inventory complete by 30 June 2023 Subsequent survey to be completed by 30 June 2024	Low (up to $250k) for initial Inventory	Universities, DNSPs, energy retailers, state government energy departments, local governments, AEMO, ECA, CSIRO, ARENA, ABS.
2 Australian Least Cost Energy Strategy	• Using an Integrated Resource Planning (IRP) framework, identify the optimal mix of centralised and decentralised energy opportunities to meet customer needs at least cost over the next decade • Update regularly to incorporate new data	6.2, 6.6	E2.2, E2.4, E2.5, E2.7	Quantitative assessment of the optimal mix of Demand and Supply side options for meeting customer energy service needs	Progress towards identification of a genuinely optimal mix of energy opportunities to inform whole-of-system planning; identification of additional data needs to inform least-cost, whole-of-system planning; better meet customer objectives including lower bills; greater flexibility and resilience	FY22/23 start, first Least Cost Energy Strategy by 30 June 2023, then update every two years Engage with existing system planning processes, such as AEMO ISP and WA WOSP, throughout to seek improvements	Low-Medium (up to $500k) every two years	Universities, state Govts, DISR, DNSPs, TNSPs, retailers, AEMO, AER, AEMC
3 Australian Energy Futures Report series First Foresighting Report: *The future of Australian energy system planning: Towards whole-of-system and zero-carbon planning* Later reports will update the first report and add scope based on stakeholder consultation	• Qualitative review of possible futures for the Australia energy system to support more robust and informed decision-making • Summarise energy megatrends to set the context for energy planning • Evaluate current energy system planning • Participatory process to develop a shared vision for the future of energy system planning • Explore alternative pathways for achieving the vision	All	E2.2, E2.4, E2.5, E2.7	Australian Energy Futures Report every two years; qualitative assessment of energy megatrends; exploratory scenarios for the future of the Australian energy system (Subsequent reports will consult stakeholders to identify suitable scope, with some updating of the above topics alongside new topics relevant to Australian energy futures)	Improved evidence base for anticipatory action; horizon issues are brought to attention of stakeholders; greater agreement on the goals and principles of energy system planning	FY22/23 start, with completion of first report by 30 June 2023. Subsequent reports every two years.	Low-Medium (up to $500k) every two years	Universities, regulators (AER, AEMO and AEMC), Commonwealth Government and state government energy departments, CSIRO

Project	Activities	Gap addressed	Milestone	Outputs	Outcomes	Timing	Cost	Potential partners
4 Decentralised Energy Statement of Opportunities (DESOO)	• Stakeholder consultation to design the DESOO process, map interaction with other similar reports and identify research needs • Research on selected decentralised energy options to fill gaps • Review other initiatives that are pursuing better coordination of decentralised energy • Provide a roadmap for integrating DESOO innovations into market institutions	6.3, 6.4, 6.6, 6.7	E2.3, E2.5, E2.6	DESOO Design Report; studies on selected opportunities to fill gaps; two rounds of DESOO reporting; roadmap for integration of DESSO	Improved consideration of decentralised energy opportunities; progress towards whole of system planning	First DESOO Report by 30 June 2024, second DESOO Report by 30 June 2026.	High (more than $500k)	Needs comprehensive cross-section of partners from across the energy system
Supporting Projects								
5 Australian Energy Foresight Portal	• Scope, establish and maintain the Australian Energy Foresight Portal as a live online resource curating publications and data relevant to energy futures. • Run regular future-focused events and stakeholder dialogues. • Track and publicise 'weak signals' and 'wild cards' through an ongoing environmental scanning process.	6.1, 6.3, 6.5, 6.7	E2.2	Build anticipatory capacity of stakeholders; provide a 'transition arena'; improved information base for anticipation	Inclusive 'whole of system' anticipatory capacity	Establish in 2024 when first rounds of above projects are complete, then ongoing maintenance for life of RACE for 2030	High (more than $500k)	Universities, CSIRO, state and local governments
6 Roadmap for open data sharing to support energy planning	• Develop a roadmap to provide a curated, close to real-time source of data to support anticipatory planning • Curate and publish available data needed to anticipate	6.3		Data needed for anticipating energy futures is more readily available	Energy sector stakeholders routinely engage in data-driven anticipatory action	Engage with existing data portal providers during 2023 with a view to portal establishment in 2024	Low – curation (up to $150k); Medium – pilot projects	Universities, CSIRO, DNSPs

Project	Activities	Gap addressed	Milestone	Outputs	Outcomes	Timing	Cost	Potential partners
	the future of the energy system • Establish pilot projects to test ways of overcoming commercial and privacy barriers to sharing other data							
7 Short course on anticipation for zero carbon futures	• Design and develop short course • Offer short course	6.1, 6.5	E2.4, E2.5, E2.6	Course participants learn how to apply innovative anticipatory practices	Industry capability to apply innovative anticipatory practices increases	Course to launch alongside first Foresighting Report	Low – up to $150k	UTS, Curtin, Monash
8 Doctoral research	• PhD on institutional change to support anticipation	6.1, 6.5	E2.4, E2.5	Disseminate and internalize anticipatory capacity at the institutional and organisational level	Enable strategic foresight into decision-making; strengthen institutional and organisational process and capacity for anticipatory action	Seek student immediately to inform mid-term project review by 30 June 2025	Low	Monash, UTS
	• PhD on strategic foresight and policy planning for net zero energy systems	6.1, 6.2, 6.5, 6.6	E2.4, E2.5	Develop policy planning framework and options to best support strategic foresight and sustain long term impact	Harmonising strategic foresight and policy planning to achieve net zero goals	Seek student immediately to inform mid-term project review by 30 June 2025	Low	Monash, state governments
	• Doctoral research project on how to evaluate anticipation	6.1, 6.3	E2.4, E2.7, E2.8	Monitoring and evaluation framework and plan; evaluation report	The contribution of RACE for 2030's foresighting and planning innovations is evaluated	Seek student immediately to inform mid-term project review by 30 June 2025	Low	UTS
	• Doctoral research evaluating RACE for 2030 from a transition management perspective	6.5, 6.6	E2.7, E2.8	Evaluation report	RACE for 2030 evaluated in a way that contributes to transition literature	Seek student to commence by 30 June 2026	Low	UTS, Curtin

7.1 Decentralised Energy Data Inventory

Section 6.3 identified a lack of data to support whole-of-system anticipatory planning as one of the key gaps in anticipatory capacity. In particular, the lack of accessible data on the status of decentralised energy solutions is a key factor in the neglect of those solutions in systems planning.

An annual Decentralised Energy Data Inventory is proposed to collect data on the status of decentralised energy solutions. The collection of a current state-of-play of decentralised energy investment is an existing commitment under the RACE for 2030 E2 Commonwealth milestones, with the first survey of existing data sources due for completion by 30th June 2023 and at least a second required by 30th June 2024. The objective of the survey is to monitor the status and performance of a comprehensive suite of decentralised energy solutions. This will include any relevant form of data collection, including collation of existing data from a range of sources, and the collection of data on actual customer uptake and responses, recognising that customer behaviour is also one of the key anticipatory data gaps. The initial inventory will identify specific gaps in the decentralised energy data available, with subsequent inventories/surveys to fill these gaps.

We anticipate that the inventory results will be of interest to system planners trying to understand available options for meeting energy services, as well as NSPs and large customers.

7.1.1 Existing decentralised energy data collection points

There are existing surveys that collect data on decentralised energy but none covers the precise scope anticipated for this survey.

Internationally, Grand View Research produces a series of research reports on global market size for distributed energy generation, batteries, building-integrated PV, PV inverters and other technologies.[127] The company combines data mining, simulation and econometric modelling and primary interviews to arrive at market estimates and projections. Data is collected from manufacturers, technology distributors and wholesalers, and customers.

In Australia, CSIRO's GenCost project collects and published data on energy generation and storage costs.[128] It includes some decentralised energy options, including solar PV and batteries. However, its focus is on costs rather than uptake.

The Clean Energy Council tracks and reports on renewable energy generation and battery installations in its annual Clean Energy Australia Report.[129] However, the data on batteries is highly uncertain and additional survey data would be beneficial to firm up these estimates.

The Clean Energy Regulator provides granular datasets (to the postcode level) on distributed energy technologies that can access the Small-scale Renewable Energy Scheme. However, the continued availability of this data is in doubt when the Scheme concludes in 2030.

In Australia, ARENA has funded farrierswier and GridWise Energy Solutions to develop a State of Distributed Energy Resources Technology Integration Report.[130] The report provides a functional framework for assessing

[127] https://www.grandviewresearch.com/industry/construction-and-utilities
[128] https://data.csiro.au/collection/csiro:44228v6
[129] https://www.cleanenergycouncil.org.au/resources/resources-hub/clean-energy-australia-report
[130] https://arena.gov.au/knowledge-bank/state-of-der-technology-integration-report/

DER capabilities required for successful integration into the energy system. It reviewed ARENA's DER projects to assess maturity of key DER technologies. Collaboration with ARENA to align the survey with their existing DER frameworks would be recommended.

On the consumer side, ECA publishes an Energy Consumer Sentiment Survey every six months and an Energy Consumer Behaviour Survey every year.[131] The focus is on the attitudes and activity of residential and small business energy consumers in Australia. The Behaviour Survey, in particular, collects data that overlaps with the proposed scope for the Decentralised Energy Data Inventory, including data on product ownership. Further discussion with ECA to avoid overlap between these surveys would be appropriate during development of the project proposal for the Decentralised Energy Data Inventory. RACE for 2030 could even investigate the potential to expand the ECA survey to cover additional customer topics.

7.1.2 Survey audience and delivery

Where a survey of customer appliance installation is required to complement existing datasets, the primary audiences for the survey are customers (households, SMEs, large industrial customers) and energy and device (EVs, appliances etc) providers. Surveys will be tailored for these different audiences and use online survey logic to respond to participant answers.

7.1.3 Data to be collected

Based on the Stakeholder Workshops and input of the E2 OA authors, data that should be covered in any customer-based survey could include:

- General questions for customers
  - Motivation for installing decentralised energy options
  - Perceived benefits and challenges of installing decentralised energy
  - Intention to actively manage behind-meter resources, including solar PV, battery storage, EV, demand management
  - What would customers need to actively manage their demand?
- Small scale generation
  - Rooftop PV database already exists (maintained by the Clean Energy Regulator) and should be incorporated into the Decentralised Energy Data Inventory database
- Electric vehicle data:
  - Data on number and type of EVs in the vehicle fleet
  - Numbers, location, and capacity of EV charging infrastructure
  - EV charging load profiles, and information about controlled and convenience charging patterns
  - Uptake of V2X options (vehicle to grid, vehicle to home)
  - EV research programs underway to test new equipment, economic incentives or customer behaviour
- Distributed energy storage
  - Data on location, number and capacity of behind the meter storage systems (collaborate with Clean Energy Council and combine with existing data)

[131] https://ecss.energyconsumersaustralia.com.au/

- Virtual Power Plants (VPP) and other aggregation programs

- Tariff response and effectiveness
  - What are the tariff structures currently available at the residential, commercial and industrial scale?
  - How effective are tariff structures in promoting energy efficiency and/or load shifting
  - Uptake of energy management systems to automate responses to price signals

- Energy efficiency
  - Deployment of energy efficient technologies (e.g. solar hot water, LED lighting, modern HVAC and other appliances)
  - Building shell improvements to reduce HVAC requirements
  - Changes to use of appliances (e.g. reduced wastage)

- Energy Productivity improvement
  - Are businesses aware of energy productivity?
  - Have businesses observed improvements in their energy productivity?

Depending on project sequencing, data to be collected could be further refined as part of stakeholder consultation on the DESOO (see Section 7.4) to ensure that the data needs of the DESOO are met. An important part of this consultation will be to engage with researchers in other RACE for 2030 themes to incorporate any lessons about data needs and the best ways to access and format necessary data.

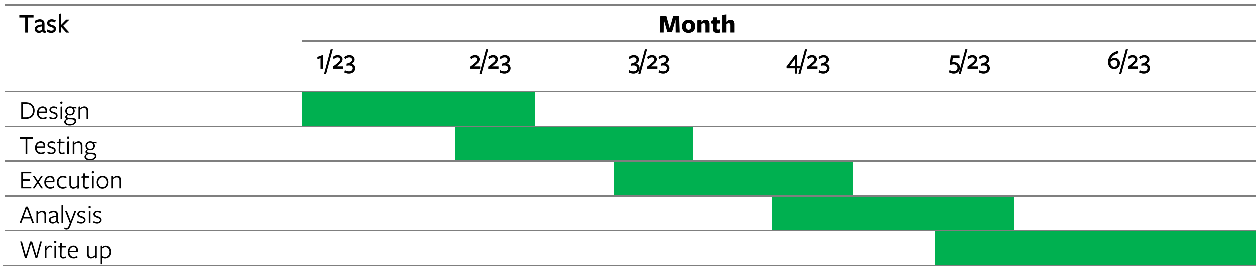
In addition to the decentralised energy data, the database should be accompanied by a database of the existing centralised (largescale) generators (both conventional plant (fossil and hydro) and utility scale distributed generation (wind and solar PV farms)) as well as utility-scale energy storage systems (batteries, pumped hydro) and ancillary services such as transmission networks and synchronous condensers. The database will include both the current capacity, and the trends in capacity (GW), output (GWh), and carbon intensity as well as wholesale market prices. These data are all freely available through the market operator (AEMO) however the data is currently not in a format that would allow easy analysis of the trends that will impact on decentralised energy systems. Timing of expected output for intermittent sources would also be valuable to include.

7.1.4 Potential project partners

In addition to universities, we anticipate that this project would be of interest to, or should be discussed with, DNSPs, energy retailers, state government energy departments, local governments, AEMO, ECA, CSIRO, ARENA and potentially the Australian Bureau of Statistics.

7.1.5 Timeline

An approximate timeline for the Decentralised Energy Data Inventory is presented below, assuming project commencement by early 2023.



7.2 Australian Least Cost Energy Strategy

The Australian Least Cost Energy Strategy is a response to the lack of least-cost, whole-of-system planning for the Australian energy system. It will use an Integrated Resource Planning (IRP) framework to guide a quantitative assessment of the optimal mix of demand and supply side options for meeting customer energy service needs, while reducing emissions towards net zero, over the next decade.

7.2.1 Objectives

The objectives of the Australian Least Cost Energy Strategy are to:

- Identify the optimal mix of energy opportunities to meet customer needs at least cost over the next decade
- Integrate data on supply and demand side options from all RACE for 2030 research themes
- Identify data gaps that need to be filled to continue progress towards least-cost, whole-of-system planning and propose strategies for addressing those gaps
- Facilitate broader industry progress towards genuine least-cost, whole-of-system planning that equally considers all available options for providing energy services.

Implicit in the above objectives is the idea that the Australian Least Cost Energy Strategy would, eventually, have an influence on existing energy system planning processes, such as AEMO's ISP.

7.2.2 Scope

The Australian Least Cost Energy Strategy will follow the established methods of Integrated Resource Planning (IRP), adapted for the Australian energy system context.[132] Key steps include:

1. For the first Least Cost Energy Strategy, determine the Integrated System Plan scenario(s) and sensitivities that will be used as the basis for developing the Least Cost Energy Strategy demand forecasts and as a baseline for understanding potential transmission costs. Subsequent releases could build towards full coverage and independent modelling of the system.

[132] See, for example, https://www.internationalrivers.org/resources/reports-and-publications/an-introduction-to-integrated-resources-planning/.

2. Investigate electricity supply options, including both centralised and decentralised generation and storage
3. Investigate a full range of demand-side management measures, including measures to encourage energy conservation, uptake of more efficient equipment, fuel switching and load management
4. Identify and document any data gaps that limit accurate assessment of demand side measures and develop recommendations to address these gaps in future iterations of the Strategy
5. Model the least cost mix of supply and demand side options to meet projected demand and achieve any other identified objectives. This is likely to involve modelling and comparison of multiple portfolios to select a preferred mix.
6. Select and report on the optimal mix of options for supplying energy services over the next decade and compare with the current mix and key planning processes.

It is highly likely that the first Australian Least Cost Energy Strategy will need to rely heavily on assumptions and modelling due to gaps in empirical data about decentralised energy options. Other projects in this roadmap, including the Decentralised Energy Data Inventory and DESOO, will start to fill these data gaps over time, but will not be available in time to include in the first Australian Least Cost Energy Strategy. Other RACE for 2030 research will also be a key source of data.

7.2.3 Potential project partners

Given the focus on moving towards least-cost, whole of system planning, participation by regulators and market institutions (AER, AEMO and AEMC), Commonwealth Government and state government energy departments would be highly desirable to increase the potential for the Australian Least Cost Energy Strategy to initiate real change. Stakeholder consultation on the scope and scale of the first Strategy should aim to include a highly representative set of stakeholders from across the energy system, covering the full energy supply chain and diverse customer types.

7.2.4 Timeline

An approximate timeline for the development of the first Australian Least Cost Energy Strategy is presented below, assuming project commencement by early 2023. If AEMO follows a similar timeline to that followed for the 2022 ISP, then stakeholder consultation on the 2024 ISP could start in September 2022 and publication of the ISP methodology and input assumptions would be on 30th July 2023, shortly after publication of the first Strategy. The team developing the Strategy should aim to collaborate with AEMO throughout the process and advocate for improvements to the 2024 ISP methodology as they emerge, rather than waiting until final publication when it may be too late to have an influence. This intention is indicated in the final row of the timeline.

Task	Month					
	1/23	2/23	3/23	4/23	5/23	6/23
Project Initiation						
Develop modelling approach						
Investigate supply-side options						
Investigate demand-side options						
Identify and document data gaps						
Model the least cost mix						
Reporting						
Engage with existing system planning processes						

7.3 Australian Energy Futures Report series

Whereas the Decentralised Energy Data Inventory collects data on the present, the role of the Australian Energy Futures Report series is to look to the future. Given the existence of other prominent publications that also look to the future, including AEMO's ISP and Western Australia's Whole of System Plan, stakeholders advised that the report series should be designed to complement existing processes and help to push them forward into new territory by pointing out emerging issues on the horizon and proposing ways to integrate them. The Australian Energy Futures Reports will provide qualitative data about possible futures, complementing the quantitative assessment in the Australian Least Cost Energy Strategy.

7.3.1 Objectives

Bearing in mind the above, and considering the identified gaps in anticipatory capacity (see Section 6), we propose the following objectives for the Australian Energy Futures Report series:

- Provide industry leadership by anticipating and publicising issues on the horizon that require greater industry attention
- Integrate insights into the future from all the RACE for 2030 research themes
- Present new qualitative data that supports the industry to take anticipatory action, including more speculative scenarios that challenge conventional thinking
- Demonstrate the application of innovative anticipatory methods to build awareness and capability in using these methods
- Engage a set of stakeholders in development of each report that represents the whole energy system
- Offer practical recommendations on how industry practices should be revised to address the issues raised in each report.

Implicit in the above objectives is the idea that the Australian Energy Futures Reports would have an influence on existing energy system planning processes, such as AEMO's ISP. Beyond this, the report will be of wider interest across the energy sector to stimulate new thinking about possible energy futures.

7.3.2 Scope

The gaps in anticipatory capacity summarised in Section 6 suggest possible scope of works for the first Australian Energy Futures Report. The gaps that most invite the application of foresighting methods are those relating to future customer needs and aspirations, whole of system planning, and planning for zero carbon futures. The topic of future customer needs and aspirations is addressed by forthcoming publications from the Monash University Digital Energy Futures Project. RACE for 2030 Theme E1 also has an explicit focus on customers. As such, the most appropriate scope for the first Foresighting Report is whole of system planning for a zero-carbon energy system. The report will help to address other gaps by consulting stakeholders, applying innovative foresighting practices and – if done well – building institutional support for foresighting. A proposed structure for the first Report is shown in Table 10.

Table 10: Proposed structure for first Foresighting Report.

Section	Description
Title	The future of Australian energy system planning: Towards whole-of-system and zero-carbon planning
Introduction	Define the objectives of the report; outline the approach taken to development of the report, including stakeholder consultation and foresighting methods used; geographical scale of the report; summarise the structure of the report
The future of energy	Summarise global and national megatrends influencing the future of Australia's energy system to provide the context within which energy system planning needs to be considered. This section should take a big-picture view of the energy system and draw attention to dynamics (such as wild cards and weak signals) that may not be well understood in the sector. A key source will be a review and synthesis of outputs from all RACE for 2030 research themes but this section should also look to international developments and reports.
Evaluating current energy system planning	Document the status of current energy system planning in Australia and identify limitations and opportunities for improvement. This Opportunity Assessment provides a starting point but some updating may be required as planning continues to develop. A review of the scenarios in the 2022 ISP and the emerging process for the 2024 ISP would be a key focus.
Scenarios for energy system planning	Apply an appropriate foresighting method, with stakeholders, to develop a set of scenarios for energy system planning in Australia. The scenarios should be developed through a broad, inclusive participatory process and will need to consider and define objectives for the energy system and principles for planning to achieve those objectives. Based on the stakeholder consultation for this Opportunity Assessment, we can anticipate that objectives will include meeting customer needs, achieving zero carbon and maintaining reliability, with a principle of genuine whole-of-system optimisation to achieve those objectives. However, broader stakeholder consultation and buy in is needed to develop scenarios and identify preferred scenarios. The consultation would include both customers and industry stakeholders, with the intention to 'have the system in the room'.
Pathways	Explore alternative pathways for responding to the scenarios and navigating towards preferred scenarios. A backcasting approach would be a suitable method to use here, to work out the steps needed to achieve a preferred scenario. As a minimum, this section should explore different regulatory and legislative arrangements, alternative modelling approaches, varying roles that different stakeholders could take, data needs and the feasibility of accessing these data, and resilience of different pathways to possible future trends and surprises. Specific ideas raised by stakeholders that should be considered include moving to an annual ISP, including zero carbon in the NEM objectives and moving to a single energy system regulator. The section should conclude with a preferred pathway and steps for achieving it.

After the first Report, subsequent reports will update the megatrends and scenarios and report on progress towards preferred scenarios. While future Reports will continue to have a focus on energy system planning, we anticipate that they may also have space to cover additional future-oriented topics that have become high-priority issues that the industry needs to consider at the time of the report. Stakeholders had several suggestions for such issues, including:

- Anticipation of future customer types and their preferences

- The future uptake trajectory for specific technologies, such as electric vehicles and offshore wind (and also how we might more rapidly bring key low carbon technologies into the system)
- Exploration of the social implications of future developments in the energy system, including the transition to net zero carbon. How might these changes affect social justice, equity, poverty and immigration? How might impacts vary across demographic categories?
- Implications of a rapid shift towards a scenario like AEMO's Hydrogen Superpower scenarios
- A Rapid Transition Roadmap that would consider a pathway to zero carbon if we acted with great urgency
- A study of the barriers to energy system transformation
- Consideration of ways to build optionality into energy system practices to improve resilience of plans to a diversity of possible futures and make 'least regrets' choices in uncertain conditions
- The role and opportunities for new modelling techniques, such as aggregation and use of non-meter data for end-use forecasting and the use of smart meter data processing to provide new insights into customer behaviour and technology use.

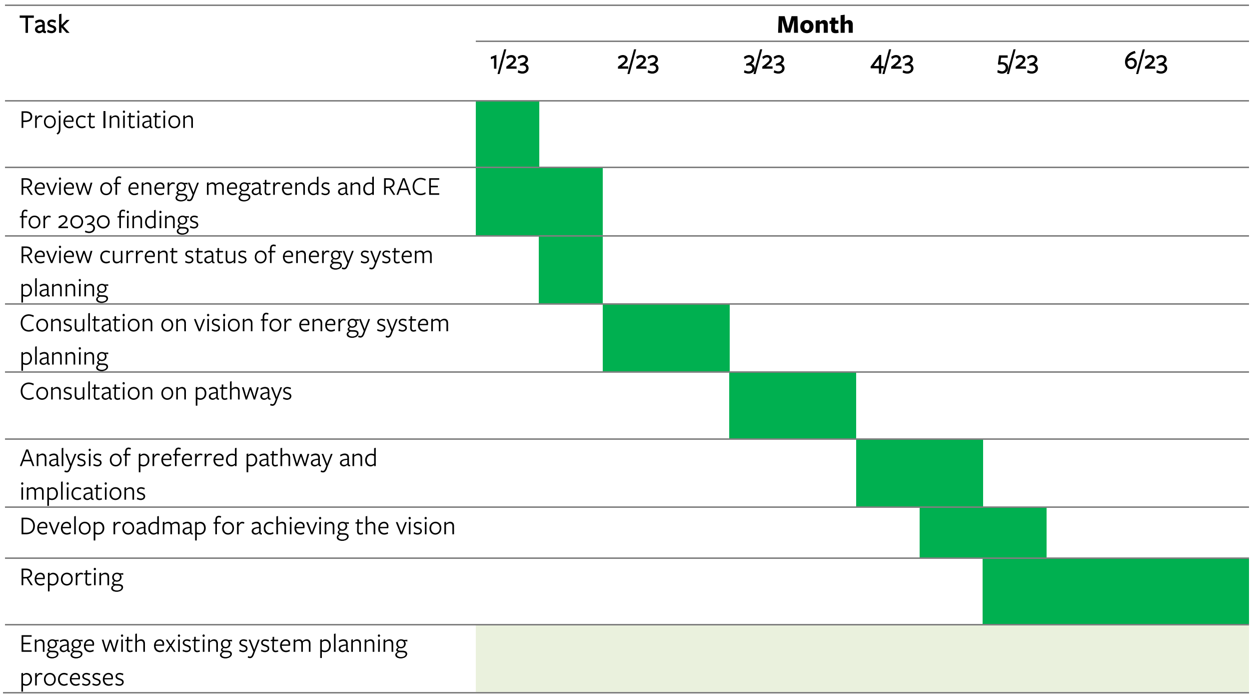
The flexible scope for each subsequent report will be chosen through stakeholder consultation with the goal of covering issues that stakeholders see as the highest priority at the time of developing the report.

7.3.3 Potential project partners

Given the focus on whole of system planning, participation by regulators and market institutions (AER, ERA AEMO and AEMC), Commonwealth Government and state government energy departments would be highly desirable to increase the potential for the reports to initiate real change. Stakeholder consultation during development of the reports should aim to include a highly representative set of stakeholders from across the energy system, covering the full energy supply chain and diverse customer types. CSIRO has substantial experience in energy foresighting and would be a valued partner.

7.3.4 Timeline

An approximate timeline for the development of the first Australian Energy Futures Report is presented below, assuming project commencement by early September 2022. If AEMO follows a similar timeline to that followed for the 2022 ISP, then stakeholder consultation on the 2024 ISP could start in September 2022 and publication of the ISP methodology and input assumptions would be on 30th July 2023, shortly after publication of the first Foresighting Report. The team developing the Foresighting Report should aim to collaborate with AEMO throughout the process and advocate for improvements to the 2024 ISP methodology as they emerge, rather than waiting until final publication when it may be too late to have an influence. This intention is indicated in the final row of the timeline.



7.4 Decentralised Energy Statement of Opportunities (DESOO)

The recent increase in the pace of the transition to a decentralised energy system has brought with it potential opportunities and challenges. Although important progress has been made towards whole of system planning, the Opportunity Assessment makes it clear that options considered when making decisions about the future of the energy system remain partial and are not treated on an equal footing. Specifically, decentralised energy options, such as energy efficiency, load management and distributed energy resources, are not yet on a level playing field with centralised infrastructure options, meaning some non-network opportunities are currently being overlooked.

A focus on established options over non-traditional solutions is not new to the energy sector. What has changed is the rapid growth in consumer and private sector interest in small scale energy solutions following the dramatic reduction in costs of distributed energy technology, in particular rooftop solar PV and, likely soon, both home batteries and electric vehicles. This shift creates implications for the energy sector that if handled well can lead to benefits. However, if outdated technologies and approaches are protected and allowed to linger this will lead to loss of opportunity, and even costly damage to the energy system given the shift to decentralisation now seems unstoppable.

In response to this context, RACE for 2030 has committed to work with its industry and government partners to develop a 'Decentralised Energy Statement of Opportunities' (DESOO) in order to provide a practical and unbiased summary of the latest opportunities for additional energy efficiency, demand management and distributed energy resources to help meet customer energy needs and support the appropriate functioning of the electricity grid. The RACE DESOO is intended to specifically complement the 'Electricity Statement of Opportunities' (ESOO) by AEMO for both the NEM and the SWIS, to allow for a greater level of investigation into specific opportunities related to decentralised approaches, undertaken in close consultation with industry, government, and consumer groups. Given that the remit of the ESOO, as per National Electricity Law, is to optimise for centralised solutions in the context of uncertain levels of decentralised investments, the role of the DESOO will be to reduce the levels of uncertainty based on practical solutions that can and have been implemented.

As such the scope of each DESOO will be tailored to complement and expand on the coverage of decentralised options in the ESOO, and other key documents. This calls for an interactive process to be undertaken to ensure complementarity and that the DESOO adds specific industry relevant contributions to broaden the focus and coverage of the ESOO. The intention is to deliver two rounds of DESOO as complements to the ESOO to facilitate conversations with government, industry and energy institutions on the potential to require greater coverage of decentralised options into the ESOO, GSOO and other related market planning documents.

7.4.1 Scope of Works

As part of the 'transition to a power system supplied almost entirely by renewable and distributed resources' anticipated in the 2021 ESOO[133], the DESOO will seek to complement the ESOO and GSOO by:

- Investigating the use of decentralised opportunities to manage the 'accelerating transition towards high instantaneous penetration of renewable generation' (2021 ESOO) in a manner that provides opportunities for related stakeholders and manages associated risks
- Updating progress on decentralised options to provide: frequency control ancillary services (FCAS); fast frequency response (FFR) and recovery services; load shifting; active management of DER; soaking up excess solar energy generation; and the implication of greater levels of electrification
- Investigating how decentralised opportunities can be used to counteract the reducing level of thermal generation reliability currently being experienced, such as prolonged periods of generation unavailability, transmission outages, commissioning delays, and gas supply shortfalls
- Investigating the use of decentralised opportunities to enhance the reliability of supply to assist in meeting the 'Interim Reliability Measure' (IRM) to reduce the level of 'Unserved Energy' (USE) in electricity grids around the country
- Considering the implications of decentralised options for reliability forecasting over 5 year periods to identify the potential for reliability gaps in each state. This will include consideration of the contribution to generation capacity from decentralised sources and the implications for maximum demand from the trend towards localised generation, storage and use.
- Contributing to consideration of the implications and opportunities of accelerated deployment of large-scale and distributed renewable resources, in particular ways to manage minimum demand thresholds in light of falling minimum demand during the day due to decentralised generation options
- Reviewing opportunities related to active management of DERs (including control of generation equipment and charging of batteries and electric vehicles), the potential contribution to foundational power system security adaptations using decentralised options, and aligning system needs with incentives provided to customers designed to influence behaviour and technology choices.

A key aspect of the DESOO will be to learn from the implications and opportunities created by use of decentralised options in the SWIS to inform planning and decisions in the NEM, such as early adaptation efforts to ensure security, reliability, safety and affordability of power as part of the transition to decentralisation. It is anticipated that the RACE CRC will use the DESOO as the basis for communication with

[133] https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2021/2021-nem-esoo.pdf?la=en&hash=D53ED10E2E0D452C79F97812BDD926ED

distributed energy resource providers and DNSPs in order to understand the evolving requirements of the power system to design decentralised options that genuinely provide useful services to the grid in the areas of FCAS, under-frequency load-shedding, and voltage disturbance ride-through.

7.4.2 Work Plan

The overarching intention of the DESOO is to draw attention to value streams that can be created using decentralised options and provide concise and approachable descriptions that can be used across society to understand how to support the transition to decentralisation. To do this, the work plan will need to focus on the development of the DESOO and subsequent integration activities in close consultation with partners and key stakeholders. The following items are recommended to be the core of the work plan, to be undertaken as a Standard Track project in two stages, the first stage running to the delivery of the second DESOO by June 2026 and the second stage running to the end of the road mapping and integration stage in June 2028.

Stage 1: Delivering the DESOO

a) **DESOO Design – April 2023**: Undertaking an initial process of partner and stakeholder engagement to refine the scope and design the process to be used to develop the DESOO to ensure it meets industry needs and delivers the outcomes required by the CRC. This process is to be completed by December 2022 and will clarify the need for, and the benefit of, a DESOO and identify preferences for reporting structures and methods. A key part of this process will be to design a strategy to pursue staged integration of the DESOO into market institutions, recognising that the eventual goal is not to keep producing a separate DESOO but to ensure that the ESOO adequately considers decentralised options and that this is effectively communicated to the sector. This will include consideration of the relation between the DESOO and a range of existing resources to avoid overlap and ensure continuity of efforts.

b) **DESOO#1 Research - September 2023**: Undertake research on the potential of selected decentralised options that are not yet properly understood or inadequately considered in the ESOO. These studies could be modelled on the 'potential studies' commonly used in the context of Integrated Resource Planning (IRP) (see Section 5.2). The identification of options to investigate will be undertaken in consultation with partners, with initial options identified as part of the Opportunity Assessment including: opportunities associated with electric vehicles and bi-directional charging infrastructure; the potential of price and incentive reform to alter customer behaviour and demand; and opportunities associated with demand response aggregation. This step will include review of the outputs of other associated RACE for 2030 research themes to identify data on decentralised opportunities. It will investigate strategies for localising the DESOO to the substation level to provide data that stakeholders can use to better plan rollout of decentralised energy opportunities. It will also review other initiatives that are pursuing coordination of decentralised energy, such as Project Symphony and Project EDGE.

c) **DESOO#1 Review - December 2023**: Following completion of the research for DESOO#1 a process of review will be undertaken with CRC partners and key stakeholders. This will include confirmation of the findings of the research phase, identification of omissions, and confirmation of the alignment to the goals of the RACE for 2030 CRC.

d) **DESOO#1 Release - June 2024**: This step will include a detailed response to the review process and amendment of the DESOO. This will also involve preparation for the release of the DESOO including the design of a launch procedure and associated events.

e) **DESOO#1 Feedback - December 2024**: This step will be run in parallel with Step f) and will involve monitoring and considering general feedback once the DESOO has been released publicly. This will also involve presentation of the DESOO at various academic and industry events for direct feedback.

f) **DESOO#2 Research - June 2025**: Repeat the research process undertaken for DESOO#1 beginning with a process of partner and stakeholder engagement to identify advances in the various areas of the DESOO, any new areas requiring research, and compare to the 2024 ESOO. This step will again include review of the outputs of other associated RACE for 2030 research themes along with other initiatives that are pursuing better coordination of decentralised energy.

g) **DESOO#2 Review - December 2025**: Following completion of the research for DESOO#2 a process of review will be undertaken with CRC partners and key stakeholders. This will include confirmation of the findings of the research phase, identification of omissions, and confirmation of the alignment to the goals of the RACE for 2030 CRC.

h) **DESOO#2 Release - June 2026**: This step will include a detailed response to the review process and amendment of the DESOO. This will also involve preparation for the release of the DESOO including the design of a launch procedure and associated events.

Stage 2: Integrating the DESOO

i) **DESOO Roadmap - June 2027**: This step will involve the development of a Roadmap for integrating DESOO innovations into market institutions and will be initiated towards the end of the DESOO#2 steps to run in parallel as appropriate. The development of the scope of this step will be undertaken during Stage 1.

j) **DESOO Integration - June 2028**: This step will involve the integration as per the roadmap of the DESOO process and findings into relevant market institutions.

The development of the DESOO program of work will be supported by doctoral research on *Integrating Decentralised Energy Opportunities into Mainstream Planning*. This PhD topic area would include students looking at three key areas, namely: 1) How the identification of decentralised energy opportunities can be undertaken with strong and appropriate stakeholder engagement, 2) How such opportunities can be integrated into system wide reforms and transitions, and 3) Where specific leverage points exist for strategic research and demonstration projects.

7.4.3 Potential project partners

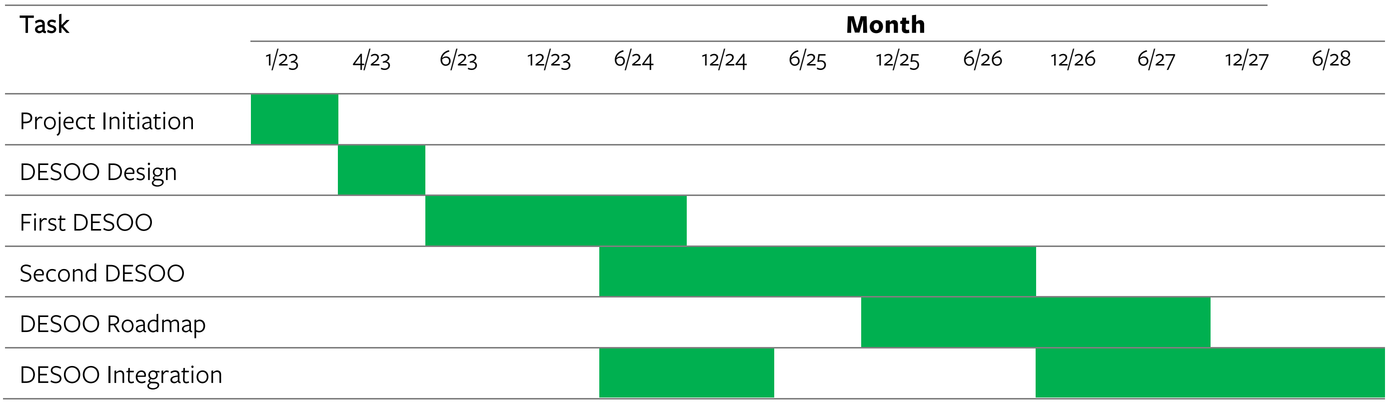
The development of a Decentralised Energy Statement of Opportunities is of benefit to partners across the energy spectrum, and therefore all partners would be invited to contribute. Following this, partners would be invited to participate in a steering group and industry reference group for the project based on intended level of engagement with the ongoing process. AEMO would be an important partner for working towards integration with the existing ESOO.

7.4.4 Timeline

The timeline for the delivery of DESOO related items are as follows as per the Commonwealth Milestones:

- DESOO Design Report due by April 2023.
- First DESOO Report by June 2024.
- Second DESOO by June 2026.
- DESOO Roadmap by June 2027.

- DESOO integration by June 2028.



7.5 Supporting projects: Building industry capacity for foresight

The Opportunity Assessment revealed that stakeholders in the energy sector lack familiarity with leading edge foresighting practices and are unable to readily access data that can help them explore a full range of possible futures. Without this industry capacity for foresight, decisions are made without full consideration of future implications. In addition to the four core projects outlined above, additional projects are recommended to build industry capacity for foresight.

7.5.1 Australian Energy Foresight Portal

This web portal will be a live online resource for learning about the future of the energy system. In transition management terms, this platform is the 'transition arena', where stakeholders will come together for dialogue about energy transitions. It will:

- Publish Foresighting Reports, the DESOO and other outputs from theme E2
- Share and interpret key international and Australian anticipatory publications, providing commentary on local implications
- Run regular future-focused events and stakeholder dialogues to build a 'community of practice' for anticipation and share learning from anticipatory planning
- Monitor and publicise 'weak signals' and 'wild cards' through an ongoing real-time environmental scanning process to identify new data with the potential to affect energy futures. The World Energy Council provides a model for this function at an international scale.
- Critically review and evaluate anticipatory practices to identify opportunities for improvement, including commenting on the accuracy of previous forecasting processes
- Highlight and celebrate best-practice in anticipation
- Publicise recommendations for reforms to embed anticipatory capacity in relevant institutions.

7.5.2 Roadmap for open anticipatory data sharing

Stakeholders pointed to the need for an 'open data' project to test ways of overcoming commercial and privacy barriers to sharing the data needed to anticipate the future of the energy system. There are existing platforms that seek to meet this need, such as CSIRO's NEAR Program[134], but it appears that this portal has not been updated in over two years. This project will bring together data providers and portal owners to develop a roadmap towards open data sharing. The roadmap will particularly focus on how to resource ongoing curation of a data portal to keep it up to date and relevant. It will explore whether to consolidate efforts behind an existing data portal or to develop a new portal. The Australian Energy Foresight Portal outlined above could become the new portal, or the content listed there could be incorporated into an existing portal.

Data that can already be shared will be curated, consolidated and made available (or linked) on the portal to support better anticipation. The project will explore options such as open data standards, regulatory reform and the use of innovations in web technology to enable more open, transparent and collaborative planning.

7.5.3 Short course on anticipation for zero carbon futures

An additional project to build capacity to use innovative anticipatory approaches would develop and offer a short course on anticipation for zero carbon futures. Stakeholders indicated that a lack of familiarity with anticipatory approaches was part of the reason why they are not currently used in the Australian energy system. A short course, made available through the Australian Energy Foresight Portal, will build industry capability to anticipate and plan for the future. The audience for such a course would be managers within organisations across the energy sector that have a role in strategic planning.

7.6 Doctoral research projects

While the need for the above projects is clear, much remains unknown about how to embed capacity for innovative foresighting and planning into energy systems. There is a role for doctoral research to explore and develop new ideas and evaluate the projects already proposed. The following doctoral research topics would be valuable to explore:

- How effective are the foresight and planning practices proposed in this Roadmap for achieving the goal of net zero carbon in energy systems? Are additional practices needed to achieve this goal?
- What are the best ways to support more inclusive stakeholder engagement in energy system anticipation? The projects described above would offer case studies to evaluate in this research and findings would be used to improve future engagement processes.
- As discussed in Section 7.2, the third and fourth Foresighting Reports could be supported by doctoral research projects on emerging topics, to be identified through consultation
- As discussed in Section 7.3, the DESOO would be supported by a doctoral research project on *Integrating Decentralised Energy Opportunities into Mainstream Planning*.
- Foresighting projects are rarely evaluated, although there has been some work in recent years to develop evaluation frameworks. There is no recognised method to evaluate the economic value of foresighting and planning reforms. As such, we propose a doctoral research project to address the question of how to evaluate the foresighting and planning practices prompted by the E2 Research Roadmap. The goal of this project would be to establish an evaluation framework and plan, which would be tested during the first assessment of the economic value of foresighting and planning reform, to be completed by 30th June 2025.

[134] https://near.csiro.au/

- Evaluation of RACE's activities from the perspective of transition management, which would make an important contribution to the report on post-CRC transition and market transformation strategy, and the final knowledge sharing activities.

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