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Enhancing anticipatory governance to accelerate just energy transitions in Australia

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ABSTRACT

Accelerating just energy transitions requires governance under uncertain conditions created by climate change, deregulated energy markets, policy volatility, accelerating technological development, and changing customer roles and expectations. In such an uncertain environment, there is a high risk that decisions will have unforeseen consequences that harm some actors, creating unjust outcomes. Energy systems must collectively develop the anticipatory capacity to explore future possibilities and the implications of different decisions and pathways for and with all affected actors. This paper assesses the anticipatory capacity of the Australian energy system and identifies ways it could be enhanced to accelerate just energy transitions. It draws on a review of representative industry publications, workshops and interviews with industry stakeholders to evaluate the mix of anticipatory practices, scope of anticipatory work, and types of anticipatory governance that prevail in the Australian energy system. Current practice is dominated by forecasting and normative foresighting approaches that do not sufficiently explore or respond to the diversity of plausible futures. Technological and economic drivers dominate anticipatory work, while politics and values are neglected. Anticipatory governance focuses primarily on assessing or pursuing probable futures to inform strategic policy planning and reduce future risks. The narrow range of current anticipatory practices leaves the sector vulnerable to trend changes, unanticipated customer behaviour, and stranding of assets, all of which can work against just transition. Opportunities exist to enhance anticipatory capacity by adopting a more holistic and coordinated approach, increasing institutional support, developing horizon scanning services and integrating household imaginaries into anticipatory planning.

1. Introduction

Globally, almost three-quarters of greenhouse gas emissions come from the production and use of energy [1]. The imperative to reduce greenhouse gas emissions is driving a global energy transition. Energy systems that relied on cheap fossil fuels are now transforming under pressure from climate change, technological development, geopolitical factors, and changes in customer roles and expectations [2–4].

While there is almost unanimous agreement that the endpoint of this transition should be a zero-carbon energy system [5], much remains uncertain. As incumbent models of energy supply break down, what exactly will replace them? How fast will decarbonisation take place? What mix of technologies will emerge and how resilient are these technologies to changes in the climate? How will governments, customers and businesses participate in this energy transition? Will these energy transitions be just and inclusive?

Acting under such uncertain conditions poses a significant challenge for the many actors that govern and participate in energy systems. When transition pathways and destinations are unclear, actions predicated on the expectation of a particular pathway carry a high risk of unforeseen negative consequences, such as financial losses, stranded investments, runaway climate change, and increasing injustice. The need to govern the energy transition so that outcomes are just and equitable is increasingly recognised [6–9]. The precise meaning of just energy transition is contested [6–8]. McCauley and Heffron define just transition as ‘a fair and equitable process of moving towards a post-carbon society’ [9] but this simple definition hides the complexity of how to define justice and fairness. Recent scholarship proposes a ‘whole-system approach’ to just transition that combines procedural justice (meaningful consultation of affected parties), distributive justice (fair sharing of costs and benefits of transition), recognitional justice (recognising that some members of society are already treated unjustly and energy transition could worsen this) and restorative justice (redressing past harm or reducing the likelihood of future harm) [8]. How to govern

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energy transitions under conditions of uncertainty and deliver fair and equitable outcomes has emerged as a key research question [6–8].

Recent scholarship on anticipatory governance [10–12] offers a possible response. Anticipatory governance is 'governing (or steering) in the present to engage with, adapt to or shape uncertain futures' [10]. While the term itself is relatively new, it builds on decades of prior scholarship in foresight [13–17] and the social sciences [18–20]. Anticipatory governance is clearly designed to address the uncertain conditions outlined above. However, it also proposes analytical tools that can be used to assess whether governance systems are providing procedural justice by including those affected by energy transition. These tools will be outlined in the next section (Conceptual Framework).

Given the importance of anticipatory governance for navigating just energy transitions and realising zero carbon futures, this paper evaluates anticipatory practices and anticipatory governance in the Australian energy sector to assess the adequacy of prevailing approaches and draw out insights for more effective and just governance of energy transitions. While no single energy system can be representative of energy systems globally, the Australian energy system has some features that make it an interesting case to consider.

First, it has historically relied more than most industrialised energy systems on abundant fossil fuels, particularly brown and black coal. Australia's reliance on fossil fuels for primary energy peaked at more than 96 % in 2008, when the OECD average was only 82 % [21]. Second, and linked to this reliance on fossil fuels, a strong nexus developed between the state and coal industry in Australia, resisting action on climate change [22]. As a result, the politics of climate change response in Australia have been highly conflictual, preventing for a long time the emergence of any clear energy policy to guide future expectations [23,24]. Finally, now that energy transition is underway in Australia, decentralised energy technologies such as rooftop solar photovoltaics (PV) have been adopted at a phenomenal rate, putting intense pressure on an electricity grid that was not designed for two-way flows [25]. Australia leads the world in rooftop solar installations, with almost one-third of households having systems installed [26].

While these energy transition dynamics are not limited to Australia, the slow start to the transition in Australia and the rapid recent pace have brought the challenges of a shift from centralised to decentralised energy systems into stark focus. The response to these challenges from governments, businesses and customers is a source of deep uncertainty, making anticipatory governance essential. It is timely to assess whether existing anticipatory practices are up to the task.

Section 2 of the paper describes the conceptual framework guiding the evaluation. It is followed by a section on methods (Section 3) and a section describing the Australian energy system as context for understanding the case (Section 4). Section 5 evaluates anticipatory practices in the Australian energy system before a discussion section (Section 6) draws out the apparent gaps in current anticipatory capacity and ways they might be addressed. Section 7 concludes the paper.

2. Conceptual framework

During the last decade, a group of future-oriented scholars have embarked on a project to bring greater discipline to futures thinking [13–17]. These efforts centre on the concept of anticipation and the development of a 'discipline of anticipation' [14] or field of 'anticipation studies' [16]. In this work, anticipation is an intentionally comprehensive term covering all forward-looking attitudes and activities [27]. It includes thinking about the future, developing expectations, and taking actions guided by those expectations.

In his introduction to the *Handbook of Anticipation*, Roberto Poli distinguishes between three levels of future study: *forecasting* is the predictive component of futures study; *foresighting* aims to generate and explore diverse possible futures; *anticipation* takes the results of forecasting and foresighting and uses them to shape decisions and actions [27]. While this distinction is useful, the positioning of anticipation as just one level of future study does not make sense if the term is intended to cover all future thinking and action. Further, the 'foresighting' category holds great diversity; exploratory foresighting, which aims to explore the range of possible futures, is a significantly different practice from normative foresighting, which seeks to imagine and realise preferred futures. Table 1 builds on Poli's distinction to categorise three types of anticipation and I have added a list of typical methods.

All these types of anticipation are potentially useful in the right circumstances. Forecasting is useful in situations where the systems being studied are stable and continuous. This was the case in Australia's energy system for most of the 20th Century; energy demand followed population and economic growth and the main challenge for system planners was to build sufficient infrastructure to meet demand. However, the disruptions described in the Introduction mean that the value of forecasting has diminished due to the uncertain dynamics in the energy system. Foresighting practices better suit the uncertain conditions currently prevailing in the energy system. Recognising that the future is emergent and cannot be fully predicted, foresighting aims to facilitate imaginative thinking about future possibilities, thereby expanding the range of possible futures that are considered when making decisions. Foresighting aims to deliver a more complete perception of the strategic options available [28]. 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 or identifying preferred futures within the range of possibilities.

Identifying the types of anticipation that are prevalent in the Australian energy system is significant, as over or under-use of certain types of anticipation may point to opportunities to improve the quality of anticipation. For example, if predictive forecasting is still widely used to guide decisions due to familiarity with its methods, this is likely to generate decisions that are not robust across multiple possible futures. However, recent work applying the concept of anticipation to climate governance [10–12] goes further than this practice-based categorization by explicitly considering the governance purpose of anticipatory work.

Anticipatory governance is a relatively new term that attempts to link established foresight practices and futures-thinking methods with governance practices [29]. Early uses of the term were focused on how to govern emerging technologies [30,31]. More recent applications focus on climate governance and add a future orientation to long-standing debates on how to govern for sustainability [10,11]. It is this more recent work on climate governance that is the focus here, as it has the most relevance to just energy transition. Muiderman et al. [10]

Table 1
Types of anticipation and associated methods [after 27].

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 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

define anticipatory governance as 'governing in the present to adapt to or shape uncertain futures' [10]. This definition usefully foregrounds the 'decisions and actions' that are central to Poli's [27] definition of anticipation. Muiderman et al. [10] go on to distinguish between four approaches to anticipatory governance with different conceptions of and engagement with the future, implications for actions to be taken in the present, and ultimate ends or purposes. These four approaches are summarised in Table 2. This categorization adds value to the one presented in Table 1. Whereas Poli's [27] distinctions are more practice-based and methodological, Muiderman et al.'s [10] categorization makes the purpose of anticipatory action explicit, in terms of both its present value and ultimate purpose.

Most importantly, the four approaches identified by Muiderman et al. have different justice implications. If procedural justice requires meaningful consultation of affected parties as defined earlier, then it can be argued that only Approach 3, which seeks to mobilise diverse societal actors to co-create new futures, delivers procedural justice. Approaches 3 and 4 have the potential to improve recognitional justice by mobilizing actors that may not normally have a voice in energy governance (Approach 3) and critiquing governance practices that marginalize specific actors (Approach 4). As such, understanding the prevalence of these four approaches to anticipatory governance can help to evaluate whether current governance practices are likely to deliver a just energy transition.

In this paper, I will use the categorizations in Tables 1 and 2 to evaluate the anticipatory practices in the Australian energy system. There are two guiding research questions:

1. How prevalent are different types of anticipation and approaches to anticipatory governance in the Australian energy system?
2. How might anticipatory governance be enhanced to accelerate a just energy transition?

The next section describes the methods used to address these questions.

3. Methods

Initial data collection and analysis were completed as part of an Opportunity Assessment on innovative foresighting and planning in the Australian energy sector, conducted for the Reliable Affordable Clean Energy for 2030 Cooperative Research Centre (RACE for 2030 CRC) [32]. The purpose of the Opportunity Assessment was to evaluate the current anticipatory planning capacity of the Australian energy system and identify opportunities for improvement. The Opportunity Assessment methods included document review and industry stakeholder consultation.

An Industry Reference Group (IRG) with 14 members from state and local governments, energy businesses, industry associations, large customers, market operators, research organisations and customer advocacy groups was the primary forum for industry stakeholder consultation. The IRG met twice during the project to advise on the scope of the assessment, provide input on the current state of anticipation, and review draft findings. One of the roles of the first IRG meeting was to identify forward-looking academic and industry publications relevant to the Australian energy sector that should be reviewed in the Opportunity Assessment. Based on this advice, the author identified and reviewed 24 publications from Australian, state and local governments, regulators and market bodies, industry, customer advocates and research organisations. The intent was to review a representative but manageable set of publications, including contributions that spanned sectors and scales, and ensuring that all widely used anticipatory publications were included.

The review scored publications based on their use of the three types of anticipation listed in Table 1. The scoring system is summarised in Table 3. The averaged scores indicated the prevalence of different types of anticipation in the Australian energy system. In addition, each publication was evaluated for the extent to which it considered different factors (or drivers) that might influence the future. This assessment used the STEEPV categorization of drivers that is commonly used in foresight work, which recognises social, technological, economic, environmental, political, and values-based drivers [33]. Table 4 defines each category of driver, and the scoring system is shown in Table 3. The intention of this assessment was to determine whether any key drivers were being systematically neglected.

The results of this publication review were reviewed by the IRG at its second meeting, and revisions were made in response to their feedback. Two additional consultation workshops provided an opportunity for stakeholders beyond the IRG to review the findings. The project team also conducted six interviews with key industry stakeholders to gather data and test emerging findings. All of the stakeholder consultation activities helped to inform the gaps and opportunities for anticipatory governance identified in Section 6. All consultation activities followed ethical practices approved by the University of Technology Sydney Human Research Ethics Committee.

The scope of the Opportunity Assessment did not allow for an assessment of anticipatory governance approaches, so the publication review was later extended by the author to assess the types of anticipatory governance evident in each publication. As shown in Table 2, Muiderman et al. [10] distinguish between the four types of anticipatory governance based on their distinct conceptions of the future, implications for present action, and ultimate aim. Each publication was evaluated against this schema. It was quickly apparent that some publications did not neatly fit a single type of anticipatory governance, so a scoring system was again used to assess the degree of fit. For each type of anticipatory governance, a point was allocated for any of the relevant conceptions of the future, actions in the present, or ultimate aims that were identified in the publication. Thus, publications could score from 0 to 3 for alignment with each type of anticipatory governance.

Before presenting the results of the assessment of anticipatory capacity in the Australian energy system, Section 4 provides a brief overview of the Australian energy system as context for understanding the case.

Table 2
Four approaches to anticipatory governance [10].

Approach	How is the future conceptualised?	With what implications for the present?	Why / to what end?
1	Assessing probable and improbable futures…	…in order to help inform strategic policy planning…	…to reduce future risks
2	Exploring plausible futures…	…in order to build adaptive capacities and preparedness…	…to reflexively navigate diverse (uncertain) futures
3	Imagining pluralistic futures…	…in order to mobilise diverse societal actors…	…to co-create new futures
4	Scrutinizing the performative power of future imaginaries…	…in order to interrogate…	…and shed light on their political implications in the present

4. The Australian energy system: case description

Under the Australian Constitution, energy policy is the domain of Australia's eight state and territory governments, whereas compliance with international agreements, such as the United Nations Framework Convention on Climate Change, is the responsibility of the Australian Government. As such, national progress on transitioning to a zero-carbon energy system requires intergovernmental collaboration. In the realm of energy policy, intergovernmental collaboration is led by the Energy National Cabinet Reform Committee (ENCRC) and the Energy

Table 3
Scoring system for types of anticipation used and drivers considered.

	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

Table 4
STEEPV driver descriptions [33].

Category	Description
Social	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).
Technological	Rates of technological progress, pace of diffusion of innovations, problems and risks associated with technology (including security and health problems)
Economic	Levels and distribution of economic growth, industrial structures, competition and competitiveness, markets and financial issues
Environmental	Pressures connected with sustainability and climate change, more localised environmental issues (including pollution, resource depletion, and associated biodiversity, and welfare concerns)
Political	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)
Values	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.

Ministers' Meeting (EMM). These Ministerial forums bring together Energy Ministers from the Australian Government and state and territory governments. They are responsible for delivering energy policy reforms, such as those needed to guide the transition to a zero-carbon energy system.

The predecessors of these current institutions established a National Electricity Market (NEM) in 1998, which now covers the interconnected electricity grids of Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia, and Tasmania. Western Australia and the Northern Territory operate independent electricity grids and are not part of the NEM. The NEM is a wholesale spot market, and several market bodies oversee its operation. The Australian Energy Market Commission (AEMC) was established in 2005 as an independent statutory body that makes rules for the NEM, as well as for natural gas and energy retailing. Also established in 2005 was the Australian Energy Regulator (AER), which is the economic regulator and rule enforcer for the system. The Australian Energy Market Operator (AEMO) followed in 2009 to operate energy systems and markets across Australia, including the NEM, Western Australia, and Australian gas markets. Finally, the Energy Security Board (ESB) was established in 2017 to provide whole system oversight for energy security and reliability. This complex regulatory arrangement oversees a system of competitive electricity and gas markets and regulated networks serving almost 10 million households.

Australia's commitment to a zero-carbon future is established in the *Climate Change Act 2022*, which legislates a target of reducing Australia's net greenhouse gas emissions to 43 % below 2005 levels by 2030 and to zero by 2050. All state and territory governments and many local governments have similar targets. Some aim to achieve net zero sooner and some jurisdictions, like Tasmania, have already reached this goal. This clear and unified vision is a relatively recent development that has reduced uncertainty about long-term goals and is accelerating the energy transition. However, this vision is only slowly penetrating existing institutions. Most notably, emission reduction objectives were only added to the legislated National Energy Objectives that guide regulation of the energy system in late 2023. Prior to that, the operation of the energy system was focused only on price, quality, safety, reliability, and security of supply of energy.

Further, the shared vision around targets hides significant contestation and uncertainty about how to achieve the targets. Participants in our first stakeholder consultation workshop identified six key sources of uncertainty that are a continuing challenge for anticipatory governance of the Australian energy system: future government policy and the influence of political ideology; customer choices and practices; the resilience of energy infrastructure to climate change; the rate of uptake of new energy technologies; the outcomes of market and pricing reform; and the transition pathways that are taken. This persistent uncertainty points to the need for anticipatory governance capacity that can imagine, model, and compare multiple possible future pathways and take those possibilities into account in decision-making.

5. Anticipatory practices in the Australian energy system

This section reports findings on the type (Section 5.1) and scope (Section 5.2) of current anticipatory practices and the prevalent approaches to anticipatory governance (Section 5.3) in the Australian energy system. Findings are summarised in Table 5 and Table 6. Examples of anticipatory work are discussed in the text to illustrate the findings in the tables.

5.1. *Types of anticipation*

Table 5 indicates that, across the Australian energy system, all types of anticipation are in use. Further, some key sector publications, such as AEMO's Integrated System Plan (ISP) [34], make strong use of all three types of anticipation. However, the average assessment scores indicate that normative foresighting is the most common type of anticipation (average score of 2.3), followed by forecasting (2.0) and exploratory foresighting (1.5).

As outlined earlier, normative foresighting involves identifying and pursuing preferred futures. When it includes a thorough exploration of possible futures – and when decisions about which possible future to pursue are participatory and inclusive – normative foresighting is a valuable practice to connect thinking about the future with planning and action in the present. Unfortunately, the more common use of normative foresighting in the Australian energy system is as a political tool to advocate for a future that some actors desire, but not all.

Consider, for example, the twin visions released by Energy Networks Australia (ENA) in 2022 [35,36]. ENA is the peak industry organisation representing energy network businesses that transmit and distribute electricity and natural gas. Given their remit, it is not surprising that their Energy Vision 2050 imagines a future in which 'electricity and renewable gas networks will play a foundational role' [35] and their Gas Vision 2050 [36] positions natural gas as a transitional fuel on the way

Table 5
Evaluation of anticipation type, drivers considered and key methods in Australian anticipatory energy publications. See legend following table for assessment criteria [47,49–62].

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Australian Government										
Australia's Emission Projections [45]	■	▒	▒	▒	■	■	■	▒		Quantitative modelling, sensitivity analysis, roadmap
Australia's Long-term Emission Reduction Plan [47]	▓	▒	■	▒	■	■	■	▓		Quantitative modelling, scenarios (BAU and Plan), roadmap
Technology Investment Roadmap [39]	▒		■		■	■	▓	▒		Environmental scanning, technology assessment, roadmap
2021 Australian Infrastructure Plan [48]	▒	▓	■	■	■	■	■	■	▓	Visioning, scenarios, no regrets analysis, multi-criteria analysis, theory of change
State and Local Governments										
NSW Net Zero Plan [49]	▓		■	▓	■	■	■	▓	▒	Quantitative modelling, roadmap
WA Whole of System Plan [43]	▒	■		▓	■	■	▓	▒	▓	Quantitative modelling, scenarios
WA Distributed Energy Resources Roadmap [50]	▒		■	■	■	▓		▓	▓	Technology assessment, visioning, roadmap
SA Government Climate Change Action Plan [51]	▒		■	▒	■	■	■	▓		Projections, visioning, roadmap
Darwin-Katherine Electricity System Plan [52]	▓	▓	■	▒	■	▓	▒	▓		Scenarios, least regret analysis, roadmap
ACT Climate Change Strategy [53]	▓	▒	■	▓	▓	▓	■	■	▒	Visioning, roadmap, projections
City of Sydney Environmental Strategy [54]	▓	▓	■	■	▓	▓	■	▓	▓	Visioning, scenarios, roadmap, quantitative modelling
Regulators / market bodies										

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
AEMO Integrated System Plan 2022 [34]	■	■	■	▓	■	■	▓	■	▓	Quantitative modelling, scenarios, roadmap, Delphi, least regrets analysis
AEMO Electricity and Gas Statement of Opportunities [55, 56]	■	■	▒	■	■	■	▒		▒	Quantitative modelling, projections, scenarios
ESB Post-2025 Electricity Market Design [57]	▓		■	▓	■	■		■	▒	Quantitative modelling, roadmap
Industry										
Ausgrid DTAPR [58]	■	▒	■	▓	■	■	▓		▒	Quantitative modelling, least regrets analysis, GIS
ENA Electricity Network Transformation Roadmap [59]	▓	▓	■	■	■	■	▓	▓	▓	Quantitative modelling, no regrets analysis, scenarios, roadmap
ENA Network Opportunity Maps [46]	■			▓	■	■				GIS
ENA Energy Vision [35]			■	■	■	▓	■	▒		Visioning
ENA Gas Vision 2050 [36]	▒	▒	■	▓	■	▓	■	▓	▒	Visioning, quantitative modelling, pathway analysis
Western Power Grid Transformation Engine [60]	■	■	▒	▓	■	▓			▓	Quantitative modelling, GIS, scenarios
Customer advocates										
ECA Foresighting Forum [61]	▓	▒	▓	▓	▓	▒	▓	▒	■	Forecasting, visioning, scenarios
Research										
CSIRO Change and Choice (Future Grid Forum) [40]	▓	■		■	■	▓	▓	▓	▓	Quantitative modelling, scenarios
CSIRO Low Emissions Technology Roadmap [62]	▓	▓	■	▓	■	■	■	▒		Quantitative modelling, technology assessment, pathway analysis, roadmap

Publication	Type of anticipation			Drivers considered						Methods
	Forecasting	Exploratory	Normative	Social	Technological	Economic	Environmental	Political	Values	
Monash Digital Energy Futures [63]										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.

to a future where renewable and decarbonised gas is an important part of the energy system. The latter vision, in particular, conflicts with and competes for investment with those that see electrification as the more promising pathway towards a zero-carbon energy system. As such, these normative visions become advocacy tools in the debate over how to achieve zero carbon.

While industry associations like ENA are expected to advocate for their members, the tendency to 'pick winners' and pursue them vigorously is also evident in the anticipatory practices of Australian governments. The most obvious example is the technological fantasy of achieving 'clean coal' through the capture and storage of emissions from coal-fired power stations [37]. Australian governments have imagined and pursued a clean coal future for at least two decades [37,38] as a way to protect Australia's economic interest in coal use. A clean coal future has not materialised, as these imaginaries failed to account for the high cost of such technologies and the rapid reduction in costs of renewable energy.

A recent manifestation of this narrow approach to normative foresighting was the Australian Government's Technology Investment Roadmap [39]. This key component of Australian climate policy under the Morrison Government focused on technology as the response to climate change and selected seven priority technologies for investment: clean hydrogen, ultra-low-cost solar, energy storage, low emissions steel, low emissions aluminium, carbon capture and storage, and soil carbon. It is appropriate for governments to select and define priorities for public policy and investment. And, apart from carbon capture and storage, all these technologies have merit as part of climate change response. But when the primary system-wide type of anticipation is to select and pursue a narrow range of desired futures without sufficiently allowing for uncertainty and the emergence of different futures, there is a high risk that policy and investment will not deliver desired outcomes. Such foresighting, on its own, is fragile when the future turns out differently (as it almost always does).

This is why exploratory foresighting is such an essential accompaniment to normative foresighting. Exploratory foresighting aims to imagine and describe diverse futures that could plausibly develop from the present. While there are always constraints on how complete such an exercise can be, the intent is to open thinking about what might lie ahead so that we make decisions and take actions that better account for uncertainty. Table 5 indicates that exploratory foresighting is the least common type of anticipation in the Australian energy sector. It was entirely absent from seven publications and not used to its full potential in another eleven.

Nevertheless, there are prominent publications that take an exploratory approach. Australia's national science agency, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), ran a series of exploratory future forums relevant to the energy sector between 2006 and 2012, culminating in the Future Grid Forum [40] referenced in Table 5. The Future Grid Forum brought together diverse stakeholders from across the energy sector to qualitatively and quantitatively explore scenarios for the future of the electricity grid that imagined different outcomes emerging from technological change, climate action and consumer participation. While these forums introduced many stakeholders to exploratory foresighting, an evaluation found that consensus-building, impacts on policy and other industry impacts were limited, partly because there was such significant political division at the time over energy policy directions [41].

More recently, exploratory foresighting featured in planning

processes for the two largest interconnected electricity networks in Australia, the NEM and the South West Interconnected System (SWIS, in Western Australia). Planning for the NEM is led by AEMO and its cornerstone publication is the Integrated System Plan (ISP), produced every two years. The 2022 ISP [34] contains four exploratory scenarios developed through industry consultation:

- **Slow Change** imagines a challenging economic environment following the COVID-19 pandemic, resulting in slower net zero emissions action
- **Progressive Change** ratchets up emissions reduction goals over time to deliver a net zero emission economy 'just in time' to achieve a 2050 target
- **Step Change** sees rapid consumer-led transformation of the energy sector and co-ordinated economy-wide action
- **Hydrogen Superpower** assumes strong global action and significant technological breakthroughs that allow Australia to supply hydrogen to the world.

These scenarios usefully explore diverse futures where the pace of change and technological mix varies. While the drivers considered in the scenarios are arguably too narrow (see Section 5.2) the commitment to exploring multiple futures in this very prominent publication is promising. However, there is room to improve the exploratory approach further. Rather than preparing for all these possible futures, the ISP asked stakeholders to choose the most likely future (Step Change, chosen by half of the consulted stakeholders). The weightings emerging from this consultation were used in least-worst regrets analysis to contribute to the development of an 'Optimal Development Path' for network investment. Inevitably, the Optimal Development Path aligns closely with the most popular scenario. The problem with this approach is that, as implied by the language of 'optimal', it assumes an ability to predict and quantify uncertain futures that sits uncomfortably with the intent of exploratory foresighting; this is more akin to forecasting. Further, Australian energy sector stakeholders have a poor track record in anticipating future developments. Stakeholders consulted during the Opportunity Assessment indicated that the sector had previously failed to anticipate the high uptake of household air conditioners in Australia from the late 1990s to early 2010s, and its substantial impact on peak electricity demand. More recently, growth in renewable energy capacity in Australia has continually outpaced predictions. A 2024 report from AEMO showed that the 2020 scenario it considered most likely significantly underestimated actual installed renewable energy capacity in the four years that followed [42].

In contrast, Western Australia's Whole of System Plan for the SWIS also developed four exploratory scenarios but aimed to:

test the resilience of the power system to respond to high and low demand growth futures and not to present a particular 'base' case that we think more likely to occur. It is up to stakeholders to make their own interpretation of the results [43].

This is a more genuinely exploratory approach but leaves a lot in the hands of energy system stakeholders, who may lack the 'futures literacy' [44] to make good use of such open-ended analysis.

Alongside these promising institutional efforts towards exploratory foresighting, Table 5 indicates that forecasting remains prevalent, although it is increasingly used in service of other approaches. There were only two publications where forecasting was the most prominent type of anticipation – the Australian Government's greenhouse gas emission projections [45] and the Network Opportunity Maps developed by Energy Networks Australia [46], which visualise forecasts of network investment developed by network service providers. There is a telling chart on page 5 of the DISER [45] projections, showing that Australia's actual emissions have fallen faster than every previous forecast, which highlights the inability of forecasting to account for future uncertainty and human agency adequately.

5.2. Scope of anticipation

Technological and economic drivers were given the most attention in anticipatory work, with an average rating of 2.9 and 2.5 respectively. Social (2.1) and environmental (1.9) drivers received more moderate attention, while political drivers (1.4) and values (1.1) received the least attention.

The dominance of techno-economic concerns is not surprising in a sector that for decades has been focused on building the most efficient infrastructure to ensure a reliable energy supply for a growing population. This is perhaps most evident in the Australian Government's Technology Investment Roadmap [39], discussed in the previous section, which had little to say about the environmental consequences of the technologies it proposed and almost nothing about the social acceptance of those technologies in a future where values could change. However, the framing of future challenges as a techno-economic problem to solve was common across the sector and gives the sense that the future of energy is only about working out how to efficiently build new infrastructure rather than considering how customers interact with energy or how politics might influence what is feasible. The neglect of values and social drivers is particularly problematic from the perspective of just energy transition as it means that the perspectives of many affected actors are being left out of future plans for the sector.

Monash University's Digital Energy Futures Project was one of the very few examples that made social drivers and future customer values central to its foresighting [63]. The project drew on ethnographic research with households to centre people in its scenarios and challenge industry assumptions about technological solutions. For example, where industry scenarios often assume greater automation of demand management options, the ethnographic research argued that people would override automation to maintain control and use it in ways that match their everyday priorities and values. This leads to quite different scenarios that have yet to be factored into common industry thinking.

Political drivers were also largely neglected in explorations of possible futures. On one hand, this is puzzling, as the conflictual politics of climate change in Australia has arguably had more influence on the current state of the energy system than any other type of driver. On the other hand, it is easy to see why organisations that wish to maintain favour with the government of the day might be reluctant to release explorations of the future that explicitly consider the impact of political change. Nevertheless, foresighting work that neglects any key categories of driver will lead to scenarios that leave many plausible futures unconsidered. There are opportunities to consider shifts in politics without associating those shifts with political parties, for example, imagining a future in which global pressure on Australia leads to a strengthening of bipartisan political will for rapid decarbonisation.

Despite the overall neglect of some drivers, some publications considered the full range of drivers to at least a moderate level. The aforementioned ISP from AEMO was one of these, although still not as strong as it could be on social, environmental and values-based drivers [34]. The most comprehensive example was the Australian Infrastructure Plan produced by Infrastructure Australia [48]. Although its focus was more normative than exploratory, it sought to balance all drivers in its infrastructure recommendations, only somewhat neglecting how future values might change.

5.3. Anticipatory governance practices

The results of the assessment of anticipatory governance practices are presented in Table 6. The first thing that is apparent is that publications did not neatly fit the categories proposed by Muiderman et al. [10]. Conceptions of the future, actions in the present, and ultimate aims were frequently complex and did not always align in the ways that Muiderman et al. [10] indicate. It was common for publications that primarily adopted one approach to demonstrate some features of other approaches.

Table 6
Evaluation of type of anticipatory governance pursued by Australian anticipatory energy publications. See legend following table for assessment criteria [47,49–62].

Publication	Conception of the future	Actions in the present	Ultimate aim	Approach			
				1	2	3	
Australian Government							
Australia's Emission Projections [45]	Probable futures	None on its own, but could be used for strategic planning by others	Risk reduction (meeting international obligations)	■			
Australia's Long-term Emission Reduction Plan [47]	Probable futures	Strategic planning	Risk reduction, with a little attention to navigating uncertainty	■	▒		
Technology Investment Roadmap [39]	Probable futures, in the sense of imposing a desired future	Strategic planning	Risk reduction (maintaining Australia's competitive advantage)	■			
2021 Australian Infrastructure Plan [48]	Plausible futures (five scenarios)	Mainly strategic planning and enhanced preparedness, with some consideration of societal mobilisation	Primarily navigating uncertainty but with some attention to risk reduction	▒	■	▒	
State and Local Governments							
NSW Net Zero Plan [49]	A single probable future where the plan is achieved	Strategic planning	Risk reduction (reassuring community and investors that the state is doing its part on climate change)	■			
WA Whole of System Plan [43]	Plausible futures (four scenarios)	Primarily enhanced preparedness, with secondary focus on strategic planning	Primarily navigating uncertainty with lesser focus on risk reduction	▒	■		
WA Distributed Energy Resources Roadmap [50]	A single probable future, following the roadmap	Mainly strategic planning with a lesser focus on enhanced preparedness	Risk reduction (managing the risks of energy transition)	■	▒		
SA Government Climate Change Action Plan [51]	Probable futures, although a business-as-usual future is also shown	Strategic planning with occasional mention of enhanced preparedness	Risk reduction (managing climate risks)	■	▒		
Darwin-Katherine Electricity System Plan [52]	Three plausible scenarios, although one is selected as most probable	Strategic planning	Risk reduction (manage change in the energy system)	■	▒		

Publication	Conception of the future	Actions in the present	Ultimate aim	Approach			
				1	2	3	4
ACT Climate Change Strategy [53]	A single probable future where the vision is achieved	Strategic planning with some attention to adaptive capacity and community mobilisation	Risk reduction (managing climate risks) with some attention to navigating uncertainty and co-creating alternatives	■	▒	▒	
City of Sydney Environmental Strategy [54]	A single probable future where the strategy is achieved	Strategic planning	Risk reduction (managing environmental challenges) although the process leading to the strategy involved some co-creation	■		▒	
Regulators / market bodies							
AEMO Integrated System Plan 2022 [34]	Explores plausible futures (four scenarios) but then narrows in on a single future	A balance between strategic planning and enhanced preparedness	Risk reduction (ensuring electricity supply)	■	▒		
AEMO Electricity and Gas Statement of Opportunities [55, 56]	Forecasts plausible futures (four scenarios) but then narrows in on a single future	Primarily strategic planning but supports enhanced industry preparedness	Risk reduction (ensuring energy supply)	■	▒		
ESB Post-2025 Electricity Market Design [57]	A single probable future pathway	A balance between strategic planning and enhanced preparedness	Risk reduction (managing energy transition) with a lesser focus on setting up to navigate uncertainty	■	▒		
Industry							
Ausgrid DTAPR [58]	Single forecast future	Strategic planning	Risk reduction (avoiding network constraints)	■			
ENA Electricity Network Transformation Roadmap [59]	Probable future (the roadmap) with a single counterfactual scenario	Strategic planning	Primarily a roadmap for navigating uncertainty but also aims to reduce energy transition risk	■	▒		
ENA Network Opportunity Maps [46]	Single probable future	Strategic planning	Risk reduction (avoiding under-investment in electricity networks)	■			
ENA Energy Vision [35]	A single probable future where the vision is achieved	Strategic planning	Risk reduction (securing a future role for energy networks)	■			
ENA Gas Vision 2050 [36]	Explores three plausible pathways but narrows in on those that require gas	Strategic planning	Risk reduction (securing a future role for the gas industry)	■	▒		

Publication	Conception of the future	Actions in the present	Ultimate aim	Approach			
				1	2	3	4
Western Power Grid Transformation Engine [60]	Explores five plausible futures	A balance between strategic planning and enhanced preparedness	Both risk reduction (securing supply) and developing a tool to navigate uncertainty				
Customer advocates							
ECA Foresighting Forum [61]	Explored pluralistic consumer futures through the perspectives of presenters	Societal mobilisation (bringing actors together) as well as enhanced preparedness	A balance between co-creating alternatives and navigating uncertainty				
Research							
CSIRO Change and Choice (Future Grid Forum) [40]	Exploring four plausible futures	A balance between enhanced preparedness and social mobilisation	A balance between co-creating alternatives and navigating uncertainty				
CSIRO Low Emissions Technology Roadmap [62]	Explores four plausible pathways	Enhanced preparedness with a lesser focus on strategic planning	A roadmap for navigating uncertainty by investing in specific technologies				
Monash Digital Energy Futures [63]	Presents four plausible scenarios based on consumer research	Primarily critical interrogation of industry scenarios but useful for all other actions	Primarily demonstrating political implications of a customer-oriented approach but other aims also present				
Summary				**2.5**	**1.3**	**0.4**	**0.1**

Legend

	Score	Alignment of the publication with the conception of the future, actions in the present and ultimate aim attributed to each approach to anticipatory governance
	0	No apparent alignment
	1	One of the conception of the future, action in the present or ultimate aim is present
	2	Two of the conception of the future, action in the present or ultimate aim are present
	3	All of the conception of the future, action in the present and ultimate aim are present

Regardless of this complexity, Approach 1 to anticipatory governance (probable futures, strategic planning, and risk reduction) was by far the most prominent. Approach 2 (plausible futures, enhanced preparedness, and navigating uncertainty) was reasonably common, while Approach 3 (pluralistic futures, societal mobilisation and co-creating alternatives) and Approach 4 (performative futures, critical interrogation, and political implications) hardly featured at all. Given that Approach 3 (and to a lesser extent Approach 4) are those with the most potential to support just outcomes (see Section 2), their near absence from Australian anticipatory governance is troubling for just energy transition.

The dominance of the first approach to anticipatory governance aligns with the prevalence of forecasting and normative foresighting methods, which typically either forecast a single probable future or aim to create a single desired future through roadmaps, plans and strategies. The energy and gas visions already discussed [35,36] are good examples, where a single preferred future vision is expressed with the goal of protecting the interests of the industries involved and avoiding risks to their business.

Publications that primarily took the second approach to anticipatory governance typically used exploratory foresighting methods, since this facilitates consideration of multiple plausible futures. Some publications, such as the 2021 Australian Infrastructure Plan [48] and WA Whole of System Plan [43], aligned with all three categories of this second approach to anticipatory governance. However others, such as the AEMO Integrated System Plan 2022 [34], only partially aligned with the second approach to anticipatory governance because their ultimate aim was categorised as risk reduction rather than reflexively navigating uncertain futures. AEMO is strongly focused on ensuring that electricity supply meets demand and, as discussed above, stepped back from its exploratory approach to specify a single optimal development path.

The very few forays into the third and fourth approaches to anticipatory governance notably came from organisations that are not central beneficiaries of the current energy regime. For example, publications from local and territory governments aimed to co-create alternatives with their communities (alongside other aims). Forums convened by Energy Consumers Australia and the CSIRO also sought to co-create alternatives and mobilise stakeholders. The sole university publication reviewed [63] was also the only one to critically interrogate framings of the future and their political implications, although its conception of the future was more focused on plausible futures. This publication drew attention to the exclusion of customer views from most energy sector foresighting.

It is important to note that this research primarily focused on institutional publications associated with the energy regime, so the relative lack of the third and fourth approaches to anticipatory governance is expected. A review of the academic literature on the Australian energy system would undoubtedly uncover more critical work aligned with the fourth approach but this critical work would not in itself be enough to support just energy transition and was not the focus for this article.

The next section discusses the gaps in anticipatory capacity that emerge from this review of anticipatory practices in the Australian energy system.

6. Discussion: gaps and opportunities for anticipatory capacity

The analysis in the preceding section and stakeholder consultation during the Opportunity Assessment point to multiple gaps in the anticipatory capacity of the Australian energy system, some of which work against just energy transitions. This section discusses these gaps and related opportunities to improve anticipatory capacity.

6.1. Move from narrow engagement with 'the future' to broad exploration of possible futures

The analysis in Section 5 demonstrated that regime actors in the energy system typically use only a fraction of the available toolkit of anticipatory methods. The most common approaches are forecasting and roadmapping, both of which take a narrow view of the future. Energy forecasting methods emerged at a time when predicting necessary supply-side investment to meet ever-increasing electricity demand was the primary challenge for the energy sector. These methods are still widely used but can no longer cope on their own with the uncertainty and trend disruption associated with energy transition.

Normative foresighting copes with uncertainty by pursuing a singular vision of the future, and ignoring other possibilities. As there is no agreed vision for the Australian energy system, the various roadmaps, plans and strategies act as political statements that align with the narrow interests of the organisations that produce them. There are, as yet, no reliable and inclusive fora where diverse energy stakeholders can negotiate their discordant views and reach what Patterson et al. [64] call 'partial political settlements' about future directions. As a result, the many normative foresighting efforts arguably add to uncertainty by overwhelming energy system actors with competing alternatives. Powerful actors in the Australian energy system tend to 'pick winners' and pursue them vigorously rather than exploring possible futures and favouring actions that keep options open for responding to uncertainty. One example is the decades-long obsession with carbon capture and storage technologies that seem unlikely to ever be competitive.

While exploratory foresighting methods are seeing greater use, most notably in the key planning documents for the National Electricity Market [34] and SWIS [43], they are still under-used. When they are used, it is frequently as an initial step before picking a preferred scenario to focus on. Anticipation is most effective when it considers a full range of drivers and 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 needs to do all three well and have ways of integrating the outcomes. Given that AEMO's Integrated System Plan is the most prominent anticipatory publication in the sector and already includes exploratory foresighting, one strong possibility would be to continue to improve its approach and move towards genuine co-creation of scenarios with the full diversity of affected actors in the energy system, including customers. Rather than narrowing in on a most likely scenario and 'Optimal Development Path', future ISPs could instead take a least regrets approach, working with stakeholders to identify a sequence of actions that make the most sense across multiple scenarios.

Another possibility would be for a separate organisation to take on the role of synthesising foresighting activity across the sector and undertaking additional work to fill gaps. The Australian Government is in the process of establishing a new Net Zero Economy Authority to guide the transition to a net-zero economy; perhaps this Authority could take on such a role. Regardless of the specific institutional mechanism, the opportunity is to conduct more genuinely exploratory foresighting across the energy system and to bring stakeholders together to respond collectively to the plural futures that emerge from such processes.

In addition to broadening the type of anticipatory practices, there is a need to consider a more complete palette of factors influencing possible futures. The current dominance of techno-economic drivers in foresighting work leaves socio-political drivers neglected and these have arguably been the most important drivers shaping the energy transition and are the most important to consider for just energy transitions.

6.2. Develop holistic anticipatory capacity for a just energy transition

In many countries, anticipatory capacity is built into key decision-making institutions and routinely applied to challenges in diverse sectors, including energy. For example, the UK Government established a Foresight Programme more than 20 years ago and the Canadian Government has a centre of excellence in foresight called Policy Horizons Canada. These departments explore the future of chosen topics and advise policy makers. For example, the UK Foresight Programme recently advised on scenarios and pathways towards a net zero society [65]. While Australia has foresighting capacity through organisations like CSIRO, it lacks a dedicated foresighting unit within government that can provide a coordinated, holistic view of the future. Political differences over climate change response in Australia have also worked against the emergence of a clear policy vision for the future of the Australian energy system.

The complicated regulatory arrangements in the energy sector further diminish responsibility for coordinated foresighting. As outlined in Section 4, multiple regulators are responsible for different aspects of the energy system, and none has oversight of the whole. While AEMO's ISP [34] and Western Australia's Whole of System Plan [43] are welcome steps towards a more holistic foresighting approach, genuine whole-of-system planning is not yet a reality for the Australian energy system. Apart from the fact that each of those plans only focuses on part of the electricity network, they also do not treat all future technology options equally. 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 demand-side options fully in the optimisation process. This means that the potential of demand-side options to contribute towards a least-cost energy transition may not be fully realised.

Many participants advocated for a holistic approach to energy sector planning, incorporating electricity, gas and transport. Given that no single entity currently has regulatory oversight of the entire energy system, achieving this goal requires either regulatory reform or the creation of persistent spaces for cross-industry collaboration and coordination. Currently, such spaces are insufficient and foresighting remains partial and fragmented. However, they are essential to provide procedural justice and co-creation opportunities in support of just energy transitions.

One promising possibility would be to task the Climate Change Authority (CCA) with providing the necessary anticipatory capacity. The CCA is an independent statutory body established under the Climate Change Authority Act 2011 to provide expert advice to the Australian Government on climate change policy. It would be well placed to take a holistic, exploratory view of the energy transition and has already been tasked with reviewing the potential technology transition and emission pathways towards net zero in various sectors. Alternatively, the new Net Zero Economy Authority mentioned above could take on such a role.

6.3. Adopt participatory, customer-oriented approaches to anticipatory governance

Exploratory foresighting is most effective if it involves knowledge co-production by diverse stakeholder groups that bring together different perspectives on the energy system. In anticipatory governance, 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. In the terms used by Muiderman et al. [10], anticipatory governance in the Australian energy system would be much improved if the dominance of the first and second approaches was replaced by the third approach: imagining pluralistic futures in order to mobilise diverse societal actors to co-create new futures. As I have already pointed out, this would also be more likely to support just energy transitions.

While there are always opportunities available to provide input to industry planning processes, such as AEMO's ISP, these opportunities are geared towards and dominated by well-resourced industry organisations, businesses and government departments. Further, the input received through such consultation is synthesised by experts rather than

allowing for diverse stakeholders to negotiate and co-produce their own synthesis. In the terms of the well-known spectrum of public participation developed by the International Association for Public Participation, these processes are designed to inform and consult, rather than to involve stakeholders, facilitate collaboration, or empower them [66]. There is an opportunity to adopt more participatory approaches to anticipatory governance, which could include options such as citizen assemblies that have been used to explore climate change response in countries such as Ireland and the UK [67]. The CCA, mentioned above, could host such an assembly. Such a governance forum could be designed to provide a space where the contested normative futures proposed by industry organisations like the ENA could be negotiated and temporary resolutions could emerge that can guide action. They could provide space for consideration of plural futures and, importantly, could mobilise more diverse actors to co-create a just energy transition.

A more participatory approach to anticipatory governance could also go some way to addressing the current lack of industry knowledge about customer needs and aspirations and how these might shape the future of the energy system, identified by Strengers et al. [63]. Given that the purpose of the energy system is to meet people's needs for energy, it is remarkable how little data is available on such needs. 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 [63].

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. A more participatory approach to anticipatory governance that is guided by the need for the future energy system to be people-centred and just would help to shift the balance of data collection from technologies to people.

6.4. Make horizon scanning data to support anticipatory action accessible

The available data always limits the quality of our anticipation of possible futures. Signals of possible futures can be routinely overlooked if nobody is collecting and sharing the appropriate data to see those futures as they are starting to emerge. An example raised frequently by stakeholders is the rapid uptake of air conditioners by Australian households, which created a future where rapid grid investment was needed to meet peak demand on hot days. This future was not widely anticipated because there was no process in place to scan for and integrate data on climate trends, thermal efficiency of housing, customer aspirations and air conditioner retailer intentions.

Stakeholders indicated that data availability is an ongoing problem for the sector. Data that could signal possible futures is held by many different actors and some are unwilling or unable to share due to commercial interests or privacy concerns. While many organisations and individuals are engaged in horizon scanning to look for signals of possible futures, none has access to the big picture. Specific gaps identified by participants included data on current and future customer needs and aspirations (as noted above), the values and types of future employment in the energy sector, and the realisable potential of decentralised energy options.

Australia's national science agency, CSIRO, is seeking to address data gaps by developing accessible data platforms for the energy sector. Its efforts began with the development of the National Energy Analytics Research (NEAR) program[1] and are continuing with the planning of a new Smart Energy Mission, which aims to build more holistic systems intelligence into Australia's energy transformation.[2] These and other accessible data platforms that can bring together the results of horizon scanning across the system are much needed to support anticipatory governance in the energy system.

6.5. Build futures literacy

Participants described anticipatory methods used in the Australian energy sector as unimaginative, or lacking innovation. There is currently little use of established methods developed by foresighting practitioners to stimulate imagination about possible futures and open new thinking. Slaughter identified five levels in the development of the capacity for social foresight: from unreflective use of futures thinking in daily life, through use of futures concepts and methods, to the emergence of institutions of foresight, and ultimately the routine social capacity for foresight [68]. The Australian energy system is working with some futures concepts and methods but needs to build literacy with a wider range of methods so that institutions can routinely apply high-quality, imaginative anticipation. Horizon scanning sites like those discussed in the previous section offer the starting point. Such sites could seed communities of practice focused on learning how to improve anticipatory practice and build system-wide futures literacy. When there is greater awareness of the diverse range of possible futures across the system, anticipatory practices will naturally start to improve.

7. Conclusion

Current anticipatory practice in the Australian energy system is dominated by forecasting and normative foresighting approaches that do not sufficiently explore or respond to the diversity of plausible futures. Technological and economic drivers dominate anticipatory work, while politics and values are neglected. Anticipatory governance focuses primarily on assessing or pursuing probable futures in order to inform strategic policy planning to reduce future risks. The narrow range of current anticipatory practices leaves the sector vulnerable to trend changes, unanticipated customer behaviour, and stranding of assets. It also means that many voices are excluded from governance of energy futures, which works against the goal of a just energy transition.

Opportunities exist to enhance anticipatory capacity by expanding the range of anticipatory practices to include more exploratory foresighting, adopting a more holistic, coordinated and customer-oriented approach to anticipation, pursuing participatory approaches to anticipatory governance that seek to co-create plural futures, developing horizon scanning services and building futures literacy across the energy system.

There are institutional foundations already in place that could support an enhanced anticipatory capacity for just energy transitions. Exploratory foresighting approaches are now routinely used in energy system planning by AEMO, although there is much room for improvement. The CSIRO is working to make anticipatory data more available to energy system stakeholders. The independent Climate Change Authority, which has been little used in the past decade, could be tasked with developing innovative participatory approaches to anticipatory governance that put customers, social justice and climate change response at the heart of energy transition. Alternatively, the new Net Zero Economy

[1] https://www.csiro.au/en/research/technology-space/energy/energy-data-modelling/national-energy-analytics-research

[2] https://www.csiro.au/en/about/challenges-missions/smart-energy

Authority could take on this role. The greatest threat to building on these foundations is the ongoing political contestation over climate change response in Australia, which sees the two major political parties in fundamental disagreement over desirable futures. Perhaps bringing these futures into the light and involving more Australians in shaping them could open up pathways to bridge that longstanding divide.

CRediT authorship contribution statement

Chris Riedy: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization.

Declaration of competing interest

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Data availability

The authors do not have permission to share data.

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