THE UNIVERSITY OF SYDNEY

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Renewable Energy Transitions:

A Multi-Level Perspective of Electricity Policies in New South Wales

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Executive Summary

Australia has committed to an ambitious climate strategy, aiming to reduce its greenhouse gas emissions to 43 percent of 2005 levels by 2030 and achieve net zero emissions by 2050. This paper examines Australia's electricity generation sector, which is heavily reliant on coal and is the largest source of greenhouse gas emissions, contributing 34.3 percent to the total in 2024.

We first overview the Multi-Level Perspective (MLP) approach, an insightful analytical framework recognised for its ability to examine sustainability transitions through a multidimensional and interdisciplinary lens. This framework is applied to the policies and programs introduced by the New South Wales (NSW) Government between 2019 and November 2024. As Australia's most populous state, NSW's transition to renewable energy is crucial to meeting the country's renewable electricity and net zero targets. Adopting MLP's structured approach, we perform a desk-based analysis to conceptualise the renewable electricity transition as a socio-technical transition, with the aims to:

- Present a novel picture of NSW's renewable electricity policy landscape.
- Map its current renewable electricity transition pathway.
- Identify opportunities for improvement in renewable electricity policies.

Analysis of NSW's renewable electricity policies, strategies, and key programs establishes that NSW is undergoing a reconfiguration transition pathway, where niche innovations are being strategically integrated into the existing electricity regime. This shift marks a move from a market-led model to a hybrid governance framework, driven by targeted interventions, long-term planning, and supportive legislation. Multiple landscape-level pressures are accelerating this shift, including declining costs of renewables, global energy insecurity, and changing socio-political expectations around climate action. However, the findings also identify several critical gaps:

- Infrastructure delays hinder prosumer and grid initiatives, especially in Renewable Energy Zone (REZ) rollouts.
- Cultural discourse remains underutilised despite its role in building public trust and institutional legitimacy.
- Virtual power plants and decentralised systems offer untapped potential but need adaptive governance.

The energy transitions required to achieve net zero targets encompass restructuring interconnected systems supporting energy production, distribution, and consumption. The shift required extends beyond mere technological substitution, requiring a coordinated alignment of social, economic and political forces. While our review is limited to publicly available policy information, it provides a preliminary analysis of the challenges facing NSW's transition to renewable energy generation, as they are framed analytically within a complex socio-technical landscape. The MLP approach enables complex challenges to be conveyed in a holistic manner to foster sustainable policy innovation.

1. Introduction

While clean electricity is the cornerstone of a sustainable future, electricity generation remains the largest contributor to Australia's greenhouse gas (GHG) emissions, accounting for 34.3 percent of total emissions in 2024 (DCCEEW, 2024). In an increasingly climate-volatile world, it has become more urgent than ever to decarbonise electricity systems by adopting more renewable alternatives. Transitioning from a coal-dependent electricity system to renewables has been central to Australia's net zero strategy, which sets the goal of reducing GHG emissions to 43 percent of 2005 levels by 2030 and achieving net zero by 2050. Modelling by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Brinsmead, 2023) indicates that achieving these targets will require renewable electricity generation to comprise 90 percent of the national energy mix by 2030. Reaching this milestone, however, will necessitate a coordinated national effort across all states.

As Australia's most populous state, home to 32 percent of the national population, NSW bears a critical responsibility in ensuring the country meets its renewable electricity and net zero goals. In 2016, it was among the first states to announce its voluntary commitment to net zero emissions by 2050, later enshrining this target in law through the *Climate Change (Net Zero Future) Act 2023*. However, progress was initially slow, hindered by the state's historical reliance on coal, which supplied 85 percent of its electricity at that time (Department of the Environment and Energy, 2018). The availability of cheap fossil fuel-based electricity and a combination of contradictory (Cheung & Davies, 2017), uncertain (Rai & Nelson, 2019), and disjointed energy policies (Warren et al., 2016) limited incentives to transition to renewables prior to 2019. Since then, geopolitical, climatic, and economic shifts have catalysed a renewable energy boom, increasing the state's renewable electricity share to 36 percent in 2023 (NSW Government, 2024). This progress has been driven by a coordinated policy response, including the *Electricity Infrastructure Investment Act 2020 No 44*, the *NSW Electricity Strategy*, and the *Electricity Infrastructure Roadmap*, which together aim to create a more sustainable, reliable, and affordable energy system. The looming retirement by 2035 of four of the five remaining coal-fired generators in the state, currently responsible for nearly 75 percent of the state's electricity generation, adds further urgency, presenting a key opportunity for wind and solar to be cost-effective replacements (Graham et al., 2023). Yet despite this momentum, NSW is on track to achieve only a 44 percent reduction in emissions from 2005 levels by 2030, falling short of the 50 percent target mandated under the Climate Change (Net Zero Future) Act 2023.

Given the central role of the electricity sector in decarbonising the broader economy, this study aims to develop a clearer understanding of the current renewable electricity landscape in NSW and provide insights into the state's transition trajectory between 2019 and 2024. Using a desk-based policy analysis to investigate how actors, technologies, and policies interact across different levels of society, the MLP framework reveals the dynamics shaping NSW's transition.

This study has three core objectives:

1) **Present a novel picture of NSW's renewable electricity policy landscape.**
2) **Map its current renewable electricity transition pathway.**
3) **Identify opportunities for improvement in renewable electricity policies.**

2. Literature Review and Analytical Framework

As with other socio-technical systems, electricity systems are built and maintained through complex interactions and alignments between businesses, policies, technology, infrastructure and society (Geels, 2011). Transitioning to low-carbon electricity requires a nuanced understanding of these relationships and the tensions within these systems that can reinforce existing financial, institutional, and infrastructural arrangements hindering broader system transformation.

The Multi-Level Perspective (MLP)

The MLP provides one of the most prominent analytical frameworks used to examine sustainability transitions because of its multidimensional and interdisciplinary approach (Sovacool & Hess, 2017). At its core, MLP conceptualises transitions as socio-technical in nature; that is, they are transformations involving not only technological innovation but also systemic changes in institutional arrangements, policy frameworks, market structures, user practices, and cultural norms. The renewable electricity transition is socio-technical rather than being a purely technological substitution, because it entails the restructuring of interdependent systems that support energy production, distribution and consumption, in a process requiring the alignment of social, economic and political forces. The MLP framework captures this complexity by analysing how innovations emerge and interact across three heuristic levels: the *niche*, *socio-technical system* and *socio-technical landscape* (Geels, 2019).

Niches serve as a 'protected space' that nurtures innovation by fostering multidimensional learning, improving price performance of new technologies, and ensuring alignment among key actors to build momentum for systemic change (Walrave et al., 2018). The existing *socio-technical system* is the stable interplay of existing technologies, policies, industries, markets, consumers, and cultural discourses. It is reinforced by actor networks whose actions align with a shared set of values and institutions, known as the socio-technical regime (Geels, 2019). This regime creates path dependencies, lock-in mechanisms, and resistance to emerging innovations (Geels, 2014). The *socio-technical landscape* encompasses broader external forces, such as demographic shifts, political ideologies, societal values, and macro-economic trends, that shape the socio-technical system and influence innovation dynamics (Geels et al., 2018).

The MLP framework theorises that accelerated socio-technical transitions require three mutually reinforcing conditions:

1) An increasing momentum for niche innovations.
2) Destabilisation of existing socio-technical systems.
3) Amplification of external pressures that can align to create windows of opportunity where niche innovations can disrupt the pre-existing socio-technical system.

MLP Transition Pathways

Expanding upon the fundamental MLP framework and drawing from historical patterning of transitions, Geels and Schot (2007) identified four common socio-technical transition pathways: *transformation, technological substitution, reconfiguration* and *de-alignment* or *re-alignment* pathways. These pathways are based on the nature and timing of interactions within the broader landscape, existing regime and niche innovations. These interactions are summarised in Table 1.

Transition pathways	Main actors	Nature of interaction		Timing of interaction	Characteristic of transition
		Landscape pressure (Yes/No)	*Niche-regime interaction*	*Mature niche available? (Yes/No)*	
Transformation	Regime actors and outside groups (social movements)	Yes (moderate)	Competing or Symbiotic	No	Regime actors and institutional structures gradually adjust regime rules to external pressures.
Technological substitution	Incumbent actor v. new actors	Yes (strong or shock)	Competing	Yes	Newcomers produce novelties that lead to market competition with old and new suppliers.
Reconfiguration	Regime actors and suppliers	Yes (moderate)	Symbiotic	Yes or No	Regime actors adopt component level innovations leading to competition with old and new suppliers. Components of the system begin to change, leading to new practices, systemic

					relations and values in the regime.
De-alignment and re-alignment	New and niche actors	Yes (strong or shock)	Competing	No (not initially)	Emergence of multiple new niches alongside decreasing trust and legitimacy of the regime lead to competition between incumbent and niche actors. Through a period of uncertainty, a new dominant niche will emerge and restabilise the system.

Table 1. Typology of transition pathway adapted from Geels & Schot (2007)

Policy Analysis using the MLP Framework

While there are many ways the MLP framework has been used to analyse policy, for instance through systemic reviews (El Bilali, 2019) and building socio-technical scenarios (Geels et al., 2020; Rogge et al., 2020), Kern (2012) offered one of the most practically oriented and policy-relevant frameworks for examining the role of innovation policy within transitions. Drawing on MLP research, Kern's framework provides a structured method to assess how specific policy mechanisms interact with niche developments and regime-level dynamics, and how they are shaped by or respond to broader landscape pressures.

Kern's framework remains particularly valuable due to its explicit focus on the interplay between policy instruments and socio-technical change processes. Kern (2012) utilised the MLP in a way that is accessible for empirical application, making it especially well-suited for policy-focused studies. It offers a clear, structured matrix to evaluate whether and how policies support, hinder, or remain neutral toward the goals of low-carbon transitions. To enhance its applicability to the current study, the original framework has been adapted and expanded to integrate more recent theoretical advancements in the MLP literature (Geels, 2019; Geels et al., 2017), particularly emphasising the evolving complexity of regime structures and the importance of agency and institutional dynamics. A more granular analysis of the socio-technical regime, with components such as markets, infrastructure, user practices, and cultural discourses is explicitly integrated into the analytical matrix in Table 2. By combining Kern's practical policy focus with updated MLP insights, the refined framework provides a more robust tool for identifying gaps, tensions, and intervention opportunities within NSW's renewable electricity policy landscape.

Niche	**Multidimensional learning process**		**Price-performance improvements**	**Building social network**	**Shared vision**	
	Policies are fostering learning across technology, markets, consumer practices, cultural meaning and infrastructural requirements.		Policies are creating an evident price-performance improvement in emerging niche innovations.	Policies are encouraging powerful actors to join the niche support network.	Policies are aligned with the general vision of niche market, innovators and key actors.	
Socio-technical system	**Change in technologies**	**Change in policies**	**Change in infrastructure**	**Change in user patterns**	**Change in cultural discourse**	**Change in markets**
	Policies that encourage technological development to accelerate the renewable transition like investing in battery storage improvements.	Policies that institute clear rules for all system actors to abide by and that support the renewable transition, like setting statewide efficiency goals.	Policies that drive infrastructural change to accelerate the renewable transition like upgrading transmission grids to create bi-directional grid infrastructure.	Policies that encourage user pattern changes that are conducive to the renewable transition like energy efficiency behaviours.	Policies that encourage positive discourses, create cultural enthusiasm, and increase socio-political legitimacy of renewable electricity technology and practices.	Policies that encourage new entrants or incumbents from other sectors to adopt emerging niche-innovations like incentive schemes.
Landscape	**Macro-economic trends**	**Socio-economic trends**	**Macro-political developments**	**Cultural trends**		
	E.g. Global energy crisis, globalisation.	E.g. Cost of living crisis, unemployment developments.	E.g. Changing 'philosophy' behind policy making.	E.g. Trends towards climate awareness and action.		

Table 2. MLP analytical framework adapted from Geels (2019) and Kern (2012)

3. Method

This study employs a desk-based analysis of NSW's renewable electricity policies, strategies, and key programs. It visualises the state's current policy landscape, identifying dominant policy approaches, and pinpointing opportunities to strengthen and accelerate the renewable electricity transition. To guide this analysis, the study applies the MLP as the central analytical framework. The MLP is used to categorise and interpret how different policies interact with and influence socio-technical developments across three heuristic levels: *niche innovations, socio-technical regimes, and socio-technical landscapes*. This approach enables a structured understanding of how NSW's policy interventions support (or hinder) renewable electricity transition dynamics, and where opportunities for further alignment may reside. The refined policy framework, based on Kern (2012), is adapted to include more granular elements of the regime level (see Table 2), and used to systematically assess each policy's influence across the MLP levels.

Scope and Selection Criteria

Renewable energy policies typically encompass the entire energy system, covering aspects from energy production, distribution and conservation to end-use consumption (Dahal et al., 2018). This study narrows its focus to the renewable electricity transition, given its role as the largest contributor to NSW's greenhouse gas emissions, as well as the time limitations of the research project. For the purpose of this study, policies are understood as high-level legislative, regulatory frameworks or government departmental strategies, while programs refer to specific initiatives or schemes designed to implement these policies in practice (Sokołowski & Heffron, 2022). Policies and programs were included if they addressed at least one of the four key electricity policy categories mentioned above. To ensure relevance and currency, as earlier reviews (Chester & Elliot, 2019; Guidolin & Alpcan, 2019; Li et al., 2020; Rai & Nelson, 2019) focused on pre-2019 periods, only those introduced or updated between 2019 and November 2024 were considered. In doing so, this study examines the post-2019 policy landscape shaped by the release of the *Net Zero Plan Stage 1 (2020–2030)*, the first cohesive statewide transition strategy in NSW.

Data Collection and Sources

All data were sourced from official government websites and publications to ensure accuracy and credibility. Although federal-level developments were acknowledged as part of the broader socio-technical landscape, the primary focus remains on NSW-specific policies and programs. Policies outside this scope, such as those related to renewable fuels or programs with limited documentation, were excluded. Following this selection process, 16 relevant policies and programs were identified. These were drawn from 19 official documents and webpages, consisting of over 724 pages of content. The full list of policies, sources, and URLs is provided in Table 3.

Document name	Published year	Number of Pages	Link
Climate Change (Net Zero Future) Act 2023 No 48	2023	21	https://legislation.nsw.gov.au/view/html/2023-12-11/act-2023-048
Electricity Infrastructure Investment Act 2020 No 44	2020	60	https://legislation.nsw.gov.au/view/html/inforce/current/act-2020-044
NSW Net Zero Plan Stage 1: 2020–2030.	2020	40	https://www.energy.nsw.gov.au/sites/default/files/2022-08/net-zero-plan-2020-2030-200057.pdf
Consumer Energy Strategy	2024	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/energy-strategy
		2	https://www.energy.nsw.gov.au/sites/default/files/2024-12/Summary%20NSW%20Consumer%20Energy_Strategy%202024%20v2.pdf
		84	Full strategy: https://www.energy.nsw.gov.au/sites/default/files/2024-09/NSW_Consumer_Energy_Strategy_2024.pdf
NSW Renewable Hydrogen Strategy	2022	64	https://www.energy.nsw.gov.au/sites/default/files/2022-08/2021_10_NSW_HydrogenStrategy.pdf
NSW Electricity Strategy	2019	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/nsw-electricity-strategy
		34	https://www.energy.nsw.gov.au/sites/default/files/2022-08/2019_11_NSW_ElectricityStrategyDetailed.pdf
		18	https://www.energy.nsw.gov.au/sites/default/files/2022-08/2019_11_NSW_ElectricityStrategyOverview.pdf
Electricity Infrastructure Roadmap	2020	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/major-state-projects/electricity-infrastructure-roadmap
		46	https://www.energy.nsw.gov.au/sites/default/files/2022-08/NSW%20Electricity%20Infrastructure%20Roadmap%20-%20Overview_1.pdf
		58	https://www.energy.nsw.gov.au/sites/default/files/2022-08/NSW%20Electricity%20Infrastructure%20Roadmap%20-%20Detailed%20Report.pdf
REZ Development Access Scheme		13	https://www.energyco.nsw.gov.au/sites/default/files/2024-04/guidelines-access-scheme-declarations-apr-2024.pdf
Energy Security Safeguard	2021		https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard
		151	https://www.energy.nsw.gov.au/sites/default/files/2022-08/energy-security-safeguard-position-paper-20210539.pdf
Energy Savings Scheme	2021	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard
Peak Demand Reduction Scheme	2021	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard/peak-demand-reduction-scheme
Emerging Energy program	2019	Webpage	https://www.energy.nsw.gov.au/nsw-plans-and-progress/major-state-projects/shift-renewables/emerging-energy-program
		37	https://www.energy.nsw.gov.au/sites/default/files/2022-09/NSW%20EEP%20Guidelines_ISSUED%20190222.pdf
Empowering Homes program	2020	20	https://greenhomeinitiatives.com.au/wp-content/uploads/2022/03/NSW-Empowering-Homes-Program.pdf
Solar for Low Income Households Offer	2021	16	https://www.energy.nsw.gov.au/sites/default/files/2022-08/2021-12-Solar-for-Low-Income-Households-Guidelines.pdf
Primary Industries Climate Change Research Strategy	2019	24	https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/1319386/pi-ccr-strategy.pdf
NSW Government Resource Efficiency Policy (GREP)	2019	36	https://www.energy.nsw.gov.au/sites/default/files/2022-08/2019_02_NSW_GovernmentResourceEfficiencyPolicy.pdf
Total pages		**724**	

Table 3. Complete list of policies reviewed with page numbers and data sources

4. Policy Analysis and Results

4.1 Renewable Electricity Landscape

As defined above, policymakers and other key actors in NSW's electricity system cannot directly influence developments at the landscape level. The following analysis explores several landscape-level developments since 2019 that have shaped or constrained the effectiveness of policies aimed at accelerating the renewable electricity transition (see Table 4).

Macro-economic Trends

The global electricity transition has been shaped by a number of key macro-economic developments. First, the COVID-19 pandemic caused widespread supply chain disruptions for renewable electricity technologies, resulting in project delays and increased costs. These disruptions were compounded by the 2022 global energy crisis, triggered by the Ukraine-Russia conflict, which led to volatile fossil fuel prices and renewed emphasis on the need for energy security through renewable sources. Despite these disruptions, a long-term trend of declining costs for renewable energy technologies has remained a central driver of the electricity transition. Solar photovoltaic (PV) technology, in particular, has experienced a near 90 percent price drop over the past decade (Roser, 2020). Even with a 20 percent increase in costs attributed to inflation and lingering supply chain issues, utility-scale solar and onshore wind remain the most cost-effective sources of new electricity generation in Australia, costing two to seven times less than coal-fired power or small modular nuclear reactors (Graham et al., 2023).

Concurrently, global investment in clean energy and infrastructure has reached unprecedented levels. Although certain countries temporarily increased fossil fuel subsidies to cushion the impacts of rising energy prices (International Renewable Energy Agency, 2023), updated projections indicate a strong rebound. In 2024, investment in the global clean energy sector hit a record high of USD $2.2 trillion, almost doubling clean energy investment compared to five years prior (IEA, 2025b).

Socio-economic Trends

In Australia, the socio-economic landscape has been marked by a rising cost of living crisis, which has had a mixed impact on public support for the renewable energy transition. While research conducted by Ipsos (2024) showed 59 percent of Australians continued to support the shift to renewables, it also showed that growing concerns over rising energy bills had led many to prioritise affordability. Ipsos's report showed that approximately two-thirds of Australians believe that keeping energy prices low should be the top priority. Moreover, 37 percent of respondents thought that renewable energy will impact household electricity costs negatively in the short term, an increase of 10 percent since 2022. These findings suggest that while support for climate action remains strong, there is a growing anxiety about the economic implications of the transition.

Macro-political Trends

Political responses to the energy transition have also intensified, particularly among major global economies. Over the past five years, countries such as China and members of the European Union have introduced large-scale policy packages and financial incentives to accelerate decarbonisation. During this period, China has had the biggest increase in clean energy investment, making up 31 percent of spending growth globally (IEA, 2025a). In 2024, China further strengthened its green finance framework through policies advancing green bonds, carbon trading, climate finance, and ESG (Environmental, Social and Governance) disclosure, with green funds seeing a significant rebound from 2023 figures (Yue & Nedopil, 2025). Likewise, the European Union's Green Deal has mobilised over €1 trillion for climate and energy initiatives. These interventions have significantly stimulated global demand for renewables, green hydrogen, and battery technologies, contributing to a competitive global investment landscape in which countries with more favourable policy environments vie to attract international capital. Until recently, the United States has been a supporter of clean energy investment, passing the Inflation Reduction Act (IRA) in 2022, which allocated over USD $369 billion to clean energy subsidies. However, the second Trump administration has made attempts to put this policy on hold (The White House, 2025), introducing greater uncertainty into global clean energy investment markets, the full impacts of which remain to be seen.

In Australia, the energy policy narrative has evolved significantly over the past century. Initially focused on economic development and fuel independence (early 1900s–1990s), the emphasis shifted to inefficiency and competition (late 20th century–mid-2000s) and, more recently, to energy security in response to global energy challenges (Chester & Elliot, 2019). The election of the Albanese-led Labor government in 2022 marked a turning point, with the administration explicitly committing to repositioning Australia as a "renewable energy superpower" in a narrative that became central to its campaign messaging (BBC, 2022). This shift reflects a broader re-evaluation of Australia's coal-dependent energy system and its international image as a fossil fuel exporter.

Cultural Trends

Public awareness and cultural attitudes towards renewable energy have also shifted in Australia. The country has experienced increasingly severe climate impacts, such as the 2020 Black Summer bushfires and the 2022 NSW floods, which have heightened public concern over climate change and the need to decarbonise. While surveys reveal widespread support for moving away from fossil fuels, they also highlight significant knowledge gaps. The 2024 Ipsos survey found that 54 percent of Australians do not understand what actions are being taken to meet the country's net zero commitments. Despite the fact that renewables supplied nearly 40 percent of Australia's electricity in 2023 (Clean Energy Council, 2024), many Australians remained unaware of the progress being made, with some even believing that there are no plans for a transition or that such a shift will ever occur. Voter priorities have also shifted markedly in favour of climate action. This trend was particularly pronounced during the 2022 federal election, in which the Labor Party's climate platform resonated strongly with voters. However, the most significant electoral development was the so-called ‘greenslide’, which saw a record number of Greens and teal independent candidates elected to Parliament, advocating ambitious renewable energy policies. Subsequent polling showed that nearly half of voters who switched to independent candidates did so primarily out of concern for climate issues (The Sunrise Project, 2022). This indicates that climate policy is no longer a peripheral issue in Australian politics, but a defining factor influencing political alignments and policy agendas.

Macro-economic trends	Macro-political trends
Positive (+) • Global energy crisis and disrupted supply chains. • Declining cost of renewable energy. • Increasing global investment in clean energy and infrastructure.	**Positive (+)** • Large-scale clean energy policy interventions from major economies. • Shifting energy narrative and growing support of Australia as a ‘renewable superpower’.
Socio-economic trends	**Cultural trends**
Mixed (+/-) • Cost of living crisis raising concerns about negative impacts of transitions on energy prices.	**Mixed (+/-)** • Growing support for renewable energy transition but critical knowledge gaps remain. • Shifting voter priorities toward more climate action.

Table 4. Summary of renewable energy socio-technical landscape and its impact on accelerating renewable electricity transitions

4.2 NSW Renewable Electricity Policy Visualised

Pre-2019 NSW Electricity Policy

Prior to 2019, electricity policy in NSW was largely market-driven, shaped by national energy reforms that promoted deregulation and privatisation. NSW relied heavily on competition and price signals within the National Electricity Market (NEM) to guide investment, including in renewable electricity (Crossley, 2024). This approach was built on the assumption that market liberalisation would attract private capital and drive efficiency, naturally facilitating the uptake of renewables. As such, NSW-specific policy interventions remained modest, with most support coming from federal schemes, such as the Renewable Energy Target (RET).

However, by the late 2010s, the limitations of this hands-off approach became increasingly apparent. Investment uncertainty, exacerbated by inconsistent federal policy, created hesitancy among renewable electricity developers. Grid reliability concerns emerged as ageing coal infrastructure neared retirement without adequate planning for replacement. Meanwhile, other states such as Victoria and South Australia began outpacing NSW through more targeted and coordinated renewable energy strategies. These challenges revealed the inadequacy of relying solely on market forces and signalled the need for a stronger, state-led approach. This recognition marked a strategic turning point. The release of the *Net Zero Plan: Stage 1 (2020–2030)* signified a shift towards a more interventionist and coordinated policy framework in NSW, positioning the government as an active architect of the renewable electricity transition.

Current NSW Renewable Electricity Policy

Post-2019, NSW energy policy has evolved into a hybrid model: maintaining market mechanisms while significantly increasing the role of government in planning, regulation and investment. The current framework reflects a deliberate shift toward long-term energy reliability and system resilience through targeted interventions, including REZs, long-term energy service agreements, and tailored financial incentives to accelerate renewable electricity deployment.

Figure 1 below outlines NSW's current renewable electricity policy overview, illustrating how high-level policies inform strategic frameworks that translate into specific programs. The policy landscape is now anchored by two foundational pieces of legislation: the *Electricity Infrastructure Investment Act 2020* and the *Climate Change (Net Zero Future) Act 2023*. These laws set the direction for NSW's renewable energy strategy, enshrining emissions reduction targets of 50 percent below 2005 levels by 2030, 70 percent by 2035, and net zero by 2050. Supporting this legislative foundation is the *NSW Climate Change Fund*, originally established in 2007. Though predating newer strategies, it continues to play a vital role in financing renewable programs, including *Empowering Homes*, *Solar for Low-Income Households*, and the *Regional Community Energy Fund*.

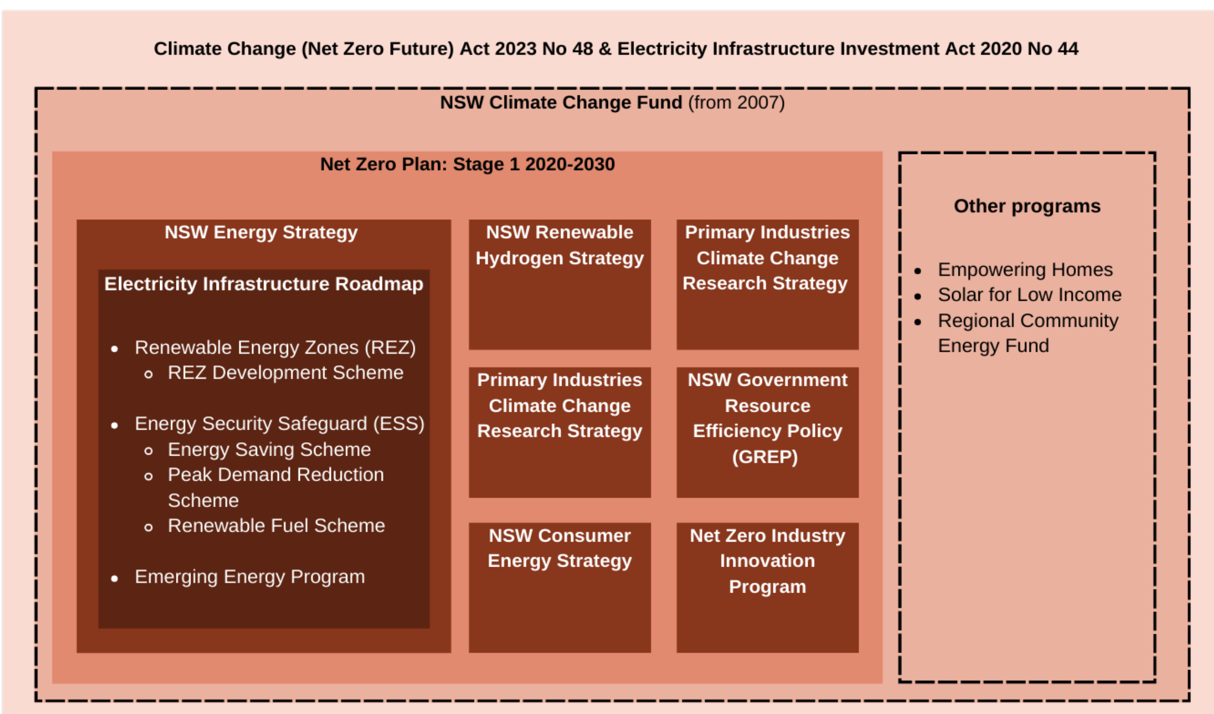

Figure 1. A map of the key renewable electricity policy, strategies and programs in NSW

Central to the energy transition is the *Net Zero Plan: Stage 1 (2020–2030)*, which outlines the overarching roadmap that is operationalised through sub-strategies such as the *NSW Energy Strategy* and the *Electricity Infrastructure Roadmap*. These include the following:

- Renewable Energy Zones (REZ) to centralise and coordinate large-scale renewable projects.
- Energy Security Safeguard (ESS) programs to improve efficiency and reliability.
- Emerging Energy Program to support new renewable technologies.

Together, these programs and initiatives represent a marked evolution in NSW electricity policy from a market-led model to a more strategically governed transition, underpinned by long-term mission and direct intervention.

4.3 NSW Renewable Electricity Policy Analysis

To analyse NSW renewable electricity policy, the adapted MLP framework (refer to Table 2) was applied to review the 16 relevant policies. Each was reviewed and coded based on its alignment with key MLP driving elements such as changes in technology, market structures, user patterns, and niche innovation dynamics (see Figure 3 below). The matrix identifies how each policy contributes to niche formation and/or regime-level reconfigurations, providing a visual representation of the depth and breadth of NSW's transition strategy.

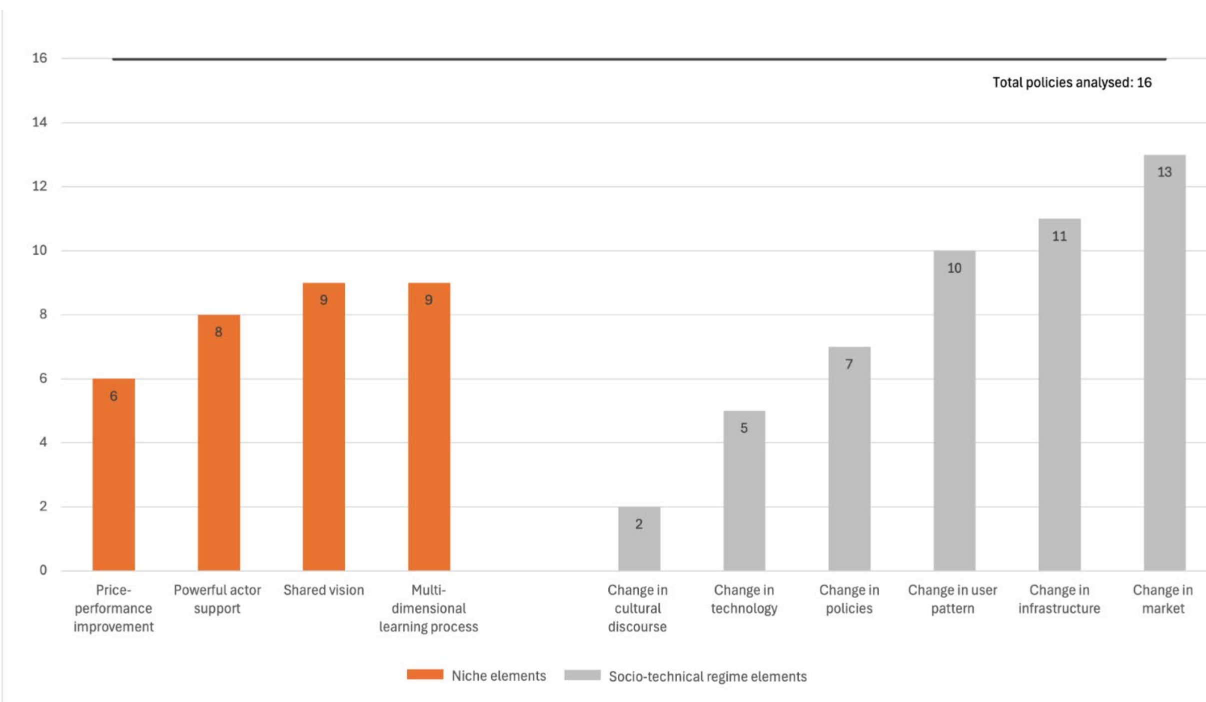

Figure 2. Breakdown of NSW Renewable Electricity Policy by MLP driving elements

The analysis revealed that NSW's renewable electricity policies are predominantly concentrated on reshaping the socio-technical regime, with the greatest emphasis on market interventions (13 of 16

policies), followed by infrastructure (11) and user behaviour change (10) (Figure 2). This pattern is reflected in the textual analysis of policy types, which shows a strong focus on electricity generation (13.2 percent) and distribution (11.28 percent) (Figures 4 & 5), highlighting how generation and distribution are treated as complementary and interconnected priorities across NSW's policy portfolio. Notably, 10 of the 16 policies (62.5 percent) incorporate driving elements spanning both the niche and regime levels, indicating that NSW's strategy extends beyond reconfiguring existing market and infrastructure arrangements to also nurturing emerging technologies and innovations. Together, these findings suggest that NSW is addressing multiple dimensions of the transition simultaneously, reflecting an integrated and systemic approach to renewable electricity policy.
The prioritisation of infrastructure investment aligns with the urgent need to address a looming generation shortfall as ageing coal-fired plants retire, most notably the Eraring Power Station, whose closure is projected to leave a 2.88 GW gap, approximately 18 percent of the State's electricity supply (NSW Government, 2022). To mitigate this, policies target renewable generation, large-scale storage, and enhanced distribution networks to maintain grid reliability and meet peak demand. At the user level, several policies aim to drive behavioural change and demand-side management. Programs like *Empowering Homes* and *Solar for Low-Income Households* support solar PV and battery storage adoption. However, their impact has been uneven, constrained by limited public awareness, infrastructure availability, and implementation challenges (ACIL Allen, 2022, 2023). Wider scale policies targeting user behaviour include the *Energy Savings Scheme*, which operates under a 'white certificate' model; an internationally recognised emissions reduction trading mechanism that rewards energy efficiency improvements.

Nearly two-thirds of the policies (10 of 16) support niche-level innovation in some form (see Figure 3), indicating a long-term strategy to incubate emerging technologies alongside mature renewable technologies. Early investments notably focused on renewable hydrogen, valued for its dual role as a fuel source and a flexible electricity vector. However, recent funding withdrawals, such as the Queensland Government's decision to cease support for the $12.5 billion Central Queensland Hydrogen Project (Lowrey, 2025) following the election of the Liberal National Party, signal both political and market-driven shifts in enthusiasm for hydrogen, underscoring the importance of adaptive, reflexive policy that keeps pace with shifting technical, political and market realities. The Emerging Energy Program runs alongside these efforts, advancing less mature technologies like Virtual Power Plants (VPPs), which remain in trial or early commercialisation phases due to low Technology Readiness Levels and ongoing technical, regulatory, and integration challenges. Continued support for these technologies provides pathways for innovation within the broader energy transition.

Cultural discourse was the least represented driving element, appearing in only two policies: the *Climate Change (Net Zero Future) Act 2023* and the *REZ Development Scheme,* indicating its presence is still relatively niche within the broader policy landscape. Nonetheless, where it does appear, it plays a critical role. The *REZ Development Scheme* explicitly states its goal to "foster local community support for investment in new generation storage, network and related infrastructure," embedding cultural discourse strategies that legitimise and socially ground the energy transition. As the designated Infrastructure Planner, EnergyCo is mandated to undertake REZ-wide community and stakeholder engagement and to implement programs that deliver tangible benefits to communities and landowners. Furthermore, the release of two new region-specific First Nations Guidelines, co-developed with Aboriginal working groups, guides proponents to consult and collaborate with relevant local communities through Industry and Aboriginal Participation Plans. Together, these measures actively support cultural discourse by embedding inclusive practices, promoting ethical engagement, and increasing the socio-political legitimacy of renewable infrastructure. Similarly, the *Climate Change Act* provides the overarching legislative foundation for climate action, legitimising the energy transition and guiding related policies. Its guiding principles in Section 8 emphasise transparency, public engagement, and informed decision-making, further reinforcing cultural discourse by framing climate action as a collective societal responsibility.

While it is more difficult to capture cultural discourse in legislative or programmatic texts, this dimension is essential for securing social legitimacy, public buy-in, and normalising new energy practices. Its underrepresentation suggests a potential gap in the state's transition strategy that may need to be addressed through complementary communication or engagement frameworks.

Policy, Strategy or Program	Niche				Regime					
	Multi-dimensional learning process	Price-performance improvement	Powerful actor support	Shared vision	Change in technology	Change in policies	Change in infrastructure	Change in user pattern	Change in cultural discourse	Change in market
Climate Change (Net Zero Future) Act 2023 No 48						(+)	(+)		(+)	(+)
Electricity Infrastructure Investment Act 2020 No 44			(+)		(+)	(+)	(+)			(+)
NSW Net Zero Plan Stage 1: 2020–2030.	(+)	(+)		(+)	(+)		(+)	(+)		(+)
Consumer Energy Strategy	(+)	(+)	(+)	(+)			(+)	(+)		
NSW Renewable Hydrogen Strategy	(+)	(+)	(+)	(+)	(+)		(+)			(+)
NSW Electricity Strategy	(+)	(+)	(+)	(+)			(+)	(+)		(+)
Electricity Infrastructure Roadmap	(+)		(+)	(+)	(+)		(+)			(+)
REZ Development Scheme						(+)	(+)		(+)	(+)
Energy Security Safeguard						(+)		(+)		(+)
Energy Savings Scheme						(+)		(+)		(+)
Peak Demand Reduction Scheme						(+)		(+)		(+)
Emerging Energy program	(+)	(+)	(+)	(+)	(+)		(+)			(+)
Empowering Homes program	(+)			(+)			(+)	(+)		
Solar for Low Income Households	(+)	(+)	(+)	(+)			(+)	(+)		
Primary Industries Climate Change Research Strategy	(+)		(+)	(+)				(+)		(+)
NSW Government Resource Efficiency Policy (GREP)						(+)		(+)		(+)
TOTAL	9	6	8	9	5	7	11	10	2	13
	32				48					

Figure 3. Detailed breakdown of NSW Renewable Electricity Policy by MLP driven elements

Document name	Type of policy			
	Generation	Utilisation	Distribution	Conservation
Climate Change (Net Zero Future) Act 2023 No 48	Y	Y	Y	Y
Electricity Infrastructure Investment Act 2020 No 44	Y		Y	
NSW Net Zero Plan Stage 1: 2020–2030.	Y	Y	Y	
Consumer Energy Strategy	Y	Y	Y	Y
NSW Renewable Hydrogen Strategy	Y	Y	Y	
NSW Electricity Strategy	Y	Y	Y	Y
Electricity Infrastructure Roadmap	Y		Y	
REZ Development Access Scheme	Y		Y	
Energy Security Safeguard		Y		Y
Energy Savings Scheme		Y		Y
Peak Demand Reduction Scheme		Y		Y
Emerging Energy program	Y		Y	
Empowering Homes program	Y		Y	Y
Solar for Low Income Households offer	Y		Y	Y
Primary Industries Climate Change Research Strategy	Y	Y		Y
NSW Government Resource Efficiency Policy (GREP),		Y		Y

Figure 4. Breakdown of policies based on policy type

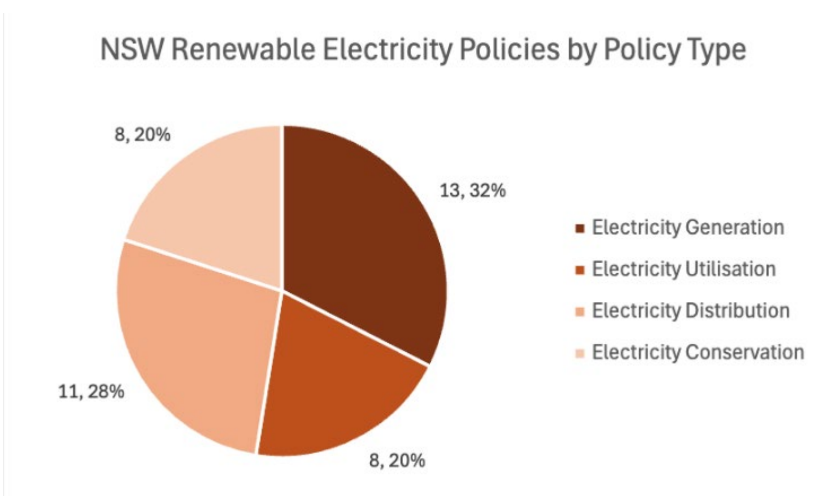

Figure 5. Breakdown of policies based on policy type in percentages

5. Discussion

5.1 NSW Electricity Transition Trajectory

The analysis of NSW's current policies suggests the state is following a *reconfiguration* pathway, in which niche innovations are integrated into the existing regime and gradually transform the system from within. Geels and Schot (2007) noted that socio-technical pressures, such as policy shifts or market demands, enable emerging technologies to scale. As regime actors adopt these innovations, co-evolution between technologies, regulations and markets drive a controlled transition. Geels (2005) observed that large technical systems, such as electricity systems, are prone to follow reconfiguration pathways due to their expansive reach and complex infrastructure that favours gradual adaptation over abrupt disruption.

The section below summarises why the NSW renewable electricity transition is characterised as a reconfiguration pathway:

- Landscape Pressures: The socio-technical landscape (as explored in section 4.1) is exerting increasing pressure on the electricity sector due to heightened climate change awareness, the recent global energy crisis, and rising commitments to net zero targets. International and domestic policy shifts, such as emissions reduction commitments and carbon pricing mechanisms, further reinforce the urgency of transition. Simultaneously, advancements in renewable energy technologies and declining costs have accelerated market investment, making the transition economically feasible and politically essential.
- Regime and Actor Dynamics: Incumbent actors are responding to landscape signals by reorienting their strategies. Turnheim and Geels (2019) suggested that incumbent actors can follow guided ‘search paths’ that reconcile legacy systems with emerging technologies, often through strategic landmark projects. Origin Energy’s investment in the New England REZ exemplifies such behaviour, where an established actor adapts to rather than resists change, blurring the line between niche and regime. Additionally, new entrants like VPP aggregators, solar firms, and battery providers introduce diversity and reshape the energy regime through both internal reconfigurations and external disruptions.
- Timing and Technological Maturity: The alignment of falling renewable energy costs with supportive policy settings has accelerated the growth of wind and solar energy, generating a positive feedback loop that can create tipping points that accelerate technological diffusion (Geels & Ayoub, 2023). These feedback mechanisms, driven by economic incentives, learning among actors, and growing standardisation, are helping to bridge emerging technologies with existing systems, supporting a gradual and coordinated transition rather than a disruptive overhaul.
- New Practices and System Reconfigurations: The introduction of REZs in NSW marks a key spatial and infrastructural reconfiguration, transitioning from a centralised, linear electricity model to a more distributed and multidirectional system. These zones not only facilitate the

integration of renewable energy but also represent institutional innovations that support systemic change. This transformation is further reinforced by the rise of VPPs and household energy generation, which are turning consumers into active ‘prosumers’ as a network of distributed participants who generate, store, and trade electricity within decentralised networks. These shifts are also driving behavioural changes, with demand-side management strategies encouraging users to align energy-intensive activities with periods of peak renewable generation. Together, these practices enhance grid flexibility and resilience, embedding renewables more deeply into the socio-technical system. Recent project studies reinforce this framing by emphasising that infrastructure projects like REZs can act as ‘vectors of change’ in sustainability transitions. Terenzi et al. (2025) argued that such projects do not simply deliver physical infrastructure but can embed new norms, technical standards, and institutional practices that guide long-term reconfigurations. In the context of NSW, REZs serve both as technical interventions and as strategic vehicles to align incumbent and emerging actors around net zero trajectories.

These reconfiguration transition dynamics are visualised in Figure 6.

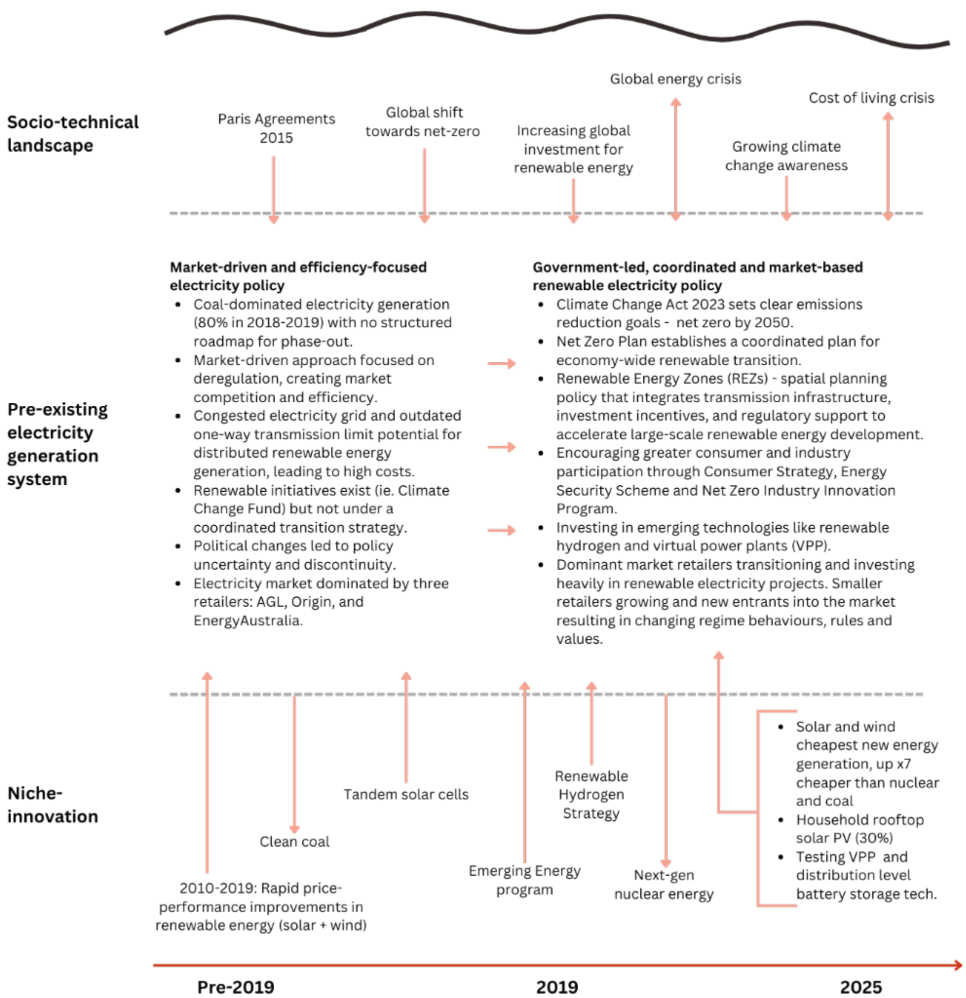

Figure 6. Reconfiguration of NSW electricity system in response to landscape and niche pressures. (Key: Arrow indicates direction of push/pull towards net zero)

5.2 NSW Renewable Electricity Policy Opportunities

Based on the above analysis, three key opportunities for future policy intervention and improvement have been identified.

Opportunity 1: Fostering the Niche - Virtual Power Plants and Their Role in NSW

VPPs are decentralised energy networks that aggregate and coordinate consumer energy resources such as rooftop solar panels, battery storage, and demand response systems into a unified flexible power plant. By leveraging digital platforms for real-time energy management, VPPs can:

- Provide grid stability and essential frequency control services.
- Optimise electricity supply and demand and reduce reliance on fossil fuels.
- Improve system reliability as coal-fired power plants are phased out.

NSW's high penetration of household solar, with one in four households having small-scale solar installed (NSW Government, 2025), presents a significant opportunity for VPPs to stabilise the grid and mitigate supply shortages. Relatively recent models estimate that legislative changes enabling the integration of price-responsive resources like VPPs could generate cost savings between $1.5 to $1.9 billion between 2025 and 2050 (Australian Energy Market Commission, 2024). However, as Wilkinson et al. (2020) noted in his MLP analysis of Western Australia's electricity transition, if the incumbent energy regime is slow to adapt or resists change, disruptive actions from niche start-ups and prosumer communities could trigger a less controlled 'de-alignment and re-alignment' pathway. Conversely, proactive adaptation by policymakers and grid operators would result in a reconfiguration of the energy system to accommodate these innovations.

Opportunity 2: Infrastructure Delays and Their Impact on Prosumer Programs

Earlier prosumer-centric programs, which aimed to empower consumers to generate and trade energy, faced setbacks due to insufficient infrastructure. One major bottleneck is the delayed rollout of REZs which in some regions have been postponed by up to two years (Hannam, 2023). These delays are particularly critical for:

- Renewable hydrogen expansion which depends on high-capacity transmission infrastructure.
- Prosumer-based programs such as rooftop solar and household battery storage which require grid enhancements to enable efficient energy export and sharing.

Although household solar adoption is extensive in NSW, current grid constraints and changes to feed-in tariff structures penalise consumers for overloading the network rather than rewarding them for contributing to energy resilience (Hannam, 2024). Such misalignment risks undermining the perceived benefits of solar PV in the short to medium term, especially with growing financial pressure in the current cost of living crisis.

If VPP integration succeeds but consumer readiness remains low, NSW risks significant wasted renewable energy generation potential. Ensuring a smooth transition requires better infrastructure planning, regulatory adjustments, and consumer education to fully harness decentralised energy resources.

From a project management perspective, these challenges and risks in infrastructure planning and delivery, such as delays in REZ development and grid upgrades, also reveal significant opportunities to reframe and strengthen the governance of infrastructure initiatives. Scholars have increasingly considered projects, programs and portfolios as crucial vehicles towards sustainability transitions (e.g. Geels & Locatelli, 2024; Terenzi et al., 2025; Whyte & Mottee, 2022; Winch et al., 2023). These insights are particularly relevant for delivering public policies such as NSW's renewable energy transitions, which can be considered as mission-oriented policies (Mazzucato, 2018), requiring a coordinated, cross-sector, and value-driven implementation. Following mission thinking, there is an urgent need to rethink how project management approaches can evolve beyond traditional cost-time-scope metrics to more adaptive, value-oriented, and human-centered project governance models. Through a mission-led project management approach, government agencies and delivery partners are expected to develop capabilities to increase public trust and deliver value in projects and programs better aligned with policy missions and community readiness, eventually accelerating energy transitions.

Opportunity 3: Cultural Discourse: A Critical Factor in NSW's Renewable Electricity Transition

NSW's current renewable electricity policies underemphasise cultural discourse, despite its critical role in shaping public perception, social acceptance, and policy legitimacy for renewable transitions (Buschmann & Oels, 2019; Yazdanpanah et al., 2015). Laakso et al. (2021) argued that transformational change requires not only technical solutions but a re-evaluation of social norms and values, ensuring they are connected to new sustainable practices through a shift in narrative. Without addressing discourse, building trust, and reinforcing socio-political legitimacy, NSW risks resistance and stagnation in renewable projects.

A key example is the discourse surrounding a 'just transition' in rural Australian communities. MacNeil and Beauman (2022) highlighted that while the concept holds political, economic, and moral legitimacy and should encourage support for the renewable energy transition, local responses vary significantly. Resistance to renewable energy solutions stems from a fragmented understanding of what a just transition entails, scepticism about renewable energy's capabilities to replace fossil fuels, and a failure to account for place-specific socio-cultural nuances in the broader discourse centring on opposition to wind turbines and transmission lines. These factors contribute to distrust and opposition, ultimately hindering the adoption of renewable energy in the region.

Perceived inconsistency in renewable programs undermines legitimacy and invites alternative actors like local cooperatives or private innovators to lead, accelerating a less centralised and controlled transition (Johnstone et al., 2020). To mitigate these risks, policy strategies must integrate cultural discourse as a key pillar of the transition, ensuring public buy-in through clear, consistent, and trust-building communication.

6. Concluding Remarks

This study has examined the renewable electricity transition in New South Wales through the Multi-Level Perspective framework, highlighting key socio-technical dynamics shaping the state's energy policies. The analysis identified NSW's transition from coal-centric electricity to renewables as following a reconfiguration pathway, where niche innovations such as solar and wind energy are being integrated into the existing energy system. Macro-economic, political, and cultural factors including global energy crises, shifting climate policies, and evolving public attitudes have played a crucial role in accelerating this shift. Nonetheless, several challenges persist, particularly around less mature renewable innovation spaces, policy consistency, and the need to prioritise socio-political legitimacy.

The findings indicate that NSW has made significant strides in scaling up large-scale renewables, notably through the establishment of REZs. However, grid limitations and the slow pace of infrastructure upgrades continue to act as critical bottlenecks. Institutional and regulatory uncertainty, particularly concerning transmission planning, the role of legacy energy providers, and the integration of emerging technologies, further complicate the transition. While public support for renewables remains strong, sustained socio-political legitimacy will require a systematic address of issues concerned with distributional justice as well as ensuring inclusive benefits, especially for rural and indigenous communities. Government policy has also tended to be reactive rather than anticipatory, raising concerns around investor confidence and long-term planning.

While the MLP framework provides valuable insights, it is not without limitations. Critics argue that its broad structural approach may overlook the context-specific institutional and socio-political dynamics shaping transitions (Coenen et al., 2012; Genus & Coles, 2008; Smith et al., 2005; Wells & Lin, 2015). To advance research, future studies should focus on in-depth policy evaluations to assess the long-term coherence and adaptability of NSW's renewable electricity strategies. A closer examination of socio-political legitimacy, particularly in relation to public trust, equity, and inclusion, could inform more durable policy outcomes. Further application of the MLP can also incorporate community perspectives, especially those of rural and indigenous populations, to increase understanding of how social acceptance and engagement shape transition pathways. Additionally, applying the MLP framework to emerging decentralised technologies like VPPs would offer valuable insights into how these innovations interact with and potentially reshape established regimes. These directions can refine transition strategies and better align them with just, inclusive, and effective decarbonisation goals.

Building on this, a critical area for future research also lies in bridging the gap between high level policy missions and on-the-ground project delivery (Nylén, 2021). Infrastructure delays in REZ development and grid upgrades illustrate a persistent disconnect between transition goals and implementation mechanisms. Understanding how projects, programs, and portfolios can serve as strategic intermediaries between policy and practice is essential for unlocking delivery bottlenecks. Future work should explore how a mission level of project management approaches—through improved planning, stakeholder engagement, adaptive governance, and cross-sector coordination—can be better integrated into transition frameworks like the MLP.

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Acknowledgments

This report is supported and funded by the Vacation Research Internship Summer Scholarship 2024-25 from the Faculty of Engineering at the University of Sydney. This work is also supported by the Sydney Policy Lab EMCR Scholarship 2025 and the Sydney Environment Institute. The author team would like to sincerely thank Professor Stewart Clegg for his valuable edits and insightful suggestions.

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