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An Analysis of Emerging Renewable Hydrogen Policy through an Energy Democracy Lens: The Case of Australia

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Abstract: As part of reducing carbon emissions, governments across the world are working on measures to transition sectors of the economy away from fossil fuels. The socio-technical regimes being constructed around the energy transition can encourage energy centralisation and constrain actor engagement without proper policy and planning. The energy transition is liable to have significant impacts across all of society, but less attention has been given to the role of democratic participation and decision-making in the energy system during this time. Using the energy democracy framework developed by Kacper Szulecki, we employ content analysis to investigate how Australia's renewable hydrogen strategies at the Commonwealth and state levels engage with the broader objective of democratising energy systems. Based on our findings, we recommend ways to support a renewable hydrogen regime in Australia in line with the principles of energy democracy, such as community engagement, built-in participation, popular sovereignty, community-level agency, and civic ownership. This study provides a perspective on the energy transition that is often overlooked, and a reminder to policymakers that the topology of an energy transition can take many forms.

Keywords: hydrogen; energy; democracy; policy; renewable; Australia

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1. Introduction

In recent times, a resurgence of support for 'green', 'clean', and 'renewable' hydrogen energy has occurred. Such names indicate the production of hydrogen via electrolysis using only electricity generated from renewable sources and water (p. 8) [1]. The renewed interest is due to technological advances in production, consumption and storage methods [2]. As a response to climate change, such low-carbon-emission hydrogen is being hailed by international organisations, national governments, scientific associations, and corporations as an important 'answer' to the general problem of climate change with a specific focus on sectors technically and/or culturally resistant to decarbonisation by electrification globally [3,4]. However, this enthusiasm is also accompanied with a considerable degree of concern and dissent. Criticisms relate to hydrogen's current limitations and challenges, including high production costs, difficulties with storage and transportation, and suspicions that its potential is being over-hyped.

The roll-out of hydrogen energy by necessity occurs within a wider political economic context and thus, notwithstanding a reappreciation of supply chain risks following COVID-19 and Russia's invasion of Ukraine, remains susceptible to the influence of neoliberalism—that is, to the privileging of market solutions to the world's combined and systemic social, economic, and ecological problems. The global energy system has been especially prone to neoliberal transformations in the past, such that today marketisation and privatisation are the modus operandi when considering policy responses [5]. A neoliberal approach to energy systems often prioritises profit and market competition over long-term sustainability,

equity, and social welfare, exacerbating environmental degradation and social inequalities. In the Australian energy sector, as elsewhere, such responses have created powerful oligopolistic firms with the capacity to manipulate market operations in their interests, rendering hollow their rhetorical claims to be acting in the 'national' or 'community' interest [5]. Evidence already exists that the emerging hydrogen industry is succumbing to the same fate [6], highlighting the need to consider the democratic dimensions of the hydrogen energy transition at this early point in the industry's development.

However, the imbalance in power relations between market, state, and community actors embedded within the neoliberal approach raises important questions about whether and how genuine democratic participation is possible as it is often either absent or cynically orchestrated through a variety of placatory 'consultative' processes to maintain, as far as possible, private sector control [7]. Scholars of the emerging approach of energy democracy argue that governance regimes should support citizenship engagement and capacity for decision-making at all stages of energy technology implementation [8]. For this to happen, the power of energy corporations must be rebalanced which can occur if the many alternative energy technologies which offer possibilities for "decentralisation, community, autonomy, equity, localism and connectedness to nature and place" (p. 469) [9] can be appropriately realised.

We examine the degree to which such citizenship engagement may be happening in the context of the recent, rapid embrace of 'green' hydrogen. Using Australia as a case, we undertake a policy study of the country's renewable hydrogen strategies at the federal and sub-national levels to understand how they engage with the broader objectives of democratising energy systems. Our central research question is the following: 'To what extent do Australia's renewable hydrogen strategies reflect and/or map onto understandings of energy democracy?" The article proceeds in eight parts: following this introduction, we overview the contested concept of democracy, describing how it manifests in the Australian democratic context. In section three, we examine interpretations of energy democracy, followed by a section that reviews the literature on energy democracy and renewable hydrogen. Noting the potential for the hydrogen energy sector to be democratised, in section five, we set out the methods employed in the study to uncover the degree to which this is happening, with sections six and seven reporting and discussing our findings. A short conclusion noting political and policy implications follows in section eight.

1.1. Energy Democracy in the Australian Context

Theorising the nature of the democratic has a long, convoluted, and contested history, ably if controversially set out by John Keane in his magisterial treatise *The Life and Death of Democracy* [10]. Today, the term is most commonly employed to identify a polity that is governed by a constitution that establishes arrangements for rule 'of the people, by the people, and for the people' as Abraham Lincoln so aptly phrased it. Despite the contention in definition, though, and in line with Lincoln's aphorism, Roper [11] helpfully notes that all interpretations of democracy seek to achieve 'a form of governance (or self-governance) that provides meaningful avenues through which the majority of citizens can exert a significant degree of influence over government decision making and policy making' (p. 1).

Liberal democracies, which today take a parliamentary or presidential form, assume that citizens are able to hold those in power to account via the device of periodic free and fair elections [12] supplemented with legislative debates, senate inquiries, royal commissions, and a free media acting as the 'fourth estate'. Proponents of participatory democracy, like Dacombe and Parvin [13], criticise liberal democracy's elite nature and claim that 'participation provides an additional layer of scrutiny over the actions of public officials by increasing the potential avenues for participation, and so dissenting voices can be heard, public figures held to account for their actions and any significant policy failure is more likely to be brought into the open' (p. 148). Further, theorists like John Dryzek [14] have called for 'deliberative democracy', which foregrounds the role of lay individuals gathering

in 'mini publics' to deliberate on and select feasible policy options (for an expansive discussion of deliberative democracy and key principles, see Curato et al. [15]).

To investigate energy democracy, we consider how Australia—founded following British invasion after 1788 that devastated the Continent's Indigenous peoples—is responding to the fossil fuel challenge by embracing renewable hydrogen. Politically, today, Australia is a federation of six states and two territories, with power divided between local, state, and federal levels of government. Institutionally, Australia is a 'Washminster' combination of the British Westminster and United States' federalist traditions [16]. For example, Australia retains the Westminster institution of responsible government, a fused executive, and a ceremonial head of state (the former Queen Elizabeth II and new King Charles III of Australia) at state and federal levels. On the other hand, it also evidences many features of US federalism, including the federal separation of powers between levels of government and between lower and upper houses, the latter a powerful and influential elected Senate.

The states that compose the Australian Commonwealth (New South Wales, Queensland, South Australia, Tasmania, Victoria, and Western Australia) are the successors of pre-federation colonies and retain, with few exceptions, plenary legislative power. Australia's two territories (Australian Capital Territory and Northern Territory) resemble states to an extent, but their laws are subject to review by the federal parliament. The federal parliament has power to make laws with respect to a limited number of subject areas specified in the country's constitution, although these powers may be expanded under limited circumstances. For example, federal powers can expand if states choose to cede them, or to reasonably uphold international treaties. Federal laws override state or territory laws in the event of inconsistency. This federal arrangement has implications for the ways that national priorities and strategies are translated into instruments of government policy, given the multilevel governance environment involved.

Australia's energy system reflects the country's liberal political economy and federated nature, especially in the way resources are located, exploited, and governed. The system is comprised of electricity and natural gas producers, transmission and distribution networks, and end users. In the populated East Coast, these electricity and gas networks became interconnected when networks were corporatised and privatised as part of neoliberal market-based reforms in the 1990s. From being government owned vertical utilities, they are now mostly split into generators, transmission network operators, distribution network operators, and retailers. The interconnected networks form the National Energy Market (NEM), which is overseen by a market operator (Australian Energy Market Operator, AEMO), a rule maker (Australian Energy Market Commission, AEMC), and a regulator (Australian Energy Regulator, AER).

The shared legal and regulatory frameworks that underpin this arrangement is an example of cooperative federalism. The system is underpinned by state-based legislation with only limited federal involvement. Under this arrangement, states avoid handing administration of the energy system over to the Commonwealth Government, but in return must ensure that their respective laws are consistent. In the energy case, states defer to a single copy of the relevant laws passed by the South Australian parliament (e.g., *National Electricity (SA) Act 1996* [17], *National Gas (SA) Act 2008* [18], *National Energy Retail Law (SA) Act 2011* [19]), which has been agreed to by participating energy ministers. Unilateral federal involvement is restricted to managing federally administered territories and providing support via grants, loans, and other financial support, though these actions still make the federal government a significant actor in energy policy.

There are several opportunities for individuals and stakeholders to participate in the National Energy Market. First and foremost, they participate in the democratic electoral process, enabling them to vote for the political party that they consider best represents their energy interests and values and to hold them to account. Free, fair, and compulsory elections enable democratically elected governments to claim legitimacy in the consultation, formulation, and implementation of energy policy. However, as discussed above with

respect to the limits of representative democracy, everyday stakeholders are too distant from decision makers for such accountability mechanisms to be fully effective and in real time. There are also many opportunities within Australia's system of representative democracy for the policy-making process to be dominated by powerful interests [20,21].

A second engagement mechanism provides for consultations when changes are proposed to the various sets of energy rules. However, such changes are typically of a technical and implementation nature and beyond the capacity of most stakeholders to engage and, as such, privilege state bureaucrats, business consultants, and academic experts. Stakeholders seeking input also employ a third, lobbying approach to ensure input into energy policy discussions. For example, Energy Consumers Australia advocates for consumer needs, Australian Energy Council for electricity suppliers, and the Minerals Council of Australia for the mining industry generally including coal. While these and other stakeholder bodies compete to set the energy agenda of the federal and state governments, options for the direct involvement of individuals and community groups are limited, as is their influence. Finally, in a market-based energy system, consumers can exercise agency with respect to energy demand [5]. For example, electricity consumers can seek out retailers that supply electricity from renewable sources [22]. However, 'voting with one's dollars' requires a significant commitment by the energy consumer as information asymmetry is high, there can be significant costs in shifting from one supplier to another, and consumers are unable to exercise the option of 'exit' by sourcing energy off the grid [23].

1.2. Theoretical Framework: Energy Democracy

There has been a steady increase in interest in energy democracy over the recent decades as a means to address environmental crises (i.e., climate change) and social crises (i.e., energy inequality) that exist in energy systems [24–27]. Energy democracy emphasises the importance of genuine citizen participation in the production, distribution, and utilisation of different types of energy through the deployment of participatory democratic processes that internalise issues usually overlooked by neoliberal capitalism [28]. Energy democracy is a compelling ideal for energy system governance [29,30]. Interpretations of 'democracy' within the concept vary and can include a focus on one or more of the following elements: models of collective ownership; access and equity; participatory processes; and benefit sharing/distribution of social/environmental/economic consequences of energy projects [31]. In advancing the field to consider how the concept is currently operationalised, Szulecki and Overland's [27] systematic literature review found that energy democracy tends to be operationalised in three ways: as a process, an outcome, or as a normative goal. Szulecki contends that conceptually, energy democracy contains three big ideas—civic ownership, participatory governance, and popular sovereignty—that emphasise the use of democratic processes to empower citizens directly, rather than through their elected representatives. We keep this distinction in mind given the different purposes ascribed to institutions in participatory democratic regimes compared to representative ones described earlier.

Energy democracy may be regarded as 'radical' given current technocratic energy governance regimes. Kunze and Becker [32] p. 8 contend that 'decisions that shape our lives should be established jointly and without regard to the principle of profit', yet the current neoliberal system positions citizens as little more than passive consumers. Instead, Szulecki [30] suggests that active 'prosumers' of energy exemplify energy democracy and illustrates what is possible in alternative governance regimes. As prosumers, these citizens simultaneously produce and consume the energy produced while providing significant input into the way it is produced, distributed, and maintained. Such a prosumer approach to energy governance is especially facilitated by the development of renewable energy technologies in the absence of high-level support from regulators and government departments. However, there are tensions in the tenets of energy democracy in pushing back against neoliberalisation and in the proposed practice of market-based approaches to democratise energy system management—of which prosumerism is an example. So, while the notion of

the prosumer constitutes a challenge to neoliberal norms relating to social dimensions of energy system governance, it does so while largely reinforcing current economic modes of interaction [33], and is unlikely to replace or fully substitute conventional organisations of energy into the future [34].

Advocates of energy democracy identify socio-cultural and socio-political contexts as critical for its development. van Veelen and van der Horst [25] are advocates of deliberative and participatory democracy; they problematise privatisation and corporate control in advancing energy democracy. Critiques of private ownership of energy are also highlighted by Tsoeu-Ntokoane and colleagues [35], who argue for the need to view energy as a public good rather than a privatised commodity; and Thompson and Bazilian [36], who call for energy governance institutions representative of the interests of society as a whole. The potential benefits of these arrangements can be seen in research by Morris and Jungjohann [37], who identify the many ways the concept of energy democracy is deployed in their examination of the German idea of *Energiewende* (literally energy transition), concluding that the drive towards affordable, low-carbon renewable energy is feasible largely due to the structure and operation of the German democratic system of corporatist governance, which enables the state to broker compromises across industry associations, labour unions, and environmental civil society groups.

In summary, then, and as synthesised by Szulecki [30], the concept of energy democracy acknowledges that 'technological change in the energy sector and the socio-political and economic context of institutions and practices that surround it are not discrete, but rather intertwined' (p. 25), and that any analysis of energy democracy needs to include the social, cultural, economic and political contexts in which it is situated. Building on past research, Szulecki [30] developed an analytical frame, shown in Table 1, to operationalise his interpretation of the concept, and we employ his framework in this article to organise and interpret the research data we collected.

Table 1. Energy democracy from conceptual to analytical/decision-making tool [30].

Main Dimensions	Components	Indicators
Participatory governance	Inclusiveness Transparency Access to information Energy education and awareness raising	Citizen interest/opinion on par with expert agenda Due process and clear procedures Existence of dedicated educational programmes Incorporation of public consultations at all levels Independent research possible and available Regulated lobbying Reporting on legislation and deliberation
Popular sovereignty	Citizens as recipients of energy policy Citizens as stakeholders (producers and consumers) Citizens as accountholders	Consumer prices and quality of service Prosumer legislation and grid access Prosumer support schemes Public accountability of energy decision makers Welfare and energy access as key benchmarks
Civic Ownership	Civic ownership of power generation Civic ownership of transmission/distribution infrastructure	Ownership structure and power in the political economy of energy Renewable energy deployment, dispersed energy capacity Share of energy from private, cooperative and communal sources Share of grid infrastructure co-owned by municipalities/communal

1.3. Hydrogen in the Renewable Energy Revolution

Energy democracy as a theoretical construct was developed largely in response to alternative energies like wind and solar [38]. Hydrogen, however, is an emerging renewable energy carrier technology, with limited theoretical and empirical investigation into whether

and how this new form of renewable energy might be democratised. To provide context for our research, this section reviews the literature on the materiality of hydrogen energy, the embeddedness of the industry in a weakening but still powerful neoliberal mindset, and the significance of several examples of the democratic development of hydrogen energy for its potential more democratic future.

While renewable energy technologies such as hydroelectric, wind and solar power are the most widespread and advanced alternative energy solutions currently deployed worldwide [39], the search for diversified sources of renewable energy carriers continues, especially in 'hard-to-decarbonise' sectors like heavy industry, heavy transport, and storage. Notwithstanding important considerations that are discussed further below, renewable hydrogen has become a strong focus for development for several reasons. First, it can be easily made using proven technologies such as electrolysis powered by renewable energy and photosynthesis of cyanobacteria in photobioreactors. Second, it can be readily deployed in a range of energy and feedstock applications in gaseous, solid, and liquid forms. Third, the energy produced can be stored for long periods, ensuring availability when needed, albeit with important caveats. Finally, hydrogen is also an important precursor to the manufacture of many other industrial chemicals such as ammonia and methanol and offers a 'green' pathway to the production of cement, steel, aluminium, and other heavy industrial processes.

While hydrogen can be produced according to several different pathways, at the core of green hydrogen technology currently is the electrolyser, with several technological variations possible [40]. Alkaline water electrolysers (AWEs) are a proven technology with low capital costs. However, they require pumps to move the electrolyte around, ongoing maintenance to manage corrosion, and produce a lower-purity hydrogen. Alternative systems (alkaline anion exchange membrane (AEM), proton exchange membrane (PEM) and the more experimental solid oxide electrolyser (SOE) technologies) overcome these difficulties but also have issues of their own. For example, PEMs use noble materials that are scarce and potentially polluting and are more costly to operate than AWEs. Importantly, however, hydrogen electrolysis is technologically scalable and there are no material barriers to developing small-scale electrolysers that, analogous to solar panels, are stackable to produce a given amount of hydrogen energy. The commercial company Enapter exemplifies this vision in developing microwave-size electrolyser units that can be stacked to household, community, and corporate requirements [41].

There are also some significant drawbacks to producing, transporting, and utilising renewable hydrogen. First, hydrogen is a gas requiring storage at high pressures to reach a volumetric energy density akin to fossil fuels. Alternatively, it must be cooled to extremely low temperatures if kept as a liquid. Both processes require significant additional expenditures of energy to achieve the desired outcome and lower the energy returned on energy invested. Second, because hydrogen atoms are so small, storage vessels must be specially designed because conventional containers penetrated by hydrogen atoms render them brittle, risking leakages and explosions. Thus, while hydrogen can be transported in pipelines, these often need to be retrofitted to prevent embrittlement and leakage and mitigate safety concerns. These concerns imply that the industry hype around hydrogen is likely overblown; however, the consensus is that hydrogen will almost certainly play a role in several 'hard-to-decarbonise' sectors. For example, van Renssen [42] predicts that hydrogen will be used to decarbonise the final 20 per cent of emissions reductions, the focus being on heavy industries, heavy transport, and long-term storage. This view is also shared by hydrogen's critics. McNamara [43], writing for the Union of Concerned Scientists, urges policymakers to 'rigorously prioritise strategic hydrogen applications, such as those where other decarbonisation options do not readily exist'. Greenpeace in a submission to the UK Government list 'industrial processes needing high-temperature heat', 'industrial processes which need hydrogen as part of the chemical process', and 'long-term storage', 'heavy transport' and 'building heat' as all potentially viable. The conclusion drawn is that, while

hydrogen may not achieve the penetration touted by today's boosters, it is still likely to make an important contribution to meaningful decarbonisation efforts.

Yet, even if hydrogen is technically positioned to contribute to the renewable energy revolution and make a solid contribution to decarbonisation, the current approach being taken to advancing it aligns closely with the dominant ecomodernist interpretation of sustainable development transitions. 'Big hydrogen' is reproducing a techno-economic mindset for managing people–planet and people–people relations [6] while maintaining the neoliberal imperative of infinite growth. Such an approach is very evident in Australia, a country notable for its ambitions to become a large-scale hydrogen exporter [44]. Australia's current plans are to use its vast renewable electricity resources to produce large quantities of hydrogen cheaply and export it to countries like Japan, South Korea, and Germany which are desperate to decarbonise but lack the renewable energy resources to do so. While it is not surprising that governments and industry are conceptualising renewable hydrogen from within an ecological modernisation perspective, the modest but important potential of hydrogen to decarbonisation raises the question as to whether and to what degree it could be subject to a stronger sustainability approach that embraces more popular and deliberative democratic forms of governance. We thus next turn to considering this literature.

The potential of hydrogen to contribute to energy democracy has been recognised in theoretical research. In 2006, Eames and colleagues published a paper [45] exploring guiding visions for the hydrogen economy drawing on materials from the UK, Europe, and the US. They claim that there is potential for 'a hydrogen energy system [to] drive a more decentralised, empowered and democratic world' (p. 353) [45]. Over a decade later, Sovacool et al. [46] similarly examined the rhetoric surrounding hydrogen, the position of agents and actors, and the strategies proposed to advance its development. In their study, the potential of hydrogen to contribute toward energy democratisation features as one of five narratives that could secure 'pluralistic, participatory, and community-owned forms of energy production' (p. 659) [46]. At the same time, they claimed that the emergence of hydrogen as a potential renewable energy encouraged debates over the merits of centralised versus decentralised energy supplies, a claim expressed similarly by Szulecki and Overland [27]. In a similar vein are the theoretical studies that focus on designing hybrid renewable energy systems for small, isolated, remote, and indigenous communities [47–49]. Despite the variability in the communities investigated and the way the systems are configured, considerable optimism is expressed about renewable hydrogen as a solution to current dependence on noisy, polluting, and costly diesel generators. Viteri et al.'s systematic review [49] of examples concludes that green hydrogen is of assistance, especially in long-term energy storage.

Collectively, much theoretical research aspires to advance the establishment of the renewable hydrogen economy; however, 'real-world' empirical research of how hydrogen is contributing to fundamental energy system change are currently largely lacking. We identified numerous trials of small-scale, community hydrogen projects, however that, taken collectively, highlight the potential for hydrogen to be democratised. The best example of hydrogen being developed within a popular democratic context is on the Orkney Islands in Scotland. As explained in Laura Watts' evocative *Energy at the End of the World* [50], the Orkney Islands combine an abundance of renewable energy with significant technical knowhow from agencies like the European Marine Energy Centre (EMEC) and academics at a campus of Heriot Watt University. When the energy from a wind turbine constructed to feed the electricity grid was deemed surplus to capacity, members of the Orkney community on the island of Shapinsay explored the option of manufacturing, storing and consuming hydrogen instead. Their interest led to the formation of a wider, European Union-funded partnership known as BIG H_2IT [51], which purchased a 1 MW proton membrane exchange electrolyser to produce hydrogen for a range of local purposes. According to a study by Westrom [52], the project enables a community-based company, the Shapinsay Development Trust, to 'to heat the Shapinsay primary school, power five Orkney

Island Council (OIC) vans, and power docked ferries and a building on the mainland' (p. 4).

Other examples of small-scale renewable community-based hydrogen are emerging, although many remain in the planning stage and are speculative. For example, Balta and Balta [53] provided a list of 'sustainable hydrogen city' concepts including the Danish Dream City (H2PIA) initiative, the Harumi Flag project in Japan, and Wuhan, China's 'hydrogen city'. In these urban hydrogen visions, objectives often stretch far into the future, an emphasis is placed on greening heavy transportation systems, and it is not always clear just how 'green' the consumed hydrogen will be. It can also be noted that the literature on urban governance suggests that in many instances it falls significantly short of meeting the requirements of popular democracy. The 'grey literature' on hydrogen identifies numerous trials of community-based renewable hydrogen underway or planned. In Europe, the Remote area Energy with Multiple Options for integrated hydrogen-based Techologies (REMOTE) is running a 4-year project to trial hydrogen micro-grids. The projects are located in Spain (Gran Canaria), Greece (Agkistro), and Norway (Rye) and REMOTE's broad aim is to prove the feasibility of hydrogen as a storage solution to renewable energy's intermittency in isolated communities.

It can be concluded that the degree to which hydrogen can be democratised in a popular sense is mixed. The theoretical and empirical literature broadly endorses the feasibility of more participatory and democratic visions of renewable hydrogen, and the example of the Orkney Islands indicates it is at least feasible in some jurisdictions. However, it can also be noted that the only policy study we identified on this topic was more pessimistic. In a recent article, Trencher and van der Heijden [54] explored how imaginaries of hydrogen energy are realised in Japan across national and localised contexts. In their analysis, they noted that national strategy documents promote a centralised vision of hydrogen governance in the short and medium term, while holding out the possibility of a more distributed system from 2040 onwards. In interviews with representatives from small-scale renewables utilities, hydrogen was viewed as 'too cutting-edge' to be anything but governed centrally at the outset, and interviewees were despondent about options for participating in its roll-out (p. 215) [54]. Other critical voices question hydrogen's potential to further exacerbate the 'decarbonisation divide' [55] through processes of 'fossilisation'. In considering electrochemical energy solutions like hydrogen, Brannstrom [55] warned they could undermine rather than contribute to energy democracy. Renewable hydrogen production would be fossilised by large oil and gas companies, which repurpose existing infrastructure to perpetuate extractive industry practices. The danger, then, is that producing communities, especially in developing countries, would incur significant costs and see few, if any, flow-on benefits from the expansion of renewable hydrogen as it is produced for export not for domestic consumption.

While the materiality of some energy systems lends themselves to big development (notably nuclear power), we conclude that there is nothing about the materiality of hydrogen that precludes it ab initio from being democratised in a popular sense. While we heed Brannstrom's warning, we note that he is careful not to claim that hydrogen's future is pre-determined and, like us, notes the potential of small-scale, community-based, hydrogen examples including the Orkney Islands' case. Thus, whether 'Big Hydrogen' prevails or not remains an open question subject to political struggles in specific regions. In recognition that the several democratic visions for hydrogen set out in the theoretical and experimental literature are contradicted by the sole policy study investigating its early planned developed in Japan, we set out to further examine the topic in a different national context employing a systematic and replicable methodology as presented in the following section.

2. Materials and Methods

In Australia, a hydrogen strategy exists in each of the states and territories, as well as a National Hydrogen Strategy that was adopted in 2019. To understand which democratic

ideals are embedded in Australia's advancement of hydrogen, we examine the strategy documents of Australia's federal, state, and territorial governments (see Table 2).

Table 2. List of source documents analysed.

National	
Commonwealth of Australia (2019).	Australia's Hydrogen Strategy. COAG Energy Council Hydrogen Working Group, Canberra [56].
State	
Australian Capital Territory (2019).	ACT Sustainable Energy Policy 2020–25. ACT Government, Canberra [57].
New South Wales (2021).	NSW Hydrogen Strategy. Department of Planning, Industry and Environment, Sydney [58].
Northern Territory (2020).	Northern Territory Renewable hydrogen Strategy. Department of Trade, business and Innovation, Darwin [59].
South Australia (2019).	South Australia's Hydrogen Action Plan. Department of Energy and Mining, Adelaide [60].
Tasmania (2020).	Tasmanian Renewable Hydrogen Action Plan. Department of State Growth, Hobart [61].
Queensland (2019).	Queensland Hydrogen Industry Strategy 2019–2024. Department of State Development, Manufacturing, Infrastructure and Planning, Brisbane [62].
Victoria (2021).	Victorian Renewable Hydrogen Industry Development Plan. Department of Energy, Environment and Climate Change, Melbourne [63].
Western Australia (2021).	Western Australian Renewable Hydrogen Strategy. Department of Jobs, Tourism, Science and Innovation, Perth [64].

Employing Szulecki's understanding of energy democracy, we undertook an interpretive qualitative study [65] of the federal, state, and territory hydrogen strategies to assess the extent to which they reflect or map onto Szulecki's [30] three components of participatory governance, popular sovereignty, and civic ownership. The analytical framework developed by Szulecki was conceived based upon a thorough review of the research on energy democracy. While acknowledging socio-political differences necessitate a nuanced understanding and application of energy democracy and the various attributes which denote its existence (or not), no adaptation to the framework was deemed necessary for the purposes of this research because the framework was developed as a conceptual and analytical tool with broad application and drew on research from multiple geographic and socio-political contexts to inform it.

The research presented in this paper was undertaken in line with the four criteria outlined by Lincoln and Guba [66] to establish the trustworthiness of qualitative research including credibility, transferability, dependability, and neutrality. To undertake the research, first, two members of the research team independently coded one of the strategy documents (equating to 10% of the total project data) to obtain a preliminary understanding of the inter-coder reliability of deductively analysing the data using Szulecki's analytical framework [67]. The inter-coder reliability process enabled the research team 'to reflexively improve the analysis by provoking dialogue between researchers' (p. 6) [67] and supported the dependability of the research results [66]. Through this process, it was agreed that sentences and/or small paragraphs would be used as the unit of analysis. High inter-coder reliability was determined, whereby both researchers coded text to the same codes.

Second, thematic nodes according to Szulecki's framework were created in NVivo and relevant data were coded to those nodes. The number of references to each element of Szulecki's framework after completing the data analysis is included in Appendix A. Author 1 undertook the first round of coding which was then critically reviewed by Author 2 [68]. This process formed a secondary reliability check in the data analysis process. Author 3 undertook a final review of the codes to add an independent reliability

check, which affirmed the pre-established high inter-coder reliability and supported the credibility of the analysis process [66]. Neutrality implies a lack of bias in the analysis and representation of findings, and in this research, it is showcased through the presentation of direct statements from the data in the following sections [69]. Using a deductive thematic approach, the application of Szulecki's framework enables the transferability of the method and applicability of results in other contexts [66].

3. Results

In this section, we present the results of our analysis of Australia's hydrogen strategy documents using Szulecki's [30] energy democracy framework. Thematic analysis revealed differences in the way the concept of energy democracy was deployed across federal, state, and territorial jurisdictions and the degree to which governments were advancing hydrogen strategies that aligned with the principles of energy democracy.

In Table 3, the relative presence of attributes of Szulecki's three aspects of energy democracy are recorded against each jurisdiction. A critical analysis of the attributes is extended in subsequent sections. Data in the table are presented using a relative scale of inclusion: a hyphen, '-', indicates no evidence of the attribute in the strategy; '×' indicates minimal evidence; '××' indicates some evidence; and '×××' indicates reasonable evidence. For example, there were a total of eleven references to *due processes and clear procedures* identified in the National Strategy which warranted a '×××' rating, compared with the NSW Strategy where only one reference was identified, warranting only one '×'.

Table 3. Relative occurrence of energy democracy attributes in Australia's hydrogen strategies.

Energy Democracy	National	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Participatory Governance									
Citizen interest and opinion on par with expert agenda	×	-	-	-	-	×	-	×	-
Due processes and clear procedures	×××	××	×	×	××	×	××	××	×
Existence of dedicated educational programs	×××	××	××	×	××	×××	×××	×××	-
Incorporation of public consultation	×××	××	×	-	×	×	×	×	-
Independent research possible and available	×××	×	××	××	×	××	×××	×××	×
Regulated lobbying	-	-	-	-	-	-	-	-	-
Reporting on legislation and deliberation	-	×	×	×	-	×	×	-	×
Civic Ownership									
Ownership structure and power in the political economy of the energy	-	×	-	-	-	×	-	-	-
Renewable energy deployment, dispersed energy capacity	-	×	-	-	×	×	-	×××	-
Share of energy from private and cooperative resources	××	×	-	-	××	-	××	-	-
Share of grid infrastructure	×	-	×	××	×	×	××	××	-
Popular Sovereignty									
Consumer process and quality of services	××	×××	×	×	-	××	×	×	-
Prosumer legislation and grid access	×	-	-	×	-	-	×	×	-
Prosumer support schemes	-	××	-	-	-	-	-	-	-
Public accountability and energy decision makers	×	×	-	-	-	-	-	-	-
Welfare and energy access as key benchmarks	××	×××	×	-	-	-	-	-	-

Considering each attribute of energy democracy taken alone, it is evident that 'dedicated educational programs' is the most discussed initiative, receiving a high relative rating

in four jurisdictions (National, SA, TAS, VIC), a moderate rating in three others (ACT, NSW, QLD), and absent in only one (WA). Another highly ranked attribute is 'independent research', which ranked highly in National, TAS, and VIC and moderately in NSW, NT, and SA.

In contrast to these highly ranked attributes, there were several that were ranked low or absent. For instance, no strategy document referenced terms that related to the idea of 'regulated lobbying', and only one (ACT) indicated support for terms associated with 'prosumer support schemes'. Very little mention was present in any strategy document of terms associated with 'citizen interests and opinions on a par with expert agenda', 'prosumer legislation and grid access', 'public accountability and energy decision makers', 'welfare and energy access', and 'ownership structure'. A small number of attributes received a moderate rating. These included strategies with terms linked to 'due process and clear procedures', 'consumer process and quality of service', and 'share of grid infrastructure'.

Analysis of the results within the three categories of participatory governance, popular sovereignty, and civic ownership reveals that there are many more 'hits' in the participatory governance category, fewer in the civic ownership category, with the popular sovereignty category in between. Thus, for example, while four of the seven attributes for participatory governance are mentioned in at least seven strategies, this is the case for only one of the attributes of popular sovereignty (consumer process and quality of service), and for none of the civic ownership category.

Finally, looking down the table to examine the performance of each strategy against the criteria, it is evident the best performing strategy is the ACT. The ACT strategy mentions 12 of the 16 criteria, recording absences only for terms associated with 'citizen interest and opinion on par with expert agenda', 'regulated lobbying', 'prosumer legislation and grid access', and 'share of grid infrastructure'. Australia's National Strategy also performs well, with entries against 11 of the 16 attributes. In contrast, the worst performing strategy is WA, which contains terms referencing only 3 of the 16 attributes ('due processes and clear procedures', 'independent research possible and available', and 'reporting on legislation and deliberation'). We also find some interesting differences between the structure and content of renewable hydrogen energy strategies in Australia at the federal, state, and territorial levels. We discuss these similarities and differences in more detail below, focusing on what they mean for participatory governance, popular sovereignty, and civic ownership.

3.1. Participatory Governance

Across the strategies, processes and procedures to support advancing hydrogen predominantly focused on technologies and the regulatory landscape. Overwhelmingly, processes and procedures were conceived in the context of regulation and ensuring 'a supportive regulatory environment to promote hydrogen' (e.g., Tasmania's strategy). Processes to include traditional First Nations and Indigenous landowners were missing, as was the signalling to procedures that could ensure transparency of decision making. Absent from the documents also were the ways in which socio-cultural processes or procedures would be enacted to embed publics in decision making beyond public consultation periods.

Analysis revealed that the National strategy and six of the seven state strategies referred to public consultation processes. While Szulecki's [30] analytical framework allows for some insights into whether public consultation is included in the strategy documents, we turned to Chilvers and Longhurst's [70] work to consider the ways in which public consultation may be operationalised through citizen participation in efforts to nuance our understanding here. Overall, framings of public consultation in the strategy documents analysed did not reflect contemporary understandings of best-practice citizen participation. For example, Chilvers and Longhurst [70] described how effective citizen engagement within energy transitions may be evoked via deliberative democracy processes and proactive engagement by civil society groups with local policy. Both were notably absent across all strategies.

Overall, the emphasis was placed on consulting with key industry stakeholders, with minimal reference across the documents to broader public consultation initiatives, with the notable exception of the Victorian, ACT and National strategies. In contrast, these latter strategies invoked the need for community stakeholder consultation as an integral part of designing and implementing hydrogen projects and associated change. The National strategy was the most comprehensive in its inclusion of public consultation, noting: 'Governments will consult industry and the community before making any changes to current revenue arrangements that are specific to hydrogen . . . Giving local communities a say at the early stages of hydrogen project development is critical to building trust' (p. 53) [56].

The National strategy indicated that consultation should occur at all stages of development and referenced the University of Queensland guidelines for best-practice community participation and engagement. However, a public consultation plan or actionable pathways for including community in decision making were absent. Extensive public consultation processes were found in the Victorian strategy, including committing to 'Supporting the work of the Australian Hydrogen Council to develop community standards and benefits sharing guidelines and use community engagement techniques to involve the community in the decision making and benefit sharing guidelines' (p. 53) [56]. The ACT strategy reflects a commitment to public consultation throughout all stages of developing a hydrogen economy. The strategy itself calls for stakeholder feedback.

Analysis revealed an overall absence within strategy documents of including and/or deferring to citizen voices in shaping the hydrogen economy, beyond a recognition of the need to obtain a social licence or engage in post-facto community consultation. The South Australia strategy is an example of this approach as it outlines a decision-making process by Australian Gas Networks that saw the community engaged after the initial design and engineering decisions had been made.

Further analysis of strategy documents highlighted that engagement with citizens was conceived as a one-way transmission of information by governments and/or industry to the community. Some exceptions were noted, including in the Victorian Strategy, which stated that clear and open dialogue between and across government, industry, communities, research, and education is needed to ensure critical decisions are well informed, evidence-based and fit-for-purpose. The plan is informed by each of these stakeholder groups and in alignment with the broader hydrogen policy landscape (p. 7) [63].

Such a framing implies that community opinion is considered equal to the perspectives of other stakeholder groups. The strategy further states that 'strategic partnership with project proponents, landowners, development and planning authorities and the community is central to clear and coherent planning', reiterating the importance and recognition of community partnerships in progressing hydrogen. In contrast, in the National Strategy document, and despite some signalling to suggest a recognition of the need to work *with* community (p. 53) [56], responsibility is assigned to government and industry for community safety, confidence and trust, which undermines notions of authentic collaboration and shared decision, risk, and benefit sharing.

Analysis revealed that education was considered a key responsibility of governments and industry *to* the public and was conceptualised in two ways. First, to build social licence and ensure community understood hydrogen; and second, to build the skill and capacity base required to grow and sustain a hydrogen economy. Victoria referred to discrete activities underway to develop institutional capacity in hydrogen-based training and education. Similarly, Tasmania made note of specific programs to support training related to 'major energy development'. Universities and TAFE institutions were identified as the key locations for training and skill development. Northern Territory and NSW emphasised formal education and training without referencing the need to build community awareness and understanding of hydrogen. The QLD strategy reflected on the way hydrogen has been received by the community to date, and on future education needs. The ACT and SA strategies indicated an awareness of the importance of community

acceptance of hydrogen, as did the national strategy, which expressed a commitment to building community knowledge:

> 'Australia will develop a community education program to provide clear and accessible information about hydrogen's risks, benefits and safe use. The program will communicate the particular benefits hydrogen development can bring to regions as well as more general benefits such as economic growth, lower carbon emissions and reduced air pollution' (p. 58). [56]

Australia's hydrogen energy strategies considered education as vital, delivered via top–down initiatives to build community awareness, with the explicit aim to grow support for the industry and train the new hydrogen workforce.

In sum, while public consultation processes were conceived in strategies as an integral component of advancing Australia's hydrogen economy, strategies assumed centralised control and coordination by government and relevant industry bodies. The work of Bull and Eadson [71] on citizen engagement across the UK and Sweden showed how participatory governance is most successful when shared ownership and partnership arrangements are established. Here, we see energy democracy most likely to occur when the attributes of Szulecki's [30] analytical frame intersect—participatory governance and civic ownership.

3.2. Civic Ownership

A market-led approach to service delivery was identifiable across Australia's hydrogen strategy landscape, which in turn favours centralised governance and private ownership of energy provision. While many strategy documents made the case for how hydrogen could contribute to public prosperity, the idea of issuing shares to the public as occurred with the privatisation of Australia's telecommunications network Telstra was not advocated [72]. In the National Hydrogen Strategy, the public were identified as recipients and beneficiaries of hydrogen energy through job creation and increased economic activity and were not necessarily recognised as producers *or* consumers—prosumers—of the energy directly; nor were the promotion of municipal engagement or community participation through de-centralised governance and ownership schemes observed. The strategy states:

> 'As hydrogen production and use grows, appropriate taxation, excises, fees or levies could help ensure that the community shares in the economic benefits from developing a hydrogen industry. Australian governments recognise the importance of the Australian public receiving a share of future benefits from a hydrogen industry and for investors to have certainty about future revenue arrangements' (p. 53). [56]

Similarly, the Tasmanian strategy claims that the 'large-scale renewable hydrogen industry in Tasmania, using low-cost Tasmanian renewable energy' (p. 29) [61] will be of benefit to Tasmanians as the Government works with proponents to facilitate the required investments. In Queensland, the strategy identifies the need for private sector investment and commits government funding to enable hydrogen industry expansion. The same is true of New South Wales, which aims to 'incentivise the use of existing spare capacity in network infrastructure' (p. 11) [58] to support industry and to reduce costs. In their analysis of differing approaches to service and governance provision—market, municipal, and community—Brown et al. [73] observe each to hold normative dimensions that influence how prosumerism—a key tenet of energy democracy—is enacted. In market-led approaches, 'limited social and political upheaval in liberalised market economies' occurs [73]. In the documents analysed, market approaches were positioned as the way in which hydrogen energy would be advanced.

Australia's hydrogen strategy landscape recognises the need for renewable energy deployment in order to support clean hydrogen production. Specifically, Queensland, Victoria and the Australian Capital Territory consider how the hydrogen economy intersects with renewable energy projects and targets. Queensland emphasises its solar potential and identifies the possibility of an additional 19,000 megawatts of clean energy for the state if at-

the-time proposed solar PV projects are realised. Victoria reflects on the way that hydrogen will contribute toward the achievement of its legislated net zero emissions 2050 target. The ACT consider hydrogen in relation to other energy sources and products in the state. Its Sustainable Energy Policy 2020–25 discussion paper notes the significance of community solar farms in supporting increased access for people who may not otherwise be 'able to invest in solar and access the benefits of solar and contribute to a clean energy future' (p. 35) [57]. However, analysis revealed a lack of interconnectedness between hydrogen and renewable energy generation, deployment, and capacity across strategy documents, as well as a lack of support for community ownership schemes. Ownership models outside of the market led approach 'challenge the competitiveness logics of marketisation and pure commercial values' [74]; therefore, based on the underlying privatisation logics observed in the strategy documents, it is unsurprising that a weak promotion of civic ownership in developing hydrogen projects was observed.

3.3. Popular Sovereignty

Analysis revealed that there was broad recognition across the strategy documents of how the development of hydrogen energy might benefit the Australian public. Financial benefits were identified through the (eventual) lowering of energy costs, the switch to clean energy, and diversifying the energy system, Thus, the National strategy noted: 'A resilient and diverse energy system Hydrogen technologies are well-suited to balancing supply and demand in an electricity grid that increasingly relies on variable renewable sources such as solar and wind. If managed well, this could lower electricity costs for consumers' (p. 17) [56]. In this sense, hydrogen was promoted as a public good through the benefits it may equitably deliver.

State-based strategies identified the need for centralised mechanisms to support the public during initial stages of a hydrogen transition. For example, the SA strategy notes how consumers are shielded from the price impacts of blending hydrogen in the gas network:

> 'Customers receiving the 5 per cent renewable gas blend will not notice any difference about the quality of gas received and are not required to make any change to their appliances. The amount paid for gas will be no different from the cost of 100 per cent natural gas' (p. 15). [60]

Queensland noted its Community Service Obligation as a measure that supports and enables 'Achieving reliable and cost-competitive renewable hydrogen generation in regional and remote environments…' (p. 1) [62], while NSW offered temporary concessions to hydrogen producers in recognition of the potential for consumer bills to rise in initial stages of hydrogen deployment.

Equitable access to hydrogen was largely absent in the strategy documents, though the National strategy did advocate open access to government supported infrastructure. Victoria's strategy recognised the potential of hydrogen to promote energy security in remote locations:

> 'When coupled with renewable generation, this technology could enable remote communities and isolated power grids to reduce their dependence on liquid fuelled electricity generation…Actively explore opportunities to support off-grid, end of network and microgrid hydrogen trials, pilots and demonstrations' (p. 22). [63]

Tasmania's strategy recognises achievements in working with remote communities and similarly notes that 'the production and use of hydrogen presents further opportunities to reduce dependence on diesel in these communities' (p. 25) [61].

Overall, our research reveals that popular sovereignty is largely reflected in the visions and ideals set out in strategy documents as opposed to specific policies and practices to enact them. Examples of claims to popular sovereignty highlighted how governments acted in the public interest and included firming of energy supplies, guarantees of price security, and the fostering of training and job creation. In addition, it was found that strategies

largely focused on citizens as 'consumers' rather than 'prosumers', the latter being a key element of popular sovereignty according to Szulecki [30].

4. Discussion

Legitimated discourses such as those contained in government endorsed strategy documents offer a window through which to observe the dominant values and epistemologies of governing bodies [75]. Analysis of data employing Szulecki's framework revealed that Australia's governmental hydrogen narratives centre on its potential to deliver economic prosperity and environmental benefits. Like discourses elsewhere [45,54,76], Australia's approach to hydrogen aligns with ecomodernist interpretations of sustainable development transitions [6]. What is more, there is a trend internationally for hydrogen strategies to emphasise 'scaling' of technology before focusing on 'greening' or democratising the emerging sector [77]. Across the strategy documents analysed in this paper, rationales for advancing hydrogen centred on economic opportunity (through exports) and job creation benefits. At the same time, prevailing ecomodernist values and epistemologies directly shape the way the 'public' is constituted, and the way principles of democracy become enacted. While scholars have identified visions and mechanisms to democratise hydrogen in energy systems [45,46], our analysis of Australia's hydrogen strategy documents identifies an apparent disconnect between aspirations for participatory democratic governance and its manifestation in policies promoting popular sovereignty and civic ownership. Particular stakeholder groups were not part of public consultation processes (i.e., First Nations people) and therefore their views were not reflected in the resulting strategy documents. Szulecki's energy democracy conceptual framework revealed the ways in which representative democratic ideals are embedded into Australia's strategic hydrogen planning, displacing more participatory and deliberative democratic practices.

In calling for a substantive degree of de-centralisation, participation, and deliberation energy democracy challenges the prevailing ideals of representative democracy, which legitimises a centralised, managerialist governance model as the most efficient and fairest form of decision-making. Our research confirms that in Australia, federal, state, and territorial commitments to democratic action to advance the hydrogen industry subscribe to centralised governance models that seek to mediate public involvement in highly regulated and controlled ways. Advancing hydrogen energy in Australia is filtered through a mostly techno-economic lens, and risks legitimising a 'business-as-usual' approach to consultative practices towards the lower end of Arnstein's ladder [75]. Arnstein's ladder is a typology of citizen participation that illustrates how the level of involvement of citizens in government can impact their views on legitimacy, authority, and effective governance. This ladder outlines various degrees of public participation, with higher levels of participation considered more favourable [78]. While this may be at odds with the calls for transitioning energy systems in ways that promote energy justice and democracy [27,46], taken collectively, Australia's strategic approach is reflective of hydrogen strategies adopted by other countries internationally [77].

Further to this, our study suggests that Australia's representative democratic principles may inhibit the search for additional, alternative means for authentic engagement with broader publics. Positioning hydrogen as a top–down initiative with a complex technical and economic materiality resistant to citizen-led assemblages [6] creates the impression that it is something to be planned by experts operating within governments and industry. This techno-economic mindset privileges those elected, enabling politicians to 'deliver' renewable energy to 'the people', undermining and disincentivising the need to engage in alternative, more de-centralised, participatory, creative, and deliberative approaches [9]. The consequence is a disjunct between the many references to 'participatory governance' in the majority of hydrogen strategies (such as public awareness raising, education, and opportunities to provide feedback through legitimated consultation processes) that do not become reflected in the more inclusive, deliberative processes of popular sovereignty and civic ownership that energy democracy requires [75].

Szulecki [30] states that the many problems citizens experience, such as climate change, energy poverty, and energy insecurity, are overlooked when governments embrace a techno-economic mindset. Given its complexities, the energy sector is one that is especially susceptible to such an approach, creating hurdles for those in the social sciences as well as citizens more generally to participate. Unlike renewable energy sources such as wind and solar, the hydrogen industry is being enabled and advocated in Australia via a narrow form of government–business corporatism. The citizen is positioned as a consumer of energy with no role as a hydrogen prosumer. The hydrogen sector is characterised as requiring large-scale investments in infrastructure and innovation, which necessarily needs to be led by corporations with government support. Little thought is given to whether and how a citizen-ownership model could emerge.

If a renewable hydrogen economy that supports popular sovereignty and civic ownership in the design and delivery of hydrogen technologies is to be created, greater engagement from both proponents and governments is needed. A role for proponents of energy democracy exists in pushing governments to engage to a greater extent than currently; a role for governments exists in ensuring that the strategy and policy landscape includes, and enables, alternate mechanisms of resourcing, governance and ownership in the future. In particular, decentralisation of a hydrogen economy could support greater regional energy security and provide greater autonomy to communities. This could be in the form of encouraging smaller-scale projects for hydrogen production and consumption to service and benefit local communities. While community-owned and -led initiatives are not without critique (see [79]), the current Australian strategy landscape excludes—or at minimum is not imagining—alternative conceptualisations to hydrogen ownership, project topology, or governance. This is surprising given that, increasingly, the renewable energies' sector is delivered through community-owned and -governed projects [9], which provide transferrable models for renewable hydrogen projects for the future. While hydrogen technologies complicate the neat dichotomy between centralised energy projects and scalable renewable projects, both types of hydrogen projects should be considered. Here, we see a need for government recognition of prosumer and community-level agency and ownership in the development of smaller-scale decentralised hydrogen projects.

Little attempt has been made to build on Australia's publicly funded bodies exploring processes for embedding public participation into energy infrastructure projects. For instance, the Future Fuels Co-operative Research Collaboration piloted deliberative citizen panels to develop a set of decision-making principles to govern the deployment of future fuels in their communities. Such examples are enactments of popular sovereignty and civic ownership and highlight the possibilities of linking participatory governance to 'doing community' differently in the hydrogen sector. The significance of a policy setting that enables and is enabling of civic ownership is highlighted in the Berthod et al. [29] cross-country case study exploration of renewable energy projects and the democratising processes adopted. Their work suggests that institutional embedding of participative facilitation and consensus building are needed if energy democracy is to be successful in the long term of a project.

5. Conclusions

In this paper, we showcased how Australia's strategy landscape for the emerging hydrogen economy aligns with energy democracy principles. Noting that there is nothing in the materiality of hydrogen that prevents it from being democratised in a popular sense, we found that its deployment is so far largely conceived as a centralised and government- and industry-led endeavour that sees the role of community as users, consumers, and beneficiaries of hydrogen. While benefit sharing and participation of the public is referenced frequently throughout strategy documents, such inclusion is largely framed through 'business-as-usual' consultation practices and centres on 'participatory' governance approaches. A critical oversight observed through this study relates to the exclusion of Australia's First Nations people in the design and development of Australia's hydrogen

economy. References to the inclusion of, or signalling to, the necessity to consult with Australia's Indigenous peoples were missing across National and state strategies, thereby perpetuating an implicit, widespread, colonialist, and discriminatory mentality. We see this as a priority, an issue that needs immediate attention. In addition, evaluations of how the sector is advancing in Australia focus on tangible, technocratic markers, with little to no mention of how the sector is seeking to advance participatory governance, civic ownership or popular sovereignty as a means to expediate the development of industries [80].

In closing, we acknowledge this study's limitations. As a single case study, it may be that the Australian experience is unique, and further comparative studies of how energy democracy is being experienced elsewhere are required. In addition, while strategy documents present an authoritative product of deliberation and negotiation within government, we note that these texts are unable to elucidate actual practices of developing hydrogen strategies, instead illuminating 'traces of practices' (p. 250) [81]. Further exploration of how expressions of democracy are intersecting with hydrogen technologies are needed, which should include citizen and industry representation alongside government narratives within Australia and elsewhere. The analysis undertaken here is merely a springboard to the deeper and broader conversation required.

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Appendix A

Table A1. Count of references to indicators identified in document analysis.

Energy Democracy	National	ACT	SA	NSW	NT	QLD	TAS	WA	VIC
Participatory Governance									
Citizen interest and opinion on par with expert agenda	2	0	1	0	0	0	0	0	2
Due processes and clear procedures	11	3	2	1	1	3	5	1	5
Existence of dedicated educational programs	7	3	6	5	2	5	7	0	8
Incorporation of public consultation	8	3	1	1	0	2	1	0	2
Independent research possible and available	7	2	4	3	4	2	5	1	5
Regulated lobbying	0	0	0	0	0	0	0	0	0
Reporting on legislation and deliberation	0	2	1	1	1	0	1	2	0
Popular Sovereignty									
Consumer process and quality of services	4	17	3	1	1	0	1	0	1
Prosumer legislation and grid access	1	0	0	0	1	0	1	0	2
Prosumer support schemes	0	7	0	0	0	0	0	0	0
Public accountability and energy decision makers	2	2	0	0	0	0	0	0	0
Welfare energy as key benchmark	5	10	0	1	0	0	0	0	0
Civic Ownership									
Ownership structure and power in the political economy of the energy	0	2	1	0	0	0	0	0	0
Renewable energy deployment, dispersed energy capacity	0	2	1	0	0	2	0	0	8
Share of energy from private and cooperative resources	6	1	0	0	0	3	3	0	0
Share of GRID infrastructure	2	0	3	2	5	2	5	0	5

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