Australian Energy Transition Research Plan

REPORT FOUR

Social Engagement Dynamics

ACOLA RESEARCH BRIEFING PAPER

Funding partners for the Australian Energy Transition Research Plan

NERA National Energy Resources Australia

CSIRO

ARENA Australian Government Australian Renewable Energy Agency

ACOLA™ Australian Council of Learned Academies

Combining the strengths of Australia's Learned Academies

GOVERNANCE OF THE RESEARCH PLAN

The governance and monitoring of the Research Plan is by ACOLA, an independent, not-for-profit research organisation that is the forum that brings together the expertise of Australia's five Learned Academies, including their combined nearly 3,500 Fellows. ACOLA's unique ability to draw on Australia's leading research capability and expertise across the range of research disciplines allows it to provide balanced, interdisciplinary and robust research-based advice on critical issues. The project is led by a Steering Committee consisting of Fellows from the Academies that bring their multidisciplinary expertise across the energy and research sector.

Mr Drew Clarke AO PSM FTSE (Chair)

Emeritus Prof. Sue Richardson AM FASSA

Dr Bruce Godfrey FTSE

Emeritus Prof. Libby Robin FAHA

Prof. Kenneth Baldwin FTSE FAIP FInstP FOSA FAPS GAICD

Prof. Fran Baum AO FAHMS FASSA

PROJECT MANAGEMENT

Fern Beavis
Judita Hudson
Lauren Palmer
Ryan Winn

AUTHORS

Professor Tina Soliman Hunter
Dr Madeline Taylor

This report was supported through the contributions of many experts throughout Australia as acknowledged throughout the report.

ISBN 978-0-6452054-3-5 (digital)

DATE OF PUBLICATION
May 2022

PUBLISHER
Australian Council of Learned Academies
Ian Potter House
9 Gordon Street
Acton ACT 2601 Australia
www.acola.org

SUGGESTED CITATION
Clarke, D., Baldwin, K., Baum, F., Godfrey, B., Richardson, S., Robin, L., Soliman Hunter, T., and Taylor, M. (2022). *Australian Energy Transition Research Plan. Report Four: Social Engagement Dynamics*. Report for the Australian Council of Learned Academies (ACOLA), www.acola.org.

ACKNOWLEDGEMENT OF COUNTRY

ACOLA acknowledges all Aboriginal and Torres Strait Islander Traditional Custodians of Country and recognises their continuing connection to land, sea, culture and community. We pay our respect to the Elders both past and present.

Australian Energy Transition Research Plan

The Australian Energy Transition Research Plan developed by ACOLA identifies three Research Priorities: Energy System Dynamics, Social Engagement Dynamics and Transition Dynamics. This Social Engagement Dynamics research briefing paper is the second of three reviewing existing research and exploring research opportunities for the energy transition in Australia.

1. Introduction

The social engagement dynamics research theme encompasses the policy and regulatory settings that will be required for the transition, how people (individuals, communities, regions etc) will be engaged, and how principles of equity, justice and fairness throughout the course of the transition will be developed and applied.

The Australian Energy Transition Research Plan (2021), developed by the Australian Council of Learned Academies (ACOLA) in consultation with key stakeholders, identified key research priorities across three themes. This paper, on Social Engagement Dynamics, expands the second theme, reviewing existing research to identify key research gaps to address immediate and strategic needs of research users and consumers, and outlining what opportunities can be realised through Australia addressing these priorities. This theme focuses on the policy and regulatory settings that will be required for the transition, how energy users can be engaged in the process, and how principles of equity, justice, and fairness will be developed and applied throughout the transition.

The report's key findings validate the need for further research insights to guide and underpin strong policy positions by all Australian governments. Such policies will continue to be critical in building confidence and the right environment to drive the energy transition. Australia's international obligations, together with the expected pressure from international investors and consumers of Australian products and services, have driven the shift to net-zero emissions by 2050, including increasing bipartisan support for net-zero emissions. The focus of the Commonwealth's emission policy is primarily the development, application, and use of technology to drive the energy transition, rather than introducing trading or taxation systems, or imposing quantitative limits on the emission of greenhouse gases. As technologies emerge, and existing sources of energy and infrastructure are utilised in different ways, there is a need to revisit the regulatory frameworks to ensure that regulation remains comprehensive and best practice, encourages business, and supports community engagement and acceptance.

There is a clear research direction for the need for insights from the social sciences and humanities to sit alongside advancements in engineering and the physical sciences. Community, engagement, participation, and social licence are critical factors in the energy transition, and it is through these lenses that future research around Social Engagement Dynamics must also be grounded. Community engagement and acceptance has progressed in recent years, although community concerns and benefits remain highly underrepresented. Research funding and focus must encompass two critical areas – Indigenous impacts, benefits, and considerations, and the health impacts of the energy transition. Health impacts must be addressed given the importance of health in the economy and the need for a healthy population. Further, given that many of the future renewable energy projects will be on or near indigenous land and communities, such research is a high priority.

In pursuing research on Social Engagement Dynamics, a mix of urgent and more strategic local and international research across all disciplines needs to be pursued, including multidisciplinary and interdisciplinary considerations. The energy transition needs to happen at a rapid pace and scale, and insights derived from ACOLA's Research Plan will provide important knowledge for further and future domestic and global transitions.

2. Discussion of the Identified Research Priority

ACOLA released Report One of the Australian Energy Transition Research Plan following extensive consultation with stakeholders. Report One identified key research priorities for Australia's energy transition. These priorities offer those in the research ecosystem guidance on where and what research is being undertaken and what critical research is not being done to direct efforts and funding to high priority areas. The key research priorities are organised into three themes consisting of three topics, with each topic consisting of high-level driving questions for research over the next decade. These are classified as urgent (where robust answers are needed in the near future) or strategic (where robust answers are required in the longer term).

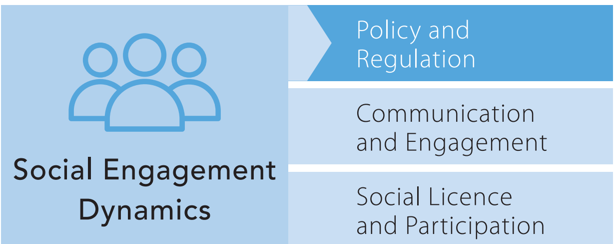
Three theme papers expand on each research priority from Report Onen, taking a deep dive into the high-level questions. From these, the papers present a review of the existing Australian and international research base, noting critical research gaps, and highlighting where Australia must accelerate or establish research efforts for a successful transition.

Further specific research questions are developed from each high-level driving question. The framing high-level questions from the Research Plan are highlighted in boxes. The additional research questions for each of the topics are highlighted throughout and gathered at the conclusion of the paper. This research theme, Social Engagement Dynamics, consists of the topics policy and regulation, communication and engagement, and social licence and participation. These encompass the policy and regulatory settings that will be required for the transition, how all people will be engaged in the transition (i.e., individuals and communities, different social and cultural context and regardless of geographic location), and how to engage the wider community in decision-making processes to ensure control, comfortable and acceptance of changes occurring (i.e., social licence and participation).

3. Literature Review

Currently, the energy transition is clearly being driven from above, from Commonwealth, state/territory, and local governments and business decisions, including implementing new technologies. What is also necessary is that the community has a role in leading and driving change. In being driven from below, it is essential that vulnerable groups, particularly low socio-economic groups, are included. It is also essential that Indigenous Australians are included, particularly given that much of the social and economic impacts are borne by Indigenous Australians (O'Neill et al., 2019).

It is also essential to recognise that existing research in legal and policy architecture of the energy transitions largely fails to consider the important innovations in social science understandings of change and does not sufficiently consider the possibilities for the social sciences to lead the agenda. This research attempts to consider social drivers, particularly within the socio-legal context.



3.1 Policy and Regulation[1]

At all levels, government policy and regulation can facilitate or impede a successful energy transition. To achieve a smooth and successful transition, research needs to identify and support best practice in policy and regulatory architecture. Therefore, this section considers the policy and regulatory position primarily of the Australian Government, who under the Constitution, has primary responsibility for setting the agenda on climate change law and policy through the domestic implementation of international law and policy. Australia's states and territories can implement energy transition policy and regulation, so long as it is not inconsistent with Commonwealth law. As per the Constitution, where an inconsistency occurs, Commonwealth law prevails.

3.1.1 Stocktake

> Which policies and regulations are supporting, impeding or missing for the transition (what can we learn from overseas experience in these areas)?

Policy

Most recently, the major driver of Australian policy for the energy transition is Australia's obligations under international law.[2] Prior to 2020, at a national level, the Australian Government established several Agencies, including the Australian Renewable Energy Agency (ARENA) and the Department of Climate Change in the 2000s, as well as several initiatives, including mandatory renewable energy targets (MRETs), the solar PV rebate systems and a carbon pricing scheme. After the abolition of the carbon pricing scheme in 2013, the Commonwealth established, and has since focused on, the Emissions Reduction Fund (Soliman Hunter and Taylor, 2020). However, under the United Nations Framework Convention on Climate Change (UNFCCC), Australia has pledged to reduce its emissions by 26-28% below 2005 levels by 2030, building on its target of 5% below 2000 levels by 2020 under the Kyoto Protocol.

1 The topic of 'policy and regulation' has three sub-topics; stocktake, markets and governments, and decision-making. Although there is no explicit section on decision-making in this paper, the underpinning strategic question (How can we integrate multi-factorial policy-making and regulatory tools to better consider the complexity of the energy transition across social, technical, and economic dimensions?) is addressed in section 3.1.1.

2 Especially the Kyoto Protocol and the Paris Agreement.

It should be noted that market forces – the economics of electricity generation, transmission, and storage – have driven considerable change in the role of renewable technologies in Australia, even in the absence of systematic and comprehensive policy. Regulators and private firms are also acting with a long-term view of the risks of stranded assets (i.e., those that are high emitters) and international penalties that will affect Australian business.

Although Australia's performance in emissions reduction targets under the Paris Agreement is questionable, progress has still been made (ClimateAction Tracker, 2021). State and territory governments have led progress over the past ten years from an energy transition policy perspective, with the Australian Government making progress since 2016, as illustrated in Appendix 1. In 2020, the Low Emissions Technology Statement and the associated Technology Roadmap for Low-Carbon Energy, combined with increased funding and role for ARENA, established a policy framework that underscores the importance of technology in the energy transition. Under the low emissions technology framework, the Commonwealth emphasises five priority technology stretch goals (Department of Industry, Science, Energy and Resources [DISER], 2020):

- the generation of clean hydrogen (blue and green) under $2/kg
- energy storage for electricity generation (batteries and pumped hydro energy storage (PHES), firming under $100 per MWh
- low carbon steel and aluminium under $900 and $2,700 tonne respectively
- carbon capture and storage, including the capture, compression, transport and storage of CO_2 under $20t/$CO_2$, and
- soil carbon storage, with a stretch target of $3 per hectare per annum. This policy will be implemented through carbon credit units from soil carbon projects, registered with the Emissions Reduction Fund.

In 2021, the second LETS was released and added a 6th priority (DISER, 2021a):

> Ultra-low-cost solar electricity generation at $15 per MWh, which is approximately a third of today's cost.

The Commonwealth has coupled its emissions reduction policy with a gas recovery strategy. In October 2020 the Commonwealth published its Modern Manufacturing Initiative (Department of Industry, Science and Technology [DIST], 2020), which plans for a manufacturing recovery led by the delivery of new gas supply at affordable prices. Central to the Modern Manufacturing Initiative is the Commonwealth's role in developing gas resources in the Northern Territory's Beetaloo Basin, as set out in the Beetaloo Basin Strategic Plan. (DISER, 2021b). The Commonwealth reasons that the development of gas resources contributes to Australia's National Hydrogen Strategy, which "sets a vision for a clean, innovative, safe, and competitive hydrogen industry, developing blue hydrogen for both domestic and export use and sequestering the resulting CO_2 in underground reservoirs" (DISER, 2019).

Considering Australia's policy focus, it is evident the Commonwealth is placing its policy position as one of net-zero emissions rather than the transition to a green economy. A net-zero emissions strategy incorporates the continued use of hydrocarbons with CO_2 abatement measures (IEA, 2020) compared to the green economy, which is resource efficient, lower carbon, less environmentally damaging, and more socially inclusive (Georgeson et al., 2017), and thus influences the triple bottom line.[3] The growth of a green economy is the aim of many international jurisdictions, particularly in the European Union, to ensure sustained economic growth and market security during the energy transition (Albekov et. al., 2017), although such a transition may have impacts on investment (Magalhaes, 2021).

3 Triple bottom line refers to the concept of people, profit and the planet, when considering actions within in a business. See Jacqueline Lang Weaver, 'Sustainable Development in the Petroleum Sector' (2003) in Adrian Bradbrook and Richard L Ottinger (eds), Energy Law and Sustainable Development (2003) IUCN Environment Policy and Law Paper No. 47, 45.

Ahead of COP 26 in November 2021 the Commonwealth Government released *Australia's Long-Term Emissions Reduction Plan* (The Plan), which sets a firm target of net-zero emissions by 2050, and how Australia will achieve this goal. The Government asserts that net-zero emissions by 2050 will be achieved in "a practical, responsible way that will take advantage of new economic opportunities while continuing to serve our traditional export markets" reaffirming Australia's pathway to net-zero emissions by 2050. The Plan focuses on the technological tools to achieve the target, described by the Prime Minister as a technology not taxes approach (Morrison, 2021), rather than new policy and regulatory settings. The Government suggests that this should ensure that traditional industries or jobs are not put at risk, particularly in the regions. A key feature of the Plan is a technology target of A$15/MWh for solar PV. Should this goal be achieved, the impact on the entire energy system will be immense, especially for Australia's thermal coal and gas sectors. One major drawback of The Plan is the failure to address the issue of polluters and provide for mechanisms to address major polluters since none of the proposed targets is likely to be enshrined into domestic legislation. This is a marked difference to most other western nations, where targets and regulatory architecture for carbon emissions are subject to legislative controls and schemes. Some also argue that this Plan ignores the social, economic or cultural aspects of the energy transition.

RQ: What emissions schemes and policies are required to complement technology developments and enable the most efficient (i.e., least cost), effective and fair long-term reduction of emissions?

Regulatory architecture and best practice

The national regulatory architecture for greenhouses gas emissions lies with the National Greenhouse and Energy Reporting Scheme[4]. Through this greenhouse gas (GHG) Account, annual volumes are calculated and the volume of reduction required to meet international obligations is determined (Clean Energy Regulator [CER], 2019).

Although the scheme is mandatory, it does not set a standard for data quality. This means that data disclosure may be designed to show a company in its best light, rather than be a true reflection of the actual GHG situation (Borghei et al., 2016). Disclosure quality also remains low, and further government intervention regarding mandated carbon reporting may be required (Liu and Yang, 2018).

Renewable energy targets are regulated under the *Renewable Energy Electricity Act 2000* (Cth) and associated regulations, with a corresponding Renewable Energy Certificate Registry, which enables participants to create, transfer, and surrender renewable energy certificates, and is administered by the Clean Energy Regulator (CER, 2020). The fund is quantified by Australian Carbon Credit Units through an auction process, which has resulted in the purchase of over 140 million tonnes of CO_2 emissions. The voluntary nature of this scheme has an impact, with a positive and significant association between the level of GHG voluntary disclosure, corporate governance, and firm size. Discretionary disclosure is more likely in companies with superior GHG performance (Borghei-Ghomi and Leung, 2013). Thus, the disclosure of voluntary GHG enables the company to acquire the benefits of communicating good news (Borghei-Ghomi and Leung, 2013). However, the content and quality of disclosure need improvement (Zhang and Liu, 2020).

The emissions reduction fund, now the Climate Solutions Fund, is a voluntary scheme providing incentives to adopt new practices and technologies to reduce carbon emissions (CER, 2021a). For a project to be eligible for registration under the ERF it must not have commenced or be required by law. A variety of projects are eligible, including the capture and storage of carbon. However, further analysis is needed to determine the success of such a fund.

While the Australian Government has committed to net-zero emissions by 2050 it has indicated that it would not implement any national legislation to underpin its net-zero emissions policy.

4 Which records emissions from the energy, transport, agriculture, industry and land use sectors, as well as measuring fugitive emissions.

State and territory governments have introduced their own climate change policies and legislation, demonstrated in Appendix 1, highlighting the variations in policies and legislative implementation between jurisdictions. Policy duplication across Commonwealth, and states / territories, as well as Australia's variable approach to emissions reduction, has impacted Australia's ability to reduce emissions and implement effective policies (Byrom et al., 2020). State and territory governments' commitments to net-zero emissions by 2050, or earlier, are expected to translate to an estimated 37-42% Australia-wide reduction on 2005 emissions by 2030, compared to Australia's Paris interim target commitment for 2030 of 26-28% below 2005 levels (ClimateWorks, 2021).

RQ: To what extent are legislation reforms necessary, especially to improve the quality and content of corporate greenhouse gas reporting, so that the regulatory frameworks are agile and dynamic to manage emerging issues?

Rooftop solar installation

Australia's solar resources have provided significant opportunities for generating and democratising energy. In the early 2000s one of the early policy responses to renewable energy targets included the incentivisation of rooftop solar installation. The success of this has contributed to Australia having one of the highest rates of residential solar adoption in the world (Zander et. al., 2019). Since 2019, Australia has had the highest global per capita solar capacity (600w per capita), representing a ten-fold increase between 2009 and 2011, and quadrupling of capacity 2011- 2016. In August 2021, the Australian Energy Market Commission (AEMC) finalised market reforms that will enable more solar energy to enter the grid, including clearer obligations by distribution businesses to support two-way energy flow options for distributors to incentivise limits to solar waste and the strengthening of customer protection through AEP regulatory oversight (AEMC, 2021). However, restrictions still prevail in some Australian markets outside the Australian Electricity Market.

CASE STUDY

Solar PV in Western Australia

Increased demand for rooftop solar PV is significantly influencing the electricity market and system operability in Western Australia. Currently, the State's legacy thermal generation assets dominate, constituting over 40% of the system's installed generation and providing most ancillary services (Wilkinson et. al., 2021). The wholesale electricity market (WEM) for the Southwest Interconnected System (SWIS) is run by AEMO, and the retail electricity market is restricted to a single state-run retailer with tariffs set on a volumetric basis (AEMO, 2018). At present 30% of dwellings in WA have rooftop Solar PV (Australian PV Institute, 2020.) By 2030 it is estimated that this will double, with an installed capacity of 2,600 MW (AEMO, 2020). However, as more rooftop solar PV is connected, there is a mismatch between the generation capacity and the underlying system load (Wilkinson, 2021) creating several challenges for the network, including more rapid frequency fluctuation, difficulties in voltage regulation, and threats to system security (Laslett et al., 2017; Wilkinson, 2021). Such challenges have been identified by the WA Government, which notes that "distributed energy resources are transforming our electricity system, and while they offer opportunities, they are presenting serious risks to our power system". (WA Government, 2020).

Role of technology in emissions reduction

The present policy position regarding the role of technology in emissions reduction is clearly iterated by the Commonwealth Government, demonstrated in the 2020 *Technology Low Emissions Roadmap*. Australia's energy transition also encompasses a response to supply chain weaknesses exposed by the COVID-19 pandemic, driving manufacturing sector reform which requires large amounts of lower-cost energy, as iterated in the Federal Government's Modern Manufacturing Strategy (DIST, 2020).

This relies largely on the deployment of solar and wind energy, complemented by green and blue hydrogen. This strategy has serious constraints. The favourable treatment of solar and wind, accompanied by large scale changes to accommodate them in the network, present several challenges including intermittency, unpredictability and need for additional forms of energy storage (Coram and Anthony, 2021). In addition, the production, storage and transportation of hydrogen, and its volatility[5] in these phases mean that it is imperative that an effective and coherent policy and regulatory framework must be implemented, without which commercialisation at scale for $2/kg will not be possible.

The Commonwealth's focus on developing and deploying technology to meet the challenges of shifting to net-zero emissions is evident in the shifts in ARENA's scope and capacity. Work is needed to determine if these shifts will be sufficient and efficient for the task. ARENA's shifts reflect a technology-led approach similar to the European Union, with hydrogen as a transition and baseload fuel (European Commission, 2021) as well as a fuel for export to replace liquified natural gas (LNG). Two types of hydrogen present opportunities for net-zero emissions; blue and green.

Blue hydrogen, from natural gas, will necessarily require the production of gas, which presents few challenges for Australia and the capture, storage, and underground storage of carbon in appropriate geological reservoirs. The greatest technological challenge will be the sequestration of carbon, which has to date comprised of pilot projects in the Otway and Cooper-Eromanga Basins, and at commercial scale on Barrow Island which, while somewhat successful, fall well short of the estimated production and financial targets. Although blue hydrogen is potentially an appropriate source of net-zero emissions, fugitive methane emissions arising from the production of gas represent a significant risk given that methane is a powerful greenhouses gas with a 20-year period global warming potential 84-86 times that of CO_2 , and a 100-year global warming potential 28-34 times that of CO_2.[6] Assessment of US unconventional gas production demonstrates that methane fugitive emissions are higher than conventional wells during the hydraulic fracturing/well completion stage. Any benefits associated with shifting from coal to gas are lost when considering fugitive methane emissions (Schneising et al., 2015). So far, regulations for gas production focus on well construction and hydraulic fracturing, with little or no regulatory requirements to monitor or eliminate fugitive emissions. Therefore, should blue hydrogen progress, a sound regulatory architecture addressing fugitive emissions needs to be developed.

Offshore carbon abatement utilising CCS is regulated under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth), with onshore CCS regulated through state acts. Such legislation is currently limited primarily to the Otway Pilot Project in Victoria, given that CCS in Western Australia is undertaken under the *Barrow Island Act* (WA), which gives effect to the Barrow Island State Agreement between Chevron and the Western Australian Government. An analysis of Australian, EU and the USA regulatory frameworks demonstrates that regulatory regimes developed in Australian jurisdictions, particularly Victoria, are some of the most comprehensive in scope, complexity, geographical coverage (Dixon et al., 2015), and are complemented by current strong policy positions supporting CCS. The lack of regulation in the NT and WA needs to be addressed through state/territory legislation, preferably modelled on the comprehensive Victorian legislation, given it is likely that CCS projects will occur in these jurisdictions.

The second type of hydrogen is green hydrogen. The production of green hydrogen requires substantial renewable energy generation (IEA, 2020). For green hydrogen generation to advance and fulfil the government's stretch goal of $2/kg, an increase of renewable energy is required at an industrial and national scale, requiring vast investment and, where onshore, land space for solar/wind power.

5 Hydrogen possesses the US National Fire Protection Association's rating of 4 on the flammability scale (the highest), due to its extreme flammability when mixed with small amounts of air, with ignition occurring at a volumetric ratio of 4%. This volatility poses unique challenges for the storage and use of hydrogen, especially due to its ease of leaking as a gaseous fuel, its low-energy ignition, buoyancy, and its capacity to embrittle metals, therefore posing storage challenges.

6 According to UNECE sustainable development goals.

These needs challenge existing legal norms and regulatory frameworks (Grattan Institute, 2021), and the establishment of a legal framework that is more suited to hydrocarbons (Taylor and Soliman Hunter, 2021). Furthermore, high demand for water in hydrogen production (both green and blue) is likely to present regulatory challenges similar to those in shale gas extraction (Hunter and Brockett, 2014).

Given the need for emissions elimination, a focus wholly on green hydrogen and ammonia is a likely strategy to decarbonise hard-to-abate industries. Most Australian states are already considering or have approved green hydrogen ammonia projects. However, green hydrogen has implications for Australia's surface water and aquifers, given the role of water as a source of hydrogen in water electrolysis (Oesterholt et al., 2018), and the high rate of water consumption associated with hydrogen production (Mehmeti et al., 2018), where even today's meagre demand for hydrogen production (around 70MTH_2), would require 617 billion litres of water (IEA 2016).

RQ: What regulatory architecture will be required for fugitive emissions and water use as Australia transitions to net-zero emissions?

RQ: What regulatory reforms will be necessary to integrate emerging technologies, and be agile to new ones as they emerge?

Indigenous peoples and communities

The energy transition has a wide impact on Australia's Indigenous peoples and communities, largely due to the need to use vast expanses of land for low-carbon energy infrastructure such as solar and wind farms, pipelines, battery storage facilities, and essential transmission infrastructure. Where Native Title exists, such infrastructure will impact Indigenous use and relationship with the land.

Whilst much of this will be addressed through a mandated Indigenous Land Use Agreement (ILUA) under the *Native Title Act 1993* (Cth), the negotiation process will likely impact both individuals and land councils. Such an impact is likely to be confined to above ground. However, the advocacy of carbon storage in underground reservoirs will challenge existing conceptions of Native Title as merely a two-dimensional, land surface issue. CCS will require the contemplation of the Native Title within a three-dimensional perspective, which hitherto has not been addressed in a legal framework.

RQ: How can Indigenous peoples, their rights and interests, be incorporated into the energy transition process and their needs addressed within a legislative and policy framework?

3.1.2 Markets and governments

> What is the optimum mix (over time) of market forces and government planning and intervention over the course of the transition?

Roles of government and industry

Prior to 2018-19, the role of the Australian Government regarding emissions reduction had largely been confined to the legislative and policy space. A gradual shift in perspectives on the role of government in the energy transition is emerging, from a regulatory role (McDonald, 2021) to a more participatory one, which commenced in 2018 with the Commonwealth assuming full ownership of Snowy Hydro Ltd after acquiring the 58% and 29% shares of the Company which had previously been owned by the NSW and Victorian governments respectively (Snowy Hydro Ltd, 2018). In February 2019, the Australian Government approved Snowy 2.0, expanding the Snowy Mountains Scheme generation capacity by 2000 MW, as well as acquiring 175 hours of energy storage through PHES, to increase generation and storage capacity. This increase was necessary after the 2016 South Australian Blackout.

As part-owner of the Snowy Mountains Scheme the Commonwealth Government undertook little participation in energy generation or the NEM. Today, as full owner, it is a major player in the energy market, regulating energy assets and owning utility assets and participating in the NEM through energy retailers, including Red Energy and Lumo Energy. Aside from owning generating assets, including power stations and solar farms, Snowy Hydro Ltd has indicated a desire to build Kurri Kurri Gas-Fired Power Station and has lodged a development proposal to the NSW Government. In all, Snowy Hydro Ltd owns and controls over 5,500 MW of generating capacity and is the fourth largest retailer in the NEM.

Although there is a need for government intervention, market forces and industry participation are also critical in the energy transition. Often industry, such as the mining and resources industry, are major emitters and the IPCC has recognised that it is industry itself that needs to develop solutions to CO_2 emissions through technology, practices, behaviours, and attitudes (Fishchedick, 2014). As such, many industry players seek to drive change and innovation as they strive to meet targets and generate alternatives to the status quo. For example, a major study of 22 Australian resource companies, which together represented one third of all emissions reported under the National Greenhouse Gas and Energy Framework, found that , half of the studied companies had commitments aligned with net-zero by 2050, three committed to specific targets and strategies to achieve net-zero by 2040, two committed to specific targets and strategies to achieve net-zero by 2050, and six expressed an 'aspiration' to reach net-zero by 2050 (Denis-Ryan et al., 2020).

What is lacking is a demonstrated integrated government-industry approach to addressing emissions and climate change. However, the example of the South Australian Roundtable for Oil and Gas Projects, which was formed in 2010, and has more than 2,250 representatives from over 1,150 organisations including industry, governments, industry representative bodies, environment protection agencies, and Aboriginal people, along with research institutions and individuals, is an interesting model. It provides a forum for members to help inform the South Australian Government on the planned directions for activities, oil and gas strategy, and policy directions.

RQ: What are the key opportunities for industry to contribute effectively to emissions reductions, and how can government policies be used to support these opportunities?

RQ: What are the best Government incentives and support needed to maximise the efficient contribution of the private sector to emissions reduction?

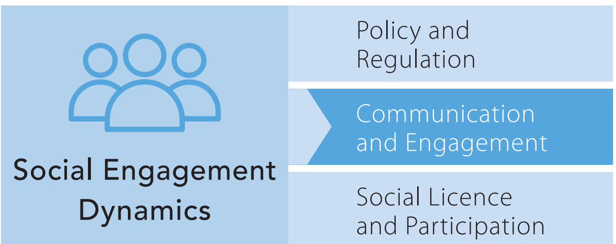
Regulation of National Energy Market resilience: reform and energy storage

At present, carbon-based generation continues to dominate the NEM, although a transition to renewable energy is underway, precipitating challenges for national energy market regulation (Godden, 2021). The existing NEM regulatory framework, policies, and infrastructure were designed based on controllable, constant, coal-fired generation operating on a frequency of around 50 Hertz (Hz) (Boston et al., 2020). However, as these facilities are decommissioned and replaced with variable renewable electricity (VRE) generation, variations in frequency and intermittency will dominate, impacting the stability of the NEM (AER, 2017). In the energy transition, one of the greatest challenges to the NEM is ensuring grid stability in the wake of the South Australian (SA) Black System, which demonstrated weaknesses in the NEM infrastructure, grid capability, and capacity (Laslett et. al., 2017), as well as the unreliability and intermittency of renewable energy and the need for battery backup rather than a reliance on a system restart (AER, 2017). The SA Black System event also demonstrated challenges that arise where energy supply shifts from hydrocarbon to renewable energy sources, requiring a fundamental transformation of the NEM to minimise variability and volatility associated with renewable energy (Keck et Al., 2019).

Part of that response and transformation of the NEM is energy storage. NEM stability was considered in depth by the 2017 Independent Review into the Future Security of the National Electricity Market which established a blueprint for the security and reliability of the NEM in the energy transition. It sets out fifty recommendations for increased security and future reliability against the backdrop of an "orderly transition" to renewable power generation, by prioritising "low emissions and affordable supply… delivered through a power system that is secure and reliable" (Finkel, 2017). However, it avoids recommending a clear energy storage policy framework and focuses on the medium-term security of the NEM requiring gas-fired generation to 'firm' the NEM (Finkel, 2017).

The use of energy storage in a low carbon energy-dominated grid has occupied the EU since the introduction of the third energy package in 2009, and the US with the integration of intermittent renewable energy in Texas and California. These jurisdictions have undertaken extensive policy and regulatory changes to support storage technologies. Such international experiences provide Australia with knowledge to assist with change management (Moore and Shabani, 2016). Further lessons were learned with the February 2021 Texas power outage, which left more than 10 million people without electricity for several days, demonstrating the consequences of sub-par energy storage in a transitioning system (Busby et al., 2021). It is essential that further research considers the consequences of such energy outage in depth to ensure that grid stability is assured as the transition away from hydrocarbon-based baseload power occurs, and variable renewable energy.

A critical component in NEM stability is the Retailer Reliability Obligation (RRO), enabling AEMO to identify and address reliability gaps in the NEM (Australian Energy Regulator, 2021). The Finkel Review also recommends establishing a Strategic Reserve Mechanism (SRM) to contract for a targeted level of capacity held in reserve outside the market and released by AEMO where there is a projected shortfall (Finkel, 2017)



3.2 Communication and Engagement

Citizen engagement and effective communication is crucial to ensuring that energy transition pathways are just, sustainable and acceptable to the wider community. Research examining responses and engagement with the energy transition is also needed to understand why energy policy has remained divisive and socially complex. Ultimately, successful and effective transition pathways rely on genuine engagement and communication, consumer, prosumer and investor confidence, and appropriate policies and support.

3.2.1 Socio-political climate

> How is Australian energy politics and our political economy different or similar to that in other developed nations (what can we learn from the overseas experience)?

As late as 2017 the Australian Government favoured fossil fuels, although a strong socio-political shift towards net-zero emissions was commencing, particularly in Australian states and territories. Two significant events in 2019 and 2020 had a profound impact on Australia's current position regarding the energy transition. The first event was the bushfires in the summer of 2019-20, which caused widespread devastation and became a focus of the political agenda. The impact of these bushfires was not only on the physical landscape but also on the psyche of the Australian nation, arguably the first time many Australians fully comprehended the causal link between emissions, climate change and shifting weather patterns (McDonald, 2021). The second event was the COVID-19 pandemic, and subsequent realities regarding supply chains in manufacturing, resulting in reduced availability and scarcity of some essential goods in Australia. These events provided additional impetus for the government to develop and implement actions to address manufacturing, particularly in the areas of resource technology, critical minerals processing, and recycling and clean energy, whilst addressing CO_2 emissions through technological development and a gas-led manufacturing recovery.

A major socio-political issue in the energy transition is the reluctance to embrace emissions taxation and trading schemes. The Australian Government initially introduced a carbon pricing scheme in 2011 to control carbon emissions in Australia below 2005 levels by 2020 as part of a broader energy reform package to reduce GHG emissions. The scheme sought to achieve these targets through investment in sustainable energy and increased energy efficiency, and required entities emitting over 2500 tonnes of CO_2 equivalent per annum (excluding transport and agriculture sectors) to obtain carbon units. Upon its introduction, it reduced emissions from participating companies by 7%.

The scheme was to transition to an emission trading scheme from 2014-15; however, it was subsequently repealed in July 2014 and replaced with the Emissions Reduction Fund. The current Government has ruled out the use of tax and trading schemes to support the energy transition, stating that the Government "will not tax our way to net-zero emissions... getting to net-zero whether here or anywhere else should be about technology not taxes and high prices" (Morrison, 2021).

There is widespread support among economists and international economic agencies for the use of a price or tax on emissions. Such a price would reflect the 'social cost of carbon', i.e., the cost on society that is not reflected in the price otherwise paid for fossil fuels. and stimulate efforts by the private sector to avoid emitting greenhouse gases, to avoid paying the price or tax (Academy of Social Sciences Australia, 2020). Experience in overseas jurisdictions demonstrates the successful nature of carbon trading and pricing mechanisms in reducing emissions (Bayer and Aklin, 2020). Evidence from cap-and-trade schemes, particularly in the EU, suggests that setting of a cap in emissions trading enables emissions to be cut in areas where it is least costly, thereby reducing emissions over time (Talus, 2013). However, this does not suggest that such a scheme could be simply transplanted from the EU (Boute, 2017; McKibbin, 2020).

RQ: What would be the advantages and disadvantages of any form of carbon-pricing, or related policy mechanisms, as part of other mechanisms to reach net zero emissions by 2050?

3.2.2 Citizen engagement

> How can communication platforms and messaging be used to best engage the breadth of Australian audiences, from national to local; what are the community (place-based) engagement issues and how does this relate to their identity, values, lived experiences, history and willingness to participate in the transition?

There are diverse opportunities for citizens to engage with the energy transition. For example, people can become prosumers or participate in decentralised energy generation projects owned by community groups. Research needs to focus on the diverse opportunities for citizen engagement that are available and emerging, and the extent to which different communities and individuals can actually be involved given there are critical barriers to engagement which need to be overcome.

Energy Justice and Energy Democracy

Energy justice is a conceptual socio-legal framework aiming to address energy poverty and injustices, and therefore difficulties in accessing energy and affordability concerns within energy systems. From more general calls in the 1980s (Basalla, 1980) the concept has solidified as a framework to enable a just energy transition within international and Australian literature. Justice for those affected by the distributional aspects and conflicts that create inequality within the energy sector is seen by some as "an integral and inseparable dimension" of international principles of sustainable development (Guruswamy, 2010). The original principles of energy justice – distributional, procedural, and recognition justice (Heffron et al. 2017; Jenkins et al., 2016) – aim to facilitate a just energy transition via effective energy policy, ensuring community benefits and mitigating the risk of energy poverty and injustice within vulnerable communities. Over time, energy justice has been reconceptualised as encapsulating restorative justice (Heffron and McCauley 2014), spatial justice (Bouzarovksi and Simock, 2017), and the combination of climate, environment, and energy justice to facilitate a just transition (McCauley and Heffron, 2018). More recent energy justice research highlights the role of renewable energy communities in mitigating energy poverty and mandating community engagement processes to enable vulnerable groups to participate within the energy justice framework (Hanke et al. 2021).

Literature aimed at decision-making practices has highlighted the need to consider "(1) availability, (2) affordability, (3) due process, (4) intra-generational equity, (5) sustainability, (6) transparency and accountability, (7) equity and (8) responsibility" (Sovacool et al. 2016).

As the energy justice literature is evolving, the eight principles decision-making framework is a methodology that has rarely been applied in the Australian context and warrants further exploration. Underpinning the myriad definitions and frameworks representing energy justice, Pellegrini-Masini et al. (2020) finds that energy justice is rooted in the "concept of equality, and in its forms of substantive and formal equality". Further, comparative research employing an energy justice framework to case studies, such as one example on four cases in Asia and Africa by Siciliano et al. (2019) is rare in the literature, particularly in the Australian context. Indeed, while European academic authors represent 60% of the energy justice literature to date according to Jenkins et al. (2021), only 16% are Asia-Pacific academic authors (including Australia and New Zealand).

To date, energy justice is not embedded within Australia's policies on the energy transition. Embedding energy justice within energy policy may allow for greater citizen engagement in the design of energy systems. The need to ensure a social licence to operate has seen energy stakeholders engage with social aspects of the energy transition via traditional engagement tools, including community participation. However, embedding concepts of energy justice and correspondingly energy democracy as another socially-focused energy transition concept, may result in "better, not just fairer, governance" (Szulecki and Overland, 2020). The challenges involved in approaching and creating a successful transition is centred on social values, ranging from technology acceptance to designing transition pathways for communities. Embedding both energy justice and energy democracy to ensure citizen engagement focuses on three methods: an engagement process; an outcome of successful decarbonisation; and a normative goal and ideal to guide the energy transition (Szulecki and Overland, 2020). For example, a database or communication system directed at communities at multiple levels, including local, state and nationally, may represent a potential process, outcome, and normative goal of a fairer transition to injustices stemming from spatial, gender, race, and other inequalities.

An inclusive discussion with communities at all levels stemming from greater citizen engagement is crucial to encompassing a functional and socially focused energy transition.

Additional research is urgently needed to examine collaborative procedures and decision-making to produce meaningful exchanges amongst communities. Community-centred policies must be harnessed to ensure energy injustices do not promulgate (Baker, 2016). In sum, research is needed to better understand 1) how government, industry, and wider stakeholders can better and more effectively engage with communities in place-based transitions and 2) how communities can best share, exchange, and engage in insights and lessons learned with other communities in similar circumstances. From a technological approach, research to date has surveyed critical minerals (Heffron, 2020), solar energy (Heffron et al., 2021), and wind (Baxter et al., 2020). A notable absence is observed in applying energy justice frameworks to storage technologies and hydrogen. Analysis of whether assessment tools in new energy development are effective, ranging from Environmental Impact Assessments, Health Impact Assessments, and Social Impact Assessments, is critical to enhancing community benefits, collaboration, and participation in the energy system. These assessment tools can assist with mapping, engaging, and addressing community concerns to provide a platform for communication exchange. Rather than local communities being engaged in isolation, a broader communication strategy and supplementary tools to connect multiple stakeholders and community actors across energy technologies at the local and national levels can help mitigate energy poverty and injustices.

In the Australian context, energy justice research has focused on solar photovoltaic energy systems (Poruschi and Ambrey, 2019; Simson et al., 2016), wind energy systems (Gross, 2007), energy vulnerability in poor housing design (Gower, 2021; ARENA, 2017), and unconventional gas development (Witt et al., 2018; Macpherson-Rice et al., 2020). Australian research has focused on state subsidies and rebates for renewable energy systems to ensure government assistance is not unevenly distributed within lower socio-economic communities, resulting in social inequalities (Simpson et al., 2016).

A survey of households in Western Australia (Simpson et al., 2016) demonstrates strong regional support for small scale renewable energy systems, but a heightened need for government assistance to realise installation possibly due to socio-economic differences with metropolitan communities. Another critical factor to consider is housing status, as renters and apartment dwellers face additional barriers to accessing renewable energy (Coalition for Community Energy [C4CE] and Community Power Agency 2016). This is also a generational issue as housing affordability issues are much more pronounced among younger generations. Researchers have found that if energy justice is to apply to all rather than some households, new access options which are not contingent on households paying upfront capital costs or having roof ownership need to be explored (Chester et al. 2018). Other published Australian studies have been confined to individual household 'plug and play' technologies rather than adopting a community-based grid project analysis. The Blue Economy Cooperative Research Centre is currently undertaking a research project examining ethics and values to provide a survey of ethical values in communities to promulgate a social licence to operate offshore energy technologies. While this project does not take an explicit energy justice approach, an examination of values and ethics is a beneficial research agenda to chart potential risks and opportunities for offshore wind development and related communities (Blue Economy, 2021).

Surveying and categorising the vast potential and opportunity for Aboriginal and Torres Strait Islander communities to benefit from community microgrid technology and procedural justice as citizen-led decision-making as a core tenet of energy justice is also urgently needed. Another research opportunity lies in the planning and engagement with communities situated within Renewable Energy Zones being developed throughout Australia. The town of Licola provides a case study example for community solar grid technology being successfully deployed.

CASE STUDY

Licola as a prototype for off-grid communities

The community of Licola Wilderness Village transitioned from diesel generator dependency to a 165KW off-grid community solar grid system in 2019. The solar system enabled Licola to be the first Victorian town to be completely off-grid. The community transition by Licola applies the principles of community-based energy justice in reducing reliance on diesel (previously representing $135,000 in fuel and maintenance cost) and adopting the solar system as the largest Selectronic solar energy system in Australia involving 600 solar panels coupled with 120 Sonnenschein A602 3920AH sealed gel batteries (Community Power Hub, 2019). This represents a case study application of distributional, recognition, and procedural justice providing a transparent, participatory, and empowering model for transitioning communities

RQ: What are the current attitudes of different Australian communities in relation to the existing and emerging clean energy technologies and developments, and how can their preferences, values and ethics be leveraged and addressed by the energy transitions?

Community-based ownership structures

Community-based energy ownership structures impact local communities' social integration and engagement in the energy transition. This raises research questions on how and what role Australian communities should play in the energy transition process (Fischer et al., 2021). Achieving a system-wide transformation in the energy transition will necessarily need to focus on the financial participation and civic engagement of communities in ownership structures. Initially, economic incentives stimulated local ownership of energy projects. For example, feed-in-tariff regimes across Europe and Germany have seen more than half of the renewables installed being owned by German local communities (Morris and Pehnt, 2016).

However, as renewable energy technologies mature, feed-in-tariffs are gradually being phased out, including in Australia as solar rebates are expected to cease in 2030. The challenge, therefore, is to create a comprehensive and integrated approach for local energy systems where local communities can sustainably control and capture the benefits of the energy system. The Coalition for Community Energy (C4CE, 2021) is a peak body representing a diverse range of community energy stakeholders consisting of 105 members groups across Australia. Harnessing and collaborating with peak bodies like C4CE to understand community benefits, barriers, and opportunities through knowledge sharing present a research opportunity to inform community-based ownership policies.

Cooperatives

Cooperatives are a particular vehicle for community ownership of renewable energy and associated infrastructure. Cooperatives can be defined as "an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise" (The Co-Op Federation, 2021). Cooperatives globally in numerous sectors subscribe to seven core principles and values outlined by the International Cooperative Alliance: "voluntary and open membership; democratic member control, economic participation by members; autonomy and independence; education, training, and information; cooperation among cooperatives; and concern for the community" (ICA, 2021). Therefore, cooperatives are intrinsically linked to their members' interests and are based on democratic principles including the 'one member one vote' method, limited liability, and low financial barriers to entry.

Much of the energy cooperative literature focuses on case studies in the EU, including Germany (Holstenkamp and Kahla, 2016; Herbes et al., 2021), Austria (Wierling et al., 2018), Belgium (Bauwens and Devine-Wright 2018), Denmark (Bauwens, 2016), France (Mignon and Rüdinger, 2016), Italy, Spain (Capellán-Pérez et al., 2018), the UK (Lehtonen et al., 2019) and Sweden (Magnusson, D and Palm, J, 2019).

As energy cooperatives are becoming increasingly common in the EU, a governing body for energy cooperatives has provided policy guidance since 2011 (RESCOOP, 2021).

Currently, no dedicated national policy or government body governing energy cooperatives exists in Australia. Rather, individual states and territories have explored energy cooperative structures within the wider context of community-based energy. For example, the NSW Government has developed two key reports on community-owned energy. First, in partnership with Community Power Agency, a not-for-profit advisory organisation, a guide to building community-owned renewable energy was produced to provide an overview on how communities can create community-owned structures, including cooperatives (Community Power Agency, 2014). Second, an Ernst and Young study examining ownership and benefit sharing models for wind farms in NSW was commissioned by the NSW government indicating support for community-owned, employee-owned, and enterprise-owned cooperative structures (Ernst and Young, 2014).

CASE STUDY

Goulburn Community Energy Cooperative, NSW

A recent example of a bourgeoning renewable energy cooperative is the Goulburn Community Energy Cooperative managed by Community Energy for Goulburn Inc. In 2021, the community of Goulburn chose a cooperatives structure based on principles of democratic ownership. The Goulburn Solar Farm run by the Goulburn Community Energy Cooperative will consist of 4000 solar panels representing 1.2 MW and battery storage with a capacity of 800 KWh. The project has also established a community fund to provide financial aid to vulnerable community members with electricity bills and is committed to local employment to maintain and run the solar farm.

Social barriers

Community-based systems raise technical, operational, and social challenges and barriers. Ensuring energy system reliability and robustness through efficient allocation of energy technologies and services, according to community needs, is essential (Scholten et al., 2015). Community-based ownership can build consumer engagement and trust, democratic governance (Yildiz et al.,2015), and valuable flexibility in the electricity market. Koirala and Hakvoort (2017) argue Integrated Community Energy Systems (ICESs) can embrace technical and social innovation by coupling energy systems integration (technical integration) with effective community engagement (socioeconomic integration) to increase penetration of renewables while creating employment opportunities for communities. However, to attain locally-embedded ownership structures in the energy transition, social barriers must be managed to increase community acceptance and participation.

Recent research has also focused on the social settings needed to mitigate social barriers as part of the energy transition. Scholarly literature has focused on the need to attain trust as a precondition and outcome of community-based vehicles (Walker et al., 2010) as well as studies based on ecological and institutional economics (Owen and Videras, 2018; Popa, 2015) following from Ostrom's 1990 pivotal work on collective action. Ensuring trust in communities can reduce transaction costs, enhance social sustainability by increasing social norms, interpersonal benefits (Kalkbrenner, 2016), and place-based stability. However, the meaning of what constitutes trust in the context of varying communities remains ill-defined and complex, especially in the unique Australian context.

Community-based energy ownership structures represent a well-studied but highly fragmented research area due to its diverse range of participation and frameworks. However, as evident from several EU jurisdictions, an established legal structure that enables legislation and policy is key to successful community-based energy ownership.

Exploring the opportunities for community-based renewable energy structures in Australia represents an important research opportunity, focusing on the social dimensions of renewable energy to promote community energy security and self-sufficiency in the energy transition. While the Australian literature has focused on community-owned energy initiatives broadly (Proudlove et al., 2020), it is important to create research opportunities for Aboriginal and Torres Strait Islander communities to seek the benefits of transitioning from often an energy-poor state (fossil fuel dependence and energy unaffordability) to community-owned renewable energy.

CASE STUDY

Hepburn Wind Farm, Leonard's Hill, Victoria

Hepburn Wind is Australia's first cooperative-owned wind farm. Hepburn Wind was created in 2011, and while Australia was comparatively late to renewable energy cooperative models than the EU, which commenced cooperative wind farms in the 1970s, Hepburn Wind is an innovative and pioneering community ownership model. The wind farm consists of two turbines with a capacity of 2.05 MW each and generates electricity for over 2000 households. The cooperative was funded by small investments from local and non-local retail investors, state government, and bank grants, leading to almost 2000 cooperative members contributing $9.8 million for the wind farm construction (Hepburn Wind, 2021). Before the commissioning of Hepburn Wind, the community was dependent on coal-fired electricity. Due to the transition to a cooperative wind farm model, the community has reached a carbon abatement level of 12,200 tonnes of CO_2 each year (Clean Energy Regulator, 2021b).

CASE STUDY

Denmark Community Wind Farm Ltd, Western Australia

The Denmark Community Wind Farm Ltd provides an example of a community-owned wind energy project that did not adopt a cooperative structure (Denmark Community Windfarm Ltd, 2021). Following community consultations in 2003, the community of Denmark resolved to build a community-centred energy project to reduce the community local carbon footprint. The Denmark community, consisting of 3,000 residents, opted to create a public company that was community owned. The first shares in the company were issued in 2012. The wind farm consists of two 800kW wind turbines and powers about 47% of Denmark's energy needs. Recently, the Denmark Community Wind Farm Ltd obtained approval to build another two turbines and battery storage to power 100% of the Danish community.

RQ: How can different communities be supported in developing and implementing community-owned renewable energy projects, including through multi-sectoral collaboration and coordination between community organisations, policymakers and industry?

Social Impact Assessment

A successful energy transition is fundamentally linked with community engagement. Engaging with communities requires shifts in the principles that underpin community relationships to equitably interact with a decentralised energy system. The current energy transition involves numerous stakeholders, which invariably requires a vital restructuring and reorganisation of socio-engagement infrastructure and methods to ensure the energy transition is just and inclusive (IAP2, 2021). One of the key tools to engage communities and assess their social needs and risks are Social Impact Assessments (SIAs). Energy projects are increasingly harnessing SIAs to monitor and evaluate direct and indirect impacts on projects in addition to Environmental Impact Assessments and Health Impact Assessments.

In Australia, SIA policies are articulated by the Planning Institute of Australia (Planning Institute of Australia, 2021) and SIA guidelines are provided at the state and territory levels. Notably, the NSW Government has just finalised its 2021 SIA Guideline applicable to state significant energy developments providing a supplement to promote ecologically sustainable development and manage social impacts (NSW Government, 2021). The NSW SIA Guidelines have incorporated an evidence-based approach to SIAs by adopting principles of cultural responsiveness; distributive equity; and inclusiveness (NSW Government, 2021). However, the SIA Guideline, like most other jurisdictions, is not mandatory for the approval of an energy project. There is an urgent need for future research on how a robust, transparent SIA approvals process could be created and implemented as a mandatory aspect of large-scale energy infrastructure and projects.

Differences are evident in SIAs for energy transition, owing to the differences in mandated requirements across projects and across jurisdictions. For example, qualitative social impacts may range from an examination of health and wellbeing to fears and aspirations for communities. To measure the variances in approaches, the MIT Centre for Energy and Environmental Policy Research has produced a working paper series with insights from social epidemiology (Beckfield et al., 2020). Some scholars have critiqued SIAs as being limited in scope, proposing they should be reformed to require community engagement with potentially-affected communities to identify appropriate social impact management strategies (Vanclay et al. 2015; Vanclay 2003; 2017). Another research gap is the focus on social impacts at the proposal stage, rather than taking a lifecycle approach to social cumulative impacts, including decommissioning and energy infrastructure (Colvin et al., 2019; Songsore, 2018; Larsen et al., 2018). For example, Australian regions such as the Hunter Valley in New South Wales may suffer cumulative social impacts and risks from several large-scale energy developments in one area (Vanclay and Esteves, 2011). These criticisms stem from SIAs having a historic focus on quantitative socio-economic impacts such as changes to land values, incomes, and some qualitative assessment of impacts to amenities, as noted by Colvin et al. (2019).

Developing cooperative discourses

Understanding SIA modes of assessment is necessary to offer pathways to predict, plan, and mitigate social impacts and harness human capital unique to the energy transition and its associated infrastructure. Research concerning social cohesion and the roles of local institutions to strengthen communities, avoid producing 'divided communities' (Grubert and Skinner, 2017), and create 'cooperative discourses' (Webler et al., 1995) may promote community-led acceptance and pursuance of collective benefits. Examples of 'divided communities' in the context of the energy transition include wind farm development in Australia such as in the town of Taralga in NSW, where significant community conflict and discussion surfaced due to wind farm development commissioned in 2015 (Gross, 2007). Unearthing and understanding multi-disciplinary energy conflicts within communities, how they are perceived, and how community consultation can be improved in harnessing mandatory and effective SIAs is central to ensure a just and fair energy transition.

RQ: How can Social Impact Assessments (SIAs) be implemented to mitigate risks of community division to create 'cooperative discourses' and achieve a just transition?

3.2.3 Confidence

> What are the drivers of consumer, prosumers and investor confidence? To what extent are consumers and investors leading or following the transition, and how can their preferences and engagement be leveraged?

Community participation in a decentralised system: The role of prosumers

An element of a just energy transition is consumer confidence through participation in a decentralised energy system (CSIRO, 2014; Finkel et al., 2017). Rethinking the purpose and functionality of consumers, from passive participants to prosumers that both consume energy and actively drive energy generation, is needed to achieve a net-zero pathway.

Research examining solar PV prosumers has increased throughout Australia, Germany (Inderberg et al., 2018; Moser, 2021), the UK (Brown et al., 2019), Spain, and US literature to date (Chilvers et al., 2018) (Lopes et al., 2016). Industry studies (Energex, 2017) also highlight the need for active involvement and early community engagement to avoid prosumer disengagement. Recent studies have focused on bargaining theories to manage conflicts of interest between prosumers and community energy managers and service providers (Jiang et al.,2021). Other broader Australian energy efficiency studies examine how stakeholders' social networks influence their degree of knowledge sharing and decision-making to enhance or lower energy efficiency in homes (Zedan and Miller, 2017). A case study example of prosumer projects in Australia is the CONSORT pilot funded by ARENA.

CASE STUDY

CONSORT Consumer Energy Systems Providing Cost-Effective Grid Support) Pilot Project

In Australia, the CONSORT (Consumer Energy Systems Providing Cost-Effective Grid Support) pilot (2016–2019) funded by ARENA was a multidisciplinary partnership to investigate the feasibility of operating household batteries as Virtual Power Plants (VPP) in Bruny Island, Tasmania (ARENA, 2019). The CONSORT pilot program has provided critical analysis on household responses to VPPs. Consumer and community acceptance is a well-recognised concept to ensure the successful adoption of new technologies in the energy system (Burchell et al., 2016; Chilvers et al., 2018). Complexity is cited as a key barrier for consumer resistance to participate in prosumer technologies and encouraging communication to produce trust as a mechanism to create agency is cited in a recent Australian study of acceptance for a prosumer-led transition (Patterson-Hann and Watson, 2021). Given the potentially increased role of prosumers in smart batteries and smart electricity grids in the Australian energy transition, key insights into the social drivers to create agency and trust within prosumer communities from an overall systems perspective are needed.

In overseas jurisdictions, notably within the EU, studies examine the role for the collectivisation of prosumers (Brown, et al., 2020) to further develop diverse decision-making bodies and create active energy citizenship. For example, the Council of European Energy Regulators (CEER, 2019) recently provided a summary and analysis of the regulatory frameworks that could apply to collective prosumers. Of a comparison of nine EU countries, France, Germany, Netherlands, and the UK hold the most favourable regulatory frameworks for collective prosumers (Inês et al., 2020). Horstink et al. (2020) provide another EU comparative study on prosumer collectives, noting the need for the appropriate legal form and structure for prosumer initiatives requiring research and whether prosumers should provide production licences to receive scheme subsidies within the EU Clean Energy Package. An evident grasp on community responses and policies to guide collective prosumers is missing in the comparative Australian context. Research opportunities exist in exploring the opportunities and barriers to collective prosumer structures at the local community level in Australia considering unique geographical, social, political conditions and financial benefits for Australian communities.

RQ: What are the key factors driving people to develop and participate in collective prosumer structures, and what are the associated barriers and risks?

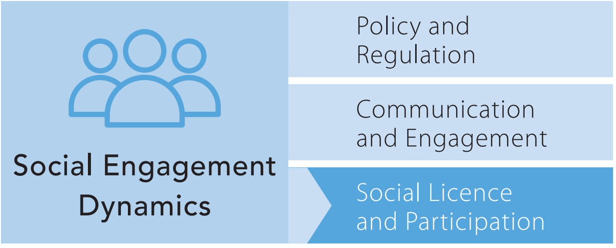
Embedding consumer confidence in energy infrastructure decentralisation

The social implications of a successful energy transition must consider unique challenges associated with a decentralised and dispersed energy system. As recognised by the World Energy Council, empowering consumers requires digitisation of distribution of energy resources as demand for electricity is earmarked to double globally by 2060 (World Energy Council, 2017). While the role of consumers is increasingly participatory, this leads to consumers in close geographical proximity competing for 'space' on the decentralised grid and the potential of disadvantaged consumers being 'outpriced'. Abdul Qadir recognises "while a wealthy household can afford the extra capital needed to invest in clean energy, the same cannot be expected from an underprivileged family. Inaccessibility to capital to invest in clean energy is one of the main barriers" (2021) for renewable energy technology uptake.

Methods to encourage social acceptance and consumer confidence in the energy transition using practical tools and research methods is an evident gap in the Australian literature. For example, research examining how vulnerable consumers can confidently access and harness 'smart technologies' to alleviate energy poverty could create confidence of an inclusive energy transition. Engaging in everyday 'smart technologies' could improve energy literacy (Mortz, 2021; Shirani et al., 2020) and consumer comfortability with a decentralised energy, storage and appliance system. A myriad of societal vulnerabilities must be addressed within a decentralised energy transition. For example, the emerging issue of 'smart' technologies being more readily taken up by younger consumers suggesting they may exacerbate existing divides, both generational and other (Shirani et al., 2020). Research into bridging generational, income, gender, and racial divides to embed consumer confidence in the Australian context is urgently needed.

According to AEMO, since 2012, nearly 90¢ of every dollar invested in energy generation in Australia is linked to wind and solar energy development (AEMO, 2021). In the common absence of strong energy policy to prioritise the energy transition at the consumer level, investors and consumers are actively engaging and leading the energy transition – resulting in Australia having one of the highest rooftop solar installation rates globally. By combining consumer and industry initiatives, such as the Australian industry energy transitions initiative and Energy Consumers Australia, future research could focus on leveraging consumer-focused investment to increase energy accessibility, knowledge, and opportunities to benefit and participate to execute a successful energy transition. Another industry-led framework to delivering consumer confidence and benefits in the energy transition is within Renewable Energy Zones spatially mapped at the federal and state level. For example, within the Queensland Renewable Energy Zones, the development and coordination of large-scale renewable energy by industry will match consumer and industry demand in key regional areas to manage grid constraints and congestion (Queensland Government, 2021).

RQ: How does age, income, gender and ethnic background impact upon people's engagement in the energy transition, including their consumer, prosumer and investor confidence?



3.3 Social licence and participation

Shifting to a more decentralised energy system is a dynamic process as social justice processes and outcomes can be enhanced or diminished by different transition pathways. This warrants more research attention on cultural and social attitudes towards the transition by different communities over time, with a focus on understanding the degree to which people want to participate in the transition and the new energy market, and how. Achieving a just transition also entails ensuring that benefits are disseminated equally and widely, with a particular focus on addressing and responding to the needs and concerns of vulnerable communities and households. For a truly inclusive energy transition, integrating multi-level and cross-sectoral perspectives from all aspects of society including importantly, Indigenous-led perspectives, is needed to better understand and facilitate genuine engagement with, and participation of, communities, at all scales and across all sectors.

3.3.1 Acceptance and support

> What are the current social attitudes towards the transition, by location, technology and sector (what is working, what isn't, why, and what could be changed)? How do consumers want to participate in the new energy market? How can it be made equitable for all sections of the community?

A key factor in reaching renewable energy targets is social acceptance as either a constraining or enabling factor in achieving these targets. Wolsink defines social acceptance as "not simply a set of static attitudes of individuals; instead, it refers more broadly to social relationships and organisations, and it is dynamic as it is shaped in learning processes" (Wolsink, 2010, p. 303). A growing body of literature focuses on the social acceptance of renewable energy generally (Jacobsson and Lauber, 2006). This is particularly apparent in renewable energy generation, such as wind energy, which has been subject to numerous studies examining community conflict in a myriad of jurisdictions due to environmental and human impacts (Hindmarsh and Matthews, 2008).

Australian state and territory governments have also taken steps to map community attitudes towards renewable energy. In 2015, the NSW Government report on Community Attitudes to Renewable Energy found a 91% support of renewable energy electricity in NSW (NSW Government, 2015). Yet only around 40% of participants in the Hunter/Central Coast and Southwest regions supported renewable energy. Region-specific engagement with communities that traditionally produce fossil fuels is an evident research gap across Australia.

An oft-cited framework for assessing community acceptance and support is based on a three-tiered analysis (McCarthy and Eagle, 2019; Wüstenhagen et al., 2007; Wolsink, 2012) comprising:

1. Socio-political acceptance of technologies, policies, and institutional change by key stakeholders
2. Community acceptance consisting of place-based acceptance of renewable energy projects in a specific location and effective support and satisfaction of energy infrastructure coupled with benefit-sharing and whether it meets social and economic needs, and
3. Market acceptance focused on the acceptance of industry actors, utilities, investors, and other economic stakeholders.

This framework utilises a nexus approach, whereby each dimension together is crucial to achieving a successful energy transition. In the Australian context, research on socio-political acceptance, community acceptance, and market acceptance has largely focused on renewable energy integration into the NEM which delivers electricity to many Australian communities.

A recent Australian study by McCarthy and Eagle (2019) surveyed the level of acceptance for the energy transition in Australia and found a low socio-political acceptance based on the following facts: fossil fuels being integral to the energy transition; the intermittency and lack of perceived energy security concerning renewable energy; and the threat of increased electricity prices due to the energy transition. The intermittency of renewable energy as a perceived threat is likely not due to technological failure, instead reflecting a lack of community and socio-political acceptance of externalities in electricity prices (Wolsink, 2012). In the Australian context, the South Australian blackout in 2016 represented an energy policy failure that resulted in diminishing community acceptance of renewable energy (Lucas, 2017). However, Proudlove, Finch, and Thomas (2020) found an increasing willingness to invest in community energy projects in Australia, with diminishing 'not in my back yard' (NIMBY) concerns leading to an increase in renewable energy support and acceptance.

RQ: What have been the changes in social attitudes towards renewable energy over the years across different Australian communities, if any, and what has driven that change?

Regardless of technology choice or jurisdiction, communities require inclusive and empowering decision-making processes that activate participation in renewable energy projects. In 2021, the NSW Government created the Regional Community Energy Fund to create 17.2 MW in electricity generation and up to 17.9 MW / 39.3 MWh of energy storage (NSW Government, 2020). The Regional Community Energy Fund creates several community-centred opportunities, including enabling access to renewable energy for low-income households. For example, projects funded include a 1 MW solar garden which is planned to be sited in Grong Grong and a community-owned solar and storage project to be sited in Goulburn. Research on these projects and other similar initiatives and tools can promulgate the transformative energy mixes needed to ensure renewable energy is affordable and accessible for regional communities and low-income households. For vulnerable off-grid communities in the Northern Territory (NT), the NT Solar Energy Transformation Program (SETuP) funded by ARENA, in partnership with the Power and Water Corporation Indigenous Essential Services Pty Ltd, has created renewable energy systems for 26 remote communities (ARENA, 2021).

Regarding wind energy in Australia, in 2015 the federal government sought to intervene and promote social acceptance by establishing the National Wind Farm Commissioner, recently renamed as the Australian Energy Infrastructure Commissioner in 2021, to resolve complaints from residents about operating wind farms (AEIC, 2021). The Australian Energy Infrastructure Commissioner's establishment and the increased scope of the commissioner role beyond wind to encompass large-scale solar, storage facilities, and major transmission projects represent community appetite and the need for meaningful engagement in the energy transition.

Another tool to engage communities and increase community acceptance is the presence of a local renewable 'energy champion' (Simpson, 2018). The literature identifies 'energy champions' as 'local level actors' who facilitate increased adoption of renewable energy, particularly residential solar (Nygren et al., 2015). To be successful, energy champions need to be trusted in the community with a legacy of commitment to public interest issues within communities (Noll et al., 2015; Hirt et al., 2021). The uptake of residential solar is thus not solely contingent on financial factors, such as incentives or patterns of income, but also social interactions (Simpson, 2016).

From a community energy perspective, Mey et al. (2016) surveyed the need for local governments by harnessing an 'enabling mode of governing' to actively engage and facilitate partnerships with community and private actors in renewable energy projects. Several states including New South Wales and Victoria now require large-scale renewable energy development approvals at the state level. Therefore, future research is needed that focuses on how local governments can increase community acceptance in small-scale renewable energy projects by promoting participation and collaborative partnerships with community members.

RQ: How can local governments effectively engage with community attitudes relating to the energy transition, including through supporting the development of opportunities for communities to benefit and participate?

The need to attain a social licence to operate was first raised in the context of the mining industry and has since gained scholarly, policy, and industry attention. As defined by Bice in the Australian mining context, the social licence to operate is "intended as a metaphor to encapsulate values, activities, and ideals which companies must espouse within society to ensure successful operation" (Bice, 2014, p. 637). Recent research has examined regional conflicts caused by renewable energy development without social acceptance and engagement including in Scotland, South Africa (Stephens and Robinson, 2020), and the Netherlands (Langbroek and Vanclay, 2012), and wind power in the Australian context (Hall, 2014). There is an increasing imperative to focus research attention on the principles of attaining a social licence to operate in the multiple pathways that the Australian energy transition will take. This raises questions of whether the social licence to operate framework needs to be modified in the context of specific energy transition projects to increase community understanding and approval of energy projects and diversify opportunities for communities to participate.

CASE STUDY

Social Licence: Otway Pilot CCS

The Otway Pilot CCS project undertaken by the CO2CRC provided an excellent opportunity to explore social issues pertaining to CCS in the community. One of the CO2CRC's key requirements for the project was community acceptance, therefore a community consultation plan was put in place early in 2005 with a focus on building successful relationships with stakeholders, informing and educating the community about CCS, and transparent, timely communication (Ashworth et al. 2011). Research regarding the Otway Basin project demonstrated that a critical challenge for project proponents considering the deployment of CCS projects across the country is to identify the benefits that a project will bring to the local community. The specific value proposition for a CCS project will vary depending on perceived local benefits and can depend on issues such as the size and socio-economic status of the community (Ashworth, 2010).

In examining the community engagement process and activities that occurred during the CO2CRC Otway Project, several successful strategies were identified (Ashworth et al., 2011), including: early proactive engagement with stakeholders; undertaking social research in the community to establish a baseline understanding; and the appointment of a trusted community member (local former schoolteacher) as a liaison officer to build trust between CO2CRC and the community; and the establishment of a community reference group. Major social issues regarding the project were also identified (Ashworth et al., 2011), including: the lack of communication, respect, and regard for landholders' properties by a seismic crew when seismic testing and landholder refusal of access in lieu of adequate compensation. These social issues experienced by the Otway Project are like those experienced in the ZeroGen project in Queensland (Ashworth et al., 2009), as well as CSG project proponents (GISERA, 2013), and are critical for the success of any project that involves CCS.

Another emerging issue to obtaining a social licence is the expansion of the existing electricity network to accommodate an influx of new renewable energy and storage projects. As indicated by AEMO's ISP modelling, Renewable Energy Zones and other regional corridors will require an inflow of new transmission infrastructure. A recent study by Re-Alliance (2021) indicates mitigating and mapping risks to obtaining a social licence for increased electricity transmission infrastructure is urgently needed to ensure communities are engaged and consulted.

Further, while much of the research investigating community acceptance of the energy transition has focused on renewable energy developments, there is a critical need to undertake more research on the community understanding and acceptance of emerging technologies such as hydrogen. Recent research on the Australian public's perception of hydrogen for energy found that while the majority of Australians have limited knowledge of hydrogen properties and its uses, they are supportive of the opportunities emerging from a potential hydrogen industry (Lambert and Ashworth 2018). As hydrogen pilot projects continue to be implemented on a federal and state level, including to inject hydrogen into existing gas networks to decarbonise gas usage, ongoing research is needed to understand how different stakeholders perceive the use of hydrogen over different scales. In particular, there is scope to assess the social impact of hydrogen infrastructure on local communities and Indigenous groups (Emodi et al. 2021). Further, as highlighted by Sandri et al. (2021), at the household level, "a transition to hydrogen will require the reorganisation of physical infrastructure, markets and new ways of communicating with and supporting customers to facilitate an equitable transition". Consequently, ongoing research is needed to examine consumer acceptance and understanding of hydrogen (Emodi et al. 2021), and ensure that existing consumer vulnerabilities in the gas network are not translated to residential consumers of hydrogen.

Critically, as the Australian public perceives that industry, research organisations and government all having a role in disseminating information about hydrogen developments (Lambert and Ashworth 2018), a coordinated approach to research on the perception and acceptance of hydrogen across these sectors is needed.

RQ: What is the current level of public understanding and social acceptance of hydrogen infrastructure and use over different scales, and how can any concerns be addressed?

3.3.2 Community considerations

> What are the broader implications of the energy transition on different communities (such as cultural, social, economic, health), including vulnerable populations? As traditional owners, how can we integrate Aboriginal and Torres Strait Islander perspectives, participation and leadership in the transition?[7]

Differential impacts on communities

For an inclusive transition, research is needed to better understand perspectives and values to facilitate genuine engagement with, and participation of, communities, at all scales and across all sectors. Community and consumer energy vulnerability relates to "the propensity of an individual to become incapable of securing a materially and socially needed level of energy service in the home" (Bouzarovski, 2014, p. 10). Beyond energy affordability, future research must focus on other dimensions of the energy transition on communities. This includes impacts relating to a shift in fuel type and use, ensuring replacement employment for fossil fuel-based industries, and creating community education tools to enhance people's energy knowledge, including of different technologies such as hydrogen. Most Australian research to date on vulnerable communities in the energy transition is focused on energy affordability, as articulated by Sandri et al. (2021).

7 This latter question is more effectively addressed in section 3.3.3.

However, a broader research and policy lens concerning vulnerabilities in the community is needed in the Australian context, to assess the impacts for consumers living with disabilities, mental illness, insecure housing tenure, and relationship breakdowns switching to renewable energy, electric vehicles, and other zero-carbon high energy density gaseous sources and fuel carriers (Nelson et al., 2019). The rapid pace of change needed to achieve a successful energy transition must ensure diverse and vulnerable communities are not disadvantaged due to economic, social, ethnic and gender differences. Conversely, opportunities for these demographics to benefit from and participate in the energy transitions should be identified and supported. Research targeting vulnerability in the transition to zero-carbon fuel sources in Australia is also needed to explore community and consumer views and pinpoint the knowledge gaps and support needed to manage the energy transition equitably.

RQ: How will the multiple pathways of the energy transition impact upon different vulnerable populations and how can these demographics be supported to benefit from and/or participate?

Co-location

The energy transition provides opportunities for energy technologies to facilitate value co-creation and co-benefits through energy co-location. Co-location involves the concurrent use of a site for renewable energy production and other activities, including agricultural production or additional forms of renewable energy generation. Pivotal to the energy transition are prospective opportunities for multiple energy technologies to co-exist and benefit neighbouring sectors and land uses. Co-location reconceptualises renewables as capable of contributing to a site, by preserving, aiding, or even improving land and water quality and the industries which rely on it.[8]

Internationally, research has been dedicated to the co-location of offshore energy. For example, studies examining the Gulf of Mexico and the UK (Hooper et al., 2018) explore the co-benefits of wild-capture fisheries and wind farms and the Canary Archipelago (Weiss et al., 2018). In Australia, the Blue Economy Cooperative Research Centre is currently undertaking a research program focused on the co-location of offshore aquaculture and energy to chart the potential logistical challenges. The program mapped five key aquaculture and energy supply chains to posit emerging solutions to challenges, decrease supply chain disruption and increase co-location. Findings included the lack of Australian research taking a systems-based approach to develop co-location multi-use offshore platforms (Blue Economy, 2020). However, the study did not include an examination of the social impacts and benefits of co-location. Given the federal government has recently introduced the *Offshore Electricity Infrastructure Bill* (2021), exploring the possibility of offshore wind co-locating with aquaculture and marine industries, the impacts and benefits on coastal communities could be an opportune research agenda (Minister for Energy and Emissions Reduction, 2021).

RQ: What are the co-benefits for stakeholders, industries, and communities engaging in offshore energy development?

Agrophotovoltaics (APV)

Agrophotovoltaics (APV) is another form of co-location where agricultural activities and photovoltaic solar production occur in the same location. With worsening volatile weather conditions and soil degradation, the land is increasingly being called upon to provide both food and energy for fast-growing populations productively. Within this context, recent Australian case law has categorised large-scale renewable energy as 'land hungry' (*Helios Volta Holdings Pty Ltd v Mildura Rural CC)*, and hence conflict has arisen by renewable energy development situated on agricultural land.

8 Initial investment costs for large-scale renewable energy can provide an inhibitor for project development. This has led to ARENA exploring potential co-location opportunities for wind and solar to reduce overall cost between 3-13 percent for CAPEX and 3-16 percent for OPEX (ARENA, 2016). However, exploring co-location opportunities and benefits beyond renewable energy generation and transmission, such as in Renewable Energy Zones (Baringa, 2020) established around Australia, remains limited.

APV can increase land-use efficiency (Gese, 2020; Guerin, 2019) and reduce the potential cumulative impacts of solar energy facilities. APV holds the potential to increase farm revenues by over 30% (Gorgian, 2020), increase land productivity by up to 70% (Weselek et al., 2019), and provide a cross-industry solutions to land-based pressures associated with food and electricity production. APV has recently reached a point of commercial viability and international studies focus on Europe, the US, and China, establishing the largest APV system globally with 700 MW capacity in Ningxia (Weselek et al., 2019). Recently in Australia, a trial of sheep grazing within a large-scale solar PV farm in Parkes, New South Wales took place (Parkes Solar Farm, 2021). However, there is a research gap in terms of understanding the social impacts and benefits of APV for agricultural communities.

APV systems can alter microclimatic conditions and, thus their success is influenced by crop type as well as the farming and PV practices employed (Weselek et al., 2019). Engagement with agricultural communities and landholders is important to ensure crop choice minimises yield loss (Weselek et al., 2019). This has greater ramifications for farmers than seems to be discussed in the literature; if they have not traditionally farmed crops that are APV suitable they will have to adapt to entirely new methods of farming. It may also be that many crops which are APV suitable cannot grow in certain climates or are specific to certain regions.

Agricultural community-led APV

Carefully thought-out, scientifically-backed planning is integral to the successful implementation of an APV system. This planning must involve members of both the solar generation and farming aspects of the system, as there is a need for collaborative and considered system management. Governments can guide this development with proactive policy by requiring feasibility assessments of a site-specific APV design as part of the permit process (Schindele et al., 2020). This process could enable an APV standard co-authored by representatives from the agricultural and solar energy sectors, providing agricultural subsidies and introducing an APV standard to guarantee quality assurance.

There is also room for greater involvement on a governmental level, as The Clean Energy Council has also recently developed an Australian Guide to Agrisolar for Large-scale Solar (Clean Energy Council, 2021). Suppose Australian jurisdictions encourage further research into the viability of APV systems. In that case, it will enable Australia to contribute to, capitalise on and benefit from technology dedicated to exploring the intersection between agricultural and energy industries. The case study of recent case law and governmental guidelines in Victoria shines a light on the potential governance of APV to ensure social benefits in Australia.

CASE STUDY

APV in Australia – Victoria Taking the Lead

Within Australia, Victoria has taken the lead in developing the only Solar Energy Facilities Design and Development Guideline to take APV into account. Victorian case law also suggests that solar farms have the potential to enhance a site via co-location. This represents a shift in other Australian policies and governance approaches to date on energy and land-use conflicts which centres on coexistence (CSIRO, 2014). Co-location is broader than coexistence in encompassing co-benefits arising from energy developments situated within multiple land uses aiming to provide a balanced, fair, economic, and sustainable use of land development. The concept of co-location moves beyond co-existence to "offer potential for a better balance to be achieved having regard to the policy tension around renewable energy facilities and agriculture" (Helios Volta [75]), it is only a viable method for balancing this tension where it is "structured based on solar energy facilities being subservient to agriculture and potentially assisting with diversifying farming incomes and acting to support ongoing agricultural activity within productive areas including irrigation districts" (*Helios Volta* [75]). At present, a strong network has not been established for the introduction of APV systems into Australia. Guerin (2019) has noted that, based on their understanding, the practical experience of APV in Australia is variable and inconclusive.

Australia's main opportunities and risks lie in the preparation and planning of APV introduction and co-location. As Davies (2019) notes, planning has an important role in the delivery, maintenance, and social licence to operate large-scale solar facilities but is presently severely undervalued and underutilised in Australia. The greater use of APV within Australia may encourage a re-framing planning law framework, as planners reconceptualise agricultural land and look to synergistic uses of the same site for both agriculture and energy production.

RQ: What are the social impacts, benefits, risks, and opportunities associated with agrophotovoltaics, and how can agricultural, pastoral, and Indigenous interests co-exist with agrophotovoltaics?

3.3.3 Benefits

> How can the benefits of the energy transition in general, and a potential renewable energy export boom in particular, best be captured for the wider community? What are the health and wellbeing impacts of a successful transition likely to be? How can they be enhanced?

Community benefit-sharing mechanisms: Community Benefit Funds

Transparent and fair distribution of benefits to communities hosting energy development is crucial to obtain a social licence to operate, realise co-benefits, and allow communities to flourish. Community benefit-sharing mechanisms can span multiple models. These include local content provisions, requiring a minimum level of goods and services that are bought or manufactured locally (Bazilian et al., 2020, 1) to revenue sharing and the development of energy tourism opportunities, such as a viewing platform (Munday et al., 2011).

A Clean Energy Council (2019) report presented case studies on different forms of benefit-sharing including neighbourhood benefit programs, the creation of grant funds, and community co-investment or co-ownership. Internationally, governmental organisations are increasingly recognising the need for social and community benefit tools. The most recent European Energy Policy, the European Green Deal, adopts a new Social Climate Fund to help EU Member States disseminate funding to communities to enhance energy efficiency and renewable energy. This includes measures to exempt vulnerable households from higher energy taxes (European Commission, 2021).

As renewable energy developments often take place under long-term leasehold interests, communities can undergo a socio-economic change in this period. Therefore, it is important to build flexibility within community benefits agreements in a life-cycle approach to address ongoing community needs. However, most benefit-sharing models deployed are voluntary and industry-led to date, with some state governments providing benefit-sharing suggestions, including the Victorian Government (Government of Victoria, 2017). It is also important to identify benefit-sharing methods that increase community acceptance and participation based on distributive fairness; rather than to stymie opposition (Bell et al., 2013). Research to date also recognises the important need to overcome conflict within communities and possible adverse psychological and social impacts (Hall et al., 2012). Thus, deploying community benefit schemes coupled with sustainable dissemination of skills to local community members is crucial to ensure knowledge transfers and a community-led approach to ongoing infrastructure upgrades. For example, the Windlab case study of Australia's first co-ownership model at the Coonooer Bridge Wind Farm provides a case study on delivering local benefits.

CASE STUDY

Windlab Coonooer Bridge Wind Farm, Bendigo, Victoria

Windlab has provided an innovative and important approach to benefit sharing in its Coonooer Bridge Wind Farm (20MW) project by offering neighbouring landholders within 3km or houses within 3.5 km radius of the six-wind turbines to contribute to buy into an equity stake of the project company. This scheme has resulted in neighbouring landholders constituting 3.5% ownership of the project. Windlab has also created a community grant program whereby landholders neighbouring the project have an equal vote in determining the dissemination of $25000 worth of grant funding to contribute to the social, economic and environmental sustainability of the community in the vicinity (Windlab, 2021). Finally, the appropriation of a Community Board Observer to act as a community representative on the Windlab Coonooer Bridge Wind Farm Board was elected in a commitment to ongoing transparency with the community.

Acknowledgement, respect, and engagement of Aboriginal and Torres Strait Islander Traditional Owners are essential to any community benefit mechanism. A place-based and Indigenous-led approach to energy development requires fundamental research to ensure that Traditional Owners benefit within the energy transition. While studies have recognised the importance of guiding principles for benefit-sharing agreements with Traditional Owners (O'Neill et al., 2019), the unique issues and opportunities for Aboriginal and Torres Strait Islander Traditional Owners require a transparent, equitable, and respectful Indigenous-led approach (Hunt et al., 2021). Such research is currently an evident gap in the Australian research landscape.

RQ: What mechanisms could be used to support diverse Australian communities, including Indigenous communities, to benefit from the transition?

Health Impacts and Co-Benefits

Health benefits of the energy transition are an increasingly important area of study in the international literature, particularly in the US (Buonocore et al., 2019) and the EU (Karlsson et al., 2020). The health benefits of successful climate change policies have been studied for decades. For example, Davis (1997) found that GHG reductions of 10-15% would avoid 7,000,000 particle-related annual deaths globally by 2020. However, the health co-benefits of renewable energy remain understudied. By displacing air pollutions, communities traditionally linked with fossil fuel production and experiencing high CO_2 and NO_x emissions can experience improvements in health conditions. This can lead to a reduction in healthcare costs which otherwise arise from the burden of addressing diseases resulting from fossil-fuel combustion and poor air quality (Armstrong 2018; Quam et al., 2017). Economic simulation models can be used to assess monetary benefits to health, with the annual benefits of both renewable energy deployment and energy efficiency measures equated to US$5.7–US$210 million and US$14–US$170 MWh (Buonocore et al., 2015).

Australian research has focused broadly on the health co-benefits of climate change mitigation. The annual *Medical Journal of Australia* (MJA)-*Lancet* Countdown reports comprehensively track the links between public health and climate change across 5 broad domains, including mitigation actions and health co-benefits. The 2021 report found that transitioning to low and zero emissions vehicles will generate significant health co-benefits and added that the decarbonisation of road transport will also lead to increased walking and cycling for shorter trips and thus help improve peoples' physical health (Beggs et al., 2021). In addition to research on the health co-benefits relating to reduced air pollution (Jalaludin and Guo, 2019), and people shifting towards alternative and active transport (Xia et al., 2015), there is emerging research attention on the interrelationship between climate change mitigation, health and equity in the housing sector.

Improving low-income households' access to energy efficiency measures is a health protection measure as having access to affordable essential services is a critical social determinant of health (Australian Council of Social services et al., 2017). Willand et al. (2019) found that small retrofits can mitigate growing energy demands of older Australians and provide better comfort while also reducing greenhouse gas emissions. However, the authors noted that the effectiveness of the retrofits was reduced by certain factors, such as the modes of energy bill payments and the physiological capabilities of the householders. Critically, the authors emphasised that health co-benefits through retrofits are not just a technical challenge, but also a social challenge that involves attention to householder practices and contextual influences. As such, there is a need for more interdisciplinary research on this area and a development of a shared vision in energy and health policies.

Conversely, another area of research interest is the increasing health risks associated with a failure to effectively mitigate climate change. There is widespread international research focusing on the health impacts of climate change, including infectious diseases, mortality and respiratory, cardiovascular or neurological outcomes (Rocque et al., 2021; Wu et al., 2016). In Australia, researchers have focused on mapping the public health and air pollution impacts of the Australian Black Summer Bushfires (Vardoluakis et al., 2020), and investigating the smoke related health burdens resulting from these Black Summer bushfires (Borchers Arriagada et al. 2020). Increasingly, researchers are also profiling the mental health impacts of bushfires on different communities, including both the Black Summer (Arjmand et al., 2021; Usher et al., 2020; McCallum et al., 2021) and Black Saturday bushfires (Bryant et al. 2021; 2018; 2014). Such research has made findings that the bushfires lead to acute and long-term mental health impacts, including post-traumatic stress disorder and depression (Bryant et al. 2014).

In Australia, climate change mitigation policies have been criticised for not meaningfully considering health co-benefits (Workman et al., 2016). However, the state and Australian governments have demonstrated greater commitment to researching and understanding the links between health and climate change in recent years. In 2019 the Western Australian Government Department of Health conducted an Inquiry led by the Chief Health Officer to investigate the implication of climate change and increased natural disasters on health. The resulting report sets a blueprint of 10 recommendations canvassing to protect the health of Western Australians facing increasing climate disaster risks in the next decade and how the medical sector can reduce emissions and waste (Government of Western Australia, 2020). More recently, the Australian Government have announced a new national research network; the Healthy Environments and Lives (HEAL) network. The multidisciplinary HEAL network aims to strengthen the Australian health system's resilience, preparedness and responsiveness to environmental change and extreme weather events through building national research capacity and capability in this area (National Health and Medical Research Council [NHMRC] 2021).

Increasing research attention on climate change and health co-benefits can assist decision-makers pursue an energy transition that benefits different communities, reduces emissions (Charlston et al., 2022), and, if carefully designed, generates substantial economic savings (Armstrong, 2018). In particular, there are calls for more transdisciplinary and cross-sector research on current and future climate-health adaptation and mitigation (Harper et al., 2021). While research on the mental health impacts of climate change is growing rapidly, there are several limitations and more research is needed on the link between climate change and mental health, including on the actual and potential mental health benefits of actions taken by individuals and communities throughout the various energy transition pathways, and policies facilitating such actions (Charlson et al., 2022). Research engaging with the energy-health-justice nexus is also needed to understand what structural factors and policies need to be implemented to justly mitigate climate change impacts on populations suffering from energy insecurity, including homeless and vulnerably housed populations (Bezgrebelna et al., 2021; Jessel et al., 2019). The healthcare sector itself has a large carbon footprint. However, achieving net-zero emissions in the health sector requires collaboration between many actors given the size and complex nature of healthcare operations. Further research is needed on the carbon footprint of the healthcare sectors of different Australian states to allow more targeted emissions-reduction interventions (Armstrong, 2018).

Aboriginal and Torres Strait Islander Health and Wellbeing Benefits

Aboriginal and Torres Strait Islander communities are more likely to have long-term health conditions, particularly remote communities with poorer access to and use of health services. These disparities combined with the close bond that Indigenous people have with traditional lands exacerbates the impacts of climate change for Indigenous communities (Australian Institute of Health and Welfare, 2020). As such, it is critical to consider Indigenous perspectives, needs and rights in the context of the energy transition, as indicated in section 3.1.1.

Specific research focused on understanding the health and wellbeing benefits of the energy transition on Aboriginal and Torres Strait Islander communities and how these benefits can be achieved is vital to achieving a successful, just, and equitable energy transition. Aboriginal communities living in off-grid regions typically rely on expensive diesel engines, creating energy poverty and health impacts. A successful energy transition presents co-benefits to overcome Indigenous socio-economic disadvantage and enable physical and mental health benefits of generating sustainable energy from Aboriginal and Torres Strait Islander lands. Most health impact assessments relating to the energy transition focus on climate change mitigation. However, an Indigenous-led approach to surveying the unique and important facets of Aboriginal and Torres Strait Islander health benefits associated specifically with the energy transition is urgently needed in both the research and policy contexts. Research is also needed to understand the barriers to uptake of new technologies for Indigenous communities. For example, transitioning to Electric Vehicles in Aboriginal and Torres Strait Islander communities presents a key co-benefit opportunity, partly because it can be used as a potential form of backup storage for households and help mitigate diesel-related health and wellbeing risks (Hunt et al. 2020). However, significant barriers to entry, charging infrastructure, and policy support to adopt Electric Vehicles are evident and need to be overcome.

There is also a need to engage more effectively with Indigenous communities and knowledges to enhance the health co-benefits of the energy transition for Indigenous communities. Critically, the HEAL network introduced above has strong Aboriginal and Torres Strait Islander leadership and will seek to respectfully integrate Indigenous and Western knowledge to build the nation's resilience, preparedness and responsiveness to climate change and extreme weather events (NHMRC 2021). For example, the HEAL Network recently collaborated with the Centre for Research Excellence in Strengthening Systems for Indigenous Health Care Equity. They released a Lowitja Institute (2021) report which summarises the extensive research that has been undertaken on understanding the links between climate change and the health impacts on Indigenous communities, and the mitigation and/or adaptation approaches to climate change that benefit the health of Indigenous communities. However, the report found there is limited research focusing on urban Indigenous communities as well as age and gender perspectives about climate change and adaptation. Further, only a small proportion of research has Aboriginal and Torres Strait Islander authorship or some level of community consultation. The report also does not provide an in-depth evaluation on the links between different energy transition pathways and the associated Indigenous impacts and health benefits. As such, there is a need to better value and centre Indigenous knowledges and rights as First Peoples and support Indigenous communities protect Country and mitigate climate change, including through decarbonising the energy system.

RQ: What are the health benefits and detriments associated with the energy transition for urban and regional Indigenous communities?

RQ: How can Indigenous communities and knowledges be better engaged to enhance the health and wellbeing co-benefits associated with the energy transition?

4. Key research questions, gaps, priorities, and opportunities for Australia

Section three above has identified numerous research questions, gaps and priorities in current research. Australian-specific research across policy and regulation, communication and engagement, and social license and participation will need to be pursued and will require both multidisciplinary and interdisciplinary considerations.

What follows below is a categorisation of these research questions formulated from the research into a mix of research questions:

- Urgent questions – where robust answers are needed to the question posed to address issues in the near future; and
- Strategic questions – which requires research to find robust answers to the question posed to address issues in the longer term.

4.1 Policy and Regulation

Urgent: Stocktake	Urgent: Markets and Government	Strategic: Decision-making
Report 1 framing questions		
Which policies and regulations are supporting, impeding or missing for the transition (what can we learn from overseas experience in these areas)?	What is the optimum mix (over time) of market forces and government planning and intervention over the course of the transition?	How can we integrate multi-factorial policy-making and regulatory tools to better consider the complexity of the energy transition across social, technical, and economic dimensions?
Further research questions from this report		
What emissions schemes and policies are required to complement technology developments and enable the most efficient (i.e., least cost), effective and fair long-term reduction of emissions?	What are the key opportunities for industry to contribute effectively to emissions reductions, and how can government policies be used to support these opportunities?	What regulatory architecture will be required for fugitive emissions and water use as Australia transitions to net-zero emissions?
To what extent are legislative reforms necessary, especially to improve the quality and content of corporate greenhouse gas reporting, so that the regulatory frameworks are agile and dynamic to manage emerging issues?	What are the best Government incentives and support needed to maximise the efficient contribution of the private sector to emissions reduction?	What regulatory reforms will be necessary to integrate emerging technologies, and be agile to new ones as they emerge?
How can Indigenous peoples, their rights and interests, be incorporated into the energy transition process and their needs addressed within a legislative and policy framework?		

4.2 Communication and Engagement

Urgent: Socio-political environment	Strategic: Citizen engagement	Strategic: Confidence
Report 1 framing questions		
How is Australian energy politics and our political economy different or similar to that in other developed nations (what can we learn from the overseas experience)?	How can communication platforms and messaging be used to best engage the breadth of Australian audiences, from national to local; what are the community (place-based) engagement issues and how does this relate to their identity, values, lived experiences, history and willingness to participate in the transition?	What are the drivers of consumer, prosumers and investor confidence? To what extent are consumers and investors leading or following the transition, and how can their preferences and engagement be leveraged?
Further research questions from this report		
What would be the advantages and disadvantages of any form of carbon-pricing, or related policy mechanisms, as part of other mechanisms to reach net zero emissions by 2050?	What are the current attitudes of different Australian communities in relation to the existing and emerging clean energy technologies and developments, and how can their preferences, values and ethics be leveraged and addressed by the energy transitions?	How does age, income, gender and ethnic background impact upon people's engagement in the energy transition, including consumer, prosumer and investor confidence?
	How can different communities be supported in developing and implementing community-owned renewable energy projects, including through multi-sectoral collaboration and coordination between community organisations, policymakers and industry? How can Social Impact Assessments (SIAs) be implemented to mitigate risks of community division to create 'cooperative discourses' and achieve a just transition?	What are the key factors driving people to develop and participate in collective prosumer structures, and what are the associated barriers and risks?

4.3 Social Licence and Participation

URGENT: Acceptance and support	STRATEGIC: Community considerations	STRATEGIC: Benefits
Report 1 framing questions		
What are the current social attitudes towards the transition, by location, technology and sector (what is working, what isn't, why, and what could be changed)? How do consumers want to participate in the new energy market? How can it be made equitable for all sections of the community?	What are the broader implications of the energy transition on different communities (such as cultural, social, economic, health), including vulnerable populations? As traditional owners, how can we integrate Aboriginal and Torres Strait Islander perspectives, participation and leadership in the transition?	How can the benefits of the energy transition in general, and a potential renewable energy export boom in particular, best be captured for the wider community? What are the health and wellbeing impacts of a successful transition likely to be? How can they be enhanced?
Further research questions from this report		
What have been the changes in social attitudes towards renewable energy over the years across different Australian communities, if any, and what has driven that change?	What are the co-benefits for stakeholders, industries, and communities engaging in offshore energy development?	What mechanisms could be used to support diverse Australian communities, including Indigenous communities, to benefit from the transition?
How can local governments effectively engage with community attitudes relating to the energy transition, including through supporting the development of opportunities for communities to benefit and participate?	What are the social impacts, benefits, risks, and opportunities associated with agrophotovoltaics, and how can agricultural, pastoral, and Indigenous interests co-exist with agrophotovoltaics?	What are the health benefits and detriments associated with the energy transition for urban and regional Indigenous communities?
What is the current level of public understanding and social acceptance of hydrogen infrastructure and use over different scales, and how can any concerns be addressed?	How will the multiple pathways of the energy transition impact upon different vulnerable populations and how can these demographics be supported to benefit from and/or participate in the energy transitions?	How can Indigenous communities and knowledges be better engaged to enhance the health and wellbeing co-benefits associated with the energy transition?

5. Action

The research questions identified in section 4 above represent the most pressing questions in the social engagement dynamics of the energy transition. To effect the energy transition, communication and engagement is critical. The research areas identified, and the research questions posed, reflect the concern that communities and vulnerable groups may well be left behind. The socio-political climate will set the tone within which the transition will take place. This means that input from all stakeholders is necessary to ensure that policy and regulation reflects intentions of community, industry and government.

The research needs to occur within all community groups, and it is imperative that both individual Indigenous groups, as well as prescribed body corporates and land councils are involved in all aspects of research where the energy transition impacts Australia's Indigenous peoples and communities. By undertaking research in the areas identified through the literature assessment, the energy transition is likely to progress with greater individual and community support, supported by effective policies and regulatory architecture, within a supportive and engaged socio-political climate.

6. References

Academy of Social Sciences in Australia. (2020). *Efficient, effective and fair climate policy: A discussion paper.*

AEIC. (2021). *Australian Energy Infrastructure Commissioner*. https://www.aeic.gov.au/about.

Albekov, A., Vovchenko, N., Medvedkina, Y., Medvedkin, Y. (2017). Green economy and economic growth: Trends, challenges and opportunities for the EU. *International Journal of Economics and Business Administration,* V,1, 49-62.

Arjmand, Seabrook, E., Bakker, D., and Rickard, N. (2021). Mental Health Consequences of Adversity in Australia: National Bushfires Associated With Increased Depressive Symptoms, While COVID-19 Pandemic Associated With Increased Symptoms of Anxiety. *Frontiers in Psychology*, 12, 635158–635158.

Armstrong, F. (2018). *Report: Review of Health and Climate Change Literature. To inform City of Melbourne Zero Net Emissions Strategy*. City of Melbourne.

Ashworth, P. (2010). Community attitudes toward carbon dioxide capture and storage. *AusIMM Bulletin, 3*, 66-67.

Ashworth, P., Pisarski, A., and Thambimuthu, K. (2009). Public acceptance of carbon dioxide capture and storage in a proposed demonstration area. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, *223*(3), 299-304.

Ashworth, P., Rodriguez, S., and Miller, A. (2011). *Case study of the CO2CRC Otway Project*. EP 103388, CSIRO.

Australian Council of Social Services, The Climate Institute, Brotherhood of St Lawrence. (2017). *Empowering disadvantaged households to access affordable, clean energy*. https://www.acoss.org.au/wp-content/uploads/2017/07/ACOSS_BSL_TCI_Empowering-households.pdf.

Australian Energy Market Commission (AEMC). (2021). *Integration of Distributed Energy Resources.* https://www.aemc.gov.au/sites/default/files/2021-08/Information%20sheet%20-%20Access%2C%20pricing%20and%20incentive%20arrangements%20for%20DER_0.pdf.

Australian Energy Market Operator (AEMO). (2017). *Final Report SA Black System 28 September 2016.* https://www.aemo.com.au/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Integrated-Final-Report-SA-Black-System-28-September-2016.pdf.

Australian Energy Market Operator (AEMO). (2018). SWIS Non-synchronous Energy Penetration Study Results. https://aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Fo rums/WA-Generator-Forum-WAGF.

Australian Energy Market Operator (AEMO). (2020). 2020 wholesale electricity market electricity statement of opportunities. In: Australian Energy Market Operator (Perth, Western Australia).

Australian Energy Regulator (AER). (2021). *Retailer Reliability Obligation.* https://www.aer.gov.au/retail-markets/retailer-reliability-obligation.

Australian Institute of Health and Welfare. (2020). *Australia's Health 2020: In brief*. https://www.aihw.gov.au/getmedia/2aa9f51b-dbd6-4d56-8dd4-06a10ba7cae8/aihw-aus-232.pdf.aspx?inline=true.

Australian PV Institute, (2020). *Percentage of dwellings with a PV system by State/ Territory. In: Australian PV Institute*. https://pv-map.apvi.org.au/historical.

Australian Renewable Energy Agency (ARENA). (2016). *Co-Location Investigation.* https://arena.gov.au/assets/2016/01/AECOM-Wind-solar-Co-location-Study-1.pdfhttps://arena.gov.au/assets/2016/01/AECOM-Wind-solar-Co-location-Study-1.pdf.

Australian Renewable Energy Agency (ARENA). (2017). *Who's missing out on renewables? It's time to talk about energy justice*. https://arena.gov.au/blog/energy-justice/.

Australian Renewable Energy Agency (ARENA). (2019). *CONSORT Project Final Report Project Results and Lessons Learnt*. https://arena.gov.au/assets/2019/06/consort-project-results-lessons-learnt.pdf.

Australian Renewable Energy Agency (ARENA). (2021). *NT Solar Energy Transformation Program.* https://arena.gov.au/projects/northern-territory-solar-energy-transformation-program/.

Australian Renewable Energy Agency (ARENA). (2019). *CONSORT Project Final Report Project Results and Lessons Learnt.* https://arena.gov.au/assets/2019/06/consort-project-results-lessons-learnt.pdf.

Baker, S. (2016). Mexican energy reform, climate change, and energy justice in indigenous communities. *Natural Resources Journal*, *56*, 369–90.

Baringa. (2020). *Development of Renewable Energy Zones in the NEM.* https://arena.gov.au/assets/2020/01/development-of-renewable-energy-zones-in-the-nem.pdf.

Basalla, G. (1980). *Energy and Civilization. Science, Technology and the Human Prospect*. (New York: Pergamon Press).

Bauwens, T. (2016). Explaining the diversity of motivations behind community renewable energy, *Energy Policy, 93*, 278–290.

Bauwens, T., and Devine-Wright, P. (2018). Positive energies? An empirical study of community energy participation and attitudes to renewable energy. *Energy Policy*, *118*, 612-625.

Baxter, J., Walker, C., Ellis, G., Devine-Wright, P., Adams, M., and Smith Fullerton, R. (2020). Scale, history and justice in community wind energy: An empirical review. *Energy Research and Social Science*, *68*, 101532.

Bayer, P., and Aklin, M. (2020). The European Union emissions trading system reduced CO2 emissions despite low process. *PNAS, 117*(16), 8804-8812.

Bazilian, M., Cuming, V., Kenyon, T. (2020) Local-content rules for renewables projects don't always work. *Energy Strategy Reviews*, 32, 1 – 10.

Beckfield, J, D.A Evrard, Sampson, R, and Waters, M. (2020). *Social Impacts of Energy Transition.* http://ceepr.mit.edu/files/papers/The-Roosevelt-Project-WP-2.pdf.

Beggs, P.J., Zhang, Y., McGushin, A., Trueck, S., Linnenluecke, M. K., Bambrick, H., Berry, H. L., Jay, O., Rychetnik, L., Hanigan, I. C., Morgan, G. G., Guo, Y., Malik, A., Stevenson, M., Green, D., Johnston, F. H., McMichael, C., Hamilton, I., and Capon, A. G. (2021). The 2021 report of the MJA–Lancet Countdown on health and climate change: Australia increasingly out on a limb. *Medical Journal of Australia*, *215*(9), 390–392.e22.

Bell, D., Gray, T., Haggett, C., and Swaffield, J. (2013). Re-visiting the 'social gap': public opinion and relations of power in the local politics of wind energy. *Environmental Politics*, *22*(1), 115-135.

Bezgrebelna, M., McKenzie, K., Wells, S., Ravindran, A., Kral, M., Christensen, J., ... & Kidd, S. A. (2021). Climate Change, Weather, Housing Precarity, and Homelessness: A Systematic Review of Reviews. International Journal of Environmental Research and Public Health, 18(11), 5812.

Bice, S. (2014). What gives you a social licence? An exploration of the social licence to operate in the Australian mining industry. *Resources, 3*(1), 62–80.

Blue Economy. (2020). *5.20.003 Logistics Challenges to Offshore/High Energy Co-location of Aquaculture and Energy Industries*. https://blueeconomycrc.com.au/wp-content/uploads/2021/03/BECRC_Flyer_5.20.003_e160321.pdf.

Blue Economy. (2021). *Ethics, Values and Social License in the Blue Economy*. https://blueeconomycrc.com.au/projects/ethics-values-and-social-license-in-the-blue-economy/.

Borghei-Ghomi, Z., and Leung, P. (2013). An Empirical Analysis of the Determinants of Greenhouse Gas Voluntary Disclosure in Australia. *Accounting and Finance Research*, *2*(1).

Borghei, Z., Leung, P., and Guthrie, J. (2016). the nature of voluntary greenhouse gas disclosure – an explanation of the changing rationale Australian evidence. *Meditari Accountancy Research, 24*(1), 113-133.

Boston, A., Geoff, B., and Steph, B. (2020). *Snowy 2.0 and Beyond: The Value of Large-Scale Energy Storage*. https://www.researchgate.net/publication/340135645_Snowy_20_and_Beyond_The_Value_of_Large-Scale_Energy_Storage.

Boute, A. (2017) The impossible transplant of the EU Emissions Trading Scheme: the challenge of Energy Market Regulation. *Transnational Envir0nmental Law*, *6*(1), 59-85.

Brown, D., Hall, S. and Davis, M. (2019). Prosumers in the post subsidy era: an exploration of new prosumer business models in the UK. *Energy Policy, 35*, 110984.

Brown, D., Hall, S., and Davis, M. (2020). What is prosumerism for? Exploring the normative dimensions of decentralised energy transitions. *Energy Research and Social Science*, *66*, 101475.

Bryant, Waters, E., Gibbs, L., Gallagher, H. C., Pattison, P., Lusher, D., MacDougall, C., Harms, L., Block, K., Snowdon, E., Sinnott, V., Ireton, G., Richardson, J., and Forbes, D. (2014). Psychological outcomes following the Victorian Black Saturday bushfires. *Australian and New Zealand Journal of Psychiatry*, *48*(7), 634–643.

Bryant, Gibbs, L., Gallagher, H. C., Pattison, P., Lusher, D., MacDougall, C., Harms, L., Block, K., Sinnott, V., Ireton, G., Richardson, J., and Forbes, D. (2018). Longitudinal study of changing psychological outcomes following the Victorian Black Saturday bushfires. *Australian and New Zealand Journal of Psychiatry*, *52*(6), 542–551.

Bryant, Gibbs, L., Colin Gallagher, H., Pattison, P., Lusher, D., MacDougall, C., Harms, L., Block, K., Ireton, G., Richardson, J., Forbes, D., Molyneaux, R., and O'Donnell, M. (2021). The dynamic course of psychological outcomes following the Victorian Black Saturday bushfires. *Australian and New Zealand Journal of Psychiatry*, *55*(7), 666–677.

Borchers Arriagada, Palmer, A. J., Bowman, D. M., Morgan, G. G., Jalaludin, B. B., and Johnston, F. H. (2020). Unprecedented smoke‐ related health burden associated with the 2019–20 bushfires in eastern Australia. *Medical Journal of Australia*, *213*(6), 282–283.

Buonocore, J., Hughes, E., Michanowicz, D., and Heo, J. (2019). Climate and health benefits of increasing renewable energy deployment in the United States. *Environmental Research Letters*, *14*, 11, 1 – 13.

Buonocore, J., Luckow, P., Norris, G., Spengler, J., Biewald, B., Fisher, J., and Levy, J. (2015). Health and climate benefits of different energy-efficiency and renewable energy choices. *Nature Climate Change*, *6*, 100-105.

Burchell, K., Rettie, R., and Roberts, T. (2016). Householder Engagement with Energy Consumption Feedback: The Role of Community Action and Communications. *Energy Policy*, *88*, 178–186.

Busby, J., Baker, K., Bazilian, M., Gilbert, A., Grubert, E., Rai, V., Rhodes, J., Shidore, S., Smith, C., and Webber, M. (2021). Cascading Rrisks: understanding the 2021 winter blackout in Texas. *Energy Research and Social Science, 77*, 1-12.

Byrne, J., and Hoffman, S. M. (1996). The ideology of progress and globalization of nuclear power. in J. Byrne, and S. M. Hoffman. *Governing the Atom: The Politics of Risk* (11–46). New York: Routledge.

Byrne, J., Glover, L., and Martinez, C. (2002). The production of unequal nature. In Byrne, J., Glover, L., and Martinez, C. *Environmental Justice: Discourses in International Political Economy* 261–291. New York: Routledge.

Byrne, J., Martinez, C., and Ruggero, C. (2009). Relocating energy in the social commons: ideas for a sustainable energy utility. *Bulletin of Science Technology and Society, 29*, 81–94.

Byrne, J., Toly, N., and Glover, L. (2006). Energy as a social project: recovering a discourse. In Byrne, J and Toly, N, *Transforming Power: Energy, Environment, and Society in Conflict* (1–32) New York: Routledge.

Byrne, J., Wang, Y.-D., Lee, H., and Kim, J. (1998). An equity and sustainability-based policy response to global climate change. *Energy Policy, 26*, 335–343.

Byrom, S., Bongers, S., Garnett, A., and Boston, A (2020). A case study of Australia's emissions reduction policies – an electrical planners' perspective. *Journal of Environmental Management.*

Capellán-Pérez, I, Campos-Celador, Á., and Terés-Zubiaga, J. (2018). Renewable Energy Cooperatives as an instrument towards the energy transition in Spain. *Energy Policy*, *123*, 215–229.

CEER. (2019). *Customers and Retail Markets and Distribution Systems Working Groups Regulatory Aspects of Self Consumption and Energy Communities*. https://www.ceer.eu/documents/104400/6509669/C18-CRM9_DS7-05-03_Report+on+Regulatory+Aspects+of+Self-Consumption+and+%20Energy+Communities_final/8ee38e61-a802-bd6f-db27-4fb61aa6eb6a?version=1.1.

Charlson, F., Ali, S., Augustinavicius, J., Benmarhnia, T., Birch, S., Clayton, S., Fielding, K., Jones, L., Juma, D., Snider, L., Ugo, V., Zeitz, L., Jayawardana, D., La Nauze, A., & Massazza, A. (2022). Global priorities for climate change and mental health research. Environment International, 158, 106984–106984.

Chester, L., Elliot, A., and Crossley, P. (2018). New forms of solar PV provisioning needed to advance energy justice for lower income households. Asia Pacific Solar Research Conference, 4-6 December 2018, Sydney, Australia.

Chilvers, J., H. Pallett, and T. Hargreaves, (2018). Ecologies of Participation in Socio-Technical Change: The Case of Energy System Transitions. *Energy Research and Social Science*, *42*, 199–210.

Clean Energy Council. (2019). *A Guide to Benefit Sharing Options for Renewable Energy Projects*. https://assets.cleanenergycouncil.org.au/documents/advocacy-initiatives/community-engagement/guide-to-benefit-sharing-options-for-renewable-energy-projects.pdf.

Clean Energy Council. (2021). *Australian Guide to Agrisolar for Large-Scale Solar*. https://assets.cleanenergycouncil.org.au/documents/resources/reports/agrisolar-guide/Australian-guide-to-agrisolar-for-large-scale-solar.pdf.

Clean Energy Regulator. (2019). *About the National Greenhouse and Energy Reporting scheme*. http://www.cleanenergyregulator.gov.au/NGER/About-the-National-Greenhouse-and-Energy-Reporting-scheme#n1.

Clean Energy Regulator. (2020). *The REC Registry*. http://www.cleanenergyregulator.gov.au/OSR/REC/The-REC-Registry.

Clean Energy Regulator. (2021a). *About the Emissions Reduction Fund*. http://www.cleanenergyregulator.gov.au/ERF/About-the-Emissions-Reduction-Fund.

Clean Energy Regulator. (2021b). *Hepburn Wind Community Co-operative*. http://www.cleanenergyregulator.gov.au/Infohub/case-studies/renewable-energy-target-case-studies/hepburn-wind-community-cooperative.

Climate Action Tracker. (2020). *Australia*. https://climateactiontracker.org/countries/australia/.

ClimateWorks. (2021). *State and Territory climate action: leading policies and programs in Australia.* https://www.climateworksaustralia.org/resource/state-and-territory-climate-action-leading-policies-and-programs-in-australia/.

Colvin, R.M., Witt, B., Lacey, J., and Witt, K. (2019). The community cost of consultation: Characterising the qualitative social impacts of a wind energy development that failed to proceed in Tasmania, Australia. E*nvironmental Impact Assessment Review, 77*, 40 – 48.

Coalition for Community Energy and Community Power Agency (2016). *Renewables for All: A priority energy policy agenda for Australia.* https://cpagency.org.au/wp-content/uploads/2019/07/Renewables-For-All-Energy-Agenda-2015.pdf.

Coalition for Community Energy. (2021). *About C4CE*. https://c4ce.net.au/aboutc4ce/.

Community Power Agency. (2014). *Community-owned renewable energy a how to guide*. https://www.environment.nsw.gov.au/resources/communities/cpa-community-energy-how-to.pdf.

Community Power Hub. (2019). *Licola Wilderness Village Upgrades*. https://www.communitypowerhub.net.au/portfolio-items/licola-wilderness-village-upgrades/.

Coram, A., and Anthony, S. (2021). *Technological pathways for reducing emissions: uncertainty and options costs for the teacher's pets, Working model, Preliminary draft, Macroeconomics Advisory*. https://macroeconomics.com.au/wp- content/uploads/2021/04/Technological_pathways_for_reducing_emissions_MEA_Preliminary_Draft.pdf.

CSIRO. (2015). *Future Grid: Change and Choice. The Future Grid Forum's Analysis of Australia's Potential Electricity Pathways to 2050*. https://publications.csiro.au/rpr/download?pid=csiro:EP1312486anddsid=DS13.

CSIRO. (2014). *Farmer's perceptions of coexistence between agriculture and large scale coal seam gas development*. https://gisera.csiro.au/wp-content/uploads/2018/03/Ag-Land-2-Working-Paper.pdf.

CSIRO. (2015). *Future Grid: Change and Choice. The Future Grid Forum's Analysis of Australia's Potential Electricity Pathways to 2050*. https://publications.csiro.au/rpr/download?pid=csiro:EP1312486anddsid=DS13.

Davies, G. (2019). Impacts on Agricultural Land from Queensland's Energy Transition. *Environmental and Planning Law Journal, 36*, 587.

Davis, D. L. (1997). Short-term improvements in public health from global-climate policies on fossil-fuel combustion: An interim report. *The Lancet*, *350*, 1341–1349.

Denis-Ryan, A., Proudlove, R., and Bravo, C. (2020). *Net Zero Momentum Tracker – resources sector*. ClimateWorks. https://www.climateworksaustralia.org/resource/net-zero-momentum-tracker--resources-sector/.

Denmark Community Windfarm Ltd. (2021). *Community Energy*. http://www.dcw.net.au/community.htm.

Department of Industry, Science and Technology (DIST). (2021). *Make it Happen: The Australian government's Modern Manufacturing Strategy*. https://www.industry.gov.au/data-and-publications/make-it-happen-the-australian-governments-modern-manufacturing-strategy.

Department of Industry, Science, Energy and Resources. (2019). *Australia's National Hydrogen Strategy*. https://www.industry.gov.au/data-and-publications/australias-national-hydrogen-strategy.

Department of Industry, Science, Energy and Resources. (2020). *First Low Emissions Technology Statement*. https://www.industry.gov.au/sites/default/files/September%202020/document/first-low-emissions-technology-statement-2020.pdf.

Department of Industry, Science, Energy and Resources. (2021a). *Low Emissions Technology Statement 2021*. https://www.industry.gov.au/sites/default/files/November%202021/document/low-emissions-technology-statement-2021.pdf.

Department of Industry, Science, Energy and Resources. (2021a). *Unlocking the Beetaloo: The Beetaloo Strategic Basin Plan*. https://www.industry.gov.au/sites/default/files/January%202021/document/beetaloo-strategic-basin-plan.pdf.

Dixon, T., McCoy, S., and Havercroft, I. (2015). Legal and Regulatory Developments on CCS. *International Journal of Greenhouse Gas Control*, *40*, 431-448.

Emodi, N. V., Lovell, H., Levitt, C., and Franklin, E. (2021). A systematic literature review of societal acceptance and stakeholders' perception of hydrogen technologies. *International Journal of Hydrogen Energy*, *46*(60), 30669-30697.

Energex. (2017). *Energex Battery Trials: Preliminary Findings Report*. https://www.energex.com.au/__data/assets/pdf_file/ 0006/528396/EGX170906-energex-battery-trails-report-2017-for-upload-and-distribution.pdf.

Energex. (2017). , *Energex Battery Trials: Preliminary Findings Report*. https://www.energex.com.au/__data/assets/pdf_file/ 0006/528396/EGX170906-energex-battery-trails-report-2017-for-upload-and-distribution.pdf.

Energy Australia. (2020) *Energy Consumption*. https://www.energy.gov.au/data/energy-consumption#:~:text=Fossil%20fuels%20%28coal%2C%20oil%20and%20gas%29%20accounted%20for,followed%20by%20coal%20%2829%25%29%20and%20natural%-20gas%20%2826%25%29.

Ernst and Young. (2014). *Strategic options for delivering ownership and benefit sharing models for wind farms in NSW*. https://www.environment.nsw.gov.au/resources/communities/EY-wind-farm-shared-benefits.pdf.

European Commission. (2021). *European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions*. https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541.

Finkel, A., K. Moses, C. Munro, T. Effeney, and M. O'Kane. (2017). *Independent Review into the Future Security of the National Electricity Market: Blueprint for the Future*. https://www.energy.gov.au/sites/default/files/ independent-review-future-nem-blueprint-for-the-future-2017.pdf.

Fischer, B., Gutsche, G., Wetzel, H. (2021) Who wants to get involved? Determining citizen willingness to participate in German renewable energy cooperatives. *Energy Research and Social Science*, *76*, 102013.

Georgeson, L., Maslin, M., and Poessinouw, M. (2017). The global green economy: a review of concepts, definitions, measurement methodologies and their interactions. *Geography and Environment,* 4(1), 1-23.

GISERA. (2013). *The social licence to operate and Coal Seam Gas development*. Brisbane, CSIRO. https://gisera.csiro.au/wp-content/uploads/2018/03/Social-5-Literature-Review-Report.pdf.

Government of Victoria. (2017). *Community Engagement and Benefit Sharing in Renewable Energy Development: A Guide for Renewable Energy Developers*. https://www.energy.vic.gov.au/__data/assets/pdf_file/0027/91377/Community-Engagement-and-Benefit-Sharing-in-Renewable-Energy-Development.pdf.

Government of Western Australia. (2020). *Climate Health WA Inquiry Final Report*. https://ww2.health.wa.gov.au/Improving-WA-Health/Climate-health-inquiry/Climate-Health-WA-Inquiry-Final-Report.

Gower, A. (2021). Energy Justice in Apartment Buildings and the Spatial Scale of Energy Sustainable Design Regulations in Australia and the UK. *Frontiers in Sustainable Cities*, *25*, 1-12.

Gross, C. (2007). Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. *Energy Policy*, *35*(5), 2727-2736.

Grubert, E., and Skinner, W. (2017). A town divided: community values and attitudes towards coal seam gas development in Gloucester. *Australia Energy Res. Soc. Sci.*, *30*, pp. 43-52.

Guerin, T. (2019). Impacts and opportunities from large-scale solar photovoltaic (PV) electricity generation on agricultural production. *Environmental Quality Management*, *28*, 7-14.

Guruswamy, L. (2010). Energy justice and sustainable development. *Colorado Journal of International Environmental Law Policy*, *21*, 231–275

Hall, N., Ashworth, P., and Shaw, H. (2012). *Exploring community acceptance of rural wind farms in Australia*. https://publications.csiro.au/publications/publication/PIcsiro:EP117743.

Hall, N. (2014). The discourse of "social licence to operate": case study of the Australian wind industry. *AIMS Energy*, *2*, 443-460

Hanke, F., Guyet, R., and Feenstra, M. (2021). Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases. *Energy Research and Social Science*, *80*, 102244.

Harper, Cunsolo, A., Babujee, A., Coggins, S., De Jongh, E., Rusnak, T., Wright, C., and Domínguez Aguilar, M. (2021). Trends and gaps in climate change and health research in North America. Environmental Research, 199, 111205–.

Heffron, R. (2020). The role of justice in developing critical minerals. *The Extractive Industries and Society*, *7*(3), 855-863.

Heffron, R. and McCauley, D. (2017). The concept of energy justice across the disciplines. *Energy Policy, 105*, 658–667.

Heffron, R., and McCauley, D. (2014). Achieving sustainable supply chains through energy justice. *Applied Energy, 123*, 435–437.

Heffron, R., Halbrügge, S., Körner, M., Obeng-Darko, N., Sumarno, T., Wagner, J., Weibelzahl, M. (2021) Justice in solar energy development, *Solar Energy*, *218*, 68-75.

Helios Volta Holdings Pty Ltd v Mildura Rural CC [2019] VCAT 1478 (Date of order 23 Sept).

Hepburn Wind. (2021). *Origins*. https://www.hepburnwind.com.au/hepburn-wind-origins/.

Hindmarsh, R., Matthews, C. (2008). Deliberative Speak at the Turbine Face: Community Engagement, Wind Farms, and Renewable Energy Transitions, in Australia. *Journal of Environmental Policy and Planning*, *10*, 217 – 232.

Hirt, L., Sahakian, M., Trutnevyte, E. (2021). What socio-technical regimes foster solar energy champions? Analysing uneven photovoltaic diffusion at a subnational level in Switzerland. *Energy Research and Social Science*, *74*, 101976

Holstenkamp, L. Kahla, F. (2016). What are community energy companies trying to accomplish? An empirical investigation of investment motives in the German case. *Energy Policy*, *97*, 112–122.

Hooper, T. Ashley, M. Austen, M. (2018). In Yates, K. and Bradshaw, C. *Offshore Energy and Marine Spatial Planning* (189-213) UK: Routledge.

Horstink, L, Wittmayer, J, Ng, K, Pontes Luz, G, Marín-González, E., Gährs, S, Campos, I., Holstenkamp, L., Oxenaar, S., and Brown, D. (2020). Collective Renewable Energy Prosumers and the Promises of the Energy Union: Taking Stock. *Energies, 13*, 421.

Hunt, J. O'Neill, L., Riley, B., and Maynard, R. (2020). *Response to A Path Forward: Developing the Western Australian Government's Aboriginal Empowerment Strategy*. https://www.wa.gov.au/sites/default/files/2020-10/Brad%20Riley%20-%20Centre%20for%20Aboriginal%20Economic%20Policy%20Research%20Attachment%201.pdf.

Hunt, J., Riley, B., O'Neill, L., and Maynard, G. (2021). Transition to Renewable Energy and Indigenous People in Northern Australia: Enhancing or Inhibiting Capabilities? *Journal of Human Development and Capabilities*, *22*, 360 – 378.

Hunter, T., and Brockett, R. (2014) Regulation of water use and environmental impacts in unconventional gas extraction: the Western Australian and Queensland frameworks. *Australian Energy and Resources bulletin, 1*(1), 3-6.

IAP2. (2021). P*ublic Participation Spectrum*. https://iap2.org.au/resources/spectrum/.

Inderberg, H., Tews, T, K., and Turner, B. (2018). Is there a Prosumer Pathway? Exploring household solar energy development in Germany, Norway, and the United Kingdom. *Energy Research and Social Science, 42*, 258-269.

Inês, C, Guilherme, L, P, Ester, M, Swantje, G, Stephen, H and Lars, H. (2020). Regulatory challenges and opportunities for collective renewable energy prosumers in the EU. *Energy, 128*, 111212.

International Cooperative Alliance. (2021). *Cooperative identity, values and principles*. https://www.ica.coop/en/cooperatives/cooperative-identity.

International Energy Agency (IEA) (2016). *World Energy Outlook 2016*. IEA, Paris.

International Energy Agency (IEA) (2019). *The Future of Hydrogen*. IEA, Paris.

Jacobsson, S., and Lauber, V. (2006). The politics and policy of energy system transformation: Explaining the German diffusion of renewable energy technology. *Energy policy, 34*(3), 256–276.

Jalaludin, B., and Guo, Y. (2019). Reduction of air pollution-related deaths associated with climate change mitigation in Sydney, Australia. *Environmental Epidemiology*, *3*, 179.

Jenkins, K., Sovacool, B., Mouter, N., Hacking, N., Burns, M. and McCauley, D. (2021). The methodologies, geographies, and technologies of energy justice: a systematic and comprehensive review. *Environmental Research Letters, 16*, 043009.

Jessel, S., Sawyer, S., and Hernández, D. (2019). Energy, poverty, and health in climate change: a comprehensive review of an emerging literature. Frontiers in public health, 7, 357.

Jiang, A., Yuan, H. Li, D. (2021). Energy management for a community-level integrated energy system with photovoltaic prosumers based on bargaining theory. *Energy*, *225*, 120271.

Kalkbrenner, B.J., Roosen, J. (2016). Citizens' willingness to participate in local renewable energy projects: The role of community and trust in Germany. *Energy Research and Social Science*, *13*, 60–70.

Karlsson, M., Alfredsson, E., Westline, N. (2020) Climate Policy Co-Benefits: A Review. *Climate Policy*, *3*, 292 – 316.

Keck, F., Lenzen, M., Vassallo, A., and Li, M. (2019). The impact of battery energy storage for renewable energy power grids in Australia. *Energy*, *173*, 647-657.

Koirala, B. Hakvoort, R. (2017). Chapter 18 - Integrated Community-Based Energy Systems: Aligning Technology, Incentives, and Regulations. In Sioshansi, F, *Innovation and Disruption at the Grid's Edge How Distributed Energy Resources are Disrupting the Utility Business Model* (Pages 363-38). Cambridge: Academic Press.

Lambert, V., and Ashworth, P. (2018). *The Australian public's perception of hydrogen for energy*. Report for the Australian Government's Renewable Energy Agency. https://arena.gov.au/assets/2018/12/the-australian-publics-perception-of-hydrogen-for-energy.pdf.

Langbroek, M and Vanclay, F. (2012). Learning from the social impacts associated with initiating a windfarm near the former island of Urk, The Netherlands. *Impact Assessment and Project Appraisal*, *30*, 167-178.

Laslett, D., Carter, C., Creagh, C., and Jennings, P. (2017). A large-scale renewable electricity supply system by 2030: Solar, wind, energy efficiency, storage and inertia for the South West Interconnected System (SWIS) in Western Australia. *Renewable Energy, 113*, 713-731.

Lehtonen, M. and de Carlo, L. (2019). Community energy and the virtues of mistrust and distrust: Lessons from Brighton and Hove energy cooperatives. *Ecological Economics*, *164*, 106367.

Lopes, M. A. R., C. Henggeler Antunes, K. B. Janda, P. Peixoto, and N. Martins. (2016). The Potential of Energy Behaviours in a Smart(er) Grid: Policy Implications from a Portuguese Exploratory Study. *Energy Policy, 90*, 233–245.

Lowitja Institute. (2021). *Climate Change and Aboriginal and Torres Strait Islander Health*. Prepared by the Healthy Environments and Lives Network and Centre for Research Excellence in Strengthening Systems for Indigenous Health Care Equity. https://www.lowitja.org.au/content/Image/Lowitja_ClimateChangeHealth_1021_D10.pdf.

Lucas, A. (2017). Confected conflict in the wake of the South Australian blackout: diversionary strategies and policy failure in Australia's energy sector. Energy Research and Social Science, *149*, 149-159.

Macpherson-Rice, B., Munro, P., de Rijke, K. (2020). Energy solution or future pollution? Applying an energy justice perspective to coal seam gas in New South Wales. *Australian Geographer*, *51*(1), 69-85.

Magalhaes, N. (2021). The green investment paradigm: Another headlong rush. *Ecological Economics* 190.

Magnusson, D and Palm, J. (2019). Come Together—The Development of Swedish Energy Communities. *Sustainability*, *11*(2), 1056.

McCallum, Dunkley, K., Hotham, E., and Suppiah, V. (2021). Bushfires, COVID-19 and Australian community pharmacists: ongoing impact on mental health and wellbeing. *The International Journal of Pharmacy Practice*, *29*(2), 186–188.

McCarthy, B., Eagle, L. Attitudes of Incumbent Regimes to a Renewable Energy Transition: A Case Study of Queensland, Australia. In Eweje G., Bathurst R. *Clean, Green and Responsible? CSR, Sustainability, Ethics and Governance* (227-252). New York: Springer

McCauley, D., Ramasar, V., Heffron, R., Sovacool, B., Mebratu, D., Mundaca, L., (2019). Energy justice in the transition to low carbon energy systems: Exploring key themes in interdisciplinary research. *Applied Energy*, *233*, 916-921.

McDonald, M., (2021) After the Fires? Climate change and security in Australia. *Australian Journal of Political Science, 56*(1), 1-18.

McKibbin, W., (2020). *Efficient, Effective and Fair Climate Policy: a discussion paper* <https://socialsciences.org.au/publications/efficient-effective-and-fair-discussion-paper/>.

Mey, F., Diesendorf, M., MacGill, I. (2016). Can local government play a greater role for community renewable energy? *A case study from Australia. Energy Research and Social Science*, *21*, 33-42.

Mignon, I and Rüdinger, A. (2016). The impact of systemic factors on the deployment of cooperative projects within renewable electricity production – An international comparison. *Renewable and Sustainable Energy Reviews*, *65*, 478–488.

Moore, J., and Shabani, B. (2016). A critical study of stationary energy storage policies in Australia in an international context: the role of hydrogen and battery technologies.

Morrison, S (2021). *Address National Press Club, Barton ACT, Transcript*. https://www.pm.gov.au/media/address-national-press-club-barton-act.

Moser, R, Xia-Bauer, C, Thema, J and Vondung, F. (2021).Solar Prosumers in the German Energy Transition: A Multi-Level Perspective Analysis of the German Mieterstrom Model. *Energies, 14*, 1188.

Munday, M., Bristow, G., and Cowell, R. (2011). Wind Farms in Rural Areas: How far do community benefits from wind farms represent a local economic development opportunity? *Journal of Rural Studies*, *27*(1), 1-12.

National Health and Medical Research Council. (2021). *$10 million national network to build resilience to the human health impacts of environmental change.* https://www.nhmrc.gov.au/about-us/news-centre/10-million-national-network-build-resilience-human-health-impacts-environmental-change.

Noll, D., Dawes, C., and Rai, V. (2014). Solar community organizations and active peer effects in the adoption of residential PV. *Energy Policy*, *67*, 330–343.

NSW Government. (2015). *Community Attitudes to Renewable Energy in NSW*. https://www.environment.nsw.gov.au/resources/actionmatters/community-attitudes-renewable-energy-150419.pdf.

NSW Government. (2021). *Social Impact Assessment Guideline.* https://shared-drupal-s3fs.s3.ap-southeast-2.amazonaws.com/master-test/fapub_pdf/SIA+Guideline+20210622v6_FINAL.pdf.

Nygren, N.A., Kontio, P., Lyytimäki, J., Varho, V., and Tapio, P. (2015). Early adopters boosting the diffusion of sustainable small-scale energy solutions. *Renewable and Sustainable Energy Reviews*, *46*, 79–87.

O'Neill, L. Thorburn, K. and Hunt, J. (2019). *Ensuring Indigenous benefit from large-scale renewable energy projects: Drawing on experience from extractive industry agreement making*. Working Paper No. 127, Centre for Aboriginal Economic Policy Research, Australian National University, Canberra. https://caepr.cass.anu.edu.au/research/publications/ensuring-indigenous-benefit-large-scale-renewable-energy-projects-drawing.

Oesterholt, F., Koeman-Stein, N., Oldenbroek, V., Boere, J., and van Wiljk, A. (2018). *The role of water in a future hydrogen economy.* Paper presented at the IWA world Water Congress and Exhibition 2016.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.

Parkes Solar Farm. (2021). *About Agrisolar.* https://parkessolarfarm.com.au/about-agrisolar-2/.

Patterson-Hann, V and Watson, P. (2021). The precursors of acceptance for a prosumer-led transition to a future smart grid. *Technology Analysis and Strategic Management, 3*, 1 – 15.

Pellegrini-Masinia, G., Pirnib, A., Maran, S. (2020). Energy justice revisited: A critical review on the philosophical and political origins of equality. *Energy Research and Social Science, 59*, 101310.

Planning Institute Australia (2021) *Policy Social Impact Assessment.* https://www.planning.org.au/policy/social-impact-assessment-1010.

Poruschi, L., and Ambrey, C. (2019). Energy justice, the built environment, and solar photovoltaic (PV) energy transitions in urban Australia: A dynamic panel data analysis. *Energy Research and Social Science*, *48*, 22-32.

Proudlove, R., Finch, S., Thomas, S. (2020). Factors influencing intention to invest in a community owned renewable energy initiative in Queensland, Australia. *Energy Policy*, *140*, 111441.

Quam, V. G., Rocklöv, J., Quam, M., and Lucas, R. A. (2017). Assessing greenhouse gas emissions and health co-benefits: a structured review of lifestyle-related climate change mitigation strategies. International journal of environmental research and public health, 14(5), 468.

Re-Alliance. (2021). *Building Trust for Our Transmission Earning the Social Licence needed to pug in Australia's Renewable Energy Zones*. https://d3n8a8pro7vhmx.cloudfront.net/vicwind/pages/2616/attachments/original/1628044697/RE-Alliance_July_21_Building_Trust_for_Transmission_Earning_the_social_licence_needed_to_plug_in_Australia's_Renewable_Energy_Zones-compressed.pdf?1628044697.

REScoop. (2021). *Home*. https://www.rescoop.eu/.

Rocque, R. J., Beaudoin, C., Ndjaboue, R., Cameron, L., Poirier-Bergeron, L., Poulin-Rheault, R.-A., Fallon, C., Tricco, A. C., and Witteman, H. O.. (2021). Health effects of climate change: an overview of systematic reviews. BMJ open, 11(6), e046333.

Schindele, S., Trommsdorff, M., Schlaak, A., Obergfell, T., Bopp, G., Reise, C., Braun, C., Weselek, A., Bauerle, A., Högy, P., Goetzberger, A., Weber, E. (2020). Implementation of agrophotovoltaics: Techno-economic analysis of the price-performance ratio and its policy implications. *Applied Energy*, *265*, 114737.

Schneising, O., Burrows. J., Dickerson, R., Buchwitz, M., and Reuter, H. (2012). Remote sensing of fugitive methane emissions form oil and gas production in North American tight geologic formations. *Earth's Future, 2*(10), 548-558.

Siciliano, G., Urban, F., Tan-Mullins, M., and Mohan, G. (2019). Large dams, energy justice and the divergence between international, national and local development needs and priorities in the global south. *Energy Research and Social Science*, *41*, 199–209.

Simpson, G. (2018). Looking beyond incentives: the role of champions in the social acceptance of residential solar energy in regional Australian communities. *Local Environment*, *23*, 127 – 143.

Simpson, G., and Clifton, J. (2016). Subsidies for residential solar photovoltaic energy systems in Western Australia: Distributional, procedural and outcome justice. *Renewable and Sustainable Energy Reviews*, *65*, 262 -273.

Snowy Hydro Limited. (2018). *Snowy Hydro Limited and its Controlled Entities. Annual Report for the financial period ended 30 June 2018*. https://www.snowyhydro.com.au/wp-content/uploads/2020/04/FINAL-SIGNED-24.09.18-Snowy-Hydro-Limited-Financial-Statements-for-the-Year-Ended-30-June-2018-2.pdf.

Soliman Hunter, T. and Taylor, M. (2020). The national energy Market 2.0: The role of energy storage in managing Australia's energy trilemma. *Oil, Gas and Energy Law Journal* (Online), *18*(6)

Sovacool B., Heffron, R., McCauley, D and Goldthau, A. (2016). Energy decisions reframed as justice and ethical concerns. *Nature Energy*, *1*, 1–6.

Stephens, S., and Robinson, B. (2021) The social license to operate in the onshore wind energy industry: A comparative case study of Scotland and South Africa. *Energy Policy*, *148*, 111981

Szulecki, K., and Overland, I. (2020). Energy democracy as a process, an outcome and a goal: A conceptual review. *Energy Research and Social Science*, *69*, 101768.

Talus, K. (2013). *EU Energy Law and Policy: A critical account*. Oxford University Press.

Taylor, M. and Soliman Hunter, T. (2021). The Hydrogen Hope? Challenges and Opportunities for an Australian Hydrogen Economy. *Oil, Gas and Energy Law Journal* (Online), *19*(1).

The Co-Op Federation. (2021). *Understanding Cooperatives*. https://fed.coop/co-operatives-in-australia-a-manual/part-one-understanding-co-operatives/co-operative-identity-values-and-principles/.

Usher, Ranmuthugala, G., Maple, M., Durkin, J., Douglas, L., Coffey, Y., and Bhullar, N. (2021). The 2019–2020 bushfires and COVID- 19: The ongoing impact on the mental health of people living in rural and farming communities. *International Journal of Mental Health Nursing*, *30*(1), 3–5.

Vanclay, F. (2003). International principles for social impact assessment. *Impact Assessment and Project Appraisal*, *21*(1), 5–11.

Vanclay, F. (2017). Principles to gain a social licence to operate for green initiatives and biodiversity projects. *Current Opinion in Environmental Sustainability*, *29*, 48-56.

Vanclay, F., and Esteves M. (Eds.), (2011). *New Directions in Social Impact Assessment: Conceptual and Methodological Advances.* Edward Elgar Pub, Cheltenham.

Vanclay, F., Esteves, A., Aucamp, I., and Franks, D. (2015). S*ocial Impact Assessment: Guidance for Assessing and Managing the Social Impacts of Projects.* http://www.iaia.org/uploads/pdf/SIA_Guidance_Document_IAIA.pdf.

Victorian Government. (2019). *Solar Energy Facilities Design and Development Guideline*. https://www.planning.vic.gov.au/__data/assets/pdf_file/0028/428275/Solar-Energy-Facilities-Design-and-Development-Guideline-August-2019.pdf.

Walker, G., Devine-Wright, P., Hunter, S., High, H., and Evans, B. (2010). Trust and community: Exploring the meanings, contexts and dynamics of community renewable energy. *Energy policy*, *38*(6), 2655-2663.

Webler, T., Kastenhol, H., and Renn, O. (1995). Public participation in impact assessment: a social learning perspective. E*nvironmental Impact Assessment Review*, *15*(5), pp. 443-463.

Weaver, J.L. (2003). 'Sustainable Development in the Petroleum Sector', in A Bradbrook and RL Ottinger (eds), *Energy Law and Sustainable Development (2003) IUCN Environment Policy and Law Paper*, (47), 45.

Weiss, C., Ondiviela, B., Guinda, X., del Jesus, F., Gonzales, J., Guanche, R., and Juanes, J. (2018). Co-location opportunities for renewable energies and aquaculture facilities in the Canary Archipelago. *Ocean and Coastal Management, 166*, 62 – 71.

Weselek, A., Ehmann, A., Zikeli S., Lewandowski I., Schindele S., and Högy P. (2019). Agrophotovoltaic Systems: Applications, Challenges, and Opportunities. A Review. *Agronomy for Sustainable Development*, *39*(4), 1–20.

Western Australian government. (2020. Distributed energy resources roadmap. https://www.wa.gov.au/government/distributed-energy-resources-roadmap.

Wierling, A., Schwanitz, V., Zeiß, J., Bout, C., Candelise,C., Gilcrease, W., and Gregg, J. (2018). Statistical Evidence on the Role of Energy Cooperatives for the Energy Transition in European Countries. *Sustainability, 10*(9), 3339.

Wilkinson, S., John, M., and Morrison, G.M. (2021). Rooftop PV and the renewable energy transition; a review of driving forces and analytical frameworks. *Sustainability*, *13*(10), 5613, 2021.

Willand, N., Maller, C., and Ridley, I. (2019). Addressing health and equity in residential low carbon transitions – Insights from a pragmatic retrofit evaluation in Australia. *Energy Research and Social Science*, *53*, 68–84.

Windlab, Coonooer Bridge Wind Farm. (2021). *Grant Program* https://coonooerbridgewindfarm.com.au/grant-program/.

Witt, K., Whitton, J., and Rifkin, W. (2018). Is the gas industry a good neighbour? A comparison of UK and Australia experiences in terms of procedural fairness and distributive justice. *The Extractive Industries and Society, 5*(4), 547.

Wolsink, M. (2010). Contested environmental policy infrastructure: Socio-political acceptance of renewable energy, water, and waste facilities. *Environmental Impact Assessment Review, 30*(5), 302–311.

Wolsink, M. (2012). The research agenda on social acceptance of distributed generation in smart grids: Renewable as common pool resources. *Renewable and Sustainable Energy Reviews, 16*(1), 822–835.

Workman, A., Blashki, G., Karoly, D., and Wiseman, J. (2016). The Role of Health Co-Benefits in the Development of Australian Climate Change Mitigation Policies. *International Journal of Environmental Research and Public Health*, *13*(9), 1 – 19.

Wu, X., Lu, Y., Zhou, S., Chen, L., and Xu, B. (2016). Impact of climate change on human infectious diseases: Empirical evidence and human adaptation. Environment international, 86, 14-23.

Wüstenhagen, R., Wolsink, M., and Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy, 35*(5), 2683–2691.

Xia, Nitschke, M., Zhang, Y., Shah, P., Crabb, S., and Hansen, A. (2015). Traffic-related air pollution and health co-benefits of alternative transport in Adelaide, South Australia. *Environment International*, *74*, 281–290.

Yildiz, Ö., Rommel, J., Debor, S., Holstenkamp, L., Mey, F., Müller, J., Radtke, J., and Rognli, J (2015). Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda. *Energy Research and Social Science*, *6*, 59-73.

Zander, K., Simpson, G., Mathew, S., Nepal, R., and Garnett, S. (2019). Preferences for and potential impacts of financial incentives to install residential rooftop solar photovoltaic systems in Australia. *Journal of Cleaner Production, 230*(1), 328-338.

Zedan, S., and Miller, S. (2017). Using social network analysis to identify stakeholders' influence on energy efficiency of housing. *International Journal of Engineering Business Management*, *9*(11), 1-11.

Zhang, J., and Liu, J. (2020). Overview of research on carbon information disclosure. *Frontiers of Engineering Management*, *7*, 47–62.

Appendix 1

Table: Climate change policy and legislative implementation, Australian states and territories.

Jurisdiction	Policy overview	Legislative action
South Australia	South Australian Government Climate Change Action Plan 2021-2025 Focus areas: 4. Clean energy transformation: accelerate transition to renewable energy economy – reduce greenhouse gas emissions within the state to 50% of 2005 levels by 2030, then achieve net-zero emissions by 2050 5. Climate smart economy by attracting and supporting business innovation and grown thin renewables and support of the circular economy 6. Climate smart agriculture, landscapes and habits 7. Low emissions transport 8. Climate smart built and urban environments	Climate Change and Greenhouse Emissions Reduction Act 2007
Queensland	Pledge for net-zero emissions by 2050 Coastal hazard adaptation plan Policy initiatives relating to solar power in homes, however these have been wound back in recent years.	No legislation at this time
Tasmania	Targeted legislation in 2008, requiring a reduction in greenhouse gas emissions to 60% below 1990 levels by 2050. Reviewed 2021. Committed to net-zero emissions by 2050, but under review, recommendation to commit to net-zero by 2030. Emissions reduction in Tasmania focuses on the implementation of business resource efficiency programs including the PowerSmart Business programme. Domestic implementation of emissions reduction is undertaken through the PowerSmart Homes programme.	Climate Change Act 2008
Victoria	Legislated a net-zero emissions target by 2050 Requiring five-year interim targets and policy objectives all designed to ensure the 2050 target will be me	Climate Change Act 2017
Northern Territory	Heavy investment in Gas in cooperation with the commonwealths Beetaloo basin strategy. Developing both the resource and existing infrastructure to realise its policy vision of a world class gas production, manufacturing, and services hub by 2030. Has climate change plan: • net-zero emissions, • a resilience to climate change for people and industry, • develop opportunities for green and low carbon technologies, • assistance in managing the risks of climate change.	No legislation at this time

Jurisdiction	Policy overview	Legislative action
Australian Capital Territory	Climate change strategy 2010-25 developed in conjunction with ACT Planning strategy and other goals such as health, waste and nature conservation The current targets are to reduce emissions (from 1990 levels) by: • 50-60% by 2025 • 565-75%by 2030 • 90-95% by 2040 • 100% (net-zero emissions) by 2050.	Climate change and Greenhouse Gas Reduction Act 2010.
Western Australia	Introduction of priority themes and practical actions to enhance climate resilience and support the low carbon transition: • Clean manufacturing and future industries • Transforming energy generation and use • Storing carbon and caring for our landscapes • Lower-carbon transport • Resilient cities and regions • Government leadership Developed the 'GHG Emissions policy for major projects' Programs and initiatives include clean energy future fund, electric vehicle strategy and addressing climate resilience.	No legislation at this time
New South Wales	Energy efficiency (NSW Energy savings scheme) Achieve net-zero emissions by 2050 Resilience to a changing climate Two prong approach – emissions reduction and impact adaptation Draft *Climate Change Fund Strategic Plan* released for consultation. Embed climate change considerations in all aspects of government	No legislation at this time

ACOLA
AUSTRALIAN COUNCIL OF LEARNED ACADEMIES

By providing a forum that brings together great minds, broad perspectives and knowledge, ACOLA is the nexus for true interdisciplinary cooperation to develop integrated problem solving and cutting edge thinking on key issues for the benefit of Australia.

www.acola.org

Working together

The Australian Council of Learned Academies (ACOLA) combines the strengths of the Australian Learned Academies.

LEARNED ACADEMIES

Academy of the Social Sciences in Australia

Australian Academy of Science

Australian Academy of the Humanities

ATSE Australian Academy of Technology & Engineering

Australian Academy of Health and Medical Sciences

ACOLA™
AUSTRALIAN COUNCIL OF LEARNED ACADEMIES