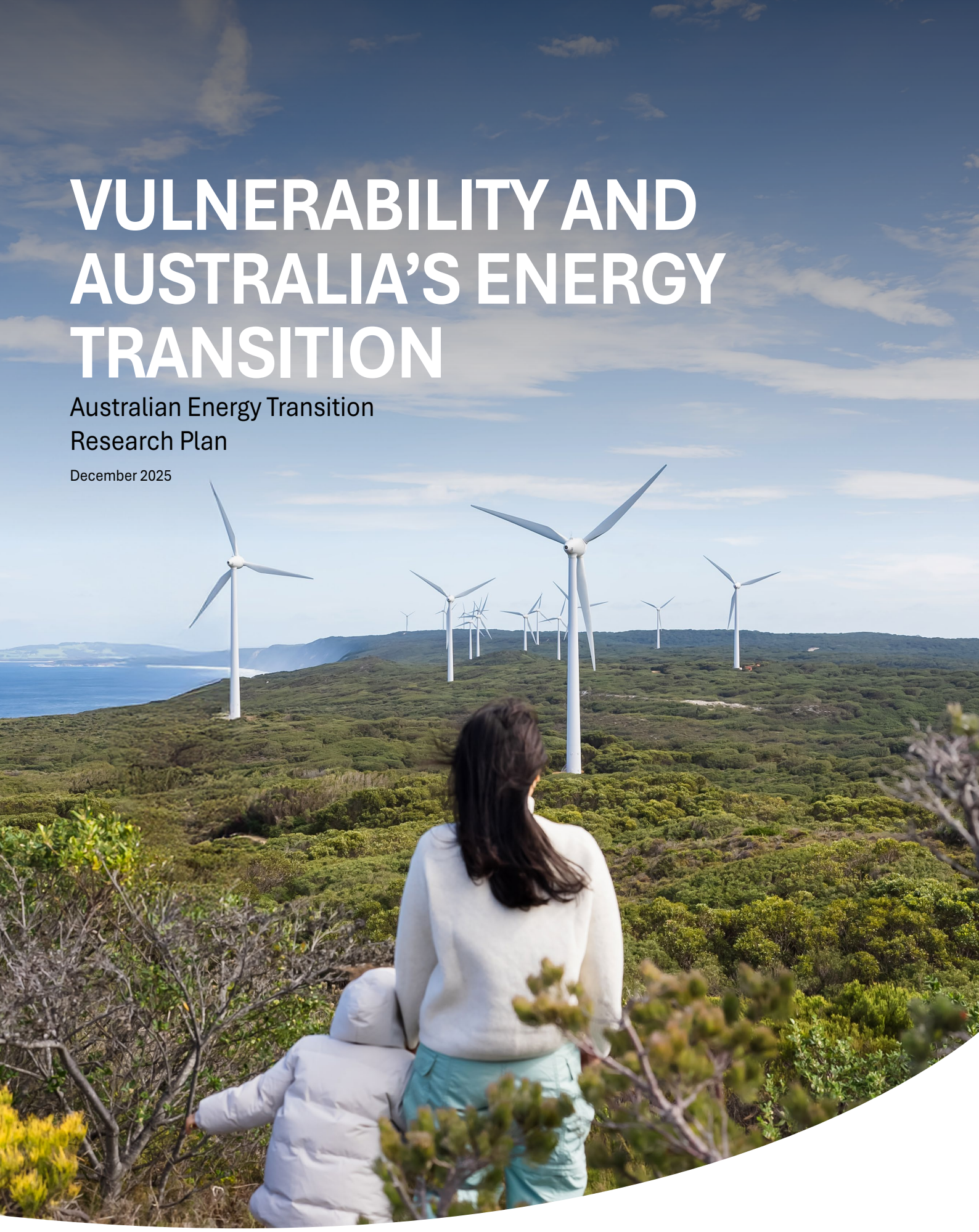
VULNERABILITY AND AUSTRALIA'S ENERGY TRANSITION

Australian Energy Transition Research Plan

December 2025



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The governance and monitoring of the Australian Energy Transition Research Plan is undertaken by the Australian Council of Learned Academies (ACOLA), an independent, not-for-profit research organisation that brings together Australia's five Learned Academies to provide interdisciplinary advice addressing national priorities and global challenges.

Through the combined expertise of nearly 3,500 Fellows and engagement with academic, public, private and not-for-profit sectors, ACOLA bridges knowledge gaps and translates research and innovation into evidence-based insights that inform policy, drive innovation, and deliver tangible outcomes for Australia.

Oversight of the project is provided by a Steering Committee comprising Fellows from the Learned Academies, who contribute multidisciplinary expertise across the energy and research sectors to ensure that the Research Plan supports a robust, inclusive and evidence-informed energy transition.

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ISBN: 978-0-6459638-2-3

PEER REVIEW

This report has been reviewed by an independent panel of experts. Members of this review panel were not asked to endorse the report's conclusions and findings. The Review Panel members acted in a personal, not organisational, capacity and were asked to declare any conflicts of interest.

ACOLA gratefully acknowledges their contribution.

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DATE OF PUBLICATION

December 2025

PUBLISHER

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

SUGGESTED CITATION

Bice, S & Parsons, R 2025, *Vulnerability and Australia's Energy Transition*. Report for the Australian Council of Learned Academies (ACOLA) Australian Energy Transition Research Plan. 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.

CONTENTS

GLOSSARY

Abbreviation	Meaning
ACOLA	Australian Council of Learned Academies
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Agency	The capacity of an individual, group or institution to act, independently or collectively, in a given situation.
Benefit sharing	The purposeful and equitable distribution of advantages or benefits arising from major projects or initiatives.
CER	Consumer Energy Resource
DCCEEW	(Commonwealth) Department of Climate Change, Energy, the Environment and Water
Distributed energy generation	Electricity generation from local, usually consumer-side sources, including rooftop solar, local battery storage or biomass.
ECCMC	Energy and Climate Change Ministerial Council
Energy justice	A form of environmental justice focused specifically on energy systems and the full energy resources lifecycle.
Energy transition	The shift from current, dominant energy resource(s) to others; here from fossil fuels to renewable energy sources.
Energy poverty	The inability of a household to access adequate energy usage levels to satisfy basic needs.
Energy vulnerability	Susceptibility of individuals or households to experience economic, social, health or other problems related to limited or no access to reliable, safe and affordable energy services.
ESG	Environmental, social and governance
Fair, equitable and just energy transition ('Fair and just transition')	Energy transition characterised by fair and equitable distribution of benefits and burdens; inclusive, accessible and transparent decision-making processes; and recognition and redress of historically, culturally and socially embedded inequalities, biases and vulnerabilities.

Abbreviation	Meaning
FPIC	Free, prior and informed consent
Fuel poverty	The inability of a household to access necessary energy services, including those for heating, necessary to a healthy and comfortable living environment.
IPCC	International Panel on Climate Change
NEM	National Energy Market
Presumed benevolence	Unconscious framing bias in which scientific advice, technological improvement or socio-environmental need creates a *presumption* that the project, policy or initiative is *benevolent* and will therefore be readily accepted by the public.
Resilience	The capacity of individuals, communities or systems to absorb shocks and changes and to 'bounce back' or adapt to those circumstances.
REZ	Renewable energy zone
SIA	Social impact assessment
Social licence	The level of acceptance of a policy, project or initiative within a defined community.
Social transition	The community and societal concerns that affect the speed, quality and success of the energy transition.
Vulnerability	Susceptibility to harm. Degrees of vulnerability are shaped by a variety of factors. Some factors might be intrinsic to an individual or community, such as ethnicity or location. Other factors might relate to external circumstances, including social or environmental changes. In all cases, vulnerability increases risk to individuals, groups, communities or societies.
Vulnerable households	Households with characteristics, usually lower socio-economic status, that make them more susceptible than others to negative impacts of policies or societal circumstances, often due to financial constraints and limited information to make informed choices.
VSD	Vulnerability Scoping Diagram

EXECUTIVE SUMMARY

The renewable energy transition will affect the daily lives of all Australians – positively for some, but with risks and challenges for others. There is a broad commitment to a 'fair, just and equitable energy transition' in which the benefits and burdens of Australia's clean energy transformation are shared equitably (ACOLA - Examining JUST energy metrics (Taylor, 2025)).

By improving our shared understanding of vulnerability – defined simply as susceptibility to harm – in Australia's energy transition, we are far better placed to deliver a fair, just and equitable energy transition. Research on vulnerability and the energy transition, however, is limited, especially when compared to scientific and economic research. We need to improve our knowledge about which individuals and communities may be most likely to experience negative impacts and how and why harms might occur.

This report contributes to the Australian Council of Learned Academies (ACOLA) *Energy Transition Research Plan*, with a focus on Theme 2: Social engagement dynamics (Clarke et al., 2022b). It identifies the knowledge gaps, research questions and opportunities that Australia should prioritise over particularly the next five years and beyond to better understand and address vulnerability in the energy transition. The report reviews international and domestic academic research, policies, and on-ground case studies in a variety of research disciplines to do this.

Improved understanding of vulnerability and the energy transition can help close knowledge gaps, build on existing research strengths, establish research priorities, deliver evidence to inform decisions, design policies, improve public understanding of the transition, and reduce or prevent harms.

The report identifies priority research topics that can help to achieve these aims. Priority topics where Australian research is lacking or lags international research include 'intersectionality' (the interactions of different social characteristics), energy vulnerability/energy poverty, gender and the energy transition, and consideration of vulnerabilities in energy policy. Priority topics where Australia has existing strengths that could be leveraged to focus more on vulnerability include Aboriginal and Torres Strait Islander Australians and vulnerability, the relationship between location (i.e. rural/remote) and vulnerability, transition jobs and skills, energy justice, critical minerals, social licence, social impact assessment, and benefit sharing.

The report sets out a clear framework to support consistent and comprehensive approaches to research on vulnerability and the energy transition across the diverse priority topics identified. It offers research questions to spark research investigations and guide attention towards key issues identified in the academic literature. The report also identifies three cross-cutting themes for all research into vulnerability and the energy transition: structural and institutional dimensions of vulnerability; lived experiences of vulnerability; and development of methodologies to advance a fair, equitable and just energy transition.

Together, the background knowledge, research gaps identified, and analytical framing provide Australia with a clear and important foundation for targeted and impactful research on vulnerability and the energy transition.

1 INTRODUCTION

KEY MESSAGES

- **Australia's energy transition will affect every household and community – positively for some, but with risks and challenges for others.** Understanding *who* is most vulnerable to harm, *how* and *why*, is critical to ensuring the transition is fair and equitable.
- **Research on vulnerability in the energy transition remains limited compared to technological and economic research.** This report identifies key knowledge gaps, research strengths and future priorities to guide evidence-informed policy and improve social, cultural and economic outcomes across the transition.
- **The energy transition is more than a technological shift – it is a complex social process.** It will require wide-ranging participation, careful management of trade-offs, and stronger attention to social licence, communication, and equity to ensure benefits are shared fairly.
- **A fair, equitable and just transition depends on recognising and addressing vulnerability as a national research and policy priority.** Targeted, interdisciplinary research can help identify risks early, build resilience, and ensure decision-making processes are transparent, inclusive and responsive to community needs.
- **Australia's transition is unfolding within a fast-changing global and domestic context.** Understanding how international instability, evolving markets and national policy settings shape local vulnerabilities will be essential to guide future research, strengthen resilience, and inform effective policy responses.

The renewable energy transition will affect the daily lives of all Australians in both positive and negative ways. For some, the transition will involve relatively modest changes in electricity bills or local amenities. For others, it will be an experience of considerable and lasting change. Australia's clean energy transition is complex in nature. It is tightly interwoven with dimensions of personal and community identity, experiences of environmental change, economic and policy circumstances, culture, and class. All Australians' experiences of the energy transition will occur in the midst of lives whose many facets make it challenging for even the best researchers to unpick cause and effect.

Despite the energy transition's far-reaching impacts on people's lives, limited attention has been given to its effects on individuals, communities, and society compared with its technological, environmental and economic aspects (Clarke et al., 2021). *Vulnerability* is defined simply in this report as susceptibility to harm. Vulnerability is among the most critical and urgent societal issues facing the energy transition. As such, it demands a clear, scalable and comprehensive domestic research response.

In 2021, the Australian Council of Learned Academies (ACOLA) initiated the Australian Energy Transition Research Plan (the Research Plan), a keystone effort to outline the research themes and priorities necessary to realise Australia's energy transition (Clarke et al., 2021). The Research Plan established three central research themes:

1. energy system dynamics
2. transition dynamics
3. social engagement dynamics.

The Research Plan outlines nine key research topics within these three themes. The most important of those topics for the purposes of this report are: (a) social licence and participation; (b) communication and engagement; and (c) policy and regulation. Ultimately, the Research Plan aims to identify research gaps and promote research priorities for a successful Australian energy transition (Clarke et al., 2021).

Timely guidance on vulnerability and the energy transition (a key aspect of the 'social engagement dynamics' theme) is needed as a national priority. Improved understanding of vulnerability in Australia's energy transition is vital to guide the discussions and focus of current and future research that will support our capability to achieve a fair, equitable and just energy transition.

This report offers two important contributions to ACOLA's Energy Transition Research Plan:

- **research-led identification of the key knowledge gaps and opportunities regarding vulnerabilities and the energy transition in Australia**, with reference to domestic and international literature
- **establishment of future research priorities for vulnerability and the energy transition** to support evidence-informed decision-making and improved attention to the socio-cultural, socio-economic and system dynamics that shape and are shaped by Australia's energy transition.

Establishing priorities for Australian research on vulnerability and the energy transition offers a pathway for:

- closing critical and urgent gaps in our current knowledge, while building on existing research strengths
- establishing promising research questions and opportunities
- delivering a research evidence base to inform decisions, build policies, improve public understanding, mitigate or prevent harm, and respond meaningfully to support agency and resilience in the energy transition.

This report identifies the knowledge gaps, research questions and opportunities Australia should prioritise over the next five years. It also identifies existing areas of research strength that could boost knowledge about vulnerability and Australia's energy transition through more explicit attention to the issue. An ongoing, interdisciplinary research effort – led by social and policy sciences and humanities and integrating technological sciences – can facilitate more holistic, evidence-informed decision-making to advance Australia's energy transition. This report is therefore guided by two primary research questions.

What critical knowledge gaps about vulnerability and Australia's energy transition require research to inform the policies and practices necessary for a fair, equitable and just energy transition?

What research strengths or opportunities can be leveraged to better inform our understanding of vulnerability and Australia's energy transition?

As vulnerability is defined, explored and mapped through this report, important research topics and questions will emerge. These topics and questions can be used as a platform for future studies. This report also provides a series of **short, illustrative case studies**, with links to related **organisations and initiatives** (see Appendix A). The **reference list** can be used as a basis for further investigations into vulnerability and the energy transition.

1.1 More than a technological transition

The energy transition will require a full-scale societal effort and wide-ranging participation of Australia's superdiverse population (Henderson et al., 2024). It needs to establish and carefully maintain 'social licences' for the transition's many facets (Clarke et al., 2021). This report, therefore, investigates a variety of perspectives, issues and values shaping societies, people's daily lives, and the policies and institutions that influence them.

This 'social transition' requires research, policy and practice to address the community and societal constraints and opportunities that will affect the speed, quality and success of the energy transition. Vulnerability is a key component of this.

The social aspects essential to an effective energy transition will require trade-offs, just like all other major policy reforms and societal transformations (O'Connor et al., 2025). The transition will also deliver necessary and important benefits, including mitigating certain vulnerabilities. In order to understand vulnerability and the energy transition more deeply, several overarching questions should be considered by research. These are outlined in Table 1.

Table 1: Questions to guide research on vulnerability and Australia's energy transition

- **Who** benefits less than others from various aspects of the energy transition, and are they vulnerable? **Who** might become vulnerable or experience new or exacerbated vulnerabilities without the energy transition? **Who** should be responsible for understanding and addressing identified vulnerabilities?
- **What** are the most likely or severe negative social, socio-economic and socio-environmental impacts related to Australia's energy transition? **How** might these impacts be mitigated or prevented? **What** benefits of Australia's energy transition might address or alleviate vulnerabilities?
- **When** and **where in Australia** may different groups, individuals, institutions or systems be affected, and relative to **which aspects** of the transition?
- **Why** should those responsible for the energy transition make a concerted effort to understand vulnerability as more than an environmental, economic policy or technological issue?
- **How** should policymakers, researchers, regulators, energy sector representatives and civil society respond to vulnerabilities related to the energy transition?

Specific to research approaches and outcomes, there are also immediate opportunities to improve knowledge by asking the following questions:

- **What methodological approaches** are best suited to investigating the multidimensional and intersecting forms of vulnerability that the energy transition presents?
- **How** can improved understanding of the **social, health and economic impacts of vulnerability in people's lives** inform policies and practices to support a fair, equitable and just transition?
- **How** can a better understanding of the **interplay between vulnerability and structure/market/institutional arrangements** support a fair, equitable and just transition?

The questions set out in Table 1 help frame a broad range of non-technological issues for studies exploring vulnerability and the energy transition, regardless of discipline. Building on this foundation, this report places Australia's energy transition in a global context and outlines the current state of the domestic energy transition. This analysis identifies central research themes, questions and gaps. These findings are then overlaid with ACOLA's identified topics to pinpoint both priority areas for future research and areas where Australia already demonstrates research strengths that can be further leveraged to build understanding of vulnerability and the energy transition.

Research guided by the priorities identified in this report should also make clear that what is often referred to as a singular transition will, in practice, be many transitions, experienced differently by different groups in different places at different times. Priority research concerning vulnerability must also centre on Australia achieving a fair, equitable and just transition.

Ultimately, this report encourages careful and systematic consideration of the tangible and intangible, direct and indirect, and intended and unintended impacts of the energy transition within complex social systems.

1.2 Australia's energy transition: Context and current status

Australia's energy transition is progressing within a complicated and uncertain global context. Large-scale climate adaptation efforts are occurring at a time of increasingly frequent extreme weather events (Harrabin, 2025) and changes in ocean environments. International policy environments are tensely politicised. Wars in the Middle East and Europe are increasing energy security risks, threatening clean energy supply chains, and making global energy markets more fragile (IEA, 2024).

On the one hand, international leaders, including those who signed the COP28 Agreement, commit to 'a swift, just and equitable transition' (UN Climate Change News, 2023). On the other hand, certain major economies are adopting retrogressive environmental and energy policies that endanger a timely global energy transition while increasing fossil fuel use, environmental degradation and pollution (US Executive Order 14154, 2025; Peleggi, 2025). This context presents substantial threats to the global energy transition. It also creates considerable opportunities and pressure to act for Australia and other countries that remain committed to the energy transition and climate adaptation, including chances to boost local renewables technology manufacturing (Downie, 2025), critical minerals extraction and processing (DISR, 2023), and green investment (IGCC, 2025).

What is a fair, equitable and just energy transition?

- Benefits and burdens of the transition are distributed fairly across diverse groups and locations.
- Decision-making processes guiding the transition are transparent, accessible, equitable and inclusive.
- Historically, culturally and societally embedded inequalities, disadvantages, biases and vulnerabilities are recognised, with explicit efforts made to redress them.

Note: While this report touches on elements of energy justice relative to certain aspects of vulnerability, especially socio-economic vulnerabilities and those associated with energy poverty, a full exploration of energy justice is outside the scope of this report.

To learn more about a fair and just transition, including its relationship to environmental justice, energy poverty and Aboriginal and Torres Strait Islander communities, refer to the following ACOLA *Australian Energy Transition Research Plan* reports and peer-review articles:

- Examining JUST energy metrics: Exploring Australian research priorities (Taylor, 2025)
- Social engagement dynamics, Report 4 (Clarke et al.,2022b)
- Carley and Konisky (2020)
- O'Neill et al. (2019).

1.2.1 Australia's energy landscape: Targets, policies and regulation

Domestically, Australia aims to achieve targets of 82% renewable energy in the National Electricity Market (NEM) and a 43% reduction in emissions by 2030, with a net zero emissions target of 2050 (IEA, 2025; DCCEEW, 2025a). In 2025, the Australian Government set a national target to reduce emissions by 62–70% below 2005 levels by 2035 (DCCEEW, 2025b). These climate targets run alongside policies to reduce fossil fuel use, reform the gas market, increase critical minerals supplies, and secure the nation's energy and fuel supply (DCCEEW, 2025a). These efforts unite under the policy umbrella of National Energy Strategies and Frameworks, including:

- 'Powering Australia': jobs, affordability, industry and transport.
- 'Energy security and emergency management': domestic and international energy supply chains.
- The National Energy Transformation Partnership: collaborative framework for joined-up Commonwealth, State and Territory efforts.
- 'Rewiring the Nation': infrastructure, affordability, jobs, joined up efforts, and community engagement.
- 'Future Made in Australia': investment, jobs, industry, regions, research and innovation, supply chains, and affordability.

Transition efforts are overseen by core agencies, including the Department of Climate Change, Energy, the Environment and Water (DCCEEW), the Australian Energy Market Operator (AEMO, market operation), the Australian Energy Market Commission (AEMC, expert policy advice, rules and regulation) and the Australian Energy Regulator (AER, energy security, network, wholesale and retail market compliance). The latter three regulators collaborate through the Energy and Climate Change Ministerial Council (ECCMC), established in 2022, and aim to guide the energy sector through cooperation between the Commonwealth, States, Territories and New Zealand (ECCMC, 2024). Each agency plays a distinct role in policy, planning, regulation, and system operation. While their primary mandates focus on market efficiency, reliability, and decarbonisation, there is growing recognition – particularly through initiatives like the AER's 'Towards Energy Equity' strategy and the ECMC's priorities – of the need to embed social equity and address consumer vulnerability within the energy system.

1.2.2 Australia's energy mix

Today, renewables exceed 40% of total electricity delivered through Australia's National Energy Market, the highest renewables contribution on record (AEMO, 2024a). The nation's renewable energy mix is made up primarily of solar, wind and hydro, with a large-scale renewable energy capacity of 29.2 GW accredited under the Large-scale Renewable Energy Target Scheme. Coal and natural gas continue to be the main sources of Australia's electricity, and maintain economic importance as the nation's second and third largest export commodities, respectively (DFAT, 2025).

Distributed energy generation – electricity generation from local, usually consumer-side sources, including rooftop solar, local battery storage or biomass – comprised about one-fifth of electricity generated in Australia in 2022 (DCCEEW, 2025a), with the NEM (2025) showing that distributed electricity generation now has a greater capacity than any single thermal generator.

A range of associated international value chains, industries and technologies, including critical minerals mining, are also part and parcel of the country's renewable energy transition. This report focuses primarily on vulnerabilities arising from the core components of the renewable energy transition, especially those related to infrastructure (e.g. solar panels/farms/batteries, wind turbines or transmission lines, as detailed in Case Study 1), economic (e.g. changes to electricity pricing or consumer electricity choice) and social aspects (e.g. changes to visual amenity or land access) associated with the energy transition.

CASE STUDY 1

Vulnerability of outback New South Wales to power outages

In late 2004, Broken Hill and other outback NSW communities experienced a series of power outages. While the causes appear to have been varied (e.g. the collapse of seven transmission towers in a severe storm), they highlighted questions of network resilience and vulnerabilities of communities to failures in the network infrastructure. For example, people reliant on power for home-based health support were unable to operate essential equipment, such as dialysis machines. The sensitivity of these incidents is illustrated by the establishment of three separate inquiries into the outages.

▶ Learn more

https://www.abc.net.au/news/2024-12-03/broken-hill-loses-power-again-after-rolling-blackouts-nsw-sa/104679408

https://reneweconomy.com.au/broken-hill-blackout-network-operator-knew-its-back-up-was-out-of-action-but-didnt-tell-anyone/

2 DEFINING AND FRAMING VULNERABILITY

KEY MESSAGES

- **Vulnerability is complex, dynamic and multidimensional.** It refers to susceptibility to harm and can arise from individual, community or systemic factors that interact and evolve over time. Understanding these layers is essential to addressing who is most at risk and why during the energy transition.
- **A clear, multi-level definition of vulnerability supports a more coordinated research response.** Vulnerability can be shaped by personal characteristics (such as location or health), external conditions (such as environmental or social change), and institutional factors that embed inequality. Clarifying these dimensions enables consistent and comparable research and policy action.
- **This report adopts the Vulnerability Scoping Diagram (VSD) as a practical analytical framework.** The VSD maps exposure, sensitivity and adaptive capacity to identify where vulnerabilities occur and how they can be reduced. Applying this framework to Australia's energy transition will help target policy, regulation and engagement efforts where they are most needed.
- **Agency and resilience are critical complements to vulnerability.** Reducing vulnerability requires recognition of people's and systems' capacity to act, adapt and recover. Research that incorporates these empowering concepts can help shape evidence-based solutions for a fair, resilient and inclusive energy transition.

2.1 Defining vulnerability

The term vulnerability is used so widely and so regularly, it is often taken for granted that its meaning is understood. To address vulnerability related to Australia's energy transition, it is critical to clarify the term's various meanings, including how it is understood differently across different research disciplines and how it is assessed or measured (Paul, 2013). What is generally agreed is that vulnerability represents susceptibility to harm. It is a dynamic, complex and contested concept that operates on multiple levels, from individual to systemic, often simultaneously (Estoque et al., 2023).

Research into vulnerability and Australia's energy transition must approach the concept of vulnerability with awareness of a variety of interests and interactions. This should include:

- the characteristics shaping individuals' lives (e.g. Axon & Morrissey, 2020)
- systemic socio-environmental concerns (e.g. Wood et al., 2024)
- societal structures that institutionalise inequities (e.g. Brooks, 2003).

This report therefore advances a multi-level definition of vulnerability to support the establishment of a comprehensive, interdisciplinary research effort:

'Vulnerability' is susceptibility to harm. Degrees of vulnerability are shaped by a variety of factors. Some factors might be intrinsic to an individual or community, such as ethnicity or remote location. Other factors might relate to external circumstances, including social or environmental changes. In all cases, vulnerability increases the risk of harm to individuals, groups, communities or societies.

In addition to establishing a clear definition of vulnerability, six key assumptions are presented in this report that underpin the research priorities, questions and opportunities.

2.2 Framing vulnerability

This report's investigation is framed by leading vulnerability assessment research, a field well-established in the disciplines of human geography, risk science and impact assessment. There is a range of analytical frameworks that encourage attention to vulnerability, including many sustainable development approaches and certain environmental, social and governance (ESG) frameworks. While these frameworks are helpful, this report adopts the Vulnerability Scoping Diagram (VSD), as it enables a specific and effective means of identifying key vulnerabilities in a system and developing means to improve or fully mitigate those vulnerabilities. The VSD (see Appendix B for details) is one of the most widely accepted frameworks for assessing vulnerability, and is used by the Intergovernmental Panel on Climate Change (IPCC; Polsky et al., 2007). It offers a comprehensive but simple way to map the core elements, components and measurements of vulnerabilities in a complex system.

Research assumptions about vulnerabilities

Assumption 1: Vulnerability in Australia's energy transition is dynamic and flows in different directions (e.g. from institutions *to* individuals, from communities *to* societal systems, and vice versa).

Assumption 2: Vulnerabilities may be *addressed by* the transition. The energy transition could improve or eliminate pre-existing or emergent vulnerabilities.

Assumption 3: Vulnerabilities may be *caused or influenced by* the transition. Vulnerabilities could emerge from or be exacerbated by the energy transition.

Assumption 4: Vulnerabilities are temporal. Vulnerabilities could be worsened or improved during certain stages of the transition but may differ in other stages.

Assumption 5: Vulnerabilities are intersectional, crossing and blurring socio-economic, socio-cultural, political, institutional, physical, cultural, temporal-spatial and environmental boundaries.

Assumption 6: Vulnerabilities exist and operate at different scales. which may range from individual, group, community and local scales to regional/rural, institutional, national and systemic/structural ones, or may exist simultaneously.

The VSD captures three core dimensions of vulnerability (Adger & Brown, 2009):

- **exposure** to risks or impacts that introduce or exacerbate vulnerabilities
- **sensitivity:** the likelihood and severity of reaction to vulnerability
- **adaptive capacity:** the ability to adapt to those circumstances.

The VSD also illustrates the key **components** of vulnerability – the characteristics or circumstances that may be vulnerable in any given system.

Finally, the VSD supports vulnerability assessment by recommending the best **measures** for each of the components identified.

An analytical framework for vulnerability research must also attend to the social groups most likely to experience vulnerabilities in the energy transition, in addition to mapping vulnerabilities against VSD dimensions (see Appendix C). Identifying these social groups and considering the nature of vulnerabilities that may be associated with them can help to close research gaps. It can also help to propose research-derived recommendations with greater specificity.

ACOLA's work on the Energy Transition Research Plan to date (Reports 1–6, especially 1 and 6) identifies several components of vulnerabilities in Australia's energy transition that can be mapped using the VSD. The components and sample measures of vulnerability listed in Table 2 are intended as an example starting point to support researchers, as opposed to being an exhaustive list. Components, in this context, may be factors that induce vulnerability or social groups exposed to vulnerabilities. Measures may be quantitative data or qualitative insights that shed light on levels or degrees of vulnerability.

Future research into the knowledge gaps, priorities and questions identified here is encouraged to consider the general questions outlined in Table 1 and to adopt the VSD analytical framing. This will help ensure comprehension, consistency and comparability across diverse research projects to advance policy and practice responses. Such responses should address the wide remit of the energy transition, including but not limited to:

- regulatory and policy guidelines for community engagement and public participation in renewables projects
- renewable electricity affordability and accessibility
- location and spread of renewables infrastructure
- private sector governance
- socio-environmental and socio-economic impacts addressed and/or generated by the energy transition
- the selection, planning and construction of renewables infrastructure.

2.3 Remembering agency and resilience

Vulnerability has real consequences, but it is not inevitable. Human agency, the resilience of individuals, communities and institutions, supportive government policies, and systemic approaches to risk and impact management all offer ready means of reducing susceptibility to harm in Australia's energy transition. This report identifies and responds to vulnerabilities, but it also offers paths to evidence-informed solutions. These solutions could include government and industry actions guided by policies that consider and seek to reduce the circumstances that create or exacerbate vulnerabilities.

Investigations into the priority issues and questions identified in this report are encouraged to also consider the related concepts of agency and resilience. These concepts do not just support solutions-focused research; they also acknowledge the capacity and potential of individuals, groups, institutions and systems to cope with and overcome vulnerabilities. In other words, agency and resilience are empowering.

Agency and resilience: Key concepts linked to vulnerability

Agency: Agency is defined as the capacity of an individual, group or institution to act, independently or collectively, in a given situation. Like vulnerability, agency is a complex and disputed concept, conceptualised in the energy transition through at least three disparate research lenses: socio-psychological, practice and relational theories, and institutionalism.

Resilience: Resilience is the capacity of individuals, communities or systems to absorb shocks and changes and to 'bounce back' or adapt to those circumstances. Resilience in the energy transition can relate to a variety of factors, from societal and policy factors to market resilience, to the resilience capacity of energy systems.

Note: For more information on agency and resilience as it relates to the energy transition, see: Huttunen et al. (2021); World Economic Forum (2021); and Adger and Brown (2009).

Table 2: Vulnerability Scoping Diagram of ACOLA-identified components of vulnerabilities in Australia's energy transition

Dimension	Components (illustrative)	Measures (illustrative)
 **Exposure**	• Price sensitivity/energy affordability • Economic dislocation • (Un)employment • Land tenure/dislocation/ change in renewable energy zones (REZs) • Resource access • Climate-related or climate-induced effects • Aboriginal and Torres Strait Islander communities • Human rights concerns	• Proportion of income devoted to electricity/ electricity pricing • Proportion of rental vs home ownership/housing affordability indicators • Distributed/off-grid vs on-grid • Government land acquisition • Co-location of prime agricultural land with REZs • Heat, flooding, fire or other severe weather vulnerability assessments • Co-location with Aboriginal and Torres Strait Islander lands • Native Title claims • Human rights claims/ombudsman or similar complaints • (Un)employment levels
 **Sensitivity**	• Flexibility to change occupations (e.g. coal sector) • Wealth/poverty • Susceptible demographics • Energy access/energy poverty • Place attachment • Health – physical and mental • Health inequities • Housing status and security of tenure	• Employment and industry data • Australian Bureau of Statistics and related demographic data • Electrification figures by geographic area • Psycho-social assessments, including those related to land attachment • Health and wellbeing indicators
 **Adaptive capacity**	• In/exclusion from decision-making • Local knowledge/expertise • Social cohesion • Resilience	• Representation of local population participating in formal community engagement or public submissions processes • Local experts formally engaged in community consultative committees or other influential bodies • Social cohesion indicators • Supportive government policies • Resilience indicators

3 MAPPING WHAT WE KNOW ABOUT VULNERABILITY

KEY MESSAGES

- **Vulnerability research must bridge knowledge gaps and leverage Australia's research strengths.** A coordinated, interdisciplinary approach that links social, policy and technological research is essential to strengthen understanding of how vulnerabilities emerge and evolve across Australia's energy transition.
- **Humanities, arts and social sciences reveal the lived and cultural dimensions of vulnerability.** These disciplines highlight how factors such as gender, income, Aboriginal and Torres Strait Islander status, and place influence vulnerability, and show how creative and community-based methods can support inclusive, locally grounded transitions.
- **Climate, risk, economic and policy research highlight systemic and structural vulnerabilities.** Studies from these fields reveal how climate change, market forces and policy design shape people's exposure and ability to adapt, reinforcing the importance of vulnerability-led, rather than risk-led, policymaking.
- **Integrating social and technological sciences is key to advancing fair and effective transition outcomes.** Bringing together quantitative system analysis with social and cultural insights will help identify who is most affected, guide equitable policy solutions, and ensure resilience across Australia's energy transition.

Research on vulnerability and Australia's energy transition must be designed in a way that it urgently and strategically addresses critical knowledge gaps, leverages existing domestic research strengths, and contributes to a growing body of international, humanities and social scientific research that advances the energy transition. This section of the report provides a concise survey of the literature, drawing on domestic and international scholarly and 'grey' literature to map the current terrain of vulnerability research. It outlines existing knowledge and key areas of research across the main disciplines studying vulnerability, and establishes a basis from which to identify the key gaps in vulnerability studies relative to Australia. Details of the rapid literature review method are provided in Appendix D. An international meta-analysis of the literature could benefit future research by helping to advance Australian understanding of vulnerability and the energy transition and to refine the advice delivered here.

3.1 Key findings from the literature

The literature surveyed for this report represents studies of vulnerability and the energy transition across diverse fields of scholarship, incorporating several disciplines. Major disciplines represented in the literature include: humanities, arts and social sciences (HASS); climate, risk and disaster sciences; economics, political science and international relations; and public policy and public administration. The review also touches on technological sciences, particularly in relation to their intersection with the above disciplines.

3.1.1 Humanities, arts and social sciences

Studies that focus on vulnerability in individual and community energy transitions usually deploy anthropological, development studies, human geographic or sociological approaches to explore the characteristics of individuals or groups that make those people more likely than others to experience harm (e.g. Chandrashekeran et al., 2024; Day & Walker, 2013). This approach most often involves consideration of the roles of gender, Aboriginal and Torres Strait Islander status (Case Study 5), socio-economic status or rural/remote location[1]. It may also involve human rights considerations, such as those detailed in Case Study 2. In many instances, understanding vulnerability requires examining how different personal, social and economic factors interact to shape degrees of vulnerability (Johnson et al., 2020). This intersectionality is important to research, as it reflects lived experiences in more nuanced and genuine ways.

Together, the humanities, arts and social sciences offer distinctive, rigorous and creative ways to investigate and understand Australia's energy transition. Disciplines including environmental history, applied ethics, language studies, cultural studies and creative arts offer important research insights. Researchers in Australia and Latin America, for instance, are successfully using storytelling and community-based art techniques to expand ideas about energy justice (Castro et al., 2024; Dahlgren et al., 2024).

Co-creation techniques also show promise for Australian communities transitioning from reliance on the coal sector (Della Bosca & Gillespie, 2018) and for supporting communities to visualise and take better control over how their local environments are shaped by the energy transition (Gray et al., 2024). These and other approaches steeped in humanities, arts and social sciences reveal the cultural dimensions of vulnerability and the energy transition, and bring to light diverse perspectives, assumptions and experiences.

1 For more information see for example: Caretta & Vela-Almeida, 2025, Sadiqa et al., 2023 (roles of gender); O'Neill & Thorburn, 2025a, 2025b, and Quail et al., 2025 (Aboriginal and Torres Strait Islander status); Day & Walker, 2013 (socio-economic status); Carley et al., 2018; Colvin et al., 2024 (rural/remote location).

CASE STUDY 2

Human rights and solar: Social science in action

Human Rights and Solar Energy, published by the Danish Institute for Human Rights, supports the Danish solar energy sector to engage in human rights due diligence. It identifies critical human rights issues throughout the solar energy value chain, from raw material extraction to manufacturing, project development, logistics, installation, power generation and decommissioning.

Relevant vulnerabilities from the VSD based on ACOLA-identified components in Australia's energy transition (Table 2):

- exposure – land tenure/dislocation/change; resource access; human rights concerns
- sensitivity/resilience – occupational changes; susceptible demographics; place attachment; health
- adaptive capacity – in/exclusion from decision-making; social cohesion

► Learn more

https://www.humanrights.dk/publications/human-rights-solar-energy

3.1.2 Climate, risk and disaster sciences

Climate science most often focuses on the environmental vulnerabilities shaped by the Earth's systems (Rockström et al., 2009). This research includes the socio-environmental nexus and related ecosystem concerns (Ford et al., 2018), especially climate-induced migration (Berchin et al., 2017), climate-related health impacts (Williams & Marmot, 2023), natural disasters (Liverman, 2024), food security, and land management (Friel et al., 2020). Such investigations are often steeped in natural hazards research and risk science (Thekdi & Aven, 2021) and articulate the relationships between vulnerability, exposure, hazards and harm within large-scale systems (e.g. Heltberg et al., 2008; Coletti et al., 2013). The IPCC, for instance, defines 'vulnerability' as the 'propensity or predisposition to be adversely affected [which] encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (resilience)' (IPCC, 2022, p. 5).

3.1.3 Economics, political science and international relations

Vulnerability is also a common focus in demographic and economic studies of energy transitions, especially development economics. This understanding of vulnerability is most commonly reflected in studies concerned with energy justice. Here, key concepts of energy vulnerability, vulnerable households, energy poverty and fuel poverty emerge (see the Glossary).

Concerns about the short-term capacity of low-income households to absorb rising energy costs (not all of which are associated with the energy transition), while also being able to benefit from the longer term benefits of an improved climate and anticipated reductions in electricity prices, are a regular focus of such studies (e.g. Bardazzi & Pazienza, 2023). The ability of individuals, households and communities experiencing lower socio-economic status to participate equally and actively in new energy markets (Byrne et al., 2022), to secure equal, reliable access to electricity (White et al., 2024), and to exercise a degree of choice and control in energy and climate-related decisions (ACOSS, 2019), are major themes of vulnerability research in these disciplines. Case Study 3 highlights a program that responds to this issue.

Related literature in economics, political science and international relations concerns new job creation (McCoy et al., 2024) and employment levels (Stambe et al., 2025; Hincapie-Ossa et al., 2023) and the ways in which the renewable energy sector may exacerbate or improve the economic circumstances of people experiencing lower socio-economic status (Prin & Motherway, 2023). Economic vulnerability research also intersects public policy, political science and international relations with particular interests in the transition's effects on businesses and industries (Weldegiorgis, 2025; Briggs & Mey, 2020), domestic energy and related markets, investment decision-making (Ivanovski & Marinucci, 2021), and international export, trade and global markets (Jotzo & Zou, 2025).

3.1.4 Public policy and public administration

Public policy and public administration scholarship offer an important focus on the need for concerted government action to address vulnerabilities. Policy research has long grappled with challenges related to the perspectives that shape policy design.

Research shows that policy outcomes differ depending on whether a policy was designed and implemented based on a risk perspective versus a vulnerability perspective (Sarewitz et al., 2003). The former, more common perspective tends to generate policies aimed at preparing for and mitigating risk, often without any focus on or intention to reduce vulnerability. Vulnerability-led policy, however, aims to improve people's situations through 'healthy decision processes' that directly reduce vulnerability (Sarewitz et al., 2003, p. 810).

Policy studies also remind us that an assumption that governments are well-intentioned and aim to 'do better' by their citizens may not be widely shared (Leong & Howlett, 2022. This 'presumed benevolence' (Bice, 2024) may lead to a range of policy challenges, including community opposition to technically sound policy solutions. For energy transition policy, vulnerability-led policymaking encourages the integration of individuals and communities experiencing vulnerability into mainstream policy responses (Garniati et al., 2014). It encourages a move beyond risk-driven policymaking and presumed benevolence towards a more reflexive, flexible and accountable policy process (Markard, 2018).

3.1.5 Technological sciences

Technological sciences most relevant to the energy transition, such as engineering, tend to assess vulnerability using quantitative methods. These studies often focus on system characteristics and are usually studied with the aim of determining probabilities of system depletion or failure and identifying fail-safes and redundancies (OSCE, 2016). Increasingly, technological disciplines are recognising the importance of human and social factors in their research. Research priorities like those outlined in this report provide opportunities to better integrate social and technological sciences. Environmental sciences also provide valuable insights into other forms of vulnerability relevant to the energy transition, especially those related to weather (Zhao et al., 2024). The NEM Wholesale Market Settings Review (Nelson et al., 2025) identifies weather vulnerability as a major concern for Australia's energy transition.

While these more technological types of vulnerability are obviously important to the energy transition (such as in relation to transmission lines or electricity grid upgrades), they are beyond the scope of this report, which focuses on social, socio-economic and socio-environmental vulnerabilities. For details on technological vulnerabilities and risk management in Australia's energy system, please see Clarke et al., 2022a.

CASE STUDY 3

Addressing energy access and affordability for low-income renting households: Allume Energy SolShare program

Melbourne-based Allume Energy's SolShare program responds to an unmet need in Australia's energy transition market: clean energy access for apartment-style social housing. Allume's unique SolShare technology connects single rooftop solar systems to multiple apartments, sharing energy among tenants and to common areas. Projects include retrofits to social housing, such as Altona North in Victoria, where 44 households have saved over $700 per year, and Ryde in New South Wales, where 17 households have saved over $400 per year.

Relevant vulnerabilities from the VSD based on ACOLA-identified components in Australia's energy transition (Table 2):

- exposure – price sensitivity/ affordability
- sensitivity/resilience – susceptible demographics; energy poverty
- adaptive capacity – resilience.

▶ Learn more

https://allumeenergy.com/au/featured_item_category/social-housing/

4 PRIORITY RESEARCH TOPICS

KEY MESSAGES

- **Australia must urgently address key knowledge gaps in research on vulnerability and the energy transition.** Critical topics such as intersectionality, energy poverty, gendered experiences, and the treatment of vulnerability in policy remain under-researched and require targeted investment to inform equitable energy transition decisions.
- **Defining energy vulnerability is vital for effective policymaking.** Australia still lacks an official definition of energy vulnerability, limiting the ability to design fair policies and programs that ensure reliable and affordable energy access for all households.
- **Australia can build on existing research strengths to lead globally.** Strong national expertise in Aboriginal and Torres Strait Islander research, regional transitions, energy justice, and social impact assessment offers a foundation for internationally recognised research leadership on vulnerability in the energy transition.
- **Policy innovation and benefit sharing frameworks must explicitly address vulnerability.** Emerging charters, guidelines and community benefit schemes provide opportunities to embed fairness and inclusion, ensuring vulnerable and host communities share in the transition's social and economic benefits.

4.1 Overview

This section of the report builds on the rapid literature review summarised above to draw out critical gaps and opportunities for priority research. While a meta-analysis of the international literature is recommended to confirm these early insights, the topics highlighted here should be among those prioritised in future vulnerability research. They reflect 'myriad societal vulnerabilities' (Clarke et al, 2022a) and provide a sound starting point for Australian investigations.

The research topics identified here fall into two priority categories.

- **Type 1: Priority research topics related to urgent and critical knowledge gaps for Australia**. These topics represent the key areas in which Australian research appears to be lacking or lagging relative to the international knowledge base.
- **Type 2: Priority research topics that leverage existing research strengths**. These topics are already benefiting from Australian research capability, either directly in relation to the energy transition, or in very closely related research areas, including climate adaptation, disaster resilience, or climate policy. A focus on these priority research topics can enrich existing knowledge and create opportunities for improved policy and action to address vulnerability in Australia's energy transition.

PRIORITY RESEARCH TOPICS: Research on vulnerability and Australia's energy transition

This report's high-level survey of international and domestic research and 'grey' literature suggests that the following topics should be prioritised in Australian research to address current knowledge gaps and leverage opportunities for improved understanding of vulnerability.

Type 1: Priority research topics related to urgent and critical knowledge gaps for Australia

- Intersectionality
- Energy vulnerability/energy poverty
- Gender and the energy transition
- Considerations of vulnerabilities in energy (and related) policy

Type 2: Priority research topics that leverage existing research strengths

- Aboriginal and Torres Strait Islander Australians and vulnerability
- Location (rural/remote) and vulnerability
- Transition jobs and skills to address socio-economic vulnerabilities
- Energy justice
- Critical minerals for energy transitions
- Energy transitions' social licence and vulnerability
- Role of social impact assessment in addressing vulnerability
- Benefit sharing

4.2 Type 1: Priority topics to address urgent and critical knowledge gaps for Australia

Australian research appears to lag international inquiries in four major topic areas:

- intersectionality influencing vulnerability
- energy vulnerability/energy poverty
- gendered experiences of the energy transition
- how vulnerabilities are addressed by or inform public policy.

There is a lack of research on these aspects of vulnerability. This is perhaps due to the relative lack of funding for humanities, arts and social science research that ACOLA has more broadly identified in relation to our knowledge of the energy transition (Clarke et al, 2022b).

4.2.1 Intersectionality

There is very limited research specifically investigating how diverse identity and social characteristics, including gender, Aboriginal and Torres Strait Islander status, class, sexual orientation and housing tenure, intersect to inform experiences of privilege or oppression in Australia's energy transition. Given the diversity of Australia's population, consideration of the ways in which culturally and linguistically diverse identities intersect with other considerations, and with the energy transition, is important. Where intersectionality is acknowledged and discussed, engagement is brief and rarely the central research concern.

4.2.2 Energy vulnerability and energy poverty

Australia appears to lag other developed nations in the sophistication and volume of research on energy vulnerability and energy poverty (Sandri et al., 2021). As recently as 2023, Australian research highlighted that the nation 'lacks an official definition of energy vulnerability', a concept vital to effective policymaking to address access to reliable, safe and affordable energy services for all Australians (Middha & Willand, 2023, p. 1). This conceptual gap persists despite research demonstrating rising energy cost burdens and the disproportionate spend of lower-income households on electricity

bills relative to total income, as compared with other households (ACOSS, 2018). Formalised definitions, including those of energy vulnerability, which are critical to informing public policy, are lacking. It is also unclear whether Australian community members are aware of existing energy poverty programs and what the enablers and barriers to participating in those programs may be. Community education and the need for programs that fairly and genuinely involve diverse community members have been identified by other ACOLA research as a key area for attention (Taylor, 2025).

4.2.3 Gender and the energy transition

There is also very little focus on, and limited scope given to, the gendered nature of Australia's energy transition. For example, research clearly demonstrates that most low-income, single-parent Australian households are headed by women (Chandrashekeran et al., 2024), making this group a key consumer and decision-maker for household electricity. Better attention appears in the transition jobs and skills literature, which seems to be the most developed topic of gendered energy transition research in Australia. Overall, the gendered aspects of Australia's energy transition are not widely considered.

4.2.4 Consideration of vulnerabilities in energy policy

Greater attention to the social transition is needed across the board in Australian policy, guidelines and regulations, including but not limited to consideration of vulnerabilities. AEMO's (2024b) Capacity Investment Scheme Social Licence Merit Criteria, for instance, offers one of the most recent efforts to begin formalising social concerns in Australia's energy policy landscape. The AER (2022) is advancing a 'Towards energy equity strategy' focused on vulnerable consumers. The current policy response, however, is limited. Vulnerabilities related to energy and the energy transition also need to be better understood more generally, and to be integrated into related policy areas, including health, social welfare and economic policy. Policy responses may be introduced outside government in the form of principles or guidance, as in Case Study 4 below. Greater concentration and research-informed development of Australian policies and guidelines specific to vulnerability and the energy transition are needed.

CASE STUDY 4

Draft Charter for Just, Equitable and Fair Development

The **Charter for Just, Equitable and Fair Development** is a multi-stakeholder initiative that aims to reshape social impact assessment and community engagement in response to the rapid development-induced changes presented by the energy transition. It proposes guiding principles, rights of development-affected communities, benefits that development-affected communities should reasonably expect from projects, and duties (legal and ethical) of relevant parties in relation to the above rights and benefits. Through these four pillars (principles, rights, benefits and duties), the charter provides an overarching framework for addressing development-related vulnerabilities.

Relevant vulnerabilities from the VSD based on ACOLA-identified components in Australia's energy transition (Table 2):

- exposure – economic dislocation; land tenure/dislocation/change; resource access; Aboriginal and Torres Strait Islander communities; human rights concerns
- sensitivity/resilience – susceptible demographics; place attachment; health
- adaptive capacity – in/exclusion from decision-making; local knowledge/ expertise; social cohesion; resilience.

4.3 Type 2: Priority topics for leveraging existing Australian research strengths

As the Type 2 priority topics show, research on vulnerability and Australia's energy transition can also leverage existing Australian research strengths. This research can inform Australia's domestic transition and establish international research leadership. Australian research shows a solid and growing body of work concerning **Aboriginal and Torres Strait Islander peoples** (e.g. O'Neill & Thorburn, 2025b), **rural/remote Australians** (e.g. Colvin et al., 2024) and **industry and employment transitions** (e.g. Edwards et al., 2024) (see Case Study 5). Our historical reliance on fossil-fuel mining and extraction means we have commensurate bodies of social scientific (e.g. Bice, 2016) and economic research (e.g. Garnaut, 2022) in those areas, much of which is applicable to the transition.

Australian researchers are also making notable contributions to understanding **energy justice** (Taylor, 2023), an area of research that is especially pertinent to concerns about vulnerabilities stemming from energy access and affordability. Australia's deep research knowledge of the mining sector is also being applied to emerging energy transition research topics, especially **critical minerals** (Owen et al., 2023).

Australia also demonstrates exceptional research strength in research led by and with Aboriginal and Torres Strait Islander peoples. Concentration on Aboriginal and Torres Strait Islander research in the energy transition should be maintained and improved to enrich a body of research that is internationally recognised. The interplay between research with Aboriginal and Torres Strait Islander peoples and influence on policy and practical outcomes is important to note (O'Neill et al., 2021). For instance, Native Title determinations, Land Rights cases, policies, and guidelines developed over the past decade rely on our strong national body of research and play a role in supporting gains for Aboriginal and Torres Strait Islander peoples, who remain susceptible to vulnerabilities.

Australian expertise on **public acceptance or 'social licence'** of environmentally harmful or controversial industries and projects (e.g. Bice et al., 2017; Parsons & Moffat, 2014) is also world-leading and presents opportunities for translation to vulnerability studies to inform Australia's energy transition.

Finally, Australia's existing expertise on **social impact assessment** (SIA) (Parsons et al., 2019) and **benefits sharing** (Quail et al., 2025) offer two further key research areas. A central theme in SIA literature, and a core objective of SIA practice, is to protect society's most vulnerable people from harm associated with development-induced change, and preferably to improve their lives (Vanclay, 2003; Vanclay et al., 2015). This idea overlaps with a strong focus on fairness, equity and justice. Historically, people in vulnerable circumstances have disproportionately experienced the negative effects of industrial developments, such as mining and infrastructure projects. The evidence suggests that this inequitable situation is being replicated and extended in many corners of the energy transition.

Benefit sharing from development projects emerged in the 1990s as a means of mitigating the effects of resettlement and has broadened in scope more recently. Benefit sharing ensures that individuals and communities affected by energy projects receive fair social and economic benefits, such as jobs, training, community investment, or reduced energy costs. This approach enables individuals and communities to participate meaningfully in the energy transition, sharing in its opportunities as well as its adverse impacts. International standards (e.g. International Finance Corporation Performance Standards, World Bank Environmental and Social Standards, and Asian Development Bank Safeguards Policy Statement) typically require benefit sharing to be fair and equitable, without necessarily being explicit about the need to address vulnerabilities. Australian research has an opportunity to improve policy and regulatory guidelines for benefit sharing, which are actively emerging in most states and territories (see Case Study 6) and relate strongly to Aboriginal and Torres Strait Islander communities, on whose land much of the nation's renewable energy infrastructure will rely (Quail et al., 2025).

A concerted research focus on vulnerability in benefit sharing will deliver a more sophisticated understanding of the host communities that benefit sharing agreements seek to serve. It would also improve relative research and policy responses to development-induced harm, including how vulnerabilities can multiply and intersect as a direct result of energy project development.

CASE STUDY 5

Aboriginal and Torres Strait Islander peoples and critical minerals: Intersecting vulnerabilities

The lands of Australia's Aboriginal and Torres Strait Islander peoples will play a central role in hosting the nation's energy transition (O'Neill & Thorburn, 2025b). Recent legal gains in relation to Aboriginal and Torres Strait Islander peoples' authority over their traditional lands, resulting primarily from historical engagement with the mining sector, present important opportunities for Aboriginal and Torres Strait Islander peoples to navigate commercial, legal and custodial negotiations more successfully. Recent research suggests that Aboriginal and Torres Strait Islander communities could benefit from hosting solar and wind power generation, but that potential gains need to be carefully supported through local capacity-building and a fair and just approach to energy development (Hunt et al., 2021).

The growth of critical minerals mining in Australia presents a further, intersecting vulnerability related to the energy transition. The Australian Government's recently adopted Critical Minerals Strategy (2023–2030) aims to grow Australia's expertise and extraction of the critical minerals essential to energy transition technologies. Recent research suggests that almost 60% of the country's critical minerals exist where Aboriginal and Torres Strait Islander peoples have a right to negotiate, including procedural rights (i.e. Native Title) for almost 80% of critical minerals claims. Australian researchers warn that the inequitable treatment of Aboriginal and Torres Strait Islander peoples, experienced for many decades in traditional mining, is only likely to be exacerbated or continued as critical minerals extraction develops (Burton et al., 2024a).

The Australian situation reflects an emerging global challenge. Izquierdo et al. (2025), for instance, demonstrate the importance of local and Indigenous knowledge in understanding the impacts of critical minerals projects on Indigenous lands. Globally, critical minerals exist disproportionately on or near such lands, presenting significant vulnerability risks. While this study involved Indigenous communities in the Andes, the issues and lessons have applicability to an Australian context with a similar concentration of critical minerals resources on Aboriginal and Torres Strait Islander lands. The authors surveyed four local and Indigenous communities to derive locally relevant indicators and their relationships with the UN Sustainable Development Goals. In so doing, they were able to integrate local and Indigenous values, priorities and knowledge systems with the scientific literature to derive a more holistic understanding.

Relevant vulnerabilities from the VSD based on ACOLA-identified components in Australia's energy transition (Table 2):

- exposure – economic dislocation; land tenure/dislocation/change; resource access; Aboriginal and Torres Strait Islander communities; human rights concerns
- sensitivity/resilience – wealth/poverty; susceptible demographics; place attachment; health
- adaptive capacity – in/exclusion from decision-making; local knowledge/expertise; social cohesion; resilience

▶ Learn more

https://iceds.anu.edu.au/indigenous-engagement-renewable-energy-industries-program; https://www.sciencedirect.com/science/article/abs/pii/S1462901125001716

Similar to benefit sharing, Australia is also advancing energy consumer policies at the Commonwealth level, which can address vulnerability in the energy transition as a policy priority. The National Consumer Energy Resource (CER) Roadmap outlines conditions to scale CER adoption across Australia. The Australian Government is progressing the National Technical Regulatory Framework for CER ('Regulatory Framework') through public consultation. The Regulatory Framework aims to deliver 'benefits and equitable outcomes to all consumers' (Australian Government, 2025, p. 4) by enabling efficient use of CER to support system stability and decarbonisation while rewarding active market participation. The CER is an important shift towards a consumer-focused energy transition. Importantly for the focus of this report, however, the Regulatory Framework currently does not incorporate targeted reforms for non-CER owners or vulnerable energy consumer groups. Ensuring the intergenerational benefits of CER, including enhanced affordability, access, resilience and energy independence, remains an unresolved challenge requiring further regulatory innovation.

CASE STUDY 6

Benefit sharing policies and approaches across Australia

In Australia, growing expectations that host communities should be compensated for the negative impacts of renewable energy developments have led some governments to introduce benefit sharing provisions. For instance:

- The **Australian Government** released new National Guidelines for Community Engagement and Benefits for Electricity Transmission Projects in 2024. The guidelines establish expectations for how developers will work with local communities, including responsibilities and principles for engaging with Aboriginal and Torres Strait Islander peoples.
- **Victoria** introduced a Community Engagement and Benefit Sharing in Renewable Energy Development guide for renewable energy developers in 2017, updated in 2021. It proposes that benefit sharing should deliver mutually beneficial outcomes, apply a fair process, and respond to community needs and aspirations (Lane & Hicks, 2017).
- The **New South Wales** Benefit sharing Guideline (November 2024) applies to large-scale renewable energy projects. It does not specifically address vulnerability but proposes that funds should be targeted towards the people and communities that are most likely to experience the effects of the proposed development (DPIH 2024, p. 20).
- **Queensland**'s Community Benefit Agreement provisions (June 2025) for large-scale wind and solar projects, similarly, do not mention vulnerabilities but are intended to ensure that the benefit being received will be targeted towards the people and communities that are likely to be impacted by the proposed development (DSDIP, 2025).
- **Western Australia**'s Community Benefits Guideline (draft as of July 2025) states upfront that it is designed for a fair and equitable energy transition. It does not define an equitable benefit or mention vulnerabilities, but proposes that benefits should be based on specific community needs and be proportionate to the impacts of the project (Government of Western Australia 2025).
- **Tasmania**'s Guideline for Community Engagement, Benefit Sharing and Local Procurement (May 2024) for renewable energy and transmission projects does not mention vulnerability but includes 'social equity' as a question to consider in benefit sharing. The supporting 'Technical Supplement 1' recommends Social Impact Assessments as a method for understanding the social context. 'Technical Supplement 3' specifically identifies vulnerability as a characteristic to consider when identifying beneficiaries, but only in relation to hydropower projects.

5 SETTING A RESEARCH AGENDA

KEY MESSAGES

- **The forward research agenda outlined in this report provides a clear pathway to close knowledge gaps on vulnerability and the energy transition.** It focuses on under-researched areas (Type 1 topics) such as intersectionality, energy poverty, gender, and policy, while encouraging continued research on areas where Australia already has strong research foundations (Type 2 topics).
- **Research must examine the structural, lived and practical aspects of vulnerability.** This means understanding how systems and institutions shape vulnerability, incorporating lived and Aboriginal and Torres Strait Islander experiences, and using inclusive, community-driven approaches to promote fair and just outcomes.
- **Australia now has a strong foundation for coordinated interdisciplinary research to support a fair and equitable energy transition.** Applying this research agenda will strengthen evidence for policy, empower communities, and help prevent or reduce vulnerabilities across the transition.

5.1 Overview

The final section of this report proposes a forward research agenda for vulnerability and Australia's energy transition. It builds on current domestic and international knowledge to address critical research gaps and opportunities, illustrating suggested research inquiries to advance Type 1 priority topics (under-researched areas). The focus on Type 1 priority topics provides detailed guidance, as these areas are less-researched in Australia. Research addressing Type 2 priority topics (research strengths) is encouraged to apply a similar Vulnerability Scoping Diagram framing and should build out research questions and agendas based on the existing research foundation.

The proposed research agenda adopts the VSD (see Table 3). It also introduces three cross-cutting themes that should shape investigations into both Type 1 and Type 2 priority topics. The themes, dimensions and research questions presented here will intersect and influence one another, often without clear boundaries. Noting this, we present the Type 1 priority research topics separately for clearer conceptualisation.

5.2 Sample research agendas to address Type 1 priority research topics

This section builds on identified **research gaps** to illustrate future research pathways that would support improved knowledge of Type 1 priority research topics. Researchers are encouraged first to consider the general research questions outlined in Table 1. These higher-order questions are relevant for both Type 1 and 2 priority research topics. Attention to the research questions outlined in Table 1 will:

- support better understanding of the individuals and groups most affected by and affecting vulnerability and the energy transition
- build improved understanding of how institutional settings and impacts influence vulnerability in the energy transition
- enhance knowledge about how energy transition timing and location relate to vulnerability
- generate important considerations for policymaking and implementation, among other general concerns.

The questions presented in Table 3 then go a step deeper. These suggested research questions demonstrate how each Type 1 priority research topic could be mapped to the VSD dimensions, offering a template to support future research on vulnerability and Australia's energy transition. It is important to note that the questions suggested are simply that: suggestions that are intended to spark researchers' thinking and to illustrate effective use of the VSD. The questions are created from gaps identified through the rapid literature review, including analysis of ACOLA reports and relevant 'grey' literature. A similar approach could be applied to all Type 2 priority research topics (research strengths).

Table 3: Suggested research questions for Type 1 priority research topics to address Australian research gaps: Mapped against VSD dimensions.

	VSD dimensions/Sample research questions		
TYPE 1: Priority research topic	**Exposure**	**Sensitivity**	**Adaptive capacity**
1. **Intersectionality**	• How do diverse identity and social characteristics (e.g. gender, culture, Aboriginal and Torres Strait Islander status, class, sexual orientation, age, disability, place and housing status) intersect to influence exposure to risks posed by the energy transition? • How might intersecting characteristics affect exposure to particular harms? • Are there intersecting characteristics that might result in reduced vulnerability or improved benefit realisation from the energy transition?	• How do diverse identity and social characteristics (e.g. gender, culture, Aboriginal and Torres Strait Islander status, class, sexual orientation, age, disability, place and housing status) intersect to inform experiences of privilege or oppression? • Who are the individuals and communities least likely to benefit from Australia's energy transition in the short term? The medium term? The long term? • At what points in the transition are individuals or communities especially vulnerable? • What, if any, are the shared characteristics of these individuals/ communities?	• How do diverse identity and social characteristics (e.g. gender, culture, Aboriginal and Torres Strait Islander status, class, sexual orientation, age, disability, place and housing status) intersect to influence people's ability to respond to the risks posed by the energy transition? To their ability to participate in decisions that affect them? • What methodological frameworks can best consider and address/mitigate the varying experiences of vulnerability that the energy transition presents, given the multidimensional and intersecting forms of vulnerability?

	VSD dimensions/Sample research questions		
TYPE 1: Priority research topic	 **Exposure**	 **Sensitivity**	 **Adaptive capacity**
2. **Energy vulnerability/ Energy poverty**	• How are the particular structural characteristics of Australia's actions to decarbonise (e.g. REZs, a deregulated retail energy market) influencing different groups' exposure to energy poverty? • In what ways are policy processes adequate to protect or limit individuals' or communities' exposure to energy poverty or vulnerability?	• What are the individual factors that contribute to experiences of energy poverty in Australia? • What are the structural factors that contribute to experiences of energy poverty in Australia? • What measures could be adopted to reduce identified sensitivities to energy poverty/ vulnerability?	• How can policy support and create a transition that avoids exacerbating vulnerabilities related to energy poverty? • How can understandings of lived experiences of energy poverty inform policy to support a fair, equitable and just transition? • What forms of government intervention can best reduce energy poverty associated with the transition?
3. **Gendered experiences of the energy transition**	• How do gender and gender identity influence exposure to risks from each aspect of the energy transition in Australia? • How can an improved understanding of the role of gender in Australia's energy transition help to reduce individuals' or groups' exposure to identified risks?	• How do gender and gender identity shape the ways that people experience different aspects of the energy transition in Australia? • In what ways might gender identity influence sensitivity to negative impacts of the energy transition? • In what ways might gender identity enable certain individuals or groups to achieve greater benefits from the energy transition?	• How can institutional arrangements and policy settings support an energy transition that is gender-equitable? • How do structural inequalities, especially those affecting Australian women (e.g. lower pay for equal work), impact their capacity to be active participants in the energy transition, including electricity choice, transition jobs, etc.? • How do men experience the gendered aspects of the energy transition, especially in relation to job transitions and changing industries?

	VSD dimensions/Sample research questions		
TYPE 1: Priority research topic	 **Exposure**	 **Sensitivity**	 **Adaptive capacity**
4. **How vulnerabilities are addressed by or inform public policy**	• How might a multidimensional and dynamic conceptualisation of vulnerability inform regulatory discussion of, and response to, how the energy transition interacts with vulnerabilities among host communities? With broader Australian society? • How might a holistic understanding of 'energy vulnerability' support joined-up policymaking, especially targeting individuals and households experiencing lower socio-economic situations? • How might such policymaking effectively address the interrelationships between household spending on essential needs, and exposure to the impacts of the energy transition?	• What are the community and societal constraints and opportunities that will affect the speed, quality and success of policies to guide Australia's energy transition? • How do nationalised versus privatised developments and transmission networks affect vulnerabilities? What role could policy play to address this? • How do centralised versus distributed power networks affect vulnerabilities? How could policy be shaped to reduce identified sensitivities related to energy distribution? • How can energy vulnerability be formally defined in Australia to facilitate improved policymaking to address it?	• How should policymakers, researchers, regulators, energy sector representatives and civil society respond (individually and collaboratively) to vulnerabilities related to the energy transition? • What institutional arrangements (including in energy policy and other sectors) can best support a fair, equitable and just energy transition in Australia? What policies, guidelines or regulations are necessary to support such arrangements? • To what extent do projects apparently designed for better outcomes (e.g. Indigenous-led renewable energy developments) actually deliver the predicted outcomes?

The forward research agenda for all priority topics (Types 1 and 2) is also guided by the following three cross-cutting themes.

Cross-cutting theme 1: Structural dimensions of vulnerability

Much of the existing research focuses on the logistics and practicalities of the energy transition (i.e. technological, engineering, construction, financial, planning and policy challenges) and, increasingly, the question of how to overcome community resistance to certain elements of the energy transition, especially overhead transmission lines. Research is still needed to understand the structural/institutional arrangements that either *exacerbate* or *alleviate* vulnerabilities. Consideration of these structural dimensions of vulnerability should be integrated into all studies to some degree.

Cross-cutting theme 2: Lived experiences of vulnerability

ACOLA's Social Engagement Dynamics briefing paper (Clarke et al., 2022b) identified that the energy transition is being driven from 'above', meaning that governments and businesses are responding to international frameworks and goals, rather than communities at the receiving end of the transition. From a research perspective, this is manifested in most research being 'expert-led', and lacking more subjective, localised and Aboriginal and Torres Strait Islander experiences of transition. The Energy Charter has established a 'Lived Experience Panel' (see Appendix A), but its remit is limited and is not explicitly focused on vulnerability. Research should incorporate lived experiences, draw on local knowledge and expertise, and use proven co-design and participatory research methods that encourage and value bottom-up engagement, community involvement and participation in processes and outcomes, and more equitable and accessible research outputs.

Cross-cutting theme 3: Methodologies to advance a fair, equitable and just transition

Research should also be innovative and attentive to the ways in which the research methods could themselves contribute to a more fair, equitable and just transition. Including Aboriginal and Torres Strait Islander research participants as co-researchers and research co-authors is a growing practice, for example. Vulnerability impact assessments offer methods underpinned by aligned principles that can support Australia's fair and just transition.

5.3 A coordinated research agenda for action

This report outlines a clear research agenda to close knowledge gaps and strengthen Australia's response to vulnerability in the energy transition. Using the **Vulnerability Scoping Diagram framework**, it structures new research around the key dimensions of exposure, sensitivity, and adaptive capacity, while prioritising under-researched areas.

The agenda also highlights three **cross-cutting themes** to guide all future work:

- examining the **structural and institutional systems** that shape vulnerability
- incorporating **lived and local experiences** through participatory and co-designed research
- advancing **inclusive and just research methods**, such as Indigenous-led collaboration and vulnerability impact assessments.

Together, these approaches provide a roadmap for targeted, coordinated and interdisciplinary research to support a fair, equitable, and evidence-based energy transition for Australia. Ultimately, this agenda can guide future research that will deliver evidence to support policy development, community empowerment and improved mitigation of transition-related vulnerabilities. Implementing this research agenda is timely and essential to ensure that no community is left behind and that benefits are shared as widely and equitably as possible.

6 REFERENCES

ACOSS 2018, *Energy stressed in Australia*, ACOSS, Brotherhood of St Laurence and ANU Centre for Social Research and Methods.

ACOSS 2019, *Affordable, clean energy for people on low incomes*, ACOSS and Brotherhood of St Laurence.

Adger, WN & Brown, K 2009, 'Vulnerability and resilience to environmental change: ecological and social perspectives', in N Castree, D Demeritt, D Liverman & B Rhoads (eds), *A companion to environmental geography*. https://doi.org/10.1002/9781444305722.ch8.

AEMO 2024a, *Energy roadmap lights the way to net zero*. https://www.aemo.com.au/newsroom/media-release/energy-roadmap-lights-the-way-to-net-zero, viewed 13 November 2025.

AEMO 2024b, *The Capacity Investment Scheme,* https://asl.org.au/en/tenders/capacity-investment-scheme, viewed 8 September 2025.

AER 2022, *Towards energy equity – a strategy for an inclusive energy market*, https://www.aer.gov.au/industry/registers/resources/reviews/towards-energy-equity-strategy-inclusive-energy-market, viewed 9 September 2025.

Australian Government 2025, *National Technical Regulatory Framework for Consumer Energy Resources- Draft prototype, https://consult.dcceew.gov.au/natl-cer-roadmap-tech-priorities-consult.*

Axon, S & Morrissey, J 2020, 'Just energy transitions? Social inequities, vulnerabilities and unintended consequences', *Buildings and Cities*, vol. 1, no. 1, pp. 393–411. https://doi.org/10.5334/bc.14.

Baert, P 2005, *Philosophy of the social sciences: towards pragmatism*, John Wiley & Sons.

Bardazzi, R & Pazienza, MG (eds) 2023, *Vulnerable households in the energy transition: energy poverty, demographics and policies*, Springer Nature.

Berchin, II, Valduga, IB, Garcia, J & De Andrade Guerra, JBSO 2017, 'Climate change and forced migrations: an effort towards recognizing climate refugees', *Geoforum*, vol. 84, pp. 147–50. https://doi.org/10.1016/j.geoforum.2017.06.022.

Bice, S 2016, *Responsible mining: key principles for industry integrity*, Routledge.

Bice, S 2024, 'How presumed benevolence will short circuit the energy transition', *Next Generation Engagement*, 9 August.

Bice, S, Brueckner, M & Pforr, C 2017, 'Putting social license to operate on the map: a social, actuarial and political risk and licensing model (SAP Model)', *Resources Policy*, vol. 53, pp. 46–55.

Bice, S & Moffat, K 2014, 'Social licence to operate and impact assessment', *Impact Assessment and Project Appraisal*, vol. 32, no. 4, pp. 257–62.

Briggs, C & Mey, F 2020, *Just transition: implications for the corporate sector and financial institutions in Australia*, prepared for ISF for Global Compact.

Brooks, N 2003, *Vulnerability, risk and adaptation: a conceptual framework*, University of East Anglia, Tyndall Centre Working Paper no. 38.

Burton, J, Kemp, D, Barnes, R & Parmenter, J 2024a, 'Mapping critical minerals projects and their intersection with Indigenous peoples' land rights in Australia', *Energy Research & Social Science*, vol. 113, p. 103556.

Burton, J, Kemp, D, Barnes, R & Parmenter, J 2024b, 'A socio-spatial analysis of Australia's critical minerals endowment and policy implications', *Resources Policy*, vol. 88, p. 104448. https://doi.org/10.1016/j.resourpol.2023.104448.

Byrne, DP, Martin, LA & Nah, JS 2022, 'Price discrimination by negotiation: a field experiment in retail electricity', *The Quarterly Journal of Economics*, vol. 137, no. 4, pp. 2499–537. https://doi.org/10.1093/qje/qjac021.

Caretta, MA & Vela-Almeida, D 2025, 'Just energy transition and gender: a systematic review for feminist research', *Energy Research & Social Science*, vol. 126, p. 104138. https://doi.org/10.1016/j.erss.2025.104138.

Carley, S & Konisky, DM 2020, 'The justice and equity implications of the clean energy transition'. *Nature Energy*, vol *5*, no.8, pp. 569–577, https://doi.org/10.1038/s41560-020-0641-6

Carley, S, Evans, TP, Graff, M & Konisky, DM 2018, 'A framework for evaluating geographic disparities in energy transition vulnerability', *Nature Energy*, vol. 3, no. 8, pp. 621–7. https://doi.org/10.1038/s41560-018-0142-z.

Castro, A, Ponce de León, A, Cantera, AL, Olofsson, V & Reina-Rozo, JD 2024, 'Energy sovereignty storytelling: art practices, community-led transitions, and territorial futures in Latin America', *Tapuya: Latin American Science, Technology and Society*, vol. 7, no. 1, p. 2309046.

Chandrashekeran, S, De Bruyn, J, Sullivan, D & Bryant, D 2024, 'Electrification and lower-income households in Australia: an integrated analysis of adaptive capacity and hardship', *Energy Research & Social Science*, vol. 116, p. 103688. https://doi.org/10.1016/j.erss.2024.103688.

Clarke, D, Baldwin, K, Baum, F, Godfrey, B, Richardson, S & Robin, L 2021, *Australian energy transition research plan*, Report for the Australian Council of Learned Academics (ACOLA). www.acola.org.

Clarke, D, Baldwin, K, Baum, F, Godfrey, B, Richardson, S & Robin, L 2022a, *Australian Energy Transition Research Plan, Report 6: Energy research translation*, Report for the Australian Council of Learned Academics (ACOLA). www.acola.org.

Clarke, D, Baldwin, K, Baum, F, Godfrey, B, Richardson, S, Robin, L, Soliman Hunter, T & Taylor, M 2022b, *Australian Energy Transition Research Plan, Report 4: Social engagement dynamics*, Report for the Australian Council of Learned Academies (ACOLA). www.acola.org.

Coletti, A, Howe, PD, Yarnal, B & Wood, NJ 2013, 'A support system for assessing local vulnerability to weather and climate', *Natural Hazards*, vol. 65, no. 1, pp. 999–1008. https://doi.org/10.1007/s11069-012-0366-3.

Colvin, RM, Jotzo, F & Fielding, KS 2024, 'Is Australia's urban–regional schism on climate reality or rhetoric?', *Journal of Rural Studies*, vol. 112, p. 103446. https://doi.org/10.1016/j.jrurstud.2024.103446.

Dahlgren, K, Kaviani, F, Strengers, Y, Pink, S & Korsmeyer, H 2024, 'Bringing energy futures to life: anticipatory household storylines as possible energy futures', *Futures*, vol. 158, p. 103347.

Day, R & Walker, G 2013, 'Household energy vulnerability as "assemblage"', in Bickerstaff, K, Walker, G. and Bulkeley, H. (eds.) *Energy justice in a changing climate*, Zed Books Ltd. https://doi.org/10.5040/9781350219908.ch-001.

DCCEEW 2025a, *Australia's energy strategies and frameworks*. https://www.dcceew.gov.au/energy/strategies-and-frameworks.

DCCEEW 2025b, *Setting our 2035 target and path to net zero*. https://www.dcceew.gov.au/about/news/setting-2035-target-path-net-zero.

Della Bosca, H & Gillespie, J 2018, 'The coal story: generational coal mining communities and strategies of energy transition in Australia', *Energy Policy*, vol. 120, pp. 734–40.

DFAT 2025, *Australia's top 25 exports, goods & services*. https://www.dfat.gov.au/sites/default/files/australias-goods-and-services-by-top-25-exports-2024.pdf.pdf.

DISR 2023, *Critical minerals strategy 2023–2030*. https://www.industry.gov.au/publications/critical-minerals-strategy-2023-2030.

Downie, C 2025, 'A reversal in US climate policy will send renewables investors packing – and Australia can reap the benefits', *The Conversation*, 11 June. http://theconversation.com/a-reversal-in-us-climate-policy-will-send-renewables-investors-packing-and-australia-can-reap-the-benefits-258388.

DPIH 2024, *Benefit sharing guideline*, NSW Department of Planning, Housing, and Infrastructure. https://www.planning.nsw.gov.au/sites/default/files/2024-11/benefit sharing-guideline.pdf.

DSDIP 2025, *Community benefit agreement*. Queensland Department of State Development, Infrastructure, and Planning. https://www.planning.qld.gov.au/__data/assets/pdf_file/0015/100356/factsheet-community-benefit-agreement.pdf.

ECMC 2025, Energy and Climate Change Ministerial Council, https://www.energy.gov.au/energy-and-climate-change-ministerial-council, viewed 8 September 2025.

Edwards, GAS, Wiseman, J & Cahill, A (eds), 2024, *Regional energy transitions in Australia: from impossible to possible*, Taylor & Francis.

EMBER 2025, *2030 Global renewable target tracker.* https://ember-energy.org/data/2030-global-renewable-target-tracker.

Estoque, RC, Ishtiaque, A, Parajuli, J, Athukorala, D, Rabby, YW & Ooba, M 2023, 'Has the IPCC's revised vulnerability concept been well adopted?', *Ambio*, vol. 52, no. 2, pp. 376–89. https://doi.org/10.1007/s13280-022-01806-z.

Executive Order 14154 2025, *Unleashing American energy*. The White House. https://www.whitehouse.gov/presidential-actions/2025/01/unleashing-american-energy/.

Fleming-Muñoz, DA, Poruschi, L, Measham, T, Meyers, J & Moglia, M 2020, 'Economic vulnerability and regional implications of a low carbon emissions future', *Australian Journal of Agricultural and Resource Economics*, vol. 64, no. 3, pp. 575–604. https://doi.org/10.1111/1467-8489.12356.

Flyvbjerg, B 2012, 'Making social science matter', in Georgios Papanagnou (ed.), *Social science and policy challenges: democracy, values, and capacities* (pp. 25–56), UNESCO Publishing, Paris, Available at SSRN: https://ssrn.com/abstract=2278218.

Ford, JD, Pearce, T, McDowell, G, Berrang-Ford, L, Sayles, JS & Belfer, E 2018, 'Vulnerability and its discontents: the past, present, and future of climate change vulnerability research', *Climatic Change*, vol. 151, no. 2, pp. 189–203. https://doi.org/10.1007/s10584-018-2304-1.

Friel, S, Schram, A & Townsend, B 2020, 'The nexus between international trade, food systems, malnutrition and climate change', *Nature Food*, vol. 1, no. 1, pp. 51–8. https://doi.org/10.1038/s43016-019-0014-0.

Garnaut, R (ed.), 2022, *The superpower transformation: building Australia›s zero-carbon future*, Black Inc.

Garniati, L, Owen, A, Kruijsen, J, Ishadamy, Y & Wibisono, I 2014, 'Interface between appropriate technology and sustainable energy policy in vulnerable societies', *Sustainable Cities and Society*, vol. 12, pp. 9–15.

Government of Western Australia 2025, *Community benefits guideline for communities hosting renewable energy projects*. https://www.wa.gov.au/organisation/energy-policy-wa/community-benefits-guideline-communities-hosting-renewable-energy-projects.

Gray, EK, Fahy, F, McArdle, R & Rohse, M 2024, 'Co-creating a community visioning methodology for energy transitions: principles, practices, and reflections', *Energy Research & Social Science*, vol. 118, p. 103783.

Harrabin, R 2025, 'NASA data reveals dramatic rise in intensity of weather events', World News, *The Guardian*, 17 June. https://www.theguardian.com/world/2025/jun/17/nasa-data-reveals-dramatic-rise-in-intensity-of-weather-events.

Heltberg, R, Siegel, PB & Jorgensen, SL 2008, 'Addressing human vulnerability to climate change: toward a "no regrets" approach', *Global Environmental Change*, vol. 19, no. 1, pp. 88–99. https://doi.org/10.1016/j.gloenvcha.2008.11.003.

Henderson, H, Ratnam, K, Mok, H, Spiller, M & Sullivan, H 2024, 'Expanding superdiversity in Australian cities and regional towns', *Urban Policy and Research*, vol. 42, no. 4, pp. 415–44. https://doi.org/10.1080/08111146.2024.2408475.

Hicks, J, Lane, T, Wood, E, Hall, N, Webb, A & Mey, F 2018, *Enhancing positive social outcomes from wind development in Australia: evaluating community engagement and benefit sharing*, Clean Energy Council, Melbourne.

Hincapie-Ossa, D, Frey, N & Gingerich, DB 2023, 'Assessing county-level vulnerability to the energy transition in the United States using machine learning', *Energy Research & Social Science*, vol. 100, p. 103099. https://doi.org/10.1016/j.erss.2023.103099.

Hunt, J, Riley, B, O'Neill, L & Maynard, G 2021, 'Transition to renewable energy and Indigenous people in northern Australia: enhancing or inhibiting capabilities?', *Journal of Human Development and Capabilities*, vol. 22, no. 2, pp. 360–78.

Huttunen, S, Kaljonen, M, Lonkila, A, Rantala, S, Rekola, A & Paloniemi, R 2021, 'Pluralising agency to understand behaviour change in sustainability transitions', *Energy Research & Social Science*, vol. 76, p. 102067.

IEA 2024, *World energy outlook 2024*, International Energy Agency, Paris. https://www.iea.org/reports/world-energy-outlook-2024.

IEA 2025, *Australia*, International Energy Agency. https://www.iea.org/countries/australia.

IGCC 2025, *The state of net zero investment 2025: analysis of $4.2 trillion managed on behalf of Australians*, Investor Group of Climate Change (IGCC). https://igcc.org.au/wp-content/uploads/2025/04/IGCC-2025-State-of-Net-Zero_Full-Report.pdf.

IPCC 2022, 'Summary for policymakers [H-O Pörtner, DC Roberts, ES Poloczanska, K Mintenbeck, M Tignor, A Alegría, M Craig, S Langsdorf, S Löschke, V Möller, A Okem (eds)], in *Climate change 2022: impacts, adaptation and vulnerability. Contribution of working group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [H-O Pörtner, DC Roberts, M Tignor, ES Poloczanska, K Mintenbeck, A Alegría, M Craig, S Langsdorf, S Löschke, V Möller, A Okem, B Rama (eds)] (pp. 3–33), Cambridge University Press, Cambridge, UK and New York. https://doi.org/10.1017/9781009325844.001.

Ivanovski, K & Marinucci, N 2021, 'Policy uncertainty and renewable energy: exploring the implications for global energy transitions, energy security, and environmental risk management', *Energy Research & Social Science*, vol. 82, p. 102415. https://doi.org/10.1016/j.erss.2021.102415.

Izquierdo, A.E., Mautner, M., Gomez, R.D., Nieva, F., Estigarribia, L. and Forni, L., 2025. Integrating local and Indigenous knowledge with sustainable development goals in lithium mining impact assessment for a fair energy transition. *Environmental Science & Policy*, *171*, p.104155.

Johnson, OW, Yi-Chen Han, J, Knight, A, et al. 2020, 'Intersectionality and energy transitions: a review of gender, social equity and low-carbon energy', *Energy Research & Social Science*, vol. 70, p. 101774. https://doi.org/10.1016/j.erss.2020.101774.

Jotzo, F & Zou, A 2025, *Australia could become the world's first net-zero exporter of fossil fuels*, ANU Institute for Climate, Energy & Disaster Solutions, Australian National University. https://iceds.anu.edu.au/news-events/news/australia-could-become-world%E2%80%99s-first-net-zero-exporter-fossil-fuels.

Lane, T & Hicks, J 2017, *Community engagement and benefit sharing in renewable energy development: a guide for applicants to the Victorian renewable energy target auction*, Department of Environment, Land, Water and Planning, Victorian Government, Melbourne. http://www.cvga.org.au/uploads/9/8/3/8/9838558/delwp_cebsg_lr_f.pdf.

Leong, C & Howlett, M 2022, 'Policy learning, policy failure, and the mitigation of policy risks: re-thinking the lessons of policy success and failure', *Administration & Society*, vol. 54, no. 7, pp. 1379–401.

Liverman, D 2024, 'Geography and climate vulnerabilities', *Transactions of the Institute of British Geographers*, vol. 49, no. 4, p. e12721. https://doi.org/10.1111/tran.12721.

Markard, J 2018, 'The next phase of the energy transition and its implications for research and policy', *Nature Energy*, vol. 3, no. 8, pp. 628–33.

Mathew, S, Bhatta, M, Baliva, G, Matthews, V, Zander, KK, et al. 2025, 'Why are solar microgrids not the norm in remote Central Australia? Exploring local perception on solar energy and health', *Journal of Cleaner Production*, vol. 486, p. 144370.

McCoy, J, Davis, D, Mayfield, E & Brear, MJ 2024, 'Labour implications of the net-zero transition and clean energy exports in Australia', *Energy Research & Social Science*, vol. 112, p. 103506. https://doi.org/10.1016/j.erss.2024.103506.

Middha, B & Willand, N 2023, 'It's not as easy as "heat or eat": exploring the intersecting vulnerabilities of energy and food in domestic practices in Australia', *Energy Research & Social Science*, vol. 105, p. 103288. https://doi.org/10.1016/j.erss.2023.103288.

Milman, O 2025, 'Trump officials decimate climate protections and consider *axeing* [sic] key greenhouse gas finding', Environment, *The Guardian*, 12 March. https://www.theguardian.com/environment/2025/mar/12/epa-trump-climate-rules.

Nelson, T, Conboy, P, Hancock, A & Hirschhorn, P 2025, *National Electricity Market wholesale market settings review: draft report August 2025*.

NEM 2025, *The National Electricity Market: NEM records: fact sheet*, AEMO.

O'Connor, R, Bice, S, Henderson, H & Thayuman, M 2025, *Strengthening Australia's reform muscle via SLO: evidence and practice*, ANZSOG Research Insights No. 44, ANZSOG Melbourne.

O'Neill, L, Riley, B, Hunt, J & Maynard, G 2021, *Clean energy agreement making on First Nations land: what do strong agreements contain?*, Centre for Aboriginal Economic Policy Research, Australian National University. https://doi.org/10.25911/VHH3-F498.

O'Neill, L & Thorburn, K 2025a, *Trending up: how clean energy agreement-making in Australia is raising the bar on benefit and co-ownership arrangements for Australian Traditional Owners*, Melbourne Climate Futures, March. https://figshare.unimelb.edu.au/ndownloader/files/54954968.

O'Neill, L & Thorburn, K 2025b, 'First Nations at the forefront: the changing landscape of clean energy agreements in Australia', *Energy Research & Social Science*, vol. 127, p. 104183. https://doi.org/10.1016/j.erss.2025.104183.

O'Neill, L, Thorburn, K, Riley, B, Maynard, G, Shirlow, E & Hunt, J 2021, 'Renewable energy development on the Indigenous Estate: free, prior and informed consent and best practice in agreement-making in Australia', *Energy Research & Social Science*, vol. 81, 102252.

O'Neill, L, Thorburn, K & Hunt, J 2019, 'Ensuring Indigenous benefit from large-scale renewable energy projects: Drawing on experience from extractive industry agreement making', http://hdl.handle.net/1885/157026.

Owen, JR, Kemp, D, Lechner, AM, Harris, J, Zhang, R & Lèbre, É 2023, 'Energy transition minerals and their intersection with land-connected peoples.' *Nature Sustainability*, vol. 6, no. 2, pp.203–211.

OSCE 2016, *Protecting electricity networks from natural hazards*, Organization for Security and Co-operation in Europe. https://www.osce.org/files/f/documents/a/d/242651.pdf.

Paul, SK 2013, 'Vulnerability concepts and its application in various fields: a review on geographical perspective', *Journal of Life and Earth Science*, vol. 8, pp. 63–81. https://doi.org/10.3329/jles.v8i0.20150.

Parsons, R, Everingham, J-A & Kemp, D 2019, 'Developing social impact assessment guidelines in a pre-existing policy context', *Impact Assessment and Project Appraisal*, vol. 37, no. 2, pp. 114–23.

Parsons, R & Moffat, K 2014, 'Integrating impact and relational dimensions of social licence and social impact assessment', *Impact Assessment and Project Appraisal*, vol. 32, no. 4, pp. 273–82.

Parsons, R & Mottee, LK 2023, 'Exploring equity in social impact assessment', *Current Sociology*, vol. 72, no. 4. https://doi.org/10.1177/00113921231203170.

Peleggi, N 2025, *Pushing the US energy transition with renewables opposition*, World Economic Forum, https://www.weforum.org/stories/2025/03/us-energy-transition-renewables-opposition/.

Polsky, C, Neff, R & Yarnal, B 2007, 'Building comparable global change vulnerability assessments: the vulnerability scoping diagram', *Global Environmental Change*, vol. 17, no. 3–4, pp. 472–85.

Prin, M & Motherway, B 2023, *How to maximise the social benefits of clean energy policies for low-income households*, IEA. https://www.iea.org/commentaries/how-to-maximise-the-social-benefits-of-clean-energy-policies-for-low-income-households.

Quail, K, Green, D & O'Faircheallaigh, C 2025, 'Large-scale renewable energy developments on the Indigenous Estate: how can participation benefit Australia's First Nations peoples?', *Energy Research & Social Science*, vol. 123, p. 104044. https://doi.org/10.1016/j.erss.2025.104044.

Raimi, D, Carley, S & Konisky, D 2022, 'Mapping county-level vulnerability to the energy transition in US fossil fuel communities', *Scientific Reports*, vol. 12, no. 1. https://doi.org/10.1038/s41598-022-19927-6.

Rockström, J, Steffen, W, Noone, K, Persson, A, Chapin III, FS, Lambin, E, Lenton, TM, et al. 2009, 'Planetary boundaries: exploring the safe operating space for humanity', *Ecology and Society*, vol. 14, no. 2.

Sadiqa, A, Sahrakorpi, T & Keppo, I 2023, 'Gender vulnerabilities in low carbon energy transitions: a conceptual review', *Environmental Research Letters*, vol. 18, no. 4, p. 043004. https://doi.org/10.1088/1748-9326/acc819.

Sandri, O, Holdsworth, S, Hayes, J, Willand, N & Moore, T 2021, 'Hydrogen for all? Household energy vulnerability and the transition to hydrogen in Australia', *Energy Research & Social Science*, vol. 79, p. 102179. https://doi.org/10.1016/j.erss.2021.102179.

Sarewitz, D, Pielke Jr, R & Keykhah, M 2003, 'Vulnerability and risk: some thoughts from a political and policy perspective', *Risk Analysis: An International Journal*, vol. 23, no. 4, pp. 805–10.

Sovacool, BK 2014, 'What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda', *Energy Research & Social Science*, vol. 1, pp. 1–29.

Stambe, R, Marston, G, Snell, D & Moss, J 2025, 'Jobs aren't enough: redefining just transitions in Australia with community voices', *Energy Research & Social Science*, vol. 122, p. 103999. https://doi.org/10.1016/j.erss.2025.103999.

Taylor, M 2023, 'The power of energy justice for rural communities', in Heffron, R.J. and de Fontenelle, L. (eds) *The power of energy justice & the social contract* (pp. 129–35), Palgrave Macmillan.

Taylor, M 2025, *Examining JUST energy metrics: Exploring Australian research priorities*, Report for the Australian Council of Learned Academies (ACOLA) Australian Energy Transition Research Plan. www.acola.org.

Thekdi, SA & Aven, T 2021, 'A risk-science approach to vulnerability classification', *Risk Analysis*, vol. 41, pp. 1289–303. https://doi.org/10.1111/risa.13637.

UN Climate Change News 2023, 'COP28: What was achieved and what happens next?', *UN Climate Change News,* available: https://unfccc.int/cop28/5-key-takeaways. Accessed: 12 August 2025.

Vanclay, F 2024, 'Benefit sharing and enhancing outcomes for project-affected communities', in F Vanclay & AM Esteves (eds), *Handbook of social impact assessment and management* (pp. 426–43), Edward Elgar, Cheltenham, UK.

Vanclay, F 2003, 'International principles for social impact assessment'. *Impact assessment and project appraisal*, vol 21, pp. 5–12.

Vanclay, F, Esteves, AM, Aucamp, I, & Franks, D 2015, 'Social Impact Assessment: Guidance for assessing and managing the social impacts of projects'. https://iaia.org/wp-content/uploads/2025/03/Social-Impact-Assessment-Guidance-for-Assessing-and-Managing-the-Social-Impacts-of-Projects.pdf.

Weldegiorgis, FS 2025, 'Australian coal mining and economic diversification in the energy transition context', *Resources Policy*, vol. 100, p. 105429. https://doi.org/10.1016/j.resourpol.2024.105429.

White, LV, Riley, B, Wilson, S, et al. 2024, 'Geographies of regulatory disparity underlying Australia's energy transition', *Nature Energy*, vol. 9, no. 1, pp. 92–105. https://doi.org/10.1038/s41560-023-01422-5.

Willand, N 2022, 'Opportunity, ideal or distraction? Exploring stakeholder perceptions of tackling energy poverty and vulnerability among older Australians', *Energy Research & Social Science*, vol. 94, p. 102852. https://doi.org/10.1016/j.erss.2022.102852.

Willand, N, Middha, B & Walker, G 2021, 'Using the capability approach to evaluate energy vulnerability policies and initiatives in Victoria, Australia', *Local Environment*, vol. 26, no. 9, pp. 1109–127. https://doi.org/10.1080/13549839.2021.1962830.

Williams, SN & Marmot, M 2023, 'Heat related health inequalities are rising', *BMJ*, vol. 383, p. 2844. doi:10.1136/bmj.p2844.

Wilson, S 2025, 'Disrupting household energy rights: examining the policy origins of prepayment for electricity services in Australia', *Energy Research & Social Science*, vol. 124, p. 104060. https://doi.org/10.1016/j.erss.2025.104060.

Wood, B, Milsom, P & Friel, S 2024, 'No silver bullets, no shortcuts: Confronting the commercial determinants of the climate crisis', *The Lancet Planetary Health*, vol. 8, no. 12, pp. e977–8. https://doi.org/10.1016/s2542-5196(24)00278-x.

World Economic Forum 2021, *Fostering effective energy transition*. https://www.weforum.org/publications/fostering-effective-energy-transition-2021/in-full/5-building-resilience-to-overcome-new-risks/.

Zhao, J, Li, F & Zhang, Q 2024, 'Impacts of renewable energy resources on the weather vulnerability of power systems', *Nature Energy*, vol. 9, no. 11, pp. 1407–14.

APPENDIX A: AUSTRALIAN RESEARCH CENTRES AND ORGANISATIONS: VULNERABILITY RESEARCH

The following research centres and organisations are conducting research on the energy transition, with at least some component focusing on vulnerability. In compiling this list, we have adopted a broad definition of 'research', going beyond conventional research-type work to include endeavours that seek to highlight and address vulnerabilities in the energy transition. Nevertheless, this list is inevitably incomplete, as much relevant research transcends formal institutional structures – for example, via multi-institutional research collaborations.

University-based research centres and institutes

ANU Institute for Climate, Energy and Disaster Solutions (ICEDS)

ICEDS connects people with climate, energy and disaster-risk research from the Australian National University. ICEDS' goal is to advance innovative solutions to address climate change, energy system transitions and disasters. ICEDS facilitates integrated approaches to research, teaching and policy engagement across disciplines. The institute's world-leading research on the energy transition includes a focus on Aboriginal and Torres Strait Islander engagement.

ANU Institute for Infrastructure in Society (I2S)

ANU I2S is a world-leading research institute for social risk management, social licence, and community engagement for infrastructure delivery, including renewables. I2S uses research co-design, working directly with industry, government, civil society and communities to transform the relationship between major projects and communities. I2S's work on environmental conflict, social licence and community engagement for renewables, mis/disinformation, social impact assessment, social risk management, sustainable infrastructure and superdiversity speaks to concerns for vulnerabilities shaping and shaped by major project delivery.

The Cooperative Research Centre for Transformations in Mining Economies (CRC TiME)

CRC TiME is a research organisation focused on improving the management of mine closure and post-mining landscapes. It aims to integrate social, cultural, economic and environmental outcomes but is not focused explicitly on vulnerability. It includes a First Nations advisory team that guides its work.

Melbourne Climate Futures (MCF)

MCF integrates University of Melbourne research committed to a sustainable, safe, fair and equitable climate future. Its 13 research themes include two of particular relevance: health, wellbeing and climate justice; and social vulnerability and adaptation.

Sydney Environment Institute (SEI)

SEI undertakes multidisciplinary research focused on environmental challenges, such as the climate and biodiversity crises, and engages in public discourse. For example, it recently published an opinion piece on the International Court of Justice's advisory opinion on climate change and its implications for policies to avoid harm.

Transforming Energy Markets (TEM) Research Centre

TEM, based at Macquarie University, is mainly focused on market design, analysis, regulation and innovation, but it also has an objective of 'fair outcomes for market participants, households and communities'.

University of Technology Sydney Institute for Sustainable Futures (ISF)

ISF's energy research program envisions a future when 'energy is clean, affordable and accessible to all'. Relevant work areas include a focus on a just transition of jobs from fossil fuels to renewables.

Industry-based organisations

Clean Energy Council (CEC)

CEC is largely focused on accelerating the energy transition but includes some work on workforce equity, diversity and inclusion, and on First Nations participation in the energy workforce.

Community Power Agency (CPA)

CPA focuses on involving communities at every stage of renewable energy development to optimise inclusive and equitable social outcomes. It does this by, for instance, supporting community-owned projects, advocating for renters and apartment residents to access clean energy, and collaborating with developers to design projects that maximise community benefits.

First Nations Clean Energy Network (FNCEN)

FNCEN works to secure equitable outcomes from renewable energy projects for First Nations communities, with a focus on self-determination, community-led development and energy justice. It provides a platform for research consistent with these objectives.

Farmers for Climate Action

Farmers for Climate Action is a movement of farmers, agricultural leaders and rural Australians working to influence Australia to adopt strong climate policies and to ensure rural communities' interests are represented. They do this, for example, through connecting farmers with each other and supporting them to advocate for and enact climate solutions both on and off farm.

Australian Renewable Energy Alliance (RE-Alliance)

RE-Alliance is an independent organisation focused on strengthening regional communities through the energy transition, mainly through advocacy and policy submissions on topics such as benefit sharing and social licence.

The Energy Charter

The Energy Charter is a coalition of energy companies, with 'community outcomes' as the first of its five principles. Its fifth principle is to 'support customers and communities facing vulnerable circumstances'. Its range of publications includes many themed around energy equity, community engagement and social licence. It has also established a 'Lived Experience Panel' of 10 landholders tasked with discussing the proposed Developer Rating Scheme, a key recommendation of the Dyer Community Engagement Review. In 2024, the Energy Charter piloted its first Regional Collaboration Framework in the Wimmera–Mallee region in an effort to adopt a 'place-based' approach to renewable energy development.

APPENDIX B: VULNERABILITY SCOPING DIAGRAM

The Vulnerability Scoping Diagram (VSD) integrates the 'biophysical, cognitive, and social dimensions of human–environment interactions' into a 'vulnerability perspective' that demands attention to the complex and interconnected aspects of human and natural systems. It first defines three core '**vulnerability dimensions**': **exposure** (to risks or impacts that introduce or exacerbate vulnerabilities); **sensitivity** (the likelihood and severity of reaction to vulnerability); and **adaptive capacity** (the ability to adapt to those circumstances).

The VSD then introduces '**vulnerability components**'; the distinct characteristics of vulnerability dimensions in a given system. Components may, as shown in the example in Figure A1 of a local water supply system, include considerations such as drought (exposure dimension), demographics (sensitivity dimension) and access to information (adaptive capacity).

Finally, the VSD introduces **measures** that facilitate assessment of identified vulnerabilities. In the example given in the figure, such measures include frequency (drought/exposure), income (demographics/sensitivity) and dissemination structure (access to information/adaptive capacity). Overall, the VSD supports 'research intended to inform ways to protect social and ecological resources for present and future generations' (Polsky et al., 2007, p. 473), providing an apt and ready framework for exploration of vulnerability and Australia's energy transition.

Interrogation of an initial VSD mapping of vulnerabilities can be enriched by deeper exploration of the ways in which the three main dimensions (what Adger & Brown, 2009, refer to as 'elements') of vulnerability interact and are weighted within any given system. Exposure, sensitivity and adaptive capacity therefore also provide three effective focus areas to inform research endeavours and solutions. *Exposure* encourages focus on 'the nature and degree to which a system experiences environmental or socio-political stress'. *Sensitivity* reveals how likely and to what extent a human or natural system is to suffer significant change or long-term effects, implicitly and simultaneously capturing levels of resilience. *Adaptive capacity* helps researchers to understand both the 'coping range' of a system and its ability to change or evolve to accommodate changing circumstances (Adger & Brown, 2009, p. 110).

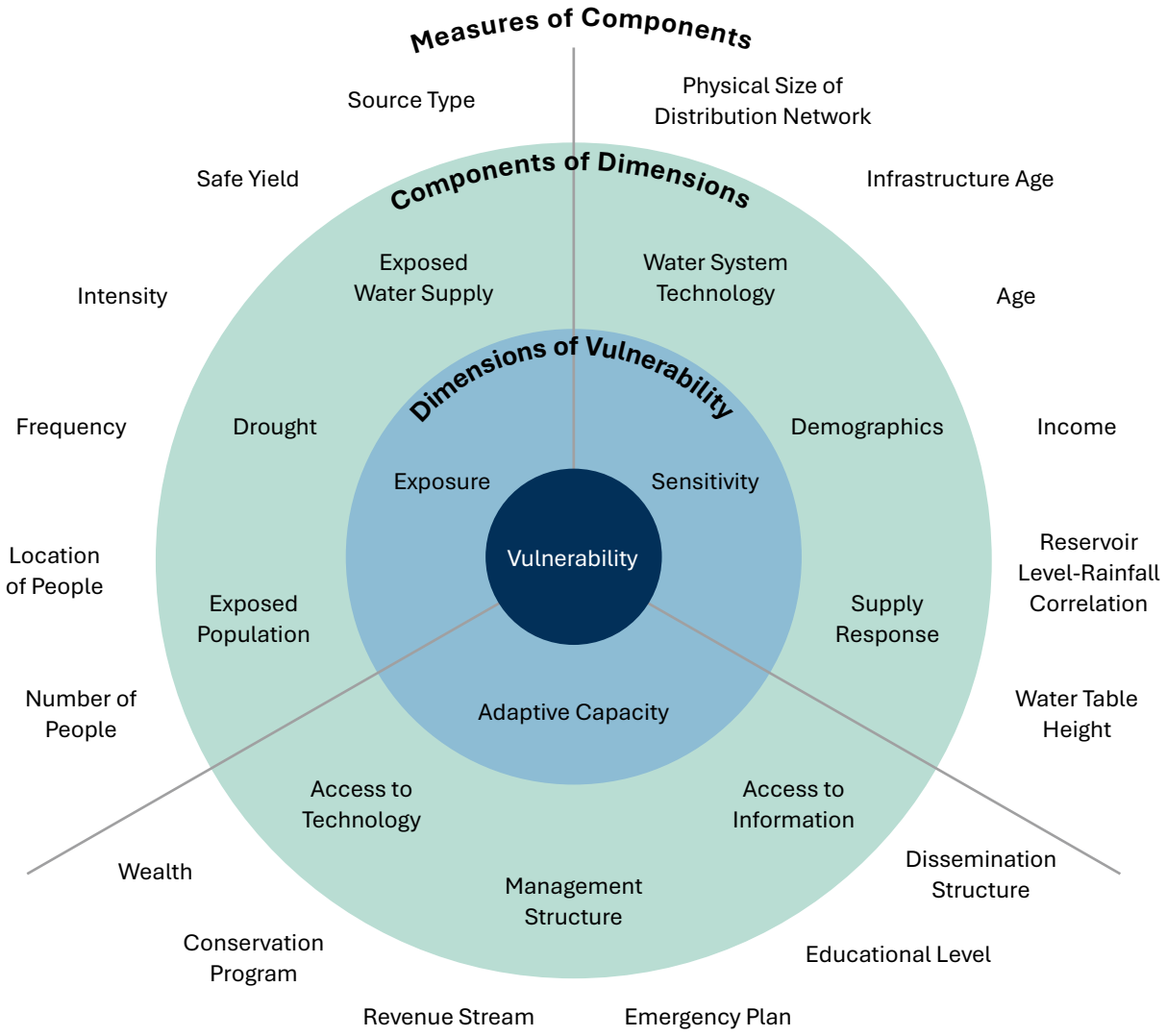

Figure A1: Hypothetical VSD demonstrating dimensions, components and measures for a local water supply system. Source: Polsky et al. (2007)

APPENDIX C: GROUPS FACING VULNERABILITY IN RELATION TO THE ENERGY TRANSITION

People and communities may face different vulnerabilities depending on a variety of factors. Some may face vulnerabilities as a direct result of energy developments or from energy poverty, while others may be more exposed to vulnerabilities from the energy transition not proceeding, or not proceeding rapidly enough. Either way, identifying different social groups and how vulnerabilities may be relevant to them can help to clarify and address research gaps.

For this exercise, the theory and practice of social impact assessment (SIA) is instructive. A central theme in SIA literature, and a core objective of SIA in practice, is to protect society's most vulnerable people from harm associated with development-induced change, and preferably to improve their lives. This idea overlaps with a strong focus on fairness, equity and justice. Historically, people living in vulnerable circumstances have tended disproportionately to experience the negative effects of industrial developments such as mining and infrastructure projects, and the evidence suggests that this inequitable situation is being replicated and extended in many corners of the energy transition.

So, who are 'people living in vulnerable circumstances', and how might the energy transition create or exacerbate vulnerabilities? Identifying people who are experiencing vulnerability need not exemplify or entrench a deficit model; rather, it is essential for underpinning more nuanced and bespoke approaches to addressing impacts and targeting benefits from energy projects and policies. This nuanced understanding can also help to inform benefit sharing initiatives that address genuine need and respond to local vulnerabilities, rather than using benefits unjustly as bribery to 'buy' local support.

Experience from SIA and beyond suggests that the groups listed in Table A1 may be considered vulnerable in the context of the energy transition. In addition, while we can identify certain vulnerabilities applicable to each group, these vulnerabilities may intersect (e.g. Willand, 2022).

Table A1: Social groups likely to experience vulnerability in the energy transition

Category of vulnerability	Social group	Examples of vulnerabilities in the context of the energy transition
Socio-economic	Those on very low incomes	Affordability of rising electricity costs associated with new technologies (e.g. smart meters) and energy sources.
	Single-parent families	Affordability of rising electricity costs associated with new technologies and energy sources. Capacity to engage with evolving energy systems and project developments.
	Isolated older people	Affordability of rising electricity costs associated with new technologies and energy sources. Adaptability to evolving energy systems.
	Those living with disabilities or poor health	Affordability of rising electricity costs associated with new technologies and energy sources. Exposure to health risks from project construction activities. Exposure to health risks from a delayed transition.
	Those experiencing homelessness or insecure housing	Affordability of rising electricity costs associated with new technologies and energy sources. Marginalisation from decision-making processes, such as project-related community engagement activities.
	Renters	Affordability of rising electricity costs associated with new technologies and energy sources. Exclusion from benefit sharing arrangements. Reduced agency in choosing low-cost energy options and tariffs.
	People experiencing vulnerable circumstances and challenging policy processes	Marginalisation from decision-making processes, such as community engagement activities. Poorly designed policy processes exacerbate vulnerabilities or make fair and genuine participation difficult or impossible.

Category of vulnerability	Social group	Examples of vulnerabilities in the context of the energy transition
Socio-demographic	Aboriginal and Torres Strait Islander and land-connected peoples	Loss or erosion of land connection and identity through industrialisation. Devaluing of cultural value and cultural knowledge as valid considerations in project planning. Exclusion from economic opportunities. Marginalisation from decision-making processes, such as community engagement activities. Continued degradation of landscapes from climate change–induced weather events if the transition is not rapid enough.
	Women	Exposure to gender-based violence associated with worker in-migration. Marginalisation from decision-making processes, such as community engagement activities.
	Gender minorities	Exposure to gender-based violence associated with worker in-migration. Marginalisation from decision-making processes, such as community engagement activities.
	Children and young people	Marginalisation from decision-making processes, such as community engagement activities. Disproportionate exposure to health risks from project construction activities. Disproportionate exposure to ongoing impacts of climate change and continued fossil fuel operations.
	Ethnic minorities, migrants, those who are culturally and linguistically diverse or from non-dominant language backgrounds	Marginalisation from decision-making processes, such as community engagement activities.

Category of vulnerability	Social group	Examples of vulnerabilities in the context of the energy transition
Place-based	Rural/remote individuals/ communities	Disproportionate exposure to impacts of renewable energy developments, transmission lines and critical minerals projects (partly depending on individual perceptions of these developments). Threats to rural character and sense of place. Continued degradation of landscapes from climate change–induced weather events if the transition is not rapid enough. Loss of livelihoods and amenities if isolated communities become unliveable owing to slow pace of transition.
	Those living in communities that host coal or gas operations ('carbon-intensive communities')	Dependence on single or few dominant industries for local livelihoods.

These potential vulnerabilities should not be used to generalise or stereotype the characteristics of any particular group. Rather, careful consideration of the intersecting contextual and structural factors shaping individual and collective vulnerabilities draws attention to the need for tailored research and policy responses.

APPENDIX D: RAPID LITERATURE REVIEW METHOD

The rapid literature review completed for this report used the ANU 'Supersearch' library meta-database. This database integrates major academic journal and publisher databases, including key humanities and social science peer-reviewed journal databases, such as SCOPUS, Web of Science and JSTOR. Google Scholar was also used as a metasearch engine to identify peer-reviewed publications.

Search terms (Table A2) for the databases used Boolean combinations and the '*' wildcard character to search for the following key terms in a variety of combinations. For instance, the term 'vulnerability' was combined with 'energy transition*' to search for 'vulnerabilit* and energy transition*'.

In total, 103 peer-reviewed articles and government and intergovernmental agency reports were included in the rapid literature review. The search concentrated primarily on the most up-to-date research, with the vast majority of papers included in the review produced within the past five years. Remaining publications were produced within the past decade, with only four papers produced earlier. Three of these four papers were related to the Vulnerability Scoping Diagram. One paper on 'vulnerability and energy policymaking' was published in 2014 and was included owing to its unique content and relevance to the topic.

The abstracts of all documents were assessed for relevance, and the majority of documents were read in full or in large part. Articles were analysed to identify key thematic issues, common disciplinary and methodological approaches, outstanding research gaps and questions, and research opportunities.

Table A2: Key search terms (in alphabetical order)

- Australia*
- benefit-creation
- benefit sharing
- clean energy
- climate change
- co-benefits
- electricity affordability
- energy accessibility
- energy affordability
- energy justice
- energy policy
- energy transformation*
- energy transition*
- energy vulnerability*
- fair and just energy transition*
- fair and just transition*
- green energy
- social licen*e
- social value
- social value creation
- vulnerabilities
- vulnerability
- vulnerabilit* framework*
- vulnerabilit* impact*
- vulnerabilit* impact assessment

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