

# AUSTRALIAN ENERGY TRANSITION RESEARCH PLAN RESEARCH PRIORITIES CONSULTATION PAPER

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**Australian Council of Learned Academies**

Level 6, 436 St Kilda Road  
Melbourne Victoria 3004 Australia  
Telephone: +61 (0)3 9864 0923  
[acola.org](http://acola.org)

**ACKNOWLEDGEMENT OF COUNTRY**

ACOLA acknowledges the Traditional Owners and custodians of the lands on which our company is located and where we conduct our business. We pay our respects to Elders past, present and emerging.

# AUSTRALIAN ENERGY TRANSITION RESEARCH PLAN RESEARCH PRIORITIES CONSULTATION PAPER

## Purpose of this consultation paper:

To test initial energy research priorities for the Australian Energy Transition Research Plan (Research Plan) following the first round of consultations and early analysis.

## Key questions:

Do the three themes of research priorities, and underpinning eight streams, provide an appropriate framework for the Research Plan, and are there areas for improvement?

Do the indicative research questions identify the most critical research gaps (are some already being adequately addressed; have any been missed)?

## Submissions due:

Submissions on this consultation paper are due on Friday 26 February 2021.

## About ACOLA

The Australian Council of Learned Academies (ACOLA) is an independent, not-for-profit research organisation that brings together Australia's Learned Academies and our Associate members to contribute expert advice to inform national policy and to develop innovative solutions to complex global problems and emerging national needs. Our methodology is founded on the recognition that the complexity of the challenges facing society today have scientific, technological, social, cultural, health and ethical dimensions, and therefore will be most effectively addressed through an interdisciplinary approach.

## ACOLA's Members



Australian Academy of  
Technology & Engineering



Australian  
Academy of Health and  
Medical Sciences

## Funding Partners for the Australian Energy Transition Research Plan



Australian Government  
Australian Renewable  
Energy Agency

\*The views and opinions expressed in this Consultation Paper are those of ACOLA and the Steering Committee, and do not reflect the opinions of NERA, CSIRO and ARENA.



# INTRODUCTION

Australia is a major energy powerhouse that exports energy to the rest of the world, yet we have a difficult energy transition to net zero emissions ahead of us, given our unique geography, climate, widely dispersed populations and federal political structure.

While the energy transition to non-fossil and renewable sources is already occurring across Australia, there is currently no coordinated and holistic picture of the research underway to support a successful energy transition. Nor is there an independent and authoritative statement of current research gaps and priorities. In addition, while international energy transition research is progressing strongly, Australia cannot rely solely on this international research to support its own transition. Australia must continue to build its own research capabilities to find local solutions and strategies to solve local problems. Our unique energy environment will give rise to distinct energy transition research considerations over the coming decade.

As a response to these issues, in late 2019, ACOLA commenced discussions with the Australian energy sector on the need for an Australian Energy Transition Research Plan (the Research Plan). In mid-2020, this work officially commenced following strong stakeholder support, and in late 2020 ACOLA secured several funding partners to support the delivery of this project.

This paper provides a progress update on the project and seeks to test the initial research priorities proposed.

## What do we mean by energy?

For this project, 'energy' encompasses electricity (all sources), natural gas, liquid fuels, coal and hydrogen, and as used in stationary energy, transport and industry sectors. This includes the generation, transport, storage, use and export of energy, and includes energy efficiency and productivity.

## Purpose of the Research Plan

The objective of the Research Plan is to identify research gaps and subsequently promote research priorities for a successful Australian energy transition to net zero carbon emissions (nominally by 2050), with the purpose of helping to inform and influence the direction, allocation and quantum of research funding in Australia. This will: 1) guide research funders, industry and researchers' activities related to the national energy transition; and 2) encourage research activities that complement existing strengths and avoid duplicative efforts. The Research Plan will be a dynamic document, produced annually and developed in consultation with stakeholders, to ensure it remains relevant over the course of the energy transition (nominally 30 years).

## Governance

This ACOLA project will be led by a Steering Committee consisting of experts and Fellows from Australia's Learned Academies that bring their multidisciplinary expertise across the energy and research sector. The overall governance and monitoring of the Research Plan will be led by ACOLA, as an independent, not-for-profit research organisation that will provide a multidisciplinary and evidence-based perspective to support this project.



**Mr Drew Clarke AO**  
PSM FTSE  
(Chair)



**Emeritus Prof.  
Sue Richardson AM**  
FASSA



**Dr Bruce Godfrey**  
FTSE



**Emeritus Prof.  
Libby Robin FAHA**



**Prof. Kenneth  
Baldwin FAIP**  
FinstP FOSA FAPS



**Prof. Fran Baum AO**  
FAHMS FASSA

## Outcome of first round of consultations

In mid-2020, ACOLA consulted with stakeholders on the scope, aims and direction of a Research Plan. This revealed a strong interest in developing a coordinated Research Plan that included annual (or regular) monitoring, that identified research gaps early, and for research priorities to be coordinated and annually re-assessed. Stakeholders agreed that ACOLA is uniquely positioned to govern the development and monitoring of this work given its independence and interdisciplinary focus.

While Australia has a strong performance in science and technology research on the energy transition, gaps exist in the social, economic and cultural dimensions.

## Australia's research direction in the global context

In parallel to the development of the research priorities, ACOLA will also undertake research and consultation to examine the quantum and allocation of Australian energy research funding in the global context. International data on publicly funded energy research from comparable nations will be reviewed and compared with Australian data to better understand Australia's research position and trajectory in the global energy transition.

## Broader Transition Research

In addition, the Research Plan itself will contribute to broader transition research, which assesses the technological, organisational, economic, institutional and political impacts of large-scale socio-economic transitions through a multidisciplinary lens. Nationally and internationally, the energy transition is happening at a rapid pace and scale, and insights and research derived from this project and the Research Plan itself will likely provide important knowledge for future global transitions.





# 1. THE AUSTRALIAN ENERGY TRANSITION

## Current global climate and energy context

The 2015 Paris Agreement established the baseline for global cooperation, with the central goal of limiting global temperature rises this century to well below 2 degrees Celsius above pre-industrial levels, and to pursue limiting temperature increase even further to 1.5 degrees Celsius.<sup>1</sup> As of January 2021, nearly 200 countries have signed up and ratified the Paris Agreement.<sup>2</sup> International action to ameliorate climate change, including emissions targets, is coordinated through the United Nations Framework Convention on Climate Change (UNFCCC). In 2018, the International Panel on Climate Change, which reports to the UNFCCC, released a key report outlining that major and immediate global transformation would be required to limit warming to 1.5 degrees Celsius. This has rapidly accelerated global policy and industry efforts to curb emissions and drive R&D in clean energy renewable technologies. Youth-driven global climate activism has also shifted to a new level of urgency, demonstrated by the Global Climate Strikes of 2018-19.

Over the last 35 years, there has been significant progress in global energy policy to decrease global carbon emissions, and achieve the target of net zero emissions by 2050. Global efforts have been largely driven by the UN's climate change efforts through the UNFCCC.

As of December 2020, more than 20 countries and the European Union have set net zero targets for 2030-2050, and more than 100 others are considering adopting targets through the Climate Ambition Alliance. Sweden, the UK, France, Denmark and New Zealand have adopted legislation enshrining their net zero targets,<sup>3</sup> as have Australia's key Asian energy trading partners Korea and Japan. China also recently announced that it will achieve net zero emissions by 2060. A growing number of companies are also committing to net zero and interim targets through the Business Ambition for 1.5°C campaign.<sup>4</sup> Following the US election in November 2020, president-elect Joe Biden has confirmed that the US will re-join the Paris Agreement and take a leadership role on global climate change. This signals the alignment of global climate policy for the first time in recent years with every member of the G7 and the EU committed to net zero emissions by 2050, and China by 2060. The next UN Climate Change Conference is scheduled to be held in Glasgow, Scotland in November 2021, and is likely to play an instrumental role in progressing future global climate policy action and country emission targets.

Australia ratified the Paris Agreement in 2016, committing to achieving a 26-28 percent reduction in emissions below 2005 levels by 2030. As a signatory, Australia will need to transition towards achieving net zero emissions in the second half of the century.

1 United Nations Framework Convention on Climate Change (2015). *Adoption of the Paris Agreement*, 21 Conference of the Parties.

2 Climate Watch (2021). *Explore Nationally Determined Contributions (NDCs)*. Accessed on 11 January 2021 at [https://www.climatewatchdata.org/ndcs-explore?indicator=pa\\_status](https://www.climatewatchdata.org/ndcs-explore?indicator=pa_status).

3 Gerholdt, R. (2020). *Statement: Japan pledges to reduce greenhouse-gas emission to net zero by 2050*. World Resources Institute. Accessed on 6 November 2020 at <https://www.wri.org/news/2020/10/statement-japan-pledges-reduce-greenhouse-gas-emissions-net-zero-2050>

4 Gerholdt, R. (2020).

## Current Australian developments

The Australian energy market and policy environment is undergoing a substantial and rapid transformation; the pace and scale of which is unparalleled. A successful energy transition will be one that is achieved in a timely manner, and ensures that unavoidable negative impacts on Australia's economic growth and social wellbeing are minimised. In this respect, Australia could potentially be an exemplar for the rest of the world.

**A successful energy transition must address the 'energy trilemma' – where Australia's future energy system is reliable, cost-effective, and on a pathway to net zero emissions.**

Australia is fortunate to have large reserves of energy resources. This has enabled Australia to be a major player in global energy markets in the export of coal, uranium and natural gas. In 2018-19, Australia's energy consumption was 6,196 petajoules, with fossil fuels providing nearly all energy (94 percent), and coal still dominating the electricity mix.<sup>5</sup> However, renewable generation increased 17 percent, contributing 20 percent of total generation.<sup>6</sup> Australia is currently the world leader in the annual rate of installed solar and wind capacity per capita; an order of magnitude greater than the world average.<sup>7</sup>

Affordability has remained a consistent challenge, with energy prices consistently high amidst low competition, limited consumer choice and increasing gas prices. The 2016 state-wide black out in South Australia, and power reliability issues under severe climate conditions in Victoria and South Australia in 2017-18 has placed security and reliability at the forefront of the energy policy agenda.

Australia's total energy consumption is largely driven by industry use, where transport, electricity, manufacturing and mining sectors make up 83.9 percent of total energy consumption in 2018-19.<sup>8</sup> Therefore, industry will have a large role in Australia's energy transition pathway.

Australia's energy transition has already commenced. Energy policy and governance remains complex and has been subject to changes in national policy direction and politics, and navigating the challenges of reducing Australia's significant carbon emissions without sacrificing economic growth. The Prime Minister of Australia has signalled that Australia is 'on track' to reach its net zero emissions target by 2050,<sup>9</sup> and may not need to use its carryover credits from its commitments under the Kyoto Protocol.<sup>10</sup>

**The Australian government, states and territories have signalled a commitment to reach net zero emissions by 2050.**

In September 2020, the Australian Government released a Technology Investment Roadmap: First Low Emissions Technology Statement to drive innovation and investment in the clean energy sector. States and territories have all established their own net zero energy policies, committing to substantial investment and policy to support the development of renewable energy technologies to meet these targets.

5 Australian Government (2020). *Australian Energy Update 2020*, p. 18. Accessed on 19 November 2020 at [https://www.energy.gov.au/sites/default/files/Australian%20Energy%20Statistics%202020%20Energy%20Update%20Report\\_0.pdf](https://www.energy.gov.au/sites/default/files/Australian%20Energy%20Statistics%202020%20Energy%20Update%20Report_0.pdf)

6 Australian Government (2020), p. 3.

7 Stocks, M., Blakers, A. and Baldwin, K. (2019). *Australia is the runaway global leader in building new renewable energy*. The Conversation, September 15

8 Australian Government (2020), p. 11.

9 Minister for Energy and Emissions Reduction. 10 December 2020. *Projections confirm Australia on track to meet and beat 2030 target*. Accessed 21 December 2020 at <https://www.minister.industry.gov.au/ministers/taylor/media-releases/projections-confirm-australia-track-meet-and-beat-2030-target>.

10 Murphy K. and Morton, A. (2020). *Scott Morrison's climate language has shifted – but actions speak louder than words*. Accessed 21 December 2020 at <https://www.theguardian.com/environment/2020/nov/29/scott-morrison-s-climate-language-has-shifted-but-actions-speak-louder-than-words>

There have also been notable successes in the domestic uptake of renewable energy technologies. Investment by the Australian Renewable Energy National Agency (ARENA), state and territory-based incentive schemes and the prevalence of single-storey housing across Australia have accelerated the uptake of wind and solar energy technologies. In particular, the installation of home solar energy photovoltaic (PV) systems has been high, with Australia having the highest penetration of solar PV systems per household (27 percent) globally.<sup>11</sup>

A number of key structural challenges for the transition remain. While other global economies can utilise a multitude of energy sources to undertake an energy transition, Australia has a high level of legacy fossil fuel use, one of the longest and skinniest energy networks in the world, ageing transmission infrastructure, no neighbouring nations with surplus energy, no legacy nuclear power, no cheap domestic gas, and limited hydroelectric infrastructure. It does, however, have abundant wind and solar resources, and extensive low-cost land on which to build solar and wind electricity generators. Citizen engagement and uptake of personal solar and other renewables is also high.

**Compared to the rest of the world, Australia faces one of most difficult energy transitions.**

To date, there has been relatively little attention paid to the social, economic and cultural aspects of the transition, and the impact on end-users and concerned citizens. Social legitimacy may have a significant impact, particularly for regional areas where high-emissions intensive industries provide the most job opportunities. Therefore, a system-wide view of the energy transition is acutely needed to account for the complexity of Australia's current energy landscape. Structural change in the sector will require taking a multi and interdisciplinary approach to tackle all the dimensions of the transition (including social, economic, cultural, human and ecological wellbeing, legal, science and technology) in a holistic and cohesive manner. This includes examining the different interdependencies and causality between the different sectors, interests and actors across the energy sector (supply chains, physical infrastructure, user practices, markets and the regulatory system).<sup>12</sup>

Addressing the social and cultural dimensions of the transition is paramount; given that the transition will affect all Australians and will require widespread acceptance and buy-in by citizens to achieve social and political legitimacy.

11 Australian PV Institute (2019). *National Survey Report of PV Power Applications in Australia*.

12 OECD (2011). *OECD Green Growth Studies Energy*, p. 62. Accessed on 4 December 2020 at <https://www.oecd.org/greengrowth/greening-energy/49157219.pdf>



## Opportunities, risks and costs

The opportunity to benefit from Australia's energy challenge is well documented. Modelling by Pricewaterhouse Coopers (PwC) has found that investing in renewables could add \$13.2 billion to the GDP and an additional \$5.6 billion in consumption by 2040.<sup>13</sup> Similarly, Deloitte has forecast that a new growth recovery pathway towards a zero-emissions scenario could increase GDP by 2.6 percent and add \$680 billion (in present value terms) to the economy in 2070. This pathway would also add over 250,000 jobs by 2070.<sup>14</sup>

**A focused and strategic trajectory towards net zero emissions can build investor confidence and lead to economic prosperity and jobs.**

Australia is beginning to position itself as global exporter of low-emission technologies. The Low Emissions Technology Statement outlines the Australian Government's plan to drive the development of five key priority technologies, to make these cost-competitive with existing technologies and capture new export markets.<sup>15</sup> This includes an investment of \$18 billion and a forecast of 130,000 jobs added to the workforce over the next decade.<sup>16</sup>

Australia has also outlined an ambitious Hydrogen Strategy that offers opportunities to carve out a hydrogen export market with Japan, South Korea and Germany. Two major renewable energy export projects have recently been granted Australian Government major project status: the Asian Renewable Energy Hub (hydrogen and ammonia) and the Australian-ASEAN Power Link (electricity). Additionally, Australia is continuing to demonstrate world-leading research capabilities in solar PV, which is likely to continue to grow and develop as global demand for renewables increases.

As demonstrated by the 'learning rates' model, technical advances and manufacturing improvements drive down the capital cost of production of new technologies. It is likely that concerted investment and focus on export opportunities for renewable technologies will have a positive impact on the pace and scale of the domestic transition in Australia, by driving down costs and increasing uptake of technologies such as hydrogen. The increased uptake of domestic solar PV in Australia has been driven in part by the dramatic learning rate, which has caused the solar module cost per watt in 2019 to fall to 1/500th of the cost in 1976.<sup>17</sup>

However, 'markets can most effectively deliver desired investments and outcomes when investors have visibility of government direction. This helps set investment priorities and reduce regulatory and commercial risks.'<sup>18</sup> The alignment of national, state and territory policy on the reduction of carbon emissions and renewable technologies would facilitate greater confidence by investors and the industry. Emerging evidence suggests that it is possible for Australia to reduce its emissions without substantial negative economic impacts; a 2019 assessment of 19 recent national reports modelling higher emission reduction targets by 2030, including three Treasury reports, concluded that various actions on emissions reductions would not have disastrous effects on the economy and, in fact, that deep reductions would likely lead to growth across the economy.<sup>19</sup>

13 PwC (2020). *The Future of Energy: Australia's Energy Choice*.

14 Deloitte Access Economics (2020). *A new choice: Australia's climate for growth*, p. 50. Accessed on 10 November 2020 at <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-dae-new-choice-climate-growth-051120.pdf?nc=1>

15 These are clean hydrogen, energy storage, low carbon materials, carbon capture storage and soil carbon measurement.

16 Department of Industry, Science, Energy and Resources (2020). *Low Emission Technology Statement to help reduce emissions and boost the economy*. Accessed on 15 December 2020 at <https://www.industry.gov.au/news/low-emissions-technology-statement-to-help-reduce-emissions-and-boost-the-economy>.

17 Baldwin, K. (2020). *The Energy Transition*, presentation to the Parliamentary Library – Parliament of Australia, slide p. 4.

18 International Energy Agency (2018). *Energy Policies of IEA Countries: Australia 2018 Review*, p. 14.

19 Swann, T. and Merzian, R. (2019). *A Model Line-up: Comparing economic models of high ambition emission reduction targets*. The Australia Institute. Accessed on 12 November 2020 at <https://www.tai.org.au/sites/default/files/P656%20A%20Model%20Line-up%20%5BWEB%5D.pdf>



While the opportunities, impacts and risks will vary depending on the actions taken, the impact of maintaining a 'business as usual' trajectory is substantial. Deloitte estimates that the economic cost to Australia of staying on its current economic trajectory, from unmitigated climate change would be losses of \$3.4 trillion in present value terms, or 6 percent of the GDP. This will result in the loss of 880,000 jobs in 2070. Even with earlier projections on impact by 2050, the 'pathway of inaction or mis-action leads to economic losses of \$1.1 trillion in present value terms by 2050 or 3.6 percent of GDP. This sees the loss of almost 330,000 jobs by 2050.<sup>20</sup> While the results of such models are approximations, the critical point outlined in the Deloitte analysis is that Australia does not have a 'no change, no cost' future available to it: at the minimum, it will have to deal with the growing damage done by climate change. Australia must act swiftly and smartly, to minimise the disruptive impact on our society and economy, and to have the best chance of an optimistic future.

**A "business as usual approach" to the energy system will likely lead to significant job losses.<sup>21</sup>**

<sup>20</sup> Deloitte Access Economics (2020), p. 35.

<sup>21</sup> Deloitte Access Economics (2020).

Wider impacts on our energy network include insecure and unreliable power supply that could lead to events similar to South Australia's state-wide black out, and volatility and spikes in energy prices that could further limit access for vulnerable populations. In addition, Australian emission intensive industries will be vulnerable to major disruption, as global demand for high emission energy resources continues to decrease and economies move towards net zero emissions.

This has significant implications for Australia's economy and society:

fossil fuel assets and the infrastructure required to develop these will be 'stranded', which could grossly affect the current value and operations of industries involved. In terms of workforce impacts, 23 percent of the Australian workforce are employed in emissions intensive industries and will need to transition or upskill as those industries evolve.<sup>22</sup>

The environmental impacts of a changing climate without global mitigation include more intense rainfall, cyclones, drought, extreme fire weather and more frequent sea level extremes. These conditions have widespread implications for Australia's economy and society: hotter temperatures impacting on labour productivity and population health; lost productive arable land due to drought and rising sea levels; capital damage resulting from destruction of infrastructure damaged by extreme weather events; the devastation to ecosystems caused by heat, drought and bushfires; and lower air quality (and associated increased mortality rates) due to increased bushfire events.

**There may be disproportionate impact on regional communities', given that 20 to 60 percent of total regional employment is in emission intensive industries.<sup>23</sup>**

## Impact of COVID-19

The impact and scale of the COVID-19 pandemic on global economies and societies has been extensive. Australia has only recently begun to recover from its first recession in almost three decades, and is likely to experience ongoing and long-lasting effects of the pandemic; some of which are still unknown. The impacts of COVID-19 will continue to influence the shape and form of government stimulus measures over the next few years. Building sovereign capabilities in the event of future border restrictions and impacts to global trade are also likely to be emerging issues. This is likely to affect the pace and trajectory of the energy transition in Australia and across the world. Given this, Australia will need to assess the long-term impact of the pandemic on our transition pathway to ensure that we align with global forces. However, it also presents an extraordinary opportunity to 'build back better', with an energy system that anticipates and contributes to a low emissions future.

<sup>22</sup> Deloitte Access Economics (2020), p. 19.

<sup>23</sup> Deloitte Access Economics (2020), p. 24.



# 2. AUSTRALIAN ENERGY RESEARCH

Australia is unique in terms of its global geography, variable climate across states (high solar intensity and extreme weather events), as well as widely dispersed populations across urban centres and regions. Our current energy system, economy and society is a product of these characteristics. Therefore, while we can draw on some aspects of international research to support our energy transition, it is critical for Australia to continue to build its domestic energy research capabilities and find locally-relevant strategies and solutions.

**More Australian research is needed to develop locally-relevant strategies and solutions to domestic challenges.**



## Challenges for Australia's Research Landscape

Well-documented challenges in Australia's broader research landscape may also impede energy transition research, and the integration between sub-sections of this research. For example, universities often place greater value on research published in international journals compared to national journals, as these metrics can be used to inform a university's international ranking. A reframing of the value and importance of local research is required, so that Australian researchers are funded and well supported to assess and solve local problems and needs to achieve a successful domestic transition.

Australia's energy research ecosystem is complex; and consists of numerous agencies, bodies and institutions. The Australian Government has historically taken a 'technology-neutral' stance in the support and development of energy research. The Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) are responsible for administering national funding to support the research sector. The Medical Research Futures Fund was also recently established as part of the Australian Government's 2019-2020 Budget to support innovation and research translation in the medical sector over the next decade. The sector has benefited from significant national investment from ARENA, which has provided over \$1.58 billion in funding grants to support R&D, market demonstration and early-stage commercialisation in renewable energy technologies. At the later stage of the innovation chain, the Clean Energy Finance Corporation (CEFC) supports the deployment and commercialisation of clean energy technologies through the Clean Energy Innovation Fund and the Advancing Hydrogen Fund.



Many Australian universities have an energy research institute, and 12 of these are collectively represented by the Energy Research Institutes Council for Australia (ERICA) to provide specialised and interdisciplinary energy research. As the national science agency, CSIRO continues to progress ongoing and consistent energy research. In addition, not-for-profit (NFPs) organisations including ACOLA, the Grattan Institute and ClimateWorks conduct disciplinary and multidisciplinary energy-related research.

Cooperative Research Centres (CRCs) have also been established to support industry-led research in deployment and commercialisation to solve industry identified issues, through co-led industry and national funding. States and territories also invest in R&D to support locally-based projects. There are also a large number of energy-related industry associations that support industry collaboration including the Australian Energy Council, the Energy Networks Association and the Clean Energy Council.

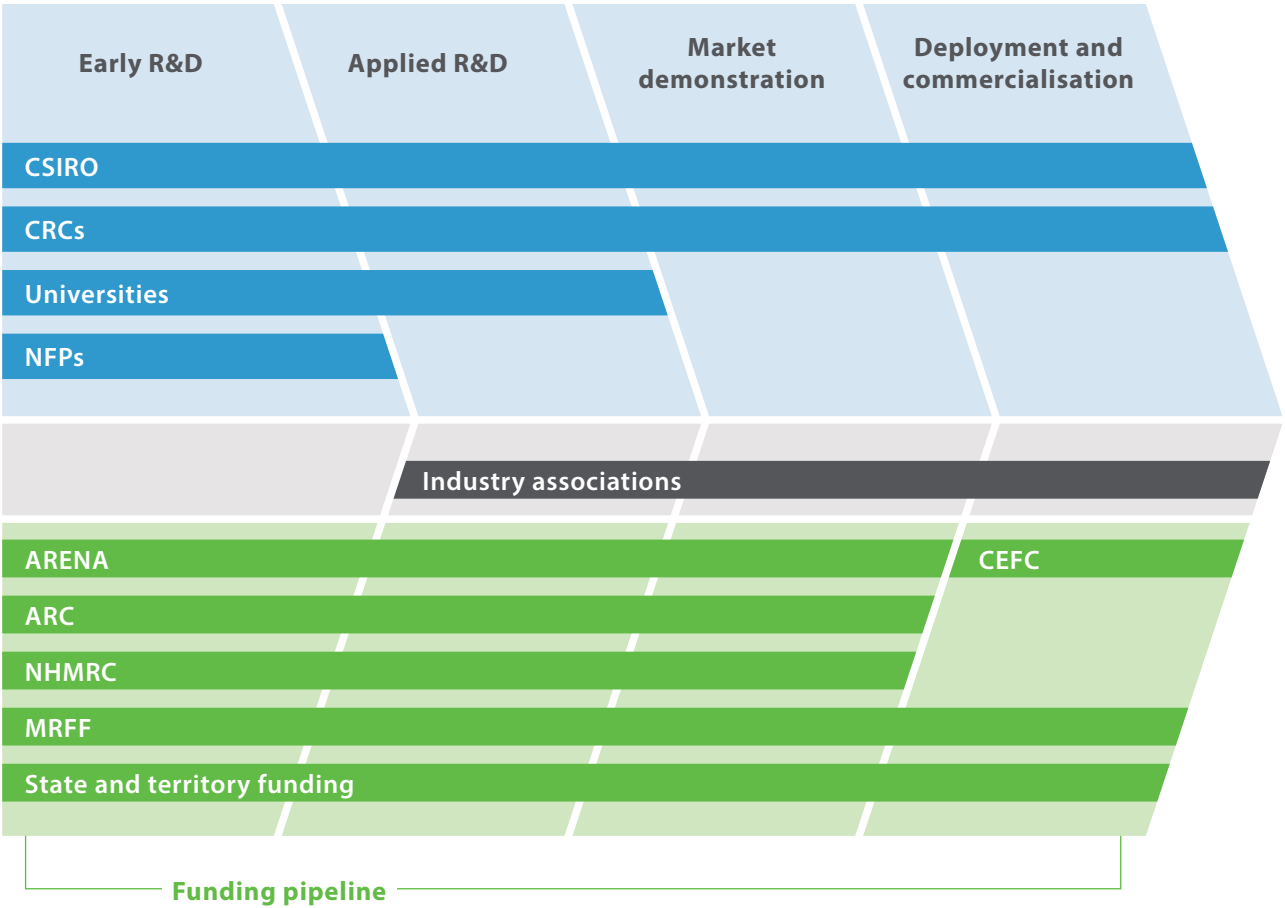


Figure 1: Australia’s Science and Technology Research Landscape. Adapted from the IEA, 2018.



While the pace and scale of the Australian energy transition has been slower than overseas efforts, our energy research sector is generally acknowledged as being globally competitive.<sup>24</sup> The strong economic incentives to develop Australia's significant natural energy resources has facilitated investment in consistent energy R&D over the past 35 years. Australia is recognised as having world-leading expertise in the mining sector, as well as the development of conventional and unconventional gas.<sup>25</sup> There has also been targeted investment in clean energy technologies, including hydrogen, large scale solar, grid scale battery, pumped hydro, bioenergy, and distributed energy technologies. As previously noted, Australia has become a world leader in the development of solar renewable energy systems and domestic appetite for cleaner alternatives to high emission energy sources.<sup>26</sup>

The recent 2020-21 Federal budget signalled a welcome injection of funding into the energy research sector including \$1.9 billion in new funding for low-emissions and renewable technologies over the next 12 years with \$1.62 billion earmarked for ARENA to finance research aligned with the Australian Government's Technology Investment Roadmap: First Low Emissions Technology Statement.

The social, cultural and economic dimensions of the energy transition process remain largely understudied and require further assessment. In particular, multidisciplinary and targeted research would be beneficial to assess the attitudes and perspectives of communities across Australia, the impacts on human and ecological wellbeing, as well as the impacts on the end use/demand side of the supply chain.

Recognising these challenges in the energy and wider research sector, the Research Plan will be dynamic; with periodic reviews to comprehensively map out the state of current energy research in Australia. This will provide a clearer picture of which areas are being progressed, and where the largest gaps exist. This will prevent the duplication of efforts so that funding and research can be directed towards the most critical issues to support the transition, including the most difficult issues that may require extended investment, focus and time (i.e. the last ten percent).

Regular updates will be provided, potentially through the annual State-of-Energy-Research Conference (SoERC) organised by ERICA.

24 For example, in the areas of solar and wind technologies, carbon capture storage, convention and unconventional gas. International Energy Agency (2018). *Energy Policies of IEA Countries: Australia 2018 Review*.

25 International Energy Agency (2018), p. 15.

26 International Energy Agency (2018), p. 17.



# 3. NOTABLE REPORTS

Work to support Australia's energy transition is already underway. Outlined below is a non-exhaustive list of recent reports and initiatives that provide the foundation and guidance for the research priorities outlined in Section 4. While these are current at the time of drafting, these may need to be periodically updated following the Research Plan's assessment of the energy landscape.

1. **Independent Review into the Future Security of the National Electricity Market – Blueprint for the Future** (Finkel Review).<sup>27</sup> This 2017 independent review chaired by Australia's Chief Scientist Dr Alan Finkel AO delivered a roadmap to the COAG Energy Council for the future security and reliability of the national electricity market (NEM) enabled by system planning, stronger governance and an orderly transition.
2. **Data Strategy Consultation Paper**.<sup>28</sup> The Energy Security Board (ESB) has released a public consultation paper on a new data strategy for the NEM, which was one of the recommendations from the Independent Review into the Future Security of the National Electricity Market – Blueprint for the Future.
3. **2020 Integrated System Plan**.<sup>29</sup> The Australian Energy Market Operator Integrated System Plan (ISP) is a whole of system actionable roadmap to guide the efficient development of Australia's NEM over the next 20 years. Its primary objective is to facilitate an energy system that is low-cost, secure and reliable, and incorporates Australia's ongoing emissions trajectory within an acceptable level of risk. It serves the regulatory purpose of identifying actionable and future ISP projects, as well as informing market participants, investors, policy decision makers and consumers.
4. **Technology Investment Roadmap: First Low Emissions Technology Statement – 2020**.<sup>30</sup> Released in 2020, this document outlines the Australian Government's plan to invest in low emission technologies across five key priority areas, and to make them market-competitive with current higher-emission technologies.

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

28 Energy Security Board (2020). *Data Strategy Consultation Paper*. Can be accessed at <http://www.coagenergycouncil.gov.au/publications/energy-security-board-data-strategy-submissions-consultation-paper-published>

29 Australian Energy Market Operator (2020). *2020 Integrated System Plan*. Can be accessed at <https://aemo.com.au/-/media/files/major-publications/isp/2020/final-2020-integrated-system-plan.pdf?la=en&hash=6BCC72F9535B8E5715216F8ECDB4451C>

30 Australian Government (2020). *Technology Investment Roadmap: First Low Emissions Technology Statement – 2020*. Can be accessed at <https://www.industry.gov.au/sites/default/files/September%202020/document/first-low-emissions-technology-statement-2020.pdf>

5. **Australia's National Hydrogen Strategy.**<sup>31</sup> The strategy outlines an approach to scale up a national hydrogen industry with a set of national coordinated actions for government, industry and the community to position Australia as a major global export by 2030.
6. **Hydrogen for Australia's Future: A briefing paper for the COAG Energy Council.**<sup>32</sup> This briefing paper was developed by the Hydrogen Strategy Group for the COAG Energy Council to support the national strategy and discusses the scope of the potential for an Australian hydrogen industry.
7. **State of the Energy Market 2020.**<sup>33</sup> This annual report from the Australian Energy Regulator highlights trends and issues across the energy industry, covering wholesale electricity and gas markets, the transmission and distribution networks and energy retail markets. The 2020 report features a new chapter on the rapid transformations across the electricity sector.
8. **Energy Security Board: Post 2025 Market Design Directions Paper.**<sup>34</sup> Following consultation in 2020, this paper sets out a high-level summary of stakeholder feedback and consolidated reform directions being considered as part of the ESB's Post-2025 market design project.
9. **Australian Industry Energy Transitions Initiative.**<sup>35</sup> Established by ClimateWorks Australia, the initiative seeks to support Australian 'hard to abate' industries (steel, aluminium, LNG, selected metals and chemicals) to develop pathways and actions towards net zero. The initiative will focus on creating a platform for industry learning and experimentation to achieve this goal.
10. **Australia's energy transition: a blueprint for success.**<sup>36</sup> This report from the Grattan Institute provides a number of recommendations for key policy and institutional reforms to support Australia's energy transition.
11. **A new choice: Australia's climate for growth.**<sup>37</sup> This 2020 Deloitte Access Economics report provides a recent economic analysis on the pathway of Australia's economic transition, and the potential impact of unconstrained actions in preventing climate change.
12. **Clean Energy Australia Report 2020.**<sup>38</sup> This report from the Clean Energy Council covers the latest key figures and statistics on the national energy market for 2020 and includes analysis across the NEM, and other major grids across the country including WA and NT.

31 Australian Government (2019). *Australia's National Hydrogen Strategy*. Can be accessed at <https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf>

32 Australian Government (2018). *Hydrogen for Australia's Future: A briefing paper for the COAG Energy Council*. Can be accessed at <http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/Hydrogen%20for%20Australia%27s%20Future.pdf>

33 Australian Energy Regulator (2020). *State of the Energy Market 2020*. Can be accessed at <https://www.aer.gov.au/system/files/State%20of%20the%20energy%20market%202020%20-%20Full%20report%20A4.pdf>

34 COAG Energy Council (2021). *Energy Security Board: Post 2025 Market Design Directions Paper*. Can be accessed at <http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/P2025%20Market%20Design%20Directions%20Paper.pdf>

35 Australian Industry Energy Transition Initiative (2020). *Australian Industry Energy Transition Initiative*. Can be accessed at <https://energytransitionsinitiative.org/>

36 Grattan Institute (2019). *Australia's energy transition: a blueprint for success*. Can be accessed at <https://grattan.edu.au/wp-content/uploads/2019/09/922-Australia-energy-transition-a-blueprint-for-success.pdf>

37 Deloitte Access Economics (2020). *A new choice: Australia's climate for growth*. Can be accessed at: <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-dae-new-choice-climate-growth-051120.pdf?nc=1>

38 Clean Energy Council (2020). *Clean Energy Australia Report 2020*. Can be accessed at <https://assets.cleanenergycouncil.org.au/documents/resources/reports/clean-energy-australia/clean-energy-australia-report-2020.pdf>

13. **Future Electricity Market Summit.** Co-organised by the ESB, the International Energy Agency and the ANU Energy Change Institute (in collaboration with ERICA), this summit captured the key issues that need to be addressed for a future zero-emissions electricity market. The outcomes were published in a series of eight papers corresponding to the Summit Themes in the November 2020 issue of the Electricity Journal.<sup>39</sup>
14. **Community Engagement and Benefit Sharing in Renewable Energy Development: A Guide for Applicants to the Victorian Renewable Energy Target Auction.**<sup>40</sup> Commissioned by the Victorian Government, this is a best practice guide for developers delivering low-emissions technologies projects for community engagement and benefit sharing across all renewable energy technologies. This includes case studies and practical information to deliver projects to benefit project hosts, neighbours and communities.
15. **Best Practice for Community Engagement: Determining who is Affected and what is at Stake.**<sup>41</sup> This paper was developed by Peta Ashworth, who is a recognised expert in her work in building energy literacy and supporting community and stakeholder engagement in the energy sector.
16. **The Clean Jobs Plan.**<sup>42</sup> Developed by AlphaBeta for the Climate Council, this Plan identifies 12 major policy opportunities to kick-start economic growth and deliver 76,000 jobs in the clean energy sector, following the bushfire crisis of 2019 and COVID-19.
17. **Just Transition: Implications for the Corporate Sector and Financial Institutions.**<sup>43</sup> This report examines practical ways for the corporate and financial sector to manage their interests, customers and shareholders to plan and prepare for transition to a low-carbon economy.

39 Various Authors, 2020. *Special Issue: The Future Electricity Market Summit*. The Electricity Journal Volume 33: 9, November 2020.

40 Lane, T. and 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. Can be accessed at [https://www.energy.vic.gov.au/\\_\\_data/assets/pdf\\_file/0027/91377/Community-Engagement-and-Benefit-Sharing-in-Renewable-Energy-Development.pdf](https://www.energy.vic.gov.au/__data/assets/pdf_file/0027/91377/Community-Engagement-and-Benefit-Sharing-in-Renewable-Energy-Development.pdf)

41 Ashworth, P. (2016). *Best practice for Community Engagement: Determining Who is Affected and What Is at Stake* in Risks, Rewards and Regulation of Unconventional Gas: A Global Perspective, ed. Grafton, R, Cronshaw, I and Moore, M. Cambridge: Cambridge University Press, 2016.

42 Climate Council (2020). *The Clean Jobs Plan*. Can be accessed at [https://www.climatecouncil.org.au/wp-content/uploads/2020/07/Climate-Council\\_AlphaBeta-Clean-Jobs-Plan-200720.pdf](https://www.climatecouncil.org.au/wp-content/uploads/2020/07/Climate-Council_AlphaBeta-Clean-Jobs-Plan-200720.pdf)

43 UN Global Compact (2020). *Just Transition: Implications for the Corporate Sector and Financial Institutions*. Can be accessed at [https://unglobalcompact.org.au/wp-content/uploads/2020/11/2020.11.18\\_Just-Transition-Report\\_Final-2.0.pdf](https://unglobalcompact.org.au/wp-content/uploads/2020/11/2020.11.18_Just-Transition-Report_Final-2.0.pdf)





# 4. DRAFT RESEARCH PRIORITIES

ACOLA has identified three streams for the research priorities, each containing several themes. Research priorities have been identified as 'urgent' (requiring timely assessment in the next one to three years) or 'strategic' (future issues or research areas that may require a longer timeframe to be adequately assessed).

**Stream 1: Energy System Dynamics:** focused on understanding how the energy system might be transformed to net zero emissions by 2050, from an interdisciplinary (including social, cultural, technical and economic) perspective. The research questions in this stream are grouped into two themes:

1. **Transition pathways:** There are multiple techno-economic pathways to a net zero emissions energy system by 2050 (most assuming massive renewable electrification with storage and a new hydrogen industry, to replace coal, oil and gas). We need to understand the social, cultural, technical and economic dynamics of these pathways and the roles that the various actors might play to optimise national outcomes.
2. **Systems integration:** The energy economy is a complex system of systems with multiple interdependencies (including supply chains, physical infrastructure, user practices, markets and the regulatory system), all now being disrupted. We need to understand how these systems interact with each other and with other sectors, as well as wider impacts and linkages for significant co-benefits (such as the impact of the transition on population health), as well as the data and tools to support the transition.



**Stream 2: Technical Capability:** focused on understanding the technical capabilities needed to achieve a successful transition. The research questions in this stream are grouped into three themes:

3. **Technology:** The Australian Government has identified five priority low-emission technologies and several emerging, enabling and 'watching brief' technologies<sup>44</sup> for government and industry support, with an annual review cycle. We need to consider how this policy framework can be further developed, or complemented, to support the transition. In addition, further work will be required on the integration and deployment of low-emission technologies into our energy system.
4. **Governance:** Government, research, industry, NGO and community energy-related institutions have important roles in the transition. Many, however, were established before the energy transition commenced at scale. We need to consider how current energy-related governance structures and institutions can be optimised to support the energy transition.
5. **Industry:** The Australian net zero emissions energy economy will need new industry capabilities and critical skills. We need to consider whether Australia has the necessary skills and capabilities, self-reliance and export potential, to develop these in the required volumes, and how these might be enhanced.

**Stream 3: Social Capability and Impact:** focused on understanding the social capabilities needed to achieve a successful transition. The research questions in this stream are grouped into three themes:

6. **Policy and regulation:** Government policy and regulation (at all levels) can facilitate or impede a successful energy transition. We need to understand how best to develop energy-related policy and regulatory architecture within the context of Australian political economy.
7. **Communication:** Effective and engaging communication from stakeholders to multiple audiences is essential. Political ambition for the energy transition remains a complicated and divisive issue in Australia. We need to hear from Australians why this issue has been so divisive, and to adopt communication approaches that enable the transition to occur on many scales. Citizen and investor confidence is essential to the transition. We need to better understand the drivers of confidence in these two critical communities and how their agency can be enhanced to support the transition.
8. **Social licence and participation:** National and local support will be critical to a successful transition, but cannot be taken for granted. Social justice, equity and wellbeing, particularly for households and communities in vulnerable circumstances, could be enhanced or diminished by the energy transition. For an inclusive transition, we need to understand how best to build and maintain broad acceptance and a fair outcome, at all scales and across all sectors.

Some indicative research questions for each theme are outlined in the table below. These are not exhaustive and, in many cases, there will be research already underway to help address them. The intent here is to identify the priorities to help develop a more intensive and integrated framework.

<sup>44</sup> These are clean hydrogen, energy storage, low carbon materials, carbon capture storage and soil carbon measurement. Emerging, enabling and watching brief technologies sectors are: electricity which includes small modular reactors, ultra-low-cost transmission, next generation Allam Cycle technologies; transport which includes more efficient and zero emissions drivetrains, mode shift technologies, and low emissions aircraft; buildings which include low carbon building materials, building integrated PV (e.g. Solar PV tiles) and new refrigerants; and other sectors which include a range of early-stage negative emission technologies (e.g. direct air capture).

## Australian Energy Transition Research Plan – Draft Research Priorities: streams, themes and key questions

Theme	Scope	Time
<b>Stream 1: Energy System Dynamics</b>		
<b>1. Transition pathways</b>	There are multiple techno-economic pathways to a net zero emission energy system by 2050 (most assuming massive renewable electrification with storage and a new hydrogen industry, to replace coal, oil and gas).	
	What are the main feasible pathways, based on current knowledge and forecasts (extent of sector coupling)?	Urgent
	What are the social, technical and economic conditions required for a successful transition of this scale?	Urgent
	What are the costs, benefits, impacts and risks to the Australian economy and society (what parts are most difficult)?	Urgent
	What is the interplay between energy export market and the domestic economy?	Strategic
	What is the optimum mix of planning and market forces (critical decision points; financing)?	Strategic
	What are Australia's comparative advantages for the transition (can these be further leveraged)?	Strategic
	What are the essential roles of governments, researchers, industry, NGOs and communities?	Strategic
<b>2. Systems integration</b>	<b>The energy economy is a complex system of systems with multiple interdependencies, all now being disrupted.</b>	
	Do stakeholders have access to the data and integrated analytics tools needed for a successful transition?	Urgent
	What role can artificial intelligence/machine learning and the Internet of Things play in a successful transition; are we well-placed to utilise these technologies?	Urgent
	What interdisciplinary capabilities will we need, do we have them and, if not, how can we get them?	Strategic
	Are there significant integration issues for low/zero/negative emission energy technologies across economic sectors?	Strategic
	Are there any technical, economic or social barriers that could impede successful integration?	Strategic
	How do we build and maintain energy system resilience against climate and cyber threats?	Strategic
<b>Stream 2: Technical Capability</b>		
<b>3. Technology</b>	<b>The Australian Government has identified five priority low-emission technologies (and several emerging, enabling and 'watching brief' technologies) for government and industry support, with an annual review cycle.</b>	
	How robust is this policy framework and the initial set of priorities (including risks and how to mitigate)?	Urgent
	Are the identified technology support mechanisms sufficient for a successful transition?	Urgent
	How could this policy best adapt over the course of the transition (including support mechanisms)?	Strategic
<b>4. Governance</b>	<b>Government, research, industry, NGO and community energy-related institutions have important roles in the transition.</b>	
	What governance models are best suited for the Australian energy transition?	Urgent
	Are the current institutions fit for this purpose (role, mandate, governance etc); what reforms are needed?	Urgent
	Are there any exemplars (Australian or international) that demonstrate the value of alternative approaches?	Urgent
	How can the Australian energy research community be structured and supported to optimise their contribution?	Strategic

Theme	Scope	Time
<b>5. Industry</b>	<b>The Australian net zero emission energy economy will need new industry capabilities. Critical skills need to be identified.</b>	
	Does Australia have the necessary industry capability and critical skills (if not, where are the gaps)?	Urgent
	What is the optimum policy response to this analysis?	Urgent
	To what extent should Australia be self-reliant on clean energy industry capability and skills?	Strategic
	What is the opportunity for Australia to export clean energy industry capability and skills?	Strategic
	What skills transition and employment pathways, policies and programs will be needed through the transition?	Strategic
<b>Stream 3: Social Capability and Impact</b>		
<b>6. Policy and regulation</b>	<b>Government (all levels) policy and regulation can facilitate or impede a successful transition.</b>	
	Which policies and regulations are supporting, impeding or missing (what is global best practice)?	Urgent
	How important is an explicit carbon price, compared to other policies?	Urgent
	What are the market re-design priorities (energy and related) in addition to electricity markets?	Strategic
	How should policy and regulation adapt over the course of the transition?	Strategic
	How can the benefits of a potential renewable energy export boom best be captured for the wider community?	Strategic
<b>7. Communication</b>	<b>Political ambition for the energy transition remains a vexed and divisive issue in Australia. Effective and engaging communication from stakeholders to multiple audiences is essential. Consumer and investor confidence is essential.</b>	
	What communication sources, forms and messages will best engage key Australian audiences?	Urgent
	How is Australian energy politics different or similar to that in other developed nations?	Strategic
	Are there any lessons for Australian political leaders from the international experience?	Strategic
	What is the current state and drivers of consumer and investor confidence (location; sector)?	Strategic
	To what extent are consumers and investors leading or following the transition (willingness to pay)?	Strategic
	How can consumer and investor preference for clean energy be leveraged and grown (institutional roles)?	Strategic
	How important is consumer participation in the new energy market?	Strategic
<b>8. Social licence and participation</b>	<b>National and local support will be critical to a successful transition, but cannot be taken for granted. Social justice, particularly for vulnerable households and communities, could be enhanced or diminished by the energy transition.</b>	
	What is the current status of social licence for the transition (by location; technology; sector etc)?	Urgent
	What are the most effective means of obtaining and retaining the necessary social licence?	Urgent
	What are the social-justice risks and opportunities in the energy transition; how should these be managed?	Strategic
	What are the social policy roles of governments, researchers, industry, NGOs and communities?	Strategic
	How can Aboriginal and Torres Strait Islander peoples wellbeing be enhanced by the energy transition and contribute to closing the gap?	Strategic
	What are the public health co-benefits of the transition (and how can they be optimised)?	Strategic



# 5. NEXT STEPS

## Key Questions for Stakeholder Engagement

The Research Plan will require wide and deep consultation with the energy sector, including researchers (public and private), research users and stakeholders, including concerned citizens.

**At this stage, informed by this consultation paper, ACOLA is seeking stakeholder views on the draft research priorities, in particular the following key questions:**

- **Do the three themes of research priorities, and underpinning eight streams, provide an appropriate framework for the Research Plan, and are there areas for improvement?**
- **Do the indicative research questions identify the most critical research gaps (are some already being adequately addressed; have any been missed)?**

## The Research Plan

The proposed process for the next three years for the Research Plan is outlined below.

### Year 1: Development of initial research priorities and plan (September 2020 – June 2021)

The initial Research Plan, including the research priorities, will be published following consideration of stakeholder feedback in early 2021. ACOLA will also publicly launch the Research Plan with a specific focus on urgent research priorities.

Following this, over the course of 2021, ACOLA will produce briefing papers for the identified research priorities. The scope of these papers will include a more detailed discussion to explore the research priorities and gaps for each theme including:

- rationale for each priority
- synthesis of current relevant research (in Australia and overseas)
- potential research questions, and how they might best be addressed, and
- key specific translation issues for each theme.

The papers will be tested with key stakeholders and will be used to refine the Research Plan. Early insights and findings will be presented at the annual ERICA SoERC subject to timing.

## Year 2: Data collection and development (July 2021 – June 2022)

In addition to continuing work on the briefing papers, ACOLA will audit current national energy transition research and data gaps (both research and translation) against the research priorities. ACOLA will be performing extensive consultation with the energy sector to ensure that audit results are consistent with the energy sector's understanding of the research landscape. Findings and insights will be presented at the 2022 ERICA SoERC.

The Research Plan's research priorities will be assessed at the end of 2022 to ensure that they remain consistent with pace and direction of the energy transition as it evolves.

ACOLA will also develop an evaluation framework to measure the impact of the Research Plan.

## Year 3 onwards: Maintenance and evaluation (July 2022 – June 2023)

ACOLA will reassess the state of the energy research landscape, building upon the audit from the previous year. ACOLA will explore the development of, for example, an online, open-source platform that identifies Australian research being progressed. This would be accessible to the research sector, industry and investors to demonstrate where work is being progressed and where gaps remain. As with previous years, ACOLA will use the ERICA SoERC to provide an annual update.

From Year 4 onwards, subject to further funding, ACOLA will annually monitor and reassess the national energy research landscape, track progress against the research priorities and maintain the online energy research database. A triannual review of this initiative is proposed in Year 6.

## Submissions on this consultation paper are due on Friday 26 February 2021.

For further information or any queries about the project, please contact:

**Stephanie Chan, Senior Research and Policy Officer**

**[stephanie@acola.org.au](mailto:stephanie@acola.org.au)**

**(03) 9864 0937**

**[acola.org/energy-transition-research-plan](https://acola.org/energy-transition-research-plan)**



