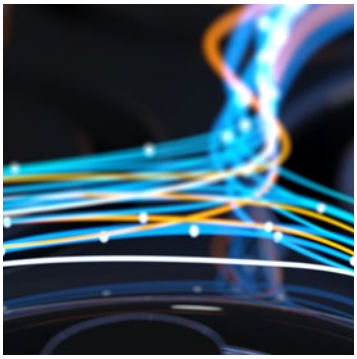
Australian Energy Transition Research Plan

REPORT SIX

Energy Research Translation



ACOLA RESEARCH BRIEFING PAPER

Funding partners for the Australian Energy Transition Research Plan

NERA NATIONAL ENERGY RESOURCES AUSTRALIA

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ARENA Australian Government Australian Renewable Energy Agency

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

Mr Drew Clarke AO PSM FTSE (Chair)

Emeritus Prof. Sue Richardson AM FASSA

Dr Bruce Godfrey FTSE

Emeritus Prof. Libby Robin FAHA

Prof. Kenneth Baldwin FTSE FAIP FInstP FOSA FAPS GAICD

Prof. Fran Baum AO FAHMS FASSA

PROJECT MANAGEMENT

Fern Beavis
Judita Hudson
Lauren Palmer
Ryan Winn

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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

1. Executive summary

While net-zero emissions by 2050 is the destination for Australia's emissions, the critical questions are how will we get there and at what rate. This is currently unclear. The Australian Energy Transition Research Plan's first report was released in June 2021 and emphasises that the research and innovation sector will play a critical role in paving a 'clever pathway' for Australia to reach this target. Further, there is the opportunity to help reduce global emissions through the export of Australian research breakthroughs and by pivoting our export future towards renewable energy-intensive products.

There are three critical limbs for research and innovation to paving this pathway: (1) appropriate prioritisation of urgent and strategic research (refer to Report One) (2) the funding of that priority research and (3) the translation of this research to impact – the last being the focus of this paper. Combined, the prioritisation and translation of appropriate research can help support an Australian energy transition that efficiently and effectively addresses the energy trilemma domestically and globally, reaching net-zero emissions reliably and affordably while ensuring a fair and equitable transition.

However, various obstacles impede the flow of research to impact. While there is not much readily available literature on Australian energy research translation, there is a general understanding of some of the key barriers. This includes a lack of: appropriate funding, effective collaboration, non-academic incentives, translation of research to policy, and engagement with research users. Importantly, building on our first report, it is clear that many research activities within the humanities, arts and social sciences (HASS) domains face a double dilemma: not being sufficiently prioritised or funded, and challenges in effectively communicating findings to impact.

The Intergovernmental Panel on Climate Change (IPCC) demonstrates the strength and translational power of having a boundary organisation that sits at the interface of research and policy. While a similar international body has not been created for energy research translation, drawing on international learnings, Australia could establish a structure to improve our translational capacity, aimed at facilitating productive synergies between the three key agents of the research ecosystem: researchers, funders and research users.

Based on these findings, ACOLA makes four sets of recommendations; one that aims to improve the cohesion and information sharing with energy stakeholders through a research translation platform, and the others targeted at a different agent in the Australian research ecosystem:

- **Research end-users** should have access to independent, interdisciplinary and robust research summaries to guide policies and investments, and open access to the underpinning research papers and findings. They should also initiate contact with and support researchers to solve their problems collaboratively.
- **Researchers** should be incentivised to actively develop and pursue research translation pathways and non-academic impacts at various stages of the project's development.
- **Funders** should increase the stock and flow of impactful research, through increasing targeted funding and incentives to researchers to focus on the non-academic impacts of their research.

2. Context

> A successful energy transition will be one that addresses the energy trilemma: reaching net zero emissions reliably and affordably, while placing the wellbeing of society at its centre. Australia's future energy system must be efficient, responsive and forward-looking, while maximising the benefits to our economy and society as much as possible.
>
> Source: ACOLA 2021

The research and innovation sector will have a key role in helping us to understand, develop and implement the 'tools', be they technology or policy, that will lead to the settings and capability to mitigate, reduce, and manage emissions to net-zero. The challenge is that the sector must respond with appropriate research, and translate it to insights, knowledge and products at a pace and time scale reflective of this critical need – which is unparalleled in modern society.

Recognising the challenges in the energy and broader research sector, in mid-2020, ACOLA commenced work on Australia's first Energy Transition Research Plan. Report One identified initial major research gaps and priorities, across three themes; energy system dynamics; social engagement dynamics, and transition dynamics. In particular, the Research Plan found a critical and urgent gap in energy research in the HASS domains.

To support a successful and fair Australian energy transition, the Research Plan aims to: guide research funders, industry and researchers' activities related to the national energy transition; encourage research activities that complement existing strengths and avoid overly duplicative efforts, and facilitate research to support evidence-based decision-making by research users (i.e. governments, industry and communities).

However, to be of direct value to the energy transition, research must move beyond the community of researchers to impact in and on the economy and society. This paper examines the key barriers that interrupt the movement of research ideas and learnings through to applied impact – i.e. research translation in the context of the Australian energy transition. It concludes by making recommendations on how each of the key agents in the research ecosystem (researchers, end-users and funders) can overcome the translation barriers.

3. Research translation

Research translation is the movement of research output through to impact, propelled by interactions between key agents in the research ecosystem, namely researchers, funders, end-users and knowledge-holders.[1] Impact is defined in different ways by various stakeholders. Often this includes commercial impact but it also extends to social, policy, cultural, health and environmental impact.

How well does Australia perform on research commercialisation?

Translation, especially in the Australian context, is often viewed through the prism of commercialisation where research insights are translated into marketable products, capital gains, income from licenses and/or revenue from the sale of a product.[2] The commercialisation of household photovoltaics, grid-scale batteries, and electric vehicles has led us on the path to more significant emissions reductions. These have been achieved through the successful and cumulative translation of research in universities, institutions and businesses, often over decades.

However, while Australia ranks highly on research output and OECD indicators of research quality, especially given our relatively small and geographically isolated location, this does not translate effectively to outcomes. The 2021 Global Innovation Index highlights a disconnect between Australia's research and development sector (17th) and university/industry research collaboration (33rd) and the generation of knowledge and technology outputs (42nd).[3] Australia also ranks behind its international counterparts on metrics such as the percentage of higher education expenditure on research and development (R&D) funded by industry.[4] Overall, Australia spends just 1.79% of GDP on research compared with the global average of 2.48%.[5]

> **Research translation is the process of exploring ideas and hypotheses and then transferring these into impact, whether it be policy, practice, social change, business models or products.**

For decades, Australia's lack of overall improvement in publicly funded research commercialisation demonstrates that efforts need to be made to fundamentally change how research is being funded, conducted and used. The Australian Government has identified improving research commercialisation within universities, in general, as a priority to secure Australia's economic and industrial future. It notes that it yields profit, attracts international investment, inspires new businesses, creates jobs, and produces social and economic benefits.[6] The research capacity of industry also needs to be enhanced as currently, there is a low level of research in, and low collaboration and co-investment in research by Australian industry.[7] As explored below, the need for translation extends beyond having a saleable product or process.

Other measures of research translation

Many argue that research institutes should not be treated as simply corporations and vessels for commercialisation,[8] as there are forms and measures of research translation which extend beyond a narrow focus on IP sequestration and exploitation.[9] For example, museums,[10] including climate museums,[11] are critical sites of education on the Anthropocene and climate change,[12] and energy research translation (see case study).[13]

Importantly, research can also be translated to inform policy, such as cultural and societal engagement, regulations, and government investment decisions. This form of research translation is necessary to ensure that commercialisable technologies are relevant, deployed and accepted, and opportunities are created for individuals, communities and businesses to benefit from and participate in the energy transition. However, it is often difficult to have clear insights and measurement of the impacts and the translation of research into policy. This reflects that evidence-based policy making is almost misleading because it assumes a linear relationship between 'what experts say' and 'what politicians do'. Policymaking requires difficult choices and trade-offs, which can involve the consideration of other evidence and insights, such as anecdotal community sentiment, party political positions and people's trust in government. [14] However, research and experts should have a key role to play.

Reflecting on the deficiencies in our research translation ecosystem, some have called for a national roadmap for research translation infrastructure.[15] The 2021 National Research Infrastructure Roadmap currently under development could provide a key opportunity to address the barriers to research translation.[16] However, these barriers must first be understood, particularly in the context of the energy transition.

Museums are key places where research insights can be translated and communicated to the public. This includes older museums, like the Deutsches Museum in Munich which was the first museum to present the Anthropocene in an exhibition, to the more recently established climate museums which help visitors understand, care about and act on the climate crisis, including through utilising interdisciplinary exhibitions and interactive panels. Recent research found these museums are achieving high levels of audience reach and impact. For example, the Climate Museum in New York recently hosted the Low Relief for High Water exhibition, which was a participatory art installation that highlighted the collective vulnerabilities of people to climate change and enabled visitors to interact with a climate psychologist.

The Museums and Climate Change Network also maintains a list of climate change and Anthropocene exhibitions. From June – October 2021, the Australian Museum hosted the SPARK exhibition where the public could learn about inventions and innovative approaches to tackling the climate crisis. A virtual tour is available online. These sorts of initiatives can be vital to building social acceptance of new technologies.

Source: Australian Museum (2021), Chand (2021), Newell (2020), Möllers (2014).

4. Barriers to energy research translation

Without understanding and removing barriers to research translation for energy research in particular, our achievement of net-zero by 2050 is at significant risk, with serious potential impacts on our economy, environment, society and health and wellbeing. Notably, despite the interest in Australian-made and owned products and sovereign manufacturing capability, not all research has to be commercialised in Australia. Rather, as the success of the PERC module cell demonstrates (see case study), there is huge scope for Australia to export our research and development and domestically reduce global emissions. In particular, Australia has the capacity to become a leader in hydrogen export. To support this, the Australian Government is partnering with other countries to attract investment, build supply chains and advance research and development.[17]

The passivated emitter and rear cell, known as PERC, has become one of the world's most successful solar technologies. It was developed in Australia in the 1980s and commercialised overseas with worldwide sales of PERC modules exceeding $100 billion. It currently contributes to mitigating ~1% of the world's carbon emissions.

The model received funding from Commonwealth and state organisations supporting renewable energy and the Australian Research Council. The diverse range of funding sources and the long-term funding support was critical in supporting the PERC commercialisation.

Source: Dingwall (2021).

Conversely, while technologies can be imported, HASS-oriented and interdisciplinary research must be undertaken and translated domestically, for example into policies, innovative business models and public engagement programs that take into account Australia's unique context. This can ensure that barriers to deployment are brought down quickly, and that the energy transition is just, dynamic and responsive to the needs and interests of different communities.

In Australia, there is a lack of readily available focused research that critically assesses the barriers to energy research translation. However, it is well understood that the energy transition needs to occur at a pace that reflects the urgency of the climate crisis, and that research incorporating STEM and HASS perspectives needs to be translated at a corresponding pace. In this context, 5 key barriers impede the translation of research to impact (including marketable products and services, innovative business models, policies and regulations). These are a lack of appropriate funding, effective collaboration, non-academic incentives, translation of research to policy, and engagement with diverse research users. To maximise research impact, researchers, users and funders must all play a role in addressing these barriers. Section 4 examines these translation barriers and how they can be overcome.

Other countries and institutions have sought to overcome barriers to translation through implementing structures that strengthen relationships and facilitate networking between researchers, users (industry, policymakers, community) and funders. Some effective examples are discussed in Section 5.

A. Funding

Effective energy research commercialisation is contingent on access to appropriate funding throughout all stages of the innovation chain, from research and development, through to demonstration and commercialisation. Funding is needed from diverse sources and over the long term.[18]

Funding along the innovation chain comes from various places, including industry, community-led initiatives and federal funding bodies and programs, particularly the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC) (Figure 1).[19]

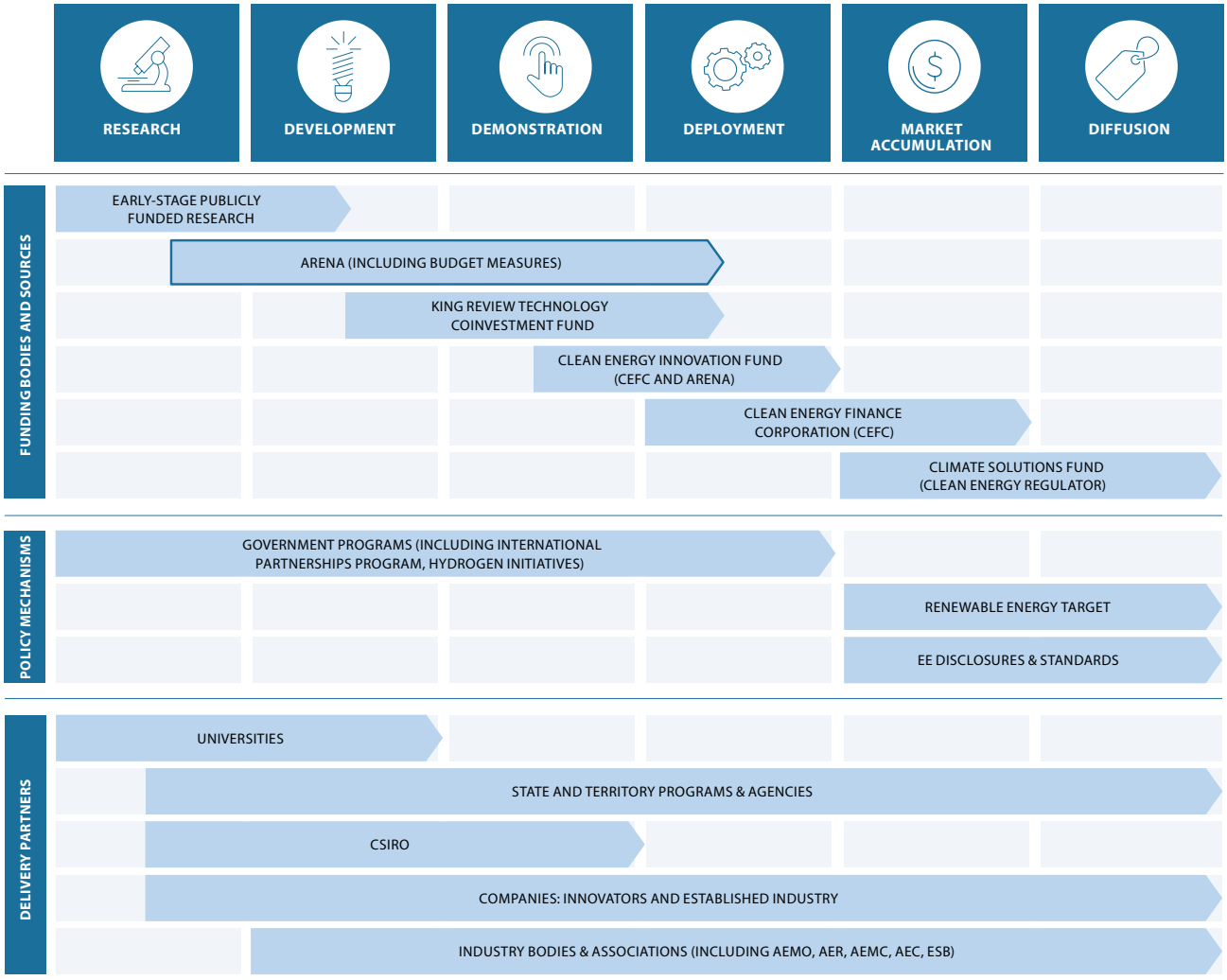

Figure 1: Key Australian bodies involved in the energy innovation chain. Source: ARENA (2021).

The 'Valley of Death'

Energy projects that are funded are concerned with generating a wide range of impacts, not merely economic impacts. Despite these efforts, barriers to impact, including commercialisation, still remain.[20] It is well-known Australia lacks a complete commercialisation ecosystem, with funding gaps being particularly prominent in the stage between the development and commercialisation of a product or service, or in other words, the 'valley of death' (Figure 2).[21]

This 'valley of death' arises for various reasons. For example, high risks, higher initial capital requirements, long market lead times and inadequate entrepreneurial experience can discourage investors from funding start-ups that can develop low emissions technologies.[22] Investors can also perceive Australia's manufacturing capability to be subpar relative to other countries, deterring investment. Australia's volatile energy policy landscape, particularly with regards to the Renewable Energy Target and carbon policy, has also, at times, impeded investor confidence and interest in renewable technologies.[23] There is also a high proportion of small to medium enterprises in Australia who have less capacity relative to larger businesses to take on the risks associated with investing in research.[24]

Commonwealth programs and bodies

Various government programs and bodies are in place to help overcome the 'valley of death' and support research commercialisation (some key programs are found in Appendix 1, Table 1), in particular, to encourage more business investment in R&D, Australia primarily relies on the R&D tax incentive.[25] While it is important in bridging the research-industry divide, quantifying outcomes is challenging and it does not currently incentivise collaborations with research organisations. Accordingly, a recent review has recommended introducing a collaboration premium of up to 20 per cent for the non-refundable tax offset for R&D undertaken with publicly-funded research organisations.[26] Section B discusses more pathways that exist or could be introduced to enhance collaboration between industry and the research sector.

Some programs and bodies have been established specifically to focus on energy research commercialisation, such as ARENA and CEFC (summarised in Appendix 1, Table 2). A 2019 impact and effectiveness evaluation concluded that ARENA's investments across the pre-commercial stages of the innovation chain helped improve Australia's competitiveness and supply of renewable energy.[27]

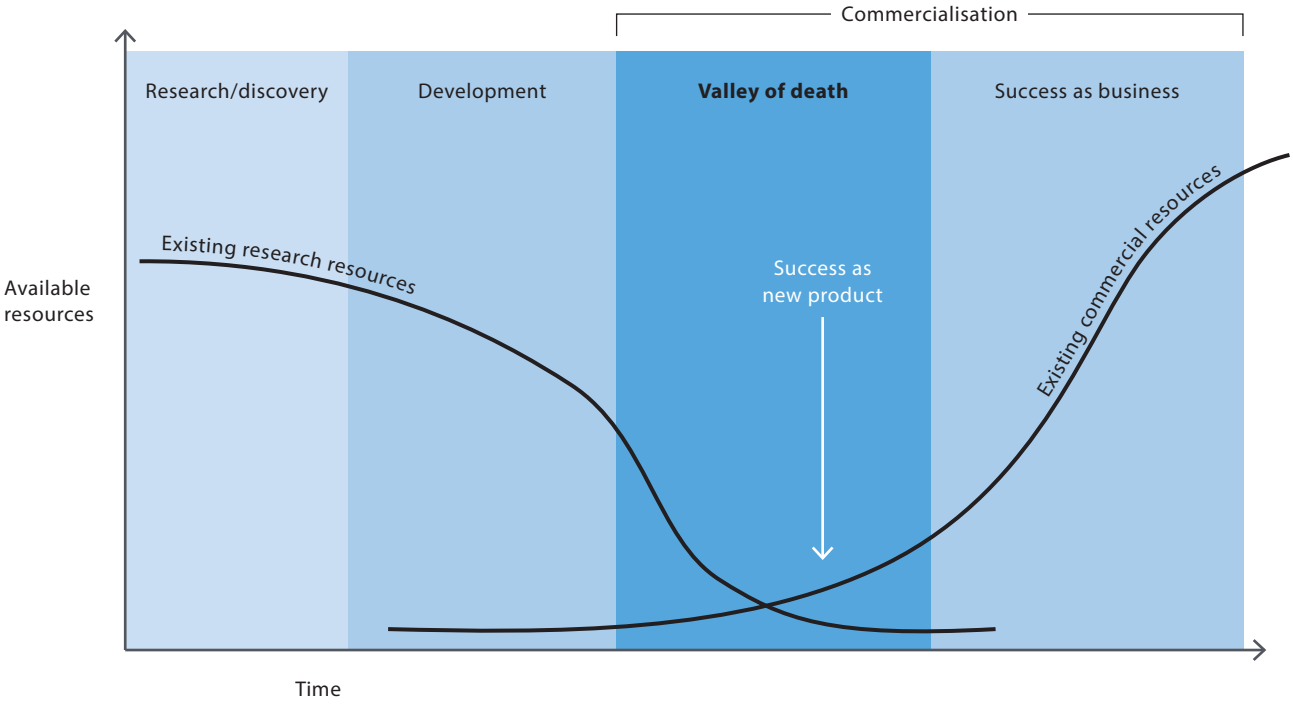

Figure 2: A diagrammatic representation of the valley of death which sits between the development and commercial application of a technology-related product or service. Source: Ball (2015).

Despite this, some energy stakeholders contend that to achieve the sectoral transformation needed to reach net-zero, we need new and diverse ways of thinking about financing and the sharing of financial and technological risk between sectors. This includes increasing the mix of private and public funding in Australia so it extends beyond short-term grant programs, one-off demonstration projects and project finance.[28]

While bodies like ARENA focus on the earlier stages of the innovation chain – research, development and demonstration – Australia lacks the scale of companies, risk capital availability, market size and mindset needed to push most technology prototypes to full global commercial application and use. While Australia does not need to commercialise all innovation domestically, government investments that support the translation of high-quality research into marketable products and the integration of intermediate products into new domestic and global value chains, such as the Australian Modern Manufacturing Initiative, may help address this gap.[29]

In 2020, the Australian Government introduced the Technology Investment Roadmap as a strategy to accelerate the development and commercialisation of low emissions technologies.[30] Annual statements will be released under this Roadmap, starting with the 2020 Low Emissions Technology Statement (LETS) which identified 5 priority technologies: hydrogen, energy storage, low carbon steel and aluminium, carbon capture and storage and soil carbon storage,[31] with ultra-low-cost solar being added as another priority technology through the 2021 LETS. [32] ARENA's mandate has also been expanded to support the technologies contained in the LETS.[33] The roadmap will guide at least $20 billion of Australian Government investment in low emissions technologies by 2030, building on the $21 billion of government investment in low emissions technologies over the last two decades.

Most recently, on 1 February 2022, recognising the need to improve research commercialisation, the Australian Government announced a $2.2 billion package to enhance commercialisation within Australian universities. Subject to the passage of legislation, this investment includes an allocation of $1.6 billion to Australia's Economic Accelerator (AEA) which is designed to attract projects at proof-of-concept and proof-of-scale with high potential for commercialisation within universities, with grants available from 1 July 2022. Importantly, the AEA will be aligned with the national manufacturing priority areas, which currently includes clean energy. $150 million is also being allocated to expand CSIRO's Main Sequence Ventures program which assists start-ups and promotes commercial research opportunities.[34]

While the governmental focus on energy research commercialisation is welcome and important, ACOLA will be releasing a separate paper with a deeper analysis on the quantum of Australia's public spending on energy research, development and demonstration (RD&D) across various technology categories. The paper will break down the spending by different institutions, compare Australia's spending on energy RD&D relative to other key economies over time and comment on its adequacy.

Lack of funding for social sciences, humanities, arts and economics research and translation

Combined, the research capacity across the social sciences, humanities and the arts for people and the economy (often known as SHAPE or HASS (Humanities, Arts and the Social Sciences)) and Science, Technology, Engineering and Mathematics (STEM) disciplines gives the research and innovation system its core capacity. It provides the platform for multidisciplinary approaches critical for understanding and tackling complex global challenges and successful implementation, e.g. social acceptance and business models.[35] However, the strategic focus and funding for energy research is currently skewed more towards the STEM side of the system.[36] For example, the citation-based STEM disciplines are better rewarded through global university ranking approaches relative to the peer-review HASS disciplines. Further, while early-career HASS researchers often seek funding from the ARC *Discovery Projects* scheme, this competitive funding program provides little support for long-term research or establishing research career paths, and has been criticised for working against cross-institutional and interdisciplinary collaboration.[37] This has implications for the role that HASS perspectives can play in shaping our energy transition.

ARENA and CEFC also do not support much HASS-oriented or transdisciplinary research, partly because of the requirement for significant industry support. Notably, funding support for testing innovative business models such as community energy models, which are underpinned by social and environmental aims rather than purely commercial aims, has been limited and piecemeal.[38] In response, an Australian Local Power Agency has been proposed to sit alongside ARENA and CEFC to invest, directly and indirectly, in community energy projects, including supporting the development and commercialisation of these projects.[39] Alternatively, existing funding bodies' remits could instead be expanded to support more HASS-oriented and transdisciplinary research and the translation of that research.[40]

B. Effective research-industry collaboration

Effective collaboration between industry and the research sector is needed to facilitate effective research translation, including commercialisation.[41] A starting point is ensuring that the business and the research sectors are connected. Some programs which facilitate/d this connection are outlined below:

- International partnerships can facilitate academic-public sector-industry collaborations. This includes the Energy Transition Hub, an Australian-German innovation partnership bringing more than 60 researchers with industry, government bodies and community organisations to address issues of energy market design, policy and regulation.[42] Launched in 2017, the program was short-lived as funding was cut in 2020 before the release of the Australian Government's technology roadmap.[43]
- Research commercialisation brokers, such as the Government's Innovation Connections Program, and technology intermediaries have a key role in connecting businesses, including SMEs, and the research sector, to facilitate communication and collaborations.[44] For example, brokers can help researchers to find the best industry partners and vice versa. [45]
- Funds that support short, medium and long-term industry-led collaborative research are extremely valuable, such as the Australian Government's Cooperative Research Centres (CRCs) program, established in 1991[46]. Several CRCs have focused on the energy transition.[i]
- Appendix 1, Table 1 provides a list of other key programs that facilitate industry collaborations and bolster research commercialisation.[47]

While these initiatives have helped improve collaboration, a 2021 report found that Australia still struggles to commercialise publicly funded research and innovation, and ranks behind international counterparts on metrics relating to research-industry engagement.[48] Critically, only around 30% of Australian researchers are based in industry, while other countries have much higher rates; for example, 80% in Korea, 73% in Japan and 71% in the US. As such more needs to be done to connect the research and industry sectors, including through research-industry exchange programs. [49] The Australian Government is taking steps to address this through new funding ($296 million) for 1,800 industry PhDs and 800 fellowships over 10 years, as part of its $2.2 billion package on university research commercialisation.[50]

Academic research is often disciplinary, while the challenges of industry, and indeed the challenges that accompany the energy transition, demand interdisciplinary solutions.[51] To support interdisciplinary research-industry collaborations, opportunities need to be provided for researchers to enhance their literacy and capacity to work effectively with researchers from other disciplines. In the context of the energy transition, STEM and HASS researchers need to be supported to better understand each other's language and research modalities, [52] particularly given that HASS research is often very individualised.[53]

i This includes Future Fuels, Future Energy Exports, Reliable, Affordable, Clean Energy (RACE) for 2030, Future Batteries and the Heavy Industry Low-carbon Transition CRCs.

Finally, research institutions and industry must collaborate to prepare the workforce and ensure it has the skills needed to deploy new and emerging technologies to support Australia's energy transition. The workforce will require traditional and new skills, for example, in sectors like geoscience, data science and digitisation, and critical soft and transdisciplinary research skills.[54] However, there is a skills shortage and mismatch between the education system offer and industry demand.[55] Education providers need to ensure that they are preparing a future workforce that can meet the demands of industry, and industry must work with education providers to make projections for the anticipated skills and number of people needed in the future workforce.[56]

C. Incentivising more research focus on non-academic impact

While not all research can or should be focused on commercialisation or policy impact, at least initially, there can also be competing or insufficient incentives for researchers to prioritise collaboration with end-users, including policymakers and industry. Instead, researchers are likely to be motivated by academic performance measures which incentivise journal article publications and participation in academic conferences.[57] For example, the Australian Research Council's (ARC) Excellence in Research in Australia (ERA) measures the quality of research outputs based on citations for STEM disciplines, and peer review processes, for HASS disciplines.[58] While this assessment is also inclusive of a wide range of non-traditional research outputs, such as creative works and live performances, which come from mainly HASS oriented disciplines, it gives little weight to translation of research or whether it is taken up by end users.[59]

The demand for these research outputs can reduce the time researchers have to engage with end-users and pursue other forms of non-academic impact. Indeed, as the 2018 ERA data demonstrates,[60] very few disciplines lead the charge on the commercialisation income.[ii] In response, incorporated into the $2.2 billion university research commercialisation package (but originally announced in November 2021),[61] the Australian Government announced $242.7 million for four universities to encourage them to work with industry partners and drive commercialisation across the Government's six manufacturing priorities, including clean energy.[iii] The Government has also emphasised that it wants universities to provide more incentives for researchers to collaborate with industry and focus on commercialisation.[62]

Incentives to publish in journals also impedes impact as journals are largely inaccessible to end-users.[63] However, there is a global focus on improving open access to research findings. Australia's Chief Scientist recently outlined her vision for all publicly funded Australian research publications to be freely available.[64] Still, the length, jargon and density in academic writing does not cater towards end-users, especially policymakers who often desire short, digestible and non-academic insights.[65] Overall, researchers need to consider, and also be incentivised and supported to generate impacts that reach beyond the academic sector.[66]

Recently, ARC has endeavoured to incentivise greater collaboration between researchers and end-users through launching the Engagement and Impact Assessment (EI). The assessment in 2018 investigated how researchers are engaging with end-users and translating research into non-academic impacts.[67] However, universities varied in their approach for gathering information on their engagement and impact. The extent to which this assessment will succeed in incentivising greater collaboration between universities and end-users remains to be seen when the next round of EI is conducted in 2024.

ii This is the commercial returns via income and/or capital gains which arise from commercialising research outputs, services and intellectual property.

iii The universities will each receive $50 million over four years to build their commercialisation capacity.

D. Translating research into policies

The translation of research into policy development and evaluation often remains elusive. This is partly because researchers are not incentivised to communicate their findings to appropriate policy venues, as discussed above in section C. However, even when researchers strive to influence policies, various challenges impede research evidence from informing policy development. Policymakers, much like industry, also have a role to play in 'pulling' research. While their role is often overlooked and inadequately researched, it was a focus in the 2019 Independent Review of the Australian Public Service (APS). There is a growing consensus that there is no formula for the effective translation of research into policy, which is recognised as being a complex rather than linear process. However, to overcome this, at a minimum, research needs to better serve policy and policymakers need to better engage with researchers, including through two-way secondments of personnel between the APS and the research sector (see case study).[68]

> The University of Cambridge centre for science and policy has pioneered innovative ways of bringing academia and government together to help improve the quality of public policy making. This includes through providing policy fellowships which connect policy professionals at different stages of their careers with academic researchers whose research is relevant to the questions drawn up by the policy Fellows. This can lead to policy Fellows gaining new perspectives on their policy areas while also providing researchers with a policy perspective on their work that can help maximise their research impact.
>
> Source: University of Cambridge centre for science and policy (n.d.)

Research does not always serve policy needs

A limiting factor in the translation of research evidence to policy is timeliness. The research outputs are more likely to succeed in shaping policies if they are communicated when unexpected events or sudden media attention open policy windows or when governments are developing their policy platforms.[69] Hence, researchers must be familiar with policy cycles and timings and maintain relationships with key policymakers. However, it is often difficult for researchers to keep up with rapidly changing policy agendas, especially given the relatively long time periods over which research is conducted.[70] There are some notable exceptions, such as the work of the Grattan Institute (see case study) and the Rapid Research Information Reports.[iv] The Learned Academies and ACOLA develop the reports and they constitute short and timely policy advice requested by the National Science and Technology Council and Government.[71] This model could be adapted to the energy context.

> The Grattan Institute provides a good example of communicating research into policy. Grattan regularly produces timely, evidence-based and open-access reports with high-quality public policy recommendations written in policy-fluent language. In 2021, the Institute released five reports in the lead-up to the 'COP26' Glasgow Climate Change conference, focusing on how Australia can build momentum in sectors like transport, industry, agriculture and electricity towards net zero.
>
> While their reports are often cited, Grattan has expressed disappointment that over two thirds of their suggested reforms from 2009-2019 have not been adopted. They attribute this to many reasons including for the proposed reforms being unpopular, crossing shibboleths or being contrary to powerful vested interests.
>
> Source: Daley (2021), Wood et al. (2021)

iv This stems from the Rapid Research Information Forum, which was convened by former Chief Scientist Alan Finkel in 2020 to bring together multidisciplinary research expertise and address questions about the Covid-19 response.

Even with the right timing, research evidence must still compete with other sources of experts and expertise, namely politics and administration.[72] Policymakers often perceive research that does not align with policy needs as irrelevant. Research can be translated more effectively if the findings are aligned with policy interests, [73] and communicated using short, digestible summaries, including a summary of the expected policy implications. [74] However, even if the research is perceived as being relevant, policymakers may not rely on the 'best' evidence as there can be an overload of expertise and evidence to choose from.[75]

Research that is perceived as irrelevant or not important by policymakers can still be of value, and be urgent. For instance, policymakers and funders often understand the challenge of decarbonisation as a technical issue but not a social issue.[76] This is particularly evident when examining interdisciplinary energy research in Europe, where HASS perspectives on the energy transition are subordinated to STEM research agendas.[77] However, effectively integrating HASS perspectives into energy policies is critical to maximising the social and democratic benefits of the energy transition.

In Australia, it is evident that HASS perspectives are being considered in the wide number of multi- and inter-disciplinary projects being undertaken on the energy transition, including by CRCs and University research institutes. However, there is limited evidence evaluating the extent to which these perspectives are integrated across the different research projects and programmes and how these insights are shaping Australia's energy policies. Meanwhile, research on energy research translation in Europe paints a worrying picture that when HASS research does influence policy, it is done indirectly, or its contributions are concentrated in the field of economics. Mobilising a large number of researchers with similar agendas can make insights into the way people adopt energy transitions more 'influential'.[78] Researchers and industry can also work together to engage in lobbying or advocacy campaigns that bring issues to the attention of policymakers which are otherwise ignored.[79]

Policymakers do not (effectively) engage with or undertake research

The duty to facilitate research translation does not rest solely on the research sector. Policymakers must 'pull' research, for example through submissions to policy developments and commissioning independent studies.[80] When asked to provide policy advice, many argue the public service:

- is too compliant with the political interests of the government of the day instead of remaining apolitical and frank and fearless.[81] This includes through articulating their advice in a way that can fit almost any interpretation or presenting advice that expunges complexity.[82]
- is not capable of providing it partly as the public service lacks the organisational and individual capacity to effectively access, engage with and integrate academic research into policy advice,[83] and
- needs intersectoral partnerships with academia to access educational materials, libraries and academic research.[84]

As the 2019 Independent Review of the APS found, part of the problem lies in the fact that some ministers don't regard the APS as their primary or preferred source of advice anymore.[85] Instead, there is growing trend of policy development being outsourced to consultants. This has raised questions of transparency and accountability, as there is a risk that consultants feel pressure to produce reports that reflect what ministers want to hear as they are dependent on repeat contracts.[86] The APS Review also found that the in-house capacity of the APS to undertake its own research and evaluation has declined. If these issues are not addressed, the public service will not effectively overcome barriers to policy reforms.[87]

The APS Review recommended that to strengthen the quality of advice to Government, the APS needs to embed high-quality research into its regular program of work, for example through establishing or strengthening in-house research units and capability to commission external research. In particular, the Review recommended that enhancing the research capability of the social and human services, health and education sectors should be an immediate priority.[88] There is also scope to undertake two-way secondments between universities and the APS, as is currently being done in the Australian National University's Grand Challenge: Zero-Carbon Energy for the Asia Pacific project.

E. Appropriate design of research

Failures in the planning and design of a research project can have cascading impacts on the research translation pathway. To encourage research translation and keep track of the research impacts throughout the research process, researchers should create a plan at the beginning of the project considering the research needs, who the end-users and potential partners might be and how the findings can be disseminated to key end-users.[89] These plans should be amended iteratively to reflect changes as projects develop.[90]

Researchers should also work collaboratively with knowledge-holders and end-users, whether that is industry, policymakers or communities, to define the problem and jointly develop the research questions and proposal. Sustained dialogue between researchers, knowledge holders and users can allow the various actors to better understand and cater for each other's needs and limitations (see case study on the Lowitja Institute).[91] However, community engagement and knowledge translation for research output are rarely funded by government bodies like NHMRC and ARC.[92] ARENA is a notable exception as all ARENA-funded projects must produce Knowledge Sharing Plans and share insights and data from their funded projects via their knowledge bank to facilitate replication.[93]

While a collaborative approach is appealing,[94] bringing diverse stakeholders together is not straightforward. It requires parties to have strong interpersonal and coordination skills and resources to sustain a continuous dialogue.[95] This may not align with the schedules or capacities of either the researchers or the end-users. There is a need to balance the investments in achieving a collaborative approach, with the potential gains.[96] Creating knowledge translation plans at the start of the research process can support this balancing act.

Ultimately, the discussion above demonstrates that while Australia has a good base for effective energy research, through our strong knowledge economy, barriers to research translation still remain. Notably, Australia still faces difficulties in commercialising publicly funded research and innovation and prioritising and translating HASS-oriented research. Enhancing the synergies and collaboration pathways between STEM and HASS researchers, users and funders is critical to maximising the translation of research into impact.

Aboriginal and Torres Strait Islander people are often experts in knowledge translation. Much can be learned from the approach adopted by the Lowitja institute – Australia's only Aboriginal and Torres Strait Islander community-controlled research institute. Recognising that research on Indigenous health is not sufficiently translated, the Institute sought to change how they did research. The Institute encourages Aboriginal and Torres Strait Islander people and organisations, government agencies and non-Indigenous organisations to collaborate from the onset of a project to jointly frame research questions and priorities. They also provide funding for researchers to create a Knowledge Translation Plan that prospectively considers research impact outcomes. These measures are supplemented with external interactions such as knowledge translation forums which showcase the Institute's work and aim to shape future decisions on policy developments, service delivery and evaluation.

Source: Williams et al. (2021); Smith (2018)

5. International efforts to facilitate effective energy research translation

The IPCC demonstrates the translational power of having a boundary organisation at the interface of science and policy. While a similar body does not exist to focus on energy research translation,[97] several countries have similar structures on a national scale to enhance collaboration between researchers, end-users and funders, and accelerate research translation. This includes Germany and the UK and these structures can help inform Australia's approach to energy research translation (see Section 6: Recommendations to enable improved energy research translation).

An international model: a boundary organisation for energy research?

The IPCC sits at the interface of science and policy and is a well-known and trusted climate science assessment body. It produces assessments on climate change and guidelines for policy decisions.[98] The assessment reports are completed by three Working groups which are tasked with exploring a different aspect of the science related to climate change; (1) physical science, (2) impacts, adaptation and vulnerability, and (3) mitigations of climate change. The Working Groups prepare the reports and select experts to work on them, with assessment reports being released every 6 to 7 years.[99]

The recent 2021 IPCC report on the physical science of climate change was written by 234 authors over 3 years.[100] It includes a summary for policymakers and has already been cited widely, from academics and media organisations to politicians and the wider public. This demonstrates the IPCC's ability to bridge the science and policy gap and provide trusted advice on climate change for various end-users.

While the IPCC reports have been criticised for being complex and difficult for non-specialists to understand and use, the reports themselves are recognised as credible sources of information on climate change.[101]

Using the IPCC as a model, researchers have proposed that an Intergovernmental Panel on energy research could coordinate a global energy research plan and oversee national efforts. This can help accelerate the commercialisation of safe, scalable and affordable low-emissions energy technologies.[102] However, such a body does not exist. In its absence, several countries have ramped up their own efforts to translate energy research, creating bodies that sit at the interface of research, funding and policy.

Germany

Germany has established itself as a leader in renewable energy patenting, generating strong economic outcomes through its innovations.[103] Its success can in part be attributed to its R&D policy, institutional set-up, and funding for energy research under the Energy Research Program (ERP). The 7th ERP aims to strategically expedite the energy transition by facilitating the research translation of innovative, integral solutions.

Recognising that transparent dialogue with a diverse range of key stakeholders is necessary to coordinate research activities and translation, a comprehensive institutional set-up to guide effective exchanges between researchers, industry and policymakers and coordinate funding across all stages of the innovation chain which is assessed using the technological readiness level (TRL) has been established.[v] The Ministry for Economic Affairs and Energy (BMWi), provides overall coordination and management of federal energy research policy, including across the TRL scale.

v This is a globally accepted benchmarking tool for tracking progress and supporting development of specific research and technologies. The nine-point scale starts at application oriented fundamental research (TRL 1–3) and progresses through to applied research (TRL 4–6) and market-ready technologies (TRL 7–9).

To support the BMWI, a strategic advisory Research and Innovation 'Platform' was established. Composed of a diverse range of high-level actors, this body discusses current developments in energy research and approaches for future strategies. It acts as a strategic advisory body on issues of energy research funding policy while enabling the dovetailing of energy research and energy-sector practice.[104] The Platform receives professional scientific advice from Energy Research Networks consisting of more than 3,500 experts.[vi] The networks are further broken down into working groups and expert committees that focus on more nuanced research fields relevant to the networks' mandates. This structure creates opportunities for researchers and industry to network and can lead to collaborative research projects later on.[105] A ministerial advisory board also meets regularly with network representatives to exchange information on funding areas and to discuss potential impacts of new research.[106] Giving researchers and industry experts opportunities to influence energy policy and funding decisions is critical as they are better positioned to spot high risk / high return opportunities.[107]

United Kingdom

The UK has established productive synergies between the government funders of research, researchers and end-users to accelerate energy research translation. The UK Research and Innovation Energy Programme was established in 2004 to fund energy research across the remit of several Research Councils including the Engineering and Physical Sciences Research Council (EPSRC), which leads the Programme.[vii] Approximately £1.1 billion was invested between 2004 and 2020. This includes funding across the innovation chain and on interdisciplinary research. [108] The investment portfolio is developed in partnership with diverse stakeholders. These partnerships ensure pathways are created for the translation of the research outputs.[109]

Through providing a coordinated and long-term approach to investment in energy research in tangent with discussions with end-users, the Energy Programme has generated substantial academic and non-academic impacts.[110]

In terms of non-academic impacts, researchers supported by the Programme have delivered more than 1000 tangible policy impacts, particularly in the fields of energy economics, sustainability and energy regulation. The Programme has also supported collaboration with various project partners, including industry partners, who have contributed to increasing UK employment and revenue.[111]

In addition to this carefully tailored funding programme, the UK also has an effective institutional mechanism to guide the translation of research into policies. Established in 1989 as an external science office, the UK Parliamentary Office of Science and Technology (POST) is now a permanent office in UK Parliament that provides Parliament with impartial, peer-reviewed briefings. The briefings are timely and forward-thinking, and they summarise scientific research evidence covering various areas,[viii] including the area of energy and environment. To help POST fulfill their role of bridging the research-policy divide effectively, POST's advisers keep in contact with diverse experts, including stakeholders from academia, industry and government.[112]

In Australia, the Rapid Research Information Reports and bodies like ACOLA facilitate collaboration across different disciplines to provide policy advice to governments. Such mechanisms provide a new pathway to navigating the scholarly research/policy/practical action silos in the energy transition. However, Australia lacks a Parliament-level process like the UK POST.[113]

Recognising the effectiveness of POST in facilitating knowledge transfer between UK Parliament and various agents in the research ecosystem, the Australian Senate Legal and Constitutional Affairs References Committee recommended that the Government establish a Parliamentary Office of Science, modelled on UK POST.[114]

Ultimately, international best practice examples demonstrate that research translation can be accelerated through implementing structures that sit at the interface of the three key agents of the research ecosystem (researchers, users and funders) and facilitate transparent dialogue between these diverse actors. However, Australia currently lacks these comprehensive structures.

vi This includes experts across the fields of: bioenergy, construction for the energy transition (buildings and neighbourhoods), energy systems analysis, renewable energy, flexible energy conversion, industry and commerce, electricity grids, start-ups and hydrogen.

vii The UK Research Councils, funded by the Department for Business, Innovation and Skills Science & Research budget, are the primary government agencies that fund basic, strategic and applied research.

viii The other areas include biology and health, physical sciences and computing, and social sciences.

6. Recommendations to enable improved energy research translation

Creating a healthy research ecosystem with productive synergies between researchers, end-users, and funders is essential in paving a 'clever pathway to net-zero by 2050'.

1. CONNECTED AND INFORMED

Efficient and effective information sharing and planning

Leveraging global insights, establish a research translation platform to support energy research translation and networking, across academia, industry and government.

- Central body
- Steering panel
- Exchange and networking

2. FUNDERS

Alignment with priorities and incentives for translation

Australia must fund energy research across the innovation chain by regularly assessing and implementing research priorities, and incentivising energy research translation.

- Incentives for translation and collaboration
- Ongoing assessment of needs
- Implementation of priorities
- Coordinating funding body

3. RESEARCHERS

Enabling planned and effective research translation

Researchers should actively develop and pursue research translation pathways and non-academic impacts at various stages of the project's development.

- Knowledge translation plan
- Targeted communication

4. RESEARCH USERS

Support and access research needed to inform policy and investments

Research users and consumers need digestible policy-relevant summaries of research.

- Commissioning research
- Research collaboration
- Open access research findings

Australia's current approach to research translation is not sufficient for the urgency of the challenge of achieving a reliable, affordable and fair transition to net-zero emissions. An effective transition hinges on enhancing the research impact culture within and building appropriate synergies between the ecosystem of researchers, funders and research users (industry, policymakers and the community). ACOLA makes the following recommendations to create, facilitate and leverage routes for more effective research impact and translation:

1. CONNECTED AND INFORMED: efficient and effective information sharing and planning

Leveraging global insights, establish a research translation platform to support energy research translation and networking, across academia, industry and government.

- **Central body**: A trusted, independent and cross-disciplinary body should be created or commissioned to bring together the energy sector stakeholders to understand and ensure research insights are shared. This includes through preparing annual or bi-annual reports on current research outcomes and directions and ensuring a link across both STEM and HASS-oriented research.[ix] The body would ensure a link to funders, including the proposed coordinating body in recommendation 2(e), and users such as industry (via industry associations) and policymakers (via ministerial forums).
- **Steering panel**: The body's steering panel should consist of policymakers (state and federal), researchers (from STEM and HASS domains), and industry and community representatives to ensure that the needs of all stakeholders are balanced and met.
- **Exchange and networking**: The body would network with and facilitate opportunities between researchers, end-users (especially policymakers and industry) and funders to enhance and expedite the translation of research findings and to ensure the reports are informed by the needs of research users and activities of the research sector.[x]

2. FUNDERS: alignment with priorities and incentives for translation

Australia must fund energy research across the innovation chain by regularly assessing and implementing research priorities, and incentivising energy research translation.

- **Incentives for translation and collaboration**: Researchers and research users should be incentivised to collaborate more with each other. In particular, research funders and institutions like universities should incentivise researchers to create translation plans at the start of the research project, in discussion with relevant end-users, and make their criteria for evaluating academic achievement more inclusive of non-academic research impacts.
- **Ongoing assessment of needs**: the regular assessment of research priorities should be funded, building on the initial work by ACOLA, to ensure that urgent and strategic priorities are identified as the energy research landscape changes over time. The information sharing platform outlined in recommendation 1 could be funded to undertake this assessment.

ix The body could be new, or an existing body can be commissioned to undertake the work, such as the Office of the Australian Chief Scientist, the Forum of Australian Chief Scientists or ACOLA.

x This can be achieved through hosting events for experts, policymakers and industry to share insights. This can range from closed round-table discussions, to seminars and workshops on key topics and conferences. An open database can also be hosted to improve the accessibility of research findings.

- **Implementation of priorities**: Where possible, government and non-government funding bodies should utilise the urgent and strategic priorities identified in ACOLA's Research Plan in selection criteria and fund the translation of this energy research across the innovation chain using diverse funding mechanisms. The identified priorities address STEM and HASS-oriented perspectives.
- **Coordinating funding body**: Modelling on the German and UK approach, the government should create or task a body with coordinating energy research funding across Australia (i.e. state, territory and federal governments) to ensure urgent and strategic priorities are funded.

Implicit in this paper is the need for a broader breadth of, an increase in and greater coordination of Australian energy research funding. ACOLA is undertaking further consideration and analysis of the current diversity and quantum of funding for energy research, development and demonstration. This will be presented in a separate paper.

3. RESEARCHERS: enabling planned and effective research translation

Researchers should actively develop and pursue research translation pathways and non-academic impacts at various stages of the project's development.

- **Knowledge translation plan**: Researchers should create translation plans at the start of the research project, in discussion with relevant end-users, and update it throughout the project to ensure it stays relevant. The plans could include an outline of the needs being addressed by the research,[xi] the research activities being supplied, and the expected research outputs, including the anticipated end-users and impacts of the outputs.
- **Targeted communication**: in addition to producing academic outputs, researchers should endeavour to communicate their research findings, including the practical implications of the findings, to end-users in a manner that is accessible and digestible. This could mean using lay, short policy and research briefs.

4. RESEARCH USERS: support and access research needed to inform policy and investments

Research users and consumers need digestible policy-relevant summaries of research.

- **Commissioning research**: Research users, especially governments, should support the development of regular summaries of current energy transition-related research, for example through engaging with the body proposed in recommendation 1.
- **Research collaboration**: Engage in early and ongoing collaboration with researchers, and provide financial and other support to researchers. This can be assisted by two-way secondments of personnel from the research and industry/policy sectors.
- **Open access research findings**: Consistent with the work of the Australian Chief Scientist, publicly funded research findings must be made open access.

xi In so far as researchers need assistance in identifying the critical energy research needs, they can rely on ACOLA's research plan.

Appendix 1

Table 1: Examples of funding initiatives designed to support research commercialisation and industry-research collaborations.[115]

Program	Description of main role
ARC Linkage Program	This program aims to support the development of national and international research partnerships between researchers and business, industry, community organisations and other publicly funded research agencies. In this way, ARC supports the transfer of skills, knowledge and ideas to help secure commercial and other research benefits. The Linkage Program already supports low emissions technologies through the Industrial Transformation Program which research hubs and training centres including research on low emissions.[116]
Biomedical Translation fund	This fund was announced in 2015 and it will distribute at least $500 million for investment in biomedical discoveries (50% from Australian Government and 50% co-investment from the private sector).
Business research and innovation initiative	The government has allocated $19 million to support entrepreneurs to create new products and innovations that meet defined government needs, while retaining their intellectual property as well as the right to commercialise the ideas in Australia or overseas
CSIRO innovation fund	Support early-stage commercialisation of innovations developed by various publicly-funded research bodies including CSIRO and universities.
Digital Market Place	This is a website which connects government buyers with digital business problems with suppliers that can provide potential solutions. It facilitates two-way collaboration between governments and suppliers and makes it easier for business start-ups and SMEs to compete for government's $5 billion per year spend on ICT products and services.
Defence Innovation programmes	This includes the Defence Innovation Hub (a virtual network bringing defence innovation programmes together and enabling the defence industry to undertake collaborative innovative activities), Next Generation Technologies Fund (will invest in significant strategic technologies critical to Australia's defence and national security capabilities), and the Defence Innovation Portal (will provide communication bridge between Defence, industry and academia thus creating the vital connections between SMEs and Defence).
Entrepreneurs' Program	This has 4 main components: Accelerating Commercialisation (assists SMEs, entrepreneurs and researchers to commercialise novel products, processes and services), Business Management (review of business operations and strategy by experienced business advisers and facilitators), Innovation Connections (helps businesses identify knowledge gaps preventing business growth) and Incubator Support (offers funding support for new incubators and accelerators, existing incubators and funding support for secondments of experienced employees from national and international institutions).
Global Innovation Strategy	Strives to increase Australia's innovation and science connections internationally including through funding five 'landing-pads' overseas, assistance for international collaboration for Australian businesses and researchers and multi-partner activities related to shared regional challenges.
Industry Growth Centres	Six growth centres have been established across the following sectors: advanced manufacturing, cyber security, food and agribusiness, medical technologies and pharmaceuticals, mining equipment, technology and services (METS), oil, gas and energy resources. These sectors are perceived as having competitive strength and strategic priority. The activities carried out by the Centres focus on improving the productivity, competitiveness and innovative capacity of the sectors.
Rural Research and Development Corporations	These are industry-government R&D investment partnerships that cover the agriculture, forestry and fishing industries. Each RDC is tasked with delivering tangible and practical improvements for their industries in terms of productivity and profitability, sustainability, and the community. This is achieved through strategic and targeted investments in and partnerships for research, development and adoption, and sometimes, market access, market development and promotion.
Hydrogen RD&D International Collaboration Program	CSIRO will deliver this $5 million program which seeks to strengthen research connections, collaboration and knowledge sharing between Australian research institutions and international hydrogen research organisations.[117]
Patent box	This was announced as part of the Commonwealth Government's budget 2021-22 and it will reduce taxes on income derived from certain biotechnology and medical technology patents. It aims to encourage businesses to keep their R&D work in Australia and thus also keep patents here.[118]
Australian Government Trailblazer Universities Initiative	Australian Government has announced $242.7 million for four universities to encourage them to work with industry partners and drive commercialisation across the national priority areas set out in the Modern Manufacturing Strategy, including clean energy, defence, space, resources technology, food and beverage and medical products.[119]

Table 2: Summary of ARENA v CEFC.[120] [121]

	ARENA	CEFC
Established	**2012**	**2012**
Role	ARENA's purpose is to support the global transition to net zero emissions by accelerating the pace of pre-commercial innovation, to the benefit of Australian consumers, businesses and workers. It provides grant funding to support the research, development, demonstration and deployment of technologies under its mandate.	The CEFC is a specialist clean energy financier which provides tailored debt finance and equity to businesses and projects which deploy proven low emission technologies, and develop and commercialise early-stage and late-stage clean energy technologies.
Mandate	Initially prioritised investment in renewable energy projects but its mandate has been expanded following the launch of the Australian Government's Technology Investment Roadmap in 2020 to support 'priority' technologies; hydrogen, energy storage, low carbon steel and aluminium, carbon capture and storage and soil carbon storage,[122] and more recently, ultra low-cost solar.[123]	Invest in eligible clean energy technologies, including renewable energy, energy efficiency and low-emissions technology. The CEFC also jointly manages the Clean Energy Innovation Fund with ARENA focusing on venture capital stage investments across the technologies under its mandate which can generate a return for commercial equity and/or debt.

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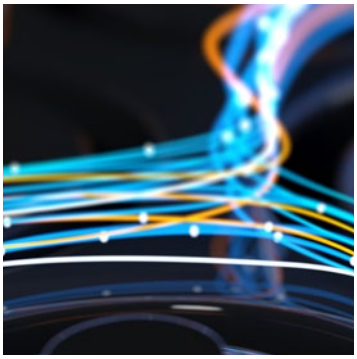

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