# Energy Research, Development and Innovation

EEC position statement

November 2024

# Table of Contents

# 1. The context

Research, development and innovation (RD&I) are critical components of the transformation to a net zero economy. The Energy Efficiency Council (EEC) is strongly supportive of a vibrant innovation ecosystem that delivers new technology, knowledge and expertise required to meet our emissions reduction commitments and a rapid, equitable and least-cost transition.

The EEC's mission is to promote energy efficiency, energy management, electrification and decarbonisation to ensure Australians have access to healthy and comfortable homes, productive and competitive businesses, and a reliable, affordable and sustainable energy system. Many of the EEC's members are businesses at the forefront of designing and deploying innovative decarbonisation technologies, and others are governments and universities working to develop knowledge and policies to rapidly effect the transition to a prosperous net zero economy.

The EEC has a strong interest in the development of a vibrant, productive and well-regarded RD&I ecosystem in Australia. While Australia will remain an importer of knowledge, technology and skills for the foreseeable future, there is a strong case for Australia to maintain an innovation capability to solve energy and decarbonisation problems that are uniquely Australian and to equip Australian households and businesses to be fast adopters of cutting-edge international knowledge, technology and practices that will accelerate the transition.

For the purposes of this statement, RD&I is a continuous process that brings a new technology, process or practice from idea through to mass deployment.[1] Within this process, there are distinct tasks carried out by different actors:

- **Research** is the process of developing new knowledge about the physical and human environments, and consolidating knowledge for application to physical and human systems. New knowledge and discoveries are required to create solutions to a range of difficult problems in the transformation. These solutions include both technologies to achieve decarbonisation, and human solutions to social, economic and political barriers to transformation. In Australia, research is principally undertaken by universities, research agencies like CSIRO, independent or special-purpose organisations and some businesses.

- **Development** is the application of knowledge derived through research to create specific solutions to solve specific problems, and the work of adapting and refining technologies or knowledge to create practical solutions. Development is undertaken by a range of organisations in Australia, such as universities, research agencies, businesses, governments and special purpose organisations.

---

[1] The definitions of research, development and innovation expressed in the OECD's Frascati and Oslo manuals on R&D and Innovation, respectively, somewhat overlap. Further, the Oslo manual's definition of innovation relates entirely to business innovation, while a number of innovations related to the transformation are likely to be social, economic and political innovations deployed by non-business actors.

- **Innovation** is the process of bringing technologies, processes or practices to deployment through market or non-market means. There are a range of modes and actors in innovation, including businesses bringing new products and services to market, governments using the outputs of research to implement new policy measures, or social and/or political organisations using new ideas or practices to effect social, economic or behavioural change.

Achieving Australia's net zero transformation requires activity at all stages of the RD&I chain. While Australia will continue to benefit from ideas, knowledge and technology developed overseas, there are still many areas of RD&I that are specific to Australia and will need to be addressed through Australian-led efforts. Examples of these needs include:

- Ongoing R&D in operating energy systems at high levels of distributed, variable renewable energy penetration, where Australia is a leader,
- RD&I to develop and/or adapt products and services for Australian climate and geographical conditions, and
- RD&I to develop solutions to challenges associated with Australia's unique social, economic and political characteristics.

In the long term, Australia must decarbonise all residential, commercial and industrial activities. This will require substantial RD&I across both public and private sectors. The purpose of this document is to establish the Energy Efficiency Council's position on priorities and policy arrangements for this RD&I.

## RD&I needs for the net zero transformation and beyond

In common with other nations, Australia has a variety of RD&I needs in the transformation on varying time scales.

**Table 1 Examples of RD&I needs by time scale**

| Time scale to solution | Examples of RD&I needs |
| --- | --- |
| **Short term (now-5 years)** | • Research into secure operation of energy systems with high levels of variable renewable energy<br>• Development of process heat systems for medium-temperature applications<br>• Innovation in business models, finance and supporting policy for retrofitting residential buildings to make them efficient and zero-carbon ready. |
| **Medium term (5-15 years)** | • Research into decarbonisation of construction materials (esp. concrete and steel)<br>• Development of alternative transportation energy carriers for long-distance/challenging transport applications<br>• Innovation in markets and policy to harness grid-interactive building and commercial loads to reduce infrastructure spend |
| **Medium-long term (15-25 years)** | • Research into non-land sector carbon removals<br>• Development of abatement technologies for agricultural emissions |

| | |
|---|---|
| | • Innovation in building social resilience and adaptive capacity in a rapidly changing climate |
| **Long term (25 years+)** | • Research into eliminating remaining non-energy process emissions<br>• Development of ultra resource-efficient energy supply and cooling technology<br>• Innovation in eliminating last fossil energy usage throughout the economy |

Table 1 indicates that RD&I is needed on a range of priorities for a range of time scales to meet a range of decarbonisation challenges. It suggests the need for a coordinated and facilitated RD&I plan to ensure Australia has access to the knowledge, expertise and technology needed to successfully transition to a net zero economy.

## The current state of play

Research, development and innovation is conducted by universities, businesses, research agencies and other special purpose vehicles. The EEC supports the goal of Australia being a vibrant, innovative economy across a range of fields, but has particular interest in RD&I in energy and decarbonisation.

### *Energy and decarbonisation RD&I*

Presently, the RD&I ecosystem in energy and decarbonisation consists of:

- Universities and research institutions conducting basic and applied research, as well as collaborative research with industry and governments,
- Research agencies (such as CSIRO and others), conducting both mission-based and collaborative research,
- Special purpose vehicles, especially the Reliable, Affordable and Clean Energy for 2030 (RACE for 2030) Cooperative Research Centre,
- The Australian Renewable Energy Agency, charged with commissioning RD&I into renewable energy, and more recently energy efficiency and electrification,
- The Clean Energy Finance Corporation (CEFC), charged with helping accelerate mass deployment of renewable energy and low emissions technology through investment and finance, and
- Businesses conducting their own RD&I, sometimes with support from the R&D Tax Incentive or other grant programs.

Formerly, the Industry Growth Centres program was also responsible for conducting and coordinating RD&I in target industry sectors, however the two energy-related growth centres are in the process of winding up.

Currently, coordination of energy and decarbonisation RD&I is limited. ARENA plays a role in commissioning needed RD&I, as does RACE for 2030, although these two organisations have a specific mandate and operational model. To a certain extent, RD&I actors set their own direction for RD&I based on their own priorities and areas of comparative advantage.

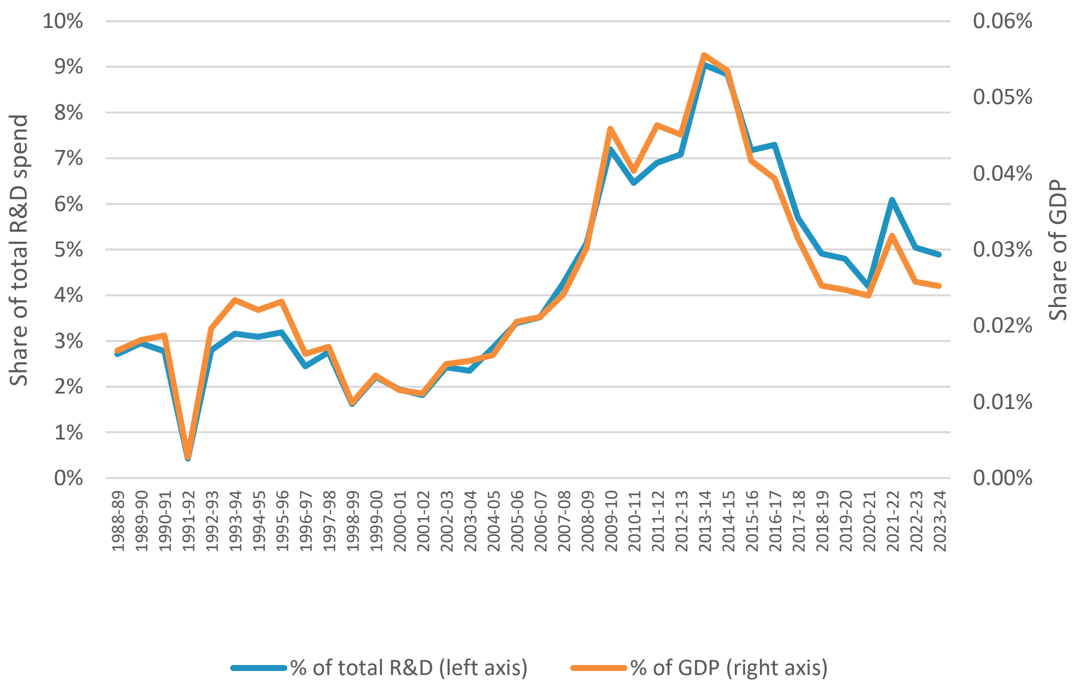
### *Resourcing for energy and decarbonisation RD&I*

There are two principal sources of funding for RD&I: government funding and business investment. The higher education sector also devotes a significant amount of own-source revenue into R&D, but this is not distinguishable by field of research. At present, Australia's overall investment in R&D is trailing comparable nations, which suggests Australia's research, development and innovation ecosystem is at risk of losing its ability to meet Australia's needs. Gross expenditure on R&D across business, government and higher education sectors totalled 1.68% of GDP in 2021-22, trailing the averages of the OECD (2.73%) and the EU-27 (2.11%), and placing Australia 27th in the world.

## Government funding

The Commonwealth is the principal government funder of RD&I, with expenditure of approximately $13.8 billion devoted to all RD&I programs in 2023-24, of which $673 million was devoted to energy. Presently, energy R&D accounts for around 5% of total R&D funding (excluding CEFC) (Figure 1). Over the last decade, the share of energy R&D as a proportion of Australia's total R&D spend has plummeted dramatically, from a peak of around 9% in 2013-14. As a share of GDP, energy R&D has halved, from around 0.06% in 2013-14 to around 0.03% today. This is alarming, as the need for RD&I in energy and decarbonisation has never been more pressing.

**Figure 1 Australian Government investment in energy R&D**

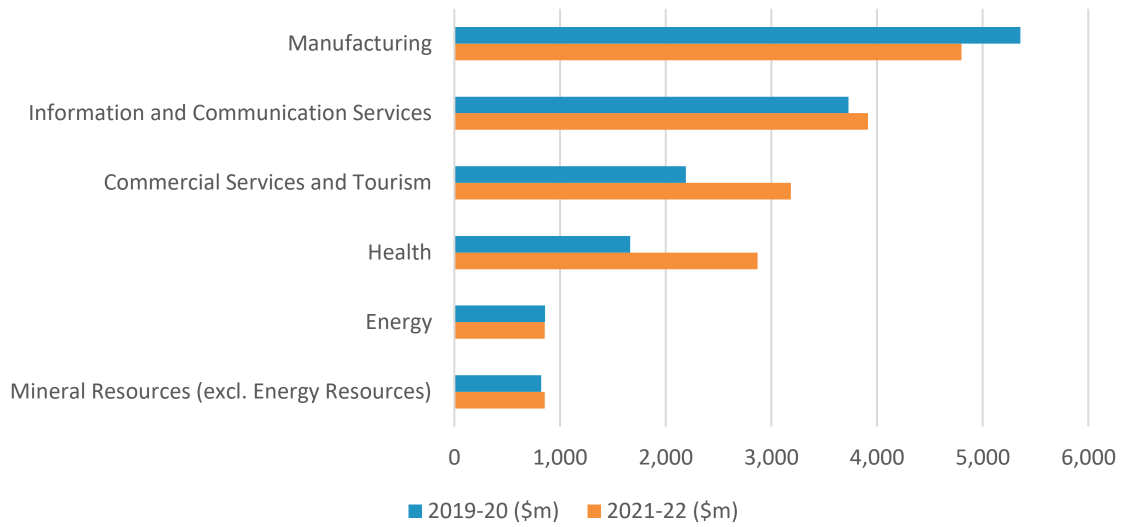



Sources: DISR, 2024, 2024-25 Science, Research and Innovation Budget Tables; ABS, Australian National Accounts: National Income, Expenditure and Product, Table 34. Key Aggregates and analytical series, Annual.

## Business expenditure on R&D

Business expenditure in energy research and development is the fifth largest area of business spend on R&D at $855m in 2021-22 (Figure 2). However, it should be noted that this also includes expenditure on fossil energy R&D including exploration – which is ultimately not an activity that is compatible with achieving net zero.

**Figure 2: Business Expenditure on R&D, by top six Socio-Economic Objectives**




Source: Australian Bureau of Statistics, Research and Experimental Development, Businesses, Australia 2021-22 financial year.

The Australian Energy Transitions Initiative estimates that transition is likely to require more than $600 billion of additional investment towards 2050, of which a substantial portion must be RD&I investment.[2] While it is not possible to identify an ideal or sufficient quantum of energy and decarbonisation RD&I, it is highly unlikely that the current level of investment is sufficient to deliver the suite of RD&I needs for Australia to successfully achieve the transition to net zero emissions by 2050.

**Recommendation**

The Energy Efficiency Council recommends that Commonwealth, State and Territory governments urgently and substantially increase government support for energy and decarbonisation research, development and innovation, in line with the need to rapidly decarbonise the Australian economy.

[2] Australian Industry Energy Transitions Initiative, *Pathways to decarbonisation – phase 3 report*, p.25

# 2. Integrated RD&I for an integrated energy transition

The energy transition has two interlinked components – energy demand and energy supply. All too frequently, policy measures seek to accelerate the decarbonisation of energy supply, without regard for the role that demand-side measures such as energy efficiency, demand flexibility and electrification can have on reducing emissions rapidly and inexpensively.

Optimising energy supply *and* demand in an integrated way has several key benefits:

- **Capital cost:** Optimising energy demand helps reduce the amount of new low-emissions infrastructure that must be built to replace high-emissions infrastructure, directly lowering the capital cost of the transition.
- **Operational cost:** Optimising energy use – particularly by matching energy demand to availability of low-cost renewable energy supply – directly reduces the marginal cost of providing energy.
- **Emissions reduction:** Matching energy use to times of low-emissions energy supply directly reduces the emissions produced to serve energy needs and reduces cumulative emissions.
- **Accelerating the transition:** Integrated energy use and planning accelerates achieving zero-emissions energy by reducing the size of infrastructure build required to complete the transition.

Constructing an energy system operated on the principle of integrating and optimising energy supply *and* demand will require substantial ongoing RD&I – tailored to Australian circumstances. For example, Australia is at the forefront of rooftop solar PV penetration, requiring significant RD&I to understand how grid security can be maintained in networks formed almost entirely of high numbers of individual inverters (rather than centralised generation plant).

**Integrated energy systems need an integrated approach to RD&I**

Activity is needed at all stages of the research, development and innovation chain to deliver an integrated energy system – one that optimises energy supply with energy demand, and successfully integrates decarbonisation technologies into household and business daily use.

A holistic approach to RD&I entails integrating the perspectives of the research community, consumers, businesses, governments and others to maximise the efficiency and impacts of RD&I efforts.

A sharper focus on the demand side also means integrating approaches from multiple research disciplines. Much of the basic and applied research to discover new technologies has already resulted in the maturation of many economically viable demand-side technologies for the net zero transition.

Nonetheless, there is still substantial interdisciplinary R&D (including STEM and HASS disciplines) required to understand how to deploy these technologies for best effect, considering human behaviour, institutional factors and business models – amongst other things.

Over the past decade, institutional arrangements for funding energy RD&I have favoured research into energy supply, delivery and storage technologies. The prime funder for clean energy R&D – ARENA – has only recently been explicitly permitted to fund energy efficiency and electrification R&D, even though these technologies work to maximise the benefits of renewable generation. These factors mean that we have not always looked at the energy system in a holistic, integrated way.

There are significant opportunities in the demand side of the energy system going unrealised. The Integrated System Plan – the document that sets out the forward plan for the electricity system – currently treats energy demand as an exogenous, static input into planning, rather than a parameter that can be optimised to create a least-cost solution. Further knowledge generation about co-optimisation of supply and demand-side energy system development could assist in bringing a truly-least cost energy system into being.

Significant RD&I is needed to grasp the opportunities presented by the demand side of the energy system, through nascent technologies including grid-interactive buildings and industry 4.0-enabled manufacturing facilities. In many cases, R&DI has brought demand-side technologies to maturity but further RD&I is required to support their adoption via new practices, processes, markets and policies. Some degree of facilitation and coordination in this RD&I effort is required, as a wide range of stakeholders and actors (consumers, businesses, governments, NGOs and others) need to collaborate to bring holistic solutions to accelerate the transition.

Since its inception, the RACE for 2030 CRC has filled some gaps in R&D on the demand side of the energy system. However, a fully integrated energy RD&I capability remains elusive – meaning that our transition will be slower, more expensive and give rise to more emissions than is necessary.

The EEC supports calls for a dedicated centre for integrated energy studies, bringing together academics, policymakers and NGOs to help develop knowledge, expertise and solutions on solving energy problems with an integrated, holistic approach. Collaboration with businesses, through mechanisms such as the RACE for 2030 CRC or the Australian Research Council's Linkage Programs is also important. This centre would act as a focal point for research into holistic energy integration, playing an important coordination and facilitation role for integrated energy studies.

**Recommendation**

The Energy Efficiency Council recommends that Commonwealth work with universities and other stakeholders to establish a centre for integrated energy studies as soon as possible to build knowledge and expertise to accelerate the clean energy transition.

# 3. An action plan for boosting energy RD&I

## Create an integrated energy RD&I strategy to guide investment

The Energy Efficiency Council calls for the development of a strategy and work plan that sets out how Australia can coordinate its RD&I efforts to develop the technology, knowledge, practices, policies and processes for building an integrated energy system. The lack of a comprehensive strategy may explain why the energy sector's share of RD&I expenditure continues to be low in Australia, relative to other countries. Current efforts to establish Australia's energy RD&I priorities are piecemeal, particularly on the demand side. For example, while ARENA sets out that enabling flexible demand is a strategic R&D priority, it does not set a holistic energy and decarbonisation R&D strategy.

The National Energy Performance Strategy includes a recommendation to scope a strategic research plan which would be used to 'identify and prioritise technological and sectoral research and development opportunities, aligning national and international research and development efforts.[3]' However, at the time of writing in Q4 2024, scoping the plan was yet to commence.

Similarly, Commonwealth, state and territory government should consider direct investment in mission-based RD&I programs that produce knowledge, technology and expertise in energy efficiency, energy management and related areas that are poorly aligned with existing funding mechanisms (such as those that incentivise scholarly publication or commercial investment). Mission-based RD&I on the demand side – such as pilots or demonstration projects to inform public policy or build public awareness, like the recent *Healthy Homes* program run by Sustainability Victoria – can drive valuable social and community outcomes but are often unable to access existing funding mechanisms.

## Target RD&I to achieve breakthroughs in hard-to-abate sectors

There are several activities – particularly in industry – where emissions are hard to abate due to a lack of technological availability, or a lack of knowledge, expertise and business models to scale up technological solutions.

In particular, Australia has significant challenges to decarbonise a number of industries that produce goods that will be required in a net zero world, with a very large R&D task ahead to meet the decarbonisation challenge. These include the production of:

- **Steel,**
- **Cement,**
- **Alumina, and**

[3] See DCCEEW, 2024, National Energy Performance Strategy, p.41, https://www.dcceew.gov.au/sites/default/files/documents/national-energy-performance-strategy.pdf

- **Chemicals and related products** (especially explosives and fertilisers).

Other hard-to-abate activities at a more advanced state of technological readiness, but where substantial innovation is required to bring solutions to market, include:

- **Long-distance road transport and remote area haulage,**
- **Air and sea transport, and**
- **Energy carrier technology** (particularly for moving energy from areas of high renewable production to those with low renewable production over long distances).

Australia must invest strategically in RD&I and set 'grand challenges' to decarbonise these vital processes in time to meet our emissions reduction targets.

Much as the United States' grand challenge to successfully land a human on the Moon was driven by contemporary strategic imperatives, Australia must go all-in on the grand challenge of decarbonising our high-emitting industries, which is the most significant strategic imperative of our time.

The EEC strongly encourages Australian governments to consider setting, and investing heavily in, grand challenges in RD&I to decarbonise strategically important industrial processes – both to maintain our competitive advantages and economic prosperity, but also to maintain important sovereign capabilities and supply chains.

## Support business contributions to delivering a vibrant RD&I ecosystem

Businesses are the critical factor in enabling mass deployment of decarbonisation technology and practices. Innovation – the process of bringing novel goods, services and processes to market – is a task that is largely the responsibility of business. Innovation in Australia is challenging; high costs of doing business and high labour costs can create uncertainty about return on investment, creating barriers to risk-taking innovative behaviour.

Unsurprisingly, innovative activity in Australian business tends to be dominated by introducing innovations that already exist in other contexts – other businesses, industrial sectors or countries. Less than 2% of Australian businesses introduced goods or services that were new-to-world in 2020-21, with the vast majority of innovative activity consisting of introducing innovations already in place in competitor businesses.[4]

While adoption of existing innovations is an important part of the mass diffusion of technologies and practices for decarbonisation, there is an incredibly important role for introducing new-to-world innovations. This is particularly the case where problems are uniquely Australian – these are unlikely to be solved through adopting innovations extant in other businesses.

---

[4] See Australian Bureau of Statistics 2022, 'Goods and services innovation', in *Innovation in Australian Business 2020-21*. Only 22% of Australian businesses produced an innovative good or service in 2020-21, of which 8.4% were new-to-world, representing 1.84% of Australian businesses introducing new-to-world innovation. A similar proportion of innovations (7.4%) were new to Australia but not the world.

Commonwealth, state and territory governments have a key role in helping businesses overcome barriers to innovation. There are a range of policy levers available to governments to de-risk innovation and build a vibrant RD&I ecosystem. Levers include:

- General innovation system incentives, such as the R&D Tax Incentive, that help improve the business case for innovative companies by helping defray the costs of innovation;
- Targeted incentives, such as grants and investments for specific innovative activities or companies;
- Government procurement, where government uses its ability to specify the terms on which it will procure goods and services to include spending on innovation as a contractual requirement, or to provide firm demand for innovative goods and services;
- The ability to issue a challenge linked to a tender where fulfilment of the tender will require innovation, sometimes supplemented by development funding[5]; and
- Investment and maintenance of the general R&D system which helps provide basic advances in knowledge and technology for further development and commercialisation by companies.

Governments should consider employing a range of these levers to build incentives for innovative activity in the energy system, with particular emphasis on ramping up innovative activity on the demand side of the energy system. Targeted investment and facilitation of innovation that supports better energy efficiency, energy management and other demand-side decarbonisation technologies, knowledge and practices will be critical to unleashing the capability of Australian business in solving our most pressing decarbonisation challenges.

## Expand the role of the social sciences in decarbonisation

Many of the decarbonisation challenges facing Australia require not only technological innovation, but also innovation in practice, process and policy. These types of innovations include:

- Economic and market innovation – getting business models right and ensuring markets are available to facilitate deployment new technologies and practices.
- Legal innovation – ensuring regulation and other legal frameworks can accommodate changing ways of making and using energy and support an equitable transition where possible.
- Social and political innovation – creating behaviour change and social licence for the transition among affected cohorts.

This means that the role of the social sciences in the transition is critical. While the role of science and technology in decarbonisation has long been recognised, energy RD&I must explicitly bring the insights of the social sciences to bear on our most difficult decarbonisation challenges. The social sciences give us the tools to make sure that technological innovations can be made to work for the people and

[5] For example, the United States' Commercial Orbital Transportation Services program, which brought a civilian space cargo transfer capability into being through a mixture of seed development funding and later commercial contract, which required civilian companies to innovatively develop low-cost cargo transport spacecraft.

businesses that will need them. Technological solutions are important, but just as important is ensuring that technological solutions are well-integrated in the social, economic and legal contexts in which they operate.

**Recommendation**

The Energy Efficiency Council recommends that Commonwealth, state and territory governments establish a comprehensive strategy to identify and fill gaps in energy research, development and innovation, and identify priority areas for a holistic energy system transition.

# 4. Conclusion

Australia has a strong research and development system, with significant capabilities in energy research and development, and a proud record of innovation in clean energy technologies. However, current policy settings for energy RD&I fail to capitalise on the opportunities available on the demand side of the energy system, which could deliver a transition faster, at lower cost, and with better outcomes for the climate. The EEC and its members call on all Governments to fill gaps in our energy RD&I policies to better exploit demand side opportunities and solve challenging decarbonisation needs to preserve our competitive advantages and deliver a transition that works for all Australians.

**Energy Efficiency Council**

Level 18, 1 Nicholson Street,
East Melbourne 3002
Victoria, Australia

**eec.org.au**