


INNOVATING ENERGY ARENA'S INVESTMENT PLAN

2019



Australian Government
Australian Renewable
Energy Agency

ARENA



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Investing in Australia's renewable energy future

The energy sector is undergoing a profound and complex transformation as the shift to renewable energy gathers momentum.

Transitioning the electricity system to deal with an increasing share of renewables and different ways of operating is challenging, but it presents many opportunities to help businesses manage their energy costs, as well as capture new sources of growth.

Electricity is only one component of the energy transition. Other sectors such as transport, heavy industry and the built environment are crucial in the pursuit of lower emissions and in ensuring Australia meets its international commitments.

There are many scenarios for the transition to a low emissions economy but technological development and innovation are part of almost every scenario.

The Australian Renewable Energy Agency's (ARENA) expertise, deep understanding of the renewable energy sector and willingness to fund innovative and ground-breaking projects mean we provide a pathway to commercialisation for many new technologies and businesses that would otherwise struggle to get off the ground or be potentially lost to overseas markets.

In other words, we help them get on with the business of renewables.

We also actively identify and troubleshoot issues arising from the energy transition – from technological and commercial issues to regulatory and market barriers, and provide funding for projects that help solve these issues.

We undertake research and inform policy decisions, we bring together people from across the energy sector, government, startups and universities to collaborate with one another, and share their knowledge.

OUR INVESTMENT PLAN

This plan sets out our three investment priorities and explains how to apply for funding. ARENA is looking for the best funding proposals that align with our objectives and investment priorities – this forms part of the merit assessment for our funding programs.

Our Investment Plan builds on the work, achievements and knowledge we have gained to date. It is reviewed and updated as required.

Further funding announcements may be published on our website arena.gov.au.

About ARENA

ARENA was established by the Australian Government in July 2012 under the *Australian Renewable Energy Act 2011*.

Our purpose is to **accelerate Australia's shift to affordable and reliable renewable energy.**

Our role is to find and support the building blocks of Australia's future energy system, helping to accelerate the transition to renewable energy.

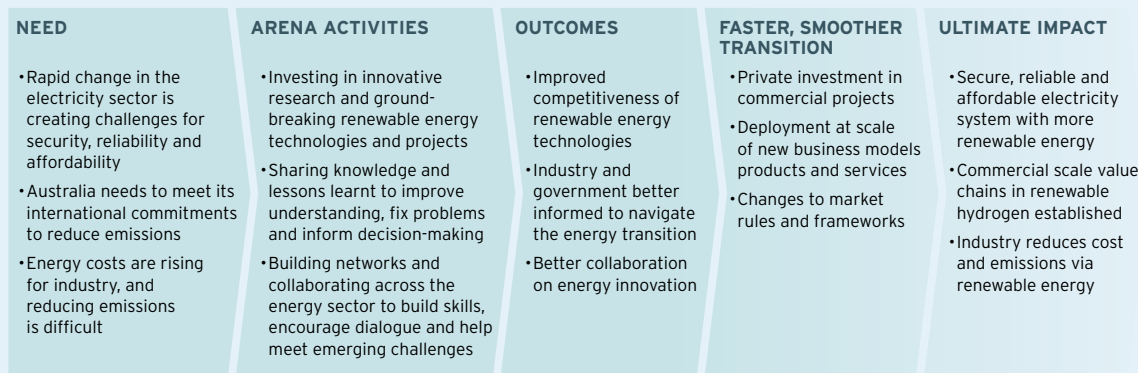
We invest in projects spanning the entire innovation chain (from research to deployment). We focus on finding and demonstrating first-of-a-

kind renewable energy technologies and business models that can reduce technical and commercial risks and grow Australia's renewable energy supply, knowledge and expertise.

We also undertake research and inform policy decisions, we bring together people from across the energy sector, government, startups and universities to collaborate with one another, and share their knowledge.

To find out more about ARENA, visit arena.gov.au

ARENA'S PURPOSE IS TO ACCELERATE AUSTRALIA'S SHIFT TO AFFORDABLE AND RELIABLE RENEWABLE ENERGY



OUR WORK SO FAR

ARENA has invested in 478 renewable energy projects with a total project value of \$5.49 billion. We have been directly responsible for many renewable energy success stories including:

- world-leading solar PV research, principally via our funding of the Australian Centre for Advanced Photovoltaics (ACAP)
- halving the cost of large-scale solar projects through our competitive auction process and \$92 million of financial assistance in our large-scale solar round (supported by a \$350 million Clean Energy Finance Corporation (CEFC) debt package)
- successful Demand Response and Virtual Power Plant (VPP) pilots to help pave the way for a better understanding of consumer behaviour and identify opportunities to reduce consumer costs

- demonstrating high penetration of renewables in off-grid sites including energy intensive mining operations
- rapid commercialisation of bioenergy and energy from waste projects
- supporting the rollout of 63 intercity Electric Vehicle (EV) fast charging stations providing the initial backbone to support the uptake of EVs
- working with the energy market operator (AEMO) and utility-scale solar and wind farms to enable them to provide their own generation forecasts, thus reducing their costs and improving reliability.

These activities, supported by our work with organisations like the CSIRO, CEFC, energy sector peak bodies, consumer groups, universities, major energy companies and startup businesses, continue to assist with the transition to cleaner and cheaper energy.

Our investment approach

ARENA is committed to achieving maximum impact and value from the projects we fund.

We invest in projects spanning the entire innovation chain with funding focused on finding and demonstrating first-of-a-kind renewable energy solutions, which reduce technical and commercial risks and grow Australia's renewable energy knowledge and expertise.

When making funding decisions we ask:

- **Is the project innovative or novel?**
- **Is there a pathway to commercialisation?**
- **Will the project help unlock future investment?**

OUR FUNDING PROGRAMS AND INITIATIVES

Our Advancing Renewables Program (ARP) funds renewable energy projects at various stages, from desktop studies through to later-stage innovation and commercialisation projects, led by Australian startups and businesses. This program is continuously open for applications.

ARENA, as required, will also actively reach out to the marketplace seeking specific projects through targeted funding rounds. Research support is available through our R&D Program funding rounds and strategic research initiatives.

These ARENA funding mechanisms are intended to work alongside other government policies such as the Climate Solutions Fund, Regional and Remote Communities Reliability Fund and the Renewable Energy Target.

Go to arena.gov.au for program funding guidelines, to stay informed of funding announcements and to find out the funds ARENA has available to commit to projects.

OUR FUNDING UNDER THE ARENA ACT

The ARENA Act contains a profile of annual appropriation of funds that ARENA is able to draw down on to meet its liabilities in each year. Funds that are not drawn down in a financial year can be rolled over to future financial years, up to 30 June 2022. Currently, ARENA cannot draw down against the appropriation post 30 June 2022 but it is able to retain and spend ARENA Money held in its bank account.

ARENA's funding and expenditure profile for the four years ending 30 June 2023

\$m	2019-20	2020-21	2021-22	2022-23
Total available to spend carried forward from prior year	260.8	233.8	151.9	55.5
Add: amounts available to spend per s.64 of the ARENA Act	254.7	134.0	132.5	0.0
Add: CEIF receipts and profile adjustments	27.3	23.0	0.0	3.1
Less: Forecast grant and operating expenses	-309.0	-238.9	-228.9	-49.3
Total available to spend at the end of the year	233.8	151.9	55.5	9.3

Our investment priorities

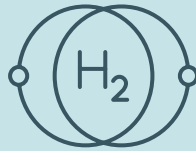
1 INTEGRATING RENEWABLES INTO THE ELECTRICITY SYSTEM

Delivering technology and business model solutions to enable higher shares of renewables in the electricity sector



2 ACCELERATING HYDROGEN

Supporting the growth of Australia's hydrogen industry for domestic applications and export



3 SUPPORTING INDUSTRY TO REDUCE EMISSIONS

Progressing technologies to reduce costs and reduce emissions



PRIORITY 1 INTEGRATING RENEWABLES INTO THE ELECTRICITY SYSTEM



By investing in innovative ways to use, store, manage and share renewable energy, ARENA can help provide affordable, secure and reliable electricity for Australians through the energy transition.

Australia's electricity system is undergoing a rapid transition. Wind and solar photovoltaics (PV) are increasingly competitive, ageing fossil fuel generation is becoming uneconomic and retiring and more Australians are choosing to install rooftop solar and other distributed energy technologies such as battery storage. Already, over two million Australian households have installed rooftop solar to help manage their electricity costs and lower emissions. Electric vehicles (EVs) are dropping in price and allow renewable energy to power transport.

Even as the problems of today are solved, new challenges and opportunities will arise in this transition. Innovation in enabling technologies and new ways of managing the electricity system will allow Australian families and businesses to confidently adopt increasing shares of renewable electricity.

Australia's world-leading solar PV research and development sector can continue its contribution to reducing the cost and improving the efficiency of solar, helping integrate solar electricity into more applications and allowing spare capacity for reliability.

WHAT WE WANT TO ACHIEVE

- demonstrate how integration costs can be reduced and where renewable energy can add value to the electricity system
- develop and commercialise new approaches and technology options to enable lower cost electricity with higher renewable energy shares
- increase confidence and capability in maintaining system security and reliability with higher shares of renewables.

WHAT WE ARE LOOKING FOR

- studies, tools and proof-of-concept projects to inform approaches for maintaining security and reliability as the share of variable renewable energy (VRE) grows
- feasibility studies for activities that target new opportunities for technologies or business models that unlock wider network, system, market, regulatory or commercial benefits
- demonstration and commercialisation of technologies that could balance the electricity system with higher shares of renewable energy, ensuring electricity is available where and when it is needed
- new ways to evolve electricity grids to solve the challenges associated with more distributed energy resources (DER), and to maximise the value DER can provide. DER includes solar PV, energy storage (including batteries and thermal energy storage), demand management and electric vehicles
- projects that inform the development of energy policy, markets, regulations and industry practices and procedures relevant to a high renewables electricity future.

LONG-TERM IMPACT

Solutions will enable the electricity sector to meet or exceed a proportional share of Australia's emissions reduction targets, while minimising costs and maintaining security and reliability. Australia could have secure, reliable and affordable electricity with a high share of annual electricity production from renewable sources.

With better integrated distributed energy, individual energy users may be using distributed renewable energy and other technologies (such as storage, electric vehicles and demand management) to contribute up to half of Australia's power capacity by 2050, with a \$100 billion saving in total cumulative expenditure in the electricity sector.¹

EXAMPLES

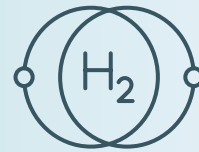
Area of innovation	Example proposals
New approaches to system security and reliability	<ul style="list-style-type: none"> • first-in-Australia electricity system stability services (including frequency control and inertia or substitutes) from wind, solar PV, batteries and other enabling technologies • new software, novel algorithms, enhanced inverter capabilities or multi-party commercial arrangements to address system strength limitations • system modelling, forecasting and data visualisation tools to improve electricity system planning and inform investment and operational decisions • studies to inform policy decisions, regulatory issues or market development options being examined by market bodies such as the Energy Security Board, AEMO, AEMC and AER • studies exploring new approaches to coordination of generation and transmission investment, or development of common-use transmission and system security infrastructure
Flexibility and storage solutions, such as batteries, pumped hydro and concentrating solar thermal (CST)	<ul style="list-style-type: none"> • demonstration of lower cost, increased performance, or advanced operating capability of low emissions flexible capacity technologies – such as demand response, pumped hydro, batteries, CST with storage, power-to-gas and bioenergy² • feasibility studies that explore pathways to commercial deployment, for example covering revenue models and commercial arrangements to make technology financeable
Distributed energy resources, including rooftop PV, battery storage, energy management systems and flexible loads	<ul style="list-style-type: none"> • new business models or approaches to realise the potential value of distributed energy resources to reduce total system costs or improve system stability • technologies and techniques to enhance cyber security in the context of distributed energy resources • projects and studies that develop further insights into customer experience and behaviour • innovative data-enabled consumer products and services • studies and projects exploring techniques to optimise distribution network capacity with distributed resources, potentially moving towards a network optimisation market • projects that demonstrate the integration and coordination of flexible loads and aggregated DER (e.g. virtual power plant (VPP) models, thermal storage, buildings as distributed resources and EVs providing services to the electricity system) • projects that progress regulatory frameworks to maximise the use and investment in network infrastructure that enables more DER (e.g. tariff reform, network hosting capacity assessment, markets for DER services)
Electric vehicles	<ul style="list-style-type: none"> • studies and demonstrations to prove up technical, economic and regulatory aspects of managed charging and vehicle-to-grid, including consumer behavioural aspects and incentives • studies and projects to inform and create momentum on the transition to electric vehicles • projects to gather EV charging data to inform forecasting and integration efforts of AEMO, network service providers and other relevant parties
Solar PV R&D	<ul style="list-style-type: none"> • deployment of novel commercial uses of solar PV energy • subject to scoping and confirmation of need, ARENA may run a funding round in R&D to continue driving down solar PV costs, improve efficiency and develop solutions for end-of-life

¹ Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Energy Networks Australia 2016, Electricity Network Transformation Roadmap: Key Concepts Report

² ARENA requires a life cycle assessment for successful funding applications that involve bioenergy or biofuel projects. Go to www.arena.gov.au/lca for further information.

PRIORITY 2 ACCELERATING HYDROGEN

ARENA will help drive innovation in hydrogen supply chains, from production to end use, creating opportunities across the domestic economy, and positioning Australia to become a major renewable energy exporter.



While much of the emissions reduction of Australia's energy consumption can be achieved with renewable electricity, not all applications are well suited to electrification. Renewable hydrogen provides a key alternative—it can be combusted to produce heat, stored for long periods and transported large distances overseas. Hydrogen is a versatile energy carrier with potential uses as a transport fuel (particularly in heavy transport), in domestic and industrial heating, as an industrial feedstock for the production of important chemicals such as ammonia and fertilisers, and in the electricity sector.

Overseas demand for hydrogen is projected to grow strongly, with countries like Japan and South Korea seeking to import renewable hydrogen to meet their long-term decarbonisation objectives. Australia can help meet these needs thanks to its abundance of renewable energy resources, land availability, good export capabilities and infrastructure, and strong relationships with key international markets. These factors offer Australia a competitive advantage against other potential hydrogen producers, in becoming a leading renewable hydrogen producer and exporter.

Developing domestic applications of hydrogen will grow Australia's experience with hydrogen technology, regulations and operation, helping establish an export industry. Conversely, growing a significant export industry will help drive production costs down, providing benefits for domestic applications.

The hydrogen sector is still in its infancy and while key technologies like electrolyzers are available, there are few large-scale systems deployed and they are still expensive. Growing this new sector will take many years and require support beyond ARENA's funding horizon. However ARENA's support now can drive the establishment of this new industry as well as progressing RD&D to unlock greater cost reductions.

WHAT WE WANT TO ACHIEVE

- reduce renewable hydrogen production costs via learning effects through demonstration in commercial-scale operations
- inform industry on commercial hydrogen costs through real data
- increase skills, capability and understanding of how to integrate hydrogen into different applications
- increase the readiness of transformative hydrogen technologies.

WHAT WE ARE LOOKING FOR

- feasibility studies for projects involving 100+ MW electrolyzers
- commercial-scale deployments involving 10-40+ MW electrolyzers focused on industries and applications with large potential demand for hydrogen (e.g. ammonia production, power-to-gas) to drive the commercialisation of key component technologies
- demonstration-scale projects involving 1-10 MW electrolyzers demonstrating new applications such as transport or remote area power systems with onsite hydrogen production and fuel cells/turbines replacing diesel generation, to drive the commercialisation for key component technologies
- projects or activities that support the implementation of the National Hydrogen Strategy.

Subject to scoping and confirmation of need, ARENA may run a funding round in research, development and demonstration (RD&D), focused on short-to medium-term industry needs.

LONG-TERM IMPACT

The establishment of a renewable hydrogen industry provides a pathway to help Australia convert its transport, industrial and domestic heating and chemicals production to renewables, and to support a high renewables share electricity grid.

As the world shifts to low emissions energy, the development of a hydrogen export industry could position Australia as a renewable energy superpower. Demand from countries such as Japan and South Korea could add up to \$10 billion to the economy by 2040³, and exponentially greater value by 2050.

EXAMPLES

Area of innovation	Example proposals
Hydrogen as an export commodity	<ul style="list-style-type: none">• feasibility studies that progress the development of an Australian hydrogen export industry• pilots and demonstrations of technologies that reduce the cost of liquefaction or conversion of hydrogen to other suitable forms for export
Hydrogen as a feedstock to industrial processes	<ul style="list-style-type: none">• feasibility studies for the commercial-scale deployment of renewable hydrogen• demonstrations for novel approaches that increase the commercial viability of renewable hydrogen• pilots and demonstration projects for industrial processes that are not existing hydrogen users (e.g. steelmaking)
Hydrogen blending in the natural gas grid	<ul style="list-style-type: none">• pilots and demonstrations that provide real-life data on costs and performance in new applications• first-in-Australia demonstration of technologies that seek to address issues with blending increasing levels of hydrogen with the natural gas grid
100% hydrogen gas networks	<ul style="list-style-type: none">• trials and studies that inform the logistics and economics of 100% hydrogen gas networks in Australia• first-in-Australia demonstration of industry and residential appliances for use with 100% hydrogen• first-in-Australia demonstration of technologies that address infrastructure issues related to moving from blended to 100% hydrogen gas networks
Transport	<ul style="list-style-type: none">• demonstration for back-to-base hydrogen-powered vehicle fleets• trials and studies that inform long-haul, heavy-haul and other relevant applications on hydrogen-powered transport deployment• demonstrations of sector coupling that can de-risk demand and improve the competitiveness of hydrogen in transport• first-in-Australia demonstrations of technologies that reduce the cost of hydrogen refuelling infrastructure
Hydrogen in the electricity sector	<ul style="list-style-type: none">• hydrogen in remote area power systems• demonstrations and studies of how and where hydrogen can support renewables for electricity
New hydrogen technologies	<ul style="list-style-type: none">• first-in-Australia demonstrations of technologies that reduce the cost of hydrogen supply chains• transformative technology developments that reduce the cost of hydrogen supply chains

³ Opportunities for Australia from hydrogen exports, ACIL Allen, 2018

PRIORITY 3: SUPPORTING INDUSTRY TO REDUCE EMISSIONS

ARENA will help Australian industry reduce emissions by investing in innovative and replicable technologies and processes that increase the adoption of renewable energy (including renewable electricity, renewable fuels, solar thermal, hydrogen and bioenergy).



Industry accounts for about 40 per cent of all energy used in Australia. Accelerating the uptake of renewable energy for this sector is therefore a critical part of helping Australia meet its long term emissions reductions commitments. Increased load flexibility and energy efficiency to make greater use of variable renewable electricity and fuel switching to replace fossil fuel used for process heating can all play a role and also help to mitigate energy price risk.

Industry covers the large industrials (or 'heavy industry') that make up the bulk of energy and emissions, as well as the manufacturing and mining sectors. About three quarters of industrial energy use is not electricity - mostly gas, coal and diesel.

Much of the challenge in heavy industry sectors like steel, alumina and cement production involves high temperature heat, with the required renewable energy technologies such as electrification, concentrating solar thermal, hydrogen, solar fuels and bioenergy generally still some way from commercialisation. The challenge is compounded by capital-intensive operations with a low tolerance for interruptions to production, and long asset replacement cycles.

Energy use for heat in manufacturing is largely at lower temperatures. While renewable energy technologies such as electrification, bioenergy (including energy from waste) and solar thermal are more commercially ready than for higher temperatures, they are not commonly deployed due to financial and non-financial barriers.

With much of Australia's industry supplying global supply chains, a faster transition to renewables will help industry meet market needs as global demand for low carbon products grows, which along with lower energy costs, will support jobs in the industrial sector.

WHAT WE WANT TO ACHIEVE

- show how renewable energy and enabling technologies can reduce energy use, cost and emissions and increase energy productivity
- inform target sectors and industries on pathways to a renewable energy future particularly for process heat, including real costs and performance data in relevant local applications, and identifying priority RD&D needs
- increase collaboration between local and international industry, equipment providers and institutions supporting industrial transition to renewable energy
- increase skills, capability and understanding in relevant industry stakeholders of how to integrate renewable technologies into different industrial heat applications
- demonstrate key technologies across priority sectors.

WHAT WE ARE LOOKING FOR

feasibility studies and demonstration projects that advance the uptake of renewable energy in industrial processes. Particular emphasis will be directed to technologies and projects that have the potential to transition substantial energy end uses, either individually or in aggregate across multiple sites and sectors

innovative projects across key technologies such as bioenergy, solar thermal, renewable hydrogen and renewably powered electrification technologies and processes

enabling technologies such as energy efficiency, energy storage (electrical, thermal or physical), demand side flexibility to match renewable energy supply and mechanical alternatives to process heating where these enable greater uptake and penetration of renewable energy into industrial processes.

LONG-TERM IMPACT

New ways to incorporate renewable energy into industrial processes and address barriers to adoption will help Australian industry remain competitive and grow in a carbon-constrained world, as well as positioning Australian industry to meet demand for low carbon commodities. Additionally, the uptake of renewables in industry will help Australia meet its international commitments.

EXAMPLES

Area of innovation	Example proposals
Heavy industry (such as production of alumina and aluminium, iron and steel, ammonia, chemicals and cement)	<ul style="list-style-type: none"> feasibility studies, demonstrations and pre-commercial deployments incorporating renewable energy and related technologies into energy intensive processes or sites
Other industries (such as food & beverage, pulp & paper, bricks & ceramics, wood & wood products, mining etc.)	<ul style="list-style-type: none"> feasibility studies, demonstrations and pre-commercial deployments incorporating renewable energy and related technologies into a manufacturing process or site demonstrations of how renewable energy and enabling and related technologies could be incorporated into greenfield or brownfield sites to deliver a 100% renewable energy industrial site information and knowledge-sharing to help decision-making and encourage transition to and adoption of renewable energy in industry demonstrations of how centralised steam generation and distribution systems can be replaced with modular, decentralised renewable technologies
Across sectors	<ul style="list-style-type: none"> lower temperature processes could be addressed using technologies such as biomass or biogas boilers; solar thermal technologies such as flat plate, evacuated tube, parabolic trough and linear Fresnel; mechanical vapour recompression; heat pumps or other electrification technologies; and renewable hydrogen higher temperature processes could be addressed using technologies including solar thermal technologies such as heliostats and towers and concentrating dish; electric heating technologies such as electromagnetic, electric resistance, electric arc; and renewable hydrogen examples of industrial "eco-parks" demonstrating opportunities to synergistically use waste heat or other energy forms across facility boundaries

Before applying for ARENA funding

Our funding is usually provided as a grant. Where a proposal has the potential for significant commercial success, a grant could be recouped.

Before applying, applicants should:

1. consider how the proposal aligns with the investment priorities in this Investment Plan or relevant funding announcements
2. review the relevant program guidelines or funding announcement on our website to check eligibility for ARENA funding
3. complete the Eligibility and Alignment Tool to help guide your future engagement (if you have not worked with ARENA before)
4. consider the potential value of knowledge-sharing from the project.

Figure 2 - Supporting innovation and commercialisation



RELATED FUNDING SOURCES

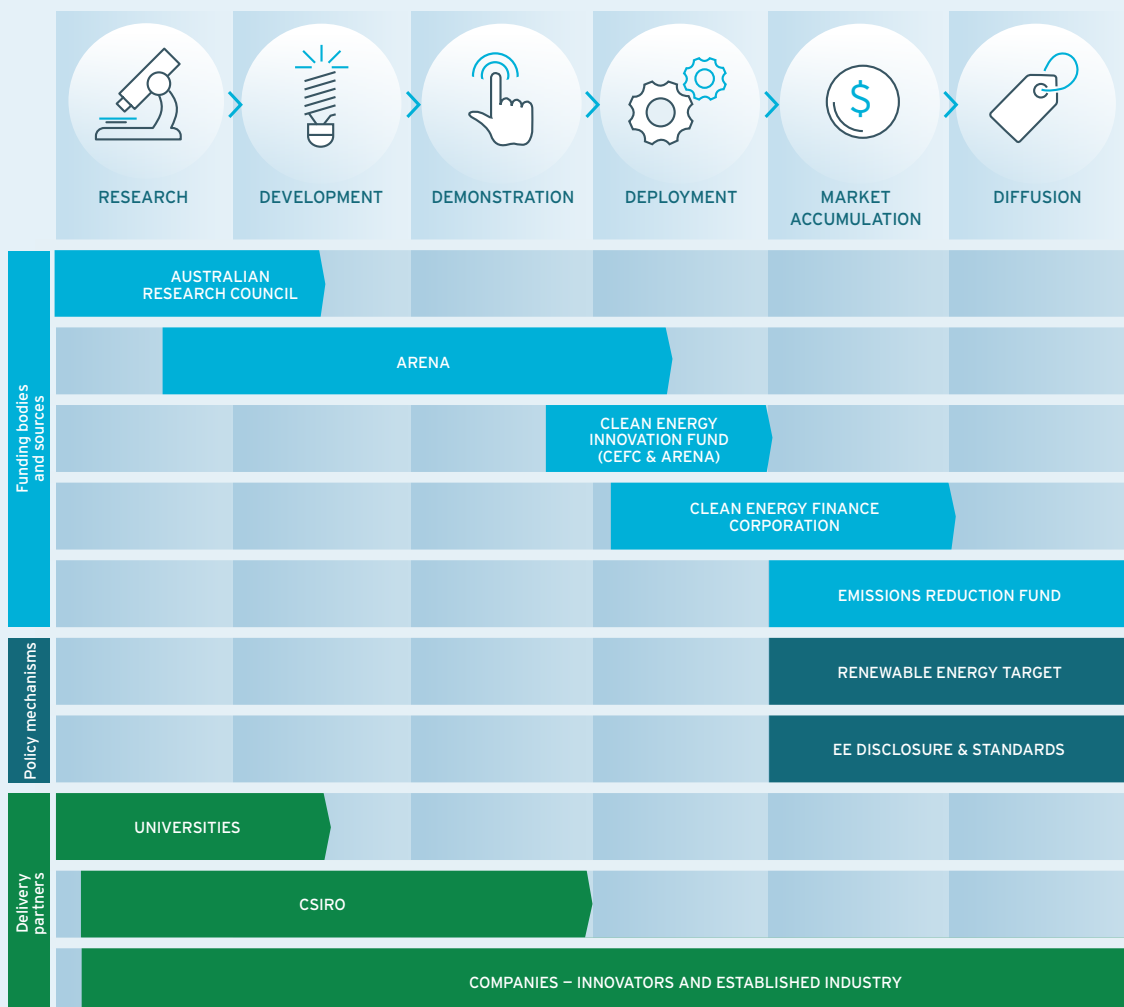
Clean Energy Innovation Fund

ARENA and the CEFC work collaboratively on operating the Clean Energy Innovation Fund. The Innovation Fund is a \$200 million program available to provide debt and/or equity finance for innovative clean energy projects and businesses that support

renewables, energy efficiency and low emissions technologies. Investments from the Innovation Fund will help eligible projects and businesses get to the next stage of commercialisation. The Innovation Fund does not make grants.

Information on the Innovation Fund is available at: cefc.com.au/innovationfund

Figure 3 - A partnership across the innovation chain



Further information is available at
arena.gov.au

Australian Renewable Energy Agency

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