



HyResource

A Short Report on Hydrogen Industry Policy Initiatives and the Status of Hydrogen Projects in Australia

December 2020

HyResource is a website collaboration between National Energy Resources Australia (NERA), CSIRO, Australian Hydrogen Council and Future Fuels CRC. It acts as a single source of information on key hydrogen-related organisations, policies and projects in Australia (with supporting information on New Zealand).

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The information in this report is current as of mid-December 2020.

Introduction

[HyResource](#), a website collaboration between National Energy Resources Australia (NERA), CSIRO, Australian Hydrogen Council and Future Fuels CRC, is a single source of information on key hydrogen-related organisations, policies and projects in Australia, with supporting information on New Zealand.

Complementing the 'database' aspects of HyResource, it is intended that short reports would be published on the HyResource site at regular intervals (around three per annum). These reports would examine specific matters of relevance to hydrogen industry development in Australia (and New Zealand as considered relevant).

The HyResource site amounts to an extensive collection of information updated in real time (or as close to as possible). The purpose of these short reports is, for the matters under discussion, to summarise the relevant information in HyResource and place it in a 'consumable form' that stakeholders can use for their own purposes and assessments.

This first report covers hydrogen industry policy initiatives and the status of hydrogen projects in Australia.

Section One summarises the key hydrogen-related policy initiatives announced across the main Australian jurisdictions since 2018. Section Two examines in greater detail the current status of the main Federal and State funding programs supporting hydrogen projects. Section Three summarises the current state of hydrogen projects in Australia, with emphases on projects presently at the operating, under construction and advanced development stages of the project life-cycle.

Section One: Current status of hydrogen industry policy initiatives¹

The clean hydrogen industry is enjoying considerable momentum in Australia.

In the period since 2018, several hydrogen-specific strategy or action plan documents have been produced or are under development by Federal, State and Territory Governments. Various funding programs have prioritised hydrogen-related investment opportunities, with resultant increased hydrogen project development and deployment activities.

Commonwealth Government

At its December 2018 meeting, the (then) Council of Australian Governments (COAG) Energy Council set a vision for an Australian hydrogen industry that would emerge as a major global player by 2030.

The Council agreed to establish a Hydrogen Working Group, chaired by Australia's Chief Scientist, Dr Alan Finkel, to develop a National Hydrogen Strategy consistent with this vision. [Australia's National Hydrogen Strategy](#) was released in November 2019.

The strategy describes an adaptive approach to industry development, with a focus on actions that remove market barriers, efficiently build supply and demand, and accelerate the global cost-competitiveness of Australia's hydrogen industry. A key element of the approach is the creation of hydrogen hubs – clusters of large-scale demand.

Since the release of the strategy, Federal efforts have focussed on its implementation.

In March 2020, the Hydrogen Project Team was established to implement the strategy. During 2020, key [focus areas](#) of the strategy have included international partnerships and engagement, a hydrogen certification scheme, national coordination, supporting priority industry projects and legislative reviews.

¹ Expansive descriptions of the various Federal, State and Territory hydrogen-related policy initiatives can be found in HyResource under the [Policy](#) page.

In September 2020, the Australian Government released its [Technology Investment Roadmap: First Low Emissions Technology Statement 2020](#). The Statement includes clean hydrogen as one of five priority low emissions technologies. The Statement sets economic stretch goals for each of the five priority technologies, including achieving under AUD\$2 per kilogram for clean hydrogen (at the site of production). The Statement includes other stretch goals that may be of relevance to hydrogen production and application, including low emissions steel production at under AUD\$900 per tonne and (in the case of carbon capture and storage) CO₂ compression, hub transport and storage costs at under AUD\$20 per tonne of CO₂.

Significant hydrogen-specific funding program announcements by the Commonwealth or related entities include:²

- April 2020 - ARENA opened its (staged) AUD\$70 million [Renewable Hydrogen Deployment Funding Round](#). This amount is in addition to the more than AUD\$55 million of ARENA funding awarded to feasibility studies, pilot and demonstration projects and research and development activities since 2018.
ARENA has [shortlisted](#) seven companies to submit full applications by January 2021, with selection of preferred projects expected by mid-2021.
- May 2020 - the Clean Energy Finance Corporation (CEFC) was able to make available AUD\$300 million of debt and equity finance to invest in suitable hydrogen projects; an early priority for the [Advancing Hydrogen Fund](#) will be to invest in projects included in the ARENA AUD\$70 million Funding Round, where they meet CEFC eligibility requirements.
- September 2020 – the Australian Government announced a [AUD\\$1.9 billion package](#) to invest in new energy technologies, including the allocation of approximately AUD\$70 million towards establishing a hydrogen export hub, research collaborations and supply chain studies.³

There has also been significant policy momentum at the State and Territory levels.

Consistent with the national strategy, these ‘regional’ documents envisage a pathway of largely domestic application of hydrogen initially (gas blending, various mobility applications and renewable ammonia production) with significant export potential targeted by the turn of the decade.

Common themes include emphasis on investment facilitation, establishment of effective regulatory frameworks and strengthened supply capabilities and skills development.

A summary of State and Territory hydrogen-related policy initiatives follow.

Western Australia

- July 2019 - the [Western Australian Renewable Hydrogen Strategy](#) is released and a AUD\$10 million Renewable Hydrogen Fund established (over four financial years, commencing in 2019-20).⁴

² Commonwealth support for the Hydrogen Energy Supply Chain (HESC) – Pilot Project as it moved into construction was announced in April 2018 (AUD\$50 million); such funding was not part of a major program package. Similar support was also provided by the Victorian Government.

³ The September 2020 announcement includes AUD\$1.62 billion in [additional funding to ARENA](#) to invest in technology innovation, including for some hydrogen technologies. It also includes AUD\$74.5 million for electric vehicle refuelling infrastructure, which may include hydrogen refuelling.

⁴ At the time of announcement, it was noted that the Fund included up to AUD\$9 million for grant funding to support feasibility studies or capital works projects.

- The strategy has four focus areas - export potential; use of renewable hydrogen in remote locations; use as a significant fuel source (including in remote locations and in mining applications); and hydrogen blending in natural gas networks.
- August 2020 – several initiatives are [announced](#) to accelerate the development of renewable hydrogen in Western Australia, including (a) capital works funding announcements, (b) an additional AUD\$5 million allocated to the Renewable Hydrogen Fund, and (c) initiatives in support of a regulatory reform package, supply chain modelling and locating suitable sites for hydrogen storage.
- Seven feasibility studies (AUD\$1.68 million) and three capital works projects (AUD\$4 million) have benefitted from Fund awards during 2020.⁵
- Total investment towards renewable hydrogen by end 2020 is at AUD\$28 million.

South Australia

- September 2019 - building on earlier 2017 Roadmap and Study reports, [South Australia's Hydrogen Action Plan](#) is released. The Plan identifies domestic and export market opportunities for renewable hydrogen and highlights five priority action themes.
- October 2020 - the [South Australian Hydrogen Export Modelling Tool](#) and the [South Australian Hydrogen Export Prospectus](#) are launched. The Tool provides an indicative view of hydrogen supply chain configurations that are possible by leveraging regional resources. The Prospectus identifies three hydrogen hub possibilities for South Australia – at Port Bonython, Port Adelaide and Cape Hardy/Port Spencer.
- November 2020 - the State Government [announces](#) AUD\$37 million is to be allocated to upgrade the Port Bonython jetty.
- Around AUD\$15 million in grant funds and more than AUD\$25 million in loan funds have been awarded to three hydrogen-related projects in South Australia through the Government's AUD\$150 million Renewable Technology Fund.

Queensland

- May 2019 - the [Queensland Hydrogen Industry Strategy 2019-2024](#) is released.
- Supporting the Strategy, the Queensland Government allocated AUD\$19 million over a four year period to support hydrogen projects in Queensland, including establishment of the AUD\$15 million Hydrogen Industry Development Fund.
- May 2020 – the [Queensland Hydrogen Investor Toolkit](#) is released. It provides an overview of the planning and other regulatory approvals processes in Queensland for renewables-based hydrogen projects.
- November 2020 - Queensland Ministerial announcements include the establishment of a [Minister for Energy, Renewables and Hydrogen](#) and an [Assistant Minister](#) for Hydrogen Development.
- December 2020 - the State Government [announces](#) a further AUD\$10 million (in addition to the original AUD\$15 million Hydrogen Development Fund) over four years to support the Queensland hydrogen industry; the announcement also included a range of funding initiatives to support industry training and skills development.

⁵ Project references in this section can be accessed through HyResource under the [Projects \(Industry\)](#) page using the relevant State name in the search filter

- Four successful projects under the first round of the Development Fund have been announced (and effectively fully subscribed the original AUD\$15 million allocation).

Victoria

- December 2018 - the [Victorian Hydrogen Investment Program](#) (VHIP) is announced. It describes a pathway for the development of a hydrogen industry in Victoria, including support for hydrogen research, projects and policy.
- Through the VHIP, the Victorian Government is developing the Victorian Hydrogen Industry Development Plan (IDP). The IDP has been informed by market testing through Requests for Industry Submissions (RFIS), extensive stakeholder engagement and information gathered from submissions to the [Green Hydrogen Discussion Paper](#).
- Under the VHIP, the Victorian Government has contributed AUD\$500,000 to the [Australian Hydrogen Centre](#) for a series of clean hydrogen feasibility studies (also supported by the South Australian Government). In addition, in 2018, the Victorian Government committed AUD\$50 million (as has a similar amount by the Commonwealth) to support the [Hydrogen Energy Supply Chain \(HESC\) Pilot](#) project in the Latrobe Valley.

New South Wales (NSW)

- March 2020 - the [Net Zero Plan Stage 1: 2020-2030](#) is released.
- Priority 3 *Invest in the next wave of emissions reduction innovation* includes the establishment of a Hydrogen Program to aid in the scale-up of hydrogen as an energy source and feedstock. The NSW Government has set an aspirational target of blending up to 10 per cent hydrogen in the gas network by 2030.
- The NSW Government hydrogen strategy is under development. It will detail the vision and direction for developing a hydrogen industry to 2030 and beyond and lay out actions to be undertaken to grow the hydrogen industry in NSW, including an initiative that will provide funding to support hydrogen projects.
- The [Manilla Solar and Renewable Energy Storage Project](#) benefitted from a AUD\$3.5 million award from the NSW Government Regional Community Energy Fund.

Tasmania

- March 2020 - the [Tasmanian Renewable Hydrogen Action Plan](#) is released following earlier (late 2019) releases of a hydrogen opportunity report and a hydrogen prospectus report.
- Tasmania's hydro-electric and wind resources are identified as areas of competitive advantage. Industrial precincts, including the Bell Bay Advanced Manufacturing Zone and the north west coast region, are viewed as having extensive infrastructure to support renewable hydrogen production.
- May 2020 - An AUD\$50 million [Tasmanian Renewable Hydrogen Industry Development Funding Program](#) over ten years is launched, which encompasses a AUD\$20 million Tasmanian Renewable Hydrogen Fund, AUD\$20 million in concessional loans, and up to AUD\$10 million in support services including financial assistance for renewable electricity supply.
- November 2020 - AUD\$2.6 million is [awarded](#) from the Program to examine the feasibility of three large-scale renewable hydrogen projects in Tasmania.

Northern Territory

- July 2020 - the [Northern Territory Renewable Hydrogen Strategy](#) is released.
- The Strategy articulates the potential hydrogen opportunities and the Territory's competitive advantages.
- No hydrogen-specific projects have progressed beyond concept stage; however, discussions are being held with several organisations considering the development of clean hydrogen projects.

Australian Capital Territory (ACT)

- April 2018 - the near-term potential for renewable hydrogen applications in the ACT is guided by the [ACT's Transition to Zero Emissions Vehicles Action Plan 2018–21](#).
- The Plan calls for all newly leased ACT Government fleet passenger vehicles to be zero-emissions vehicles from 2020-21 (where fit for purpose).
- September 2019 – the [ACT Climate Change Strategy 2019-25](#) is released. Action 4.5 is the development of a natural gas Transition Plan for achieving zero emissions from natural gas use by 2045 (green alternative options may include biogas / hydrogen).
- The [Renewable Hydrogen Refuelling Pilot](#) project is nearing operations in the ACT (expected in the first quarter of 2021).

Section Two: Current status of major hydrogen projects-related funding programs

Major Federal programs are supporting clean hydrogen research activities with several private-research partnership style arrangements of significance also having been established in the last few years.

Major Federal and State programs are facilitating investment in hydrogen projects at this market activation or pre-competitive stage (summarised in Section One).

Major research programs – as included on [HyResource](#)

Major funding routes include through ARENA (through its [September 2018 award](#) of AUD\$22 million in funding to clean hydrogen research activities), various Australian Research Council (ARC) grants schemes and the Cooperative Research Centre (CRC) Program, as well as through several private-research partnerships.

The HyResource web-site includes (is limited to) significant hydrogen-related activities arising from these major research funding programs/avenues. While not intended to be a comprehensive collection of hydrogen-related research activities in Australia, the information contained in HyResource is nevertheless broad enough to allow an indicative glimpse of research funding apportionment across the hydrogen supply chain in Australia in recent years.

Appendix A describes which of the HyResource major research program activities can support analysis of indicative supply-chain funding apportionment. Aggregation of research funding amounts is always a perilous task as it tends to come in different forms. Amounts used in this analysis include a mixture of grants awarded/announced, individual projects approved, and amounts committed. For all types, funding is only included for cases where the supply chain allocation is reasonably clear, otherwise the amounts are excluded.⁶

⁶ The main non-inclusion from the HyResource Projects listing under the [Research](#) page is the AUD\$20 million associated with the Fortescue CSIRO Partnership. The centrepiece of the collaboration is investment in CSIRO's metal membrane technology (which enables ammonia to be used as a carrier material for hydrogen storage and transport); however, there are no specific breakdowns available on supply chain funding allocation patterns for this or the full amount of the Partnership.

On this basis, a sample of around AUD\$70 million of research funding between 2017-2020 is analysed. The analysis is meant to be an **indicative picture only** of how the various elements of the hydrogen chain are being supported and by whom (where possible).

Table 1 highlights the apportionment of this (indicative) sample total across various elements of the hydrogen supply chain (apportionment shown in percentage terms).

Table 1: Hydrogen supply chain: apportionment of research funding: per cent indicative only (HyResource sample based: 2017-2020)⁷

Production	28%
Storage systems	20%
Whole supply chain*	19%
Carrier	11%
Transportation**	11%
End-use***	8%
Other	3%
TOTAL	100%

Notes:

* Includes technical as well as economic, regulatory/policy, social acceptance, etc. matters

** Mainly pipeline transportation and related infrastructure and use of pipelines as buffer storage

*** Mobility uses and impacts on residential/industrial appliances of hydrogen blends in gas networks

Not unexpectedly, of the HyResource-based research funding sample analysed, hydrogen production/generation has received the highest allocation of funding (nearly 30 per cent of the sample analysed). Reducing clean hydrogen production costs from present levels is a key enabler for its widespread deployment in the next decade. While it is anticipated that solar PV and wind generation costs will continue to decline, capital costs of electrolysers and their efficiencies, as well as balance of plant, for example, are also key determinants of the cost competitiveness of renewable hydrogen versus alternative fuels.⁸

Investments in storage systems (excluding carrier opportunities) and across the whole supply chain follow as the next most significant elements receiving research funding (in roughly equal proportions, each at around 20 per cent of the sample analysed).

Opportunities for hydrogen as a carrier, transportation and end-use applications each account for around 10 per cent of the sample analysed.

Tracking the 'source of funds' in the sample analysed reveals the following patterns:

- Production – mainly from the ARENA funding announcements of September 2018 and ongoing grant awards from various ARC schemes; these two programs account for around 85 per cent of funds included in this supply chain element (of the sample analysed); additional amounts include from approved projects undertaken by the Future Fuels CRC and, most recently, the Monash Woodside Energy Partnership.
- Storage systems – mainly from the Providence Asset Group (PAG) in its support of metal-alloy based hybrid energy storage systems research at the University of New South Wales (and being applied in the [Manilla Solar and Renewable Energy Storage](#)

⁷ Demarcation of the various elements of the hydrogen supply chain is not always straight-forward (e.g. production/storage points can intersect and carrier materials such as ammonia and liquid fuels involve the storage and transportation of hydrogen). Review of over 100 research projects that underlie the data is generally supportive of the broad allocations/funding priorities contained in this short report.

⁸ Biological hydrogen production is also supported through various avenues, including ARENA and ARC funding.

[Project](#) and other similar projects in New South Wales), a multi-million dollar CRC – Project Program award, and ongoing grant awards from various ARC schemes.⁹

- Whole supply chain – mainly from the ARENA funding announcements of September 2018, a multi-million dollar award under the ARC Industrial Transformation Research Program for the *Industrial Transformation Training Centres* scheme, and approved projects from the Future Fuels CRC (the latter addressing a range of cross-cutting matters including techno-economic modelling, regulatory/policy and social acceptance issues).
- Carrier – mainly from the ARENA funding announcements of September 2018 and from CSIRO funds addressing the storage and transportation of renewables-based hydrogen in various carrier forms (such as ammonia and liquid fuels)
- Transportation – mainly approved projects from the Future Fuels CRC addressing novel materials, design, construction and operations-related research to enhance the operations of pipeline and network’s infrastructure carrying existing and future fuels.
- End-use – mainly from the ARENA funding announcements of September 2018 and initial efforts at Hycel (both these including a mobility research element) and from approved projects at the Future Fuels CRC (including testing programs of the impacts on residential and industrial appliances of applying various hydrogen blends into gas networks).

Industry projects – as included on [HyResource](#)

Funding support for hydrogen-related feasibility studies, pilot and demonstration projects has been provided through the Federal Government and its agencies and through various State-based programs (summarised in Section One).

Since 2018, around AUD\$700 million of financial support measures specifically for Australian hydrogen (Industry) projects can be identified from analysis of the [Policy](#) and [Projects \(Industry\)](#) pages of the HyResource web-site.

Table 2 overleaf highlights the main Federal and States funding programs/commitments for Industry projects since 2018.¹⁰

Note: Table 2 reports hydrogen project-specific programs/commitments; other announced initiatives such as those dealing with skills and training development, increased departmental resourcing, various studies and reform packages, while significant, are outside the purview of this analysis.

⁹ While the PAG emphasis is on ‘bonded’ storage systems (with near term commercial applications) it should also be noted that efforts at better understanding underground storage potential in Australia is also being undertaken, especially by organisations such as CSIRO and Geoscience Australia.

¹⁰ Table 2 presents the main government-based financial support measures for Industry projects and excludes investments provided by industry proponents. This latter point is addressed in part in Section Three.

**Table 2: Main existing federal and state funding programs: industry projects
(AUD\$ million since 2018; data as at mid-December 2020)**

	<i>Awarded</i>	<i>To be Awarded</i>	<i>Total</i>
<i>Commonwealth:</i>			
<i>ARENA: Amounts awarded</i>	34.5		
<i>ARENA: Renewable Hydrogen Deployment Fund</i>		70	
<i>CEFC: Advancing Hydrogen Fund</i>		300	
<i>HESC Pilot Project (excluding FEED study)</i>	50		
<i>Establishment of hydrogen hubs, etc. (rounded)</i>		70	
TOTAL	84.5	440	524.5
<i>Western Australia</i>			
<i>Renewable Hydrogen Fund (projects-related)</i>	5.7	8.3	
<i>WA Recovery Plan (August 2020 – Denham project)</i>	4.7		
TOTAL	10.4	8.3	18.7
<i>South Australia</i>			
<i>Renewable Technology Fund:</i>			
<i>Grants</i>	15		
<i>Loans (available only at construction)</i>	27		
TOTAL	42		42
<i>Queensland</i>			
<i>Hydrogen Industry Development Fund</i>	15	10	25
<i>Victoria (excludes \$0.5 million awarded under the VHIP)</i>			
<i>HESC Pilot Project (excluding FEED study)</i>	50		50
<i>Tasmania</i>			
<i>Renewable Hydrogen Industry Development Program</i>			
<i>Tasmanian Renewable Hydrogen Fund</i>	2.6	17.4	
<i>Concessional loans / support services</i>		30	
TOTAL	2.6	47.4	50
<i>New South Wales</i>			
<i>Manilla Solar and Renewable Energy Storage Project</i>	3.5		3.5
TOTAL (rounded)	208	506	714

Notes:

Commonwealth - the Commonwealth and Victoria contributed to funding the HESC Pilot Project FEED study (which was completed in 2017) as well as contributing AUD\$50 million each post-FEED stage. The Commonwealth also contributed AUD\$2 million to the Hycel Technology Hub (not included in Table 2 as Hycel is classified under Research Programs in HyResource).

Western Australia - in August 2020, the Western Australian Government announced AUD\$5.7 million in funding allocated to the Denham Hydrogen Demonstration Plant, of which AUD\$1.0 million is from the Renewable Hydrogen Fund.

South Australia - hydrogen project funding announcements from the Renewable Technology Fund are announced on a 'as go' basis; hence it is not possible to indicate a 'To be awarded' amount. The announced AUD\$37 million funding for expansion of the Port Bonython Jetty is acknowledged as supportive of hydrogen industry development in that location but is excluded from Table 2 as it has wider benefits.

Queensland – the four successful projects under the first round of the Queensland Hydrogen Industry Development Fund have effectively fully subscribed the original AUD\$15 million allocation.

Around AUD\$210 million in financial support from government sources has been provided to hydrogen-related feasibility studies, pilot and demonstration projects in Australia since 2018 through the main identified funding programs. This amount is composed of around AUD\$180 million in grant type funds and around AUD\$27 million in loans (which would only be provided if the relevant projects – presently only in South Australia – enter construction).

Of the 56 hydrogen projects in Australia contained in HyResource (as at mid-December 2020),¹¹ over 30 have received financial support from government sources, ranging from several hundred thousand dollars to many millions.

Of the 15 hydrogen projects (in Australia) classified in HyResource as being in the operating, under construction and advanced development life-cycle stages (see Section Three for details by State),¹² have received financial assistance from (identified) major government programs totalling around AUD\$145 million in grant type funds.¹² In addition, while assistance amounts are not publicly available, the [Renewable Hydrogen Refuelling Pilot](#) project in the ACT is being supported by the ACT Government.

The largest number of supported projects are in Western Australia and Queensland. One project, the [Hydrogen Energy Supply Chain - Pilot Project](#), which will produce and transport hydrogen from the Latrobe Valley in Victoria and export it to Japan and is nearing the operations stage, has received the largest amount of support.

Table 3 overleaf provides a detailed disposition of awarded assistance by State, the number of projects that have been awarded assistance, the funding source, and the project life-cycle stage consistent with Table 2.¹³

¹¹ The HyResource Projects (Industry) page contains project descriptions for projects in Australia and New Zealand. This report examines only projects in Australia and excludes the five projects listed under New Zealand in the search filter.

¹² One project – the Denham Hydrogen Demonstration Plant in Western Australia – has received funding from both ARENA and State-based programs – and hence is ‘double-counted’ in Table 3 (shown under Advanced development).

¹³ Table 3 does not include the two projects in the ACT – one operating, one under construction. The testing project in operation, as at mid-December 2020, has an estimated cost at <AUD\$500,000 and to date has been proponent supported (with prospects of continued support in 2021). For the much larger project under construction, relevant funding information is not publicly available (or easily discovered).

Table 3: Major existing funding programs: awarded assistance: industry projects: since 2018

State / Program	Operating	Under Construction	Advanced Development	Under Development	Total
Western Australia					
ARENA-funded					
No. of projects assisted	1	1	1	2	5
Awarded assistance	\$1,800,000	\$9,400,000	\$2,570,000	\$2,700,000	\$16,470,000
State-based funded					
No. of projects assisted		2	1	7	10
Awarded assistance		\$3,000,000	\$5,700,000	\$1,680,000	\$10,380,000
South Australia					
ARENA-funded					
No. of projects assisted				1	1
Awarded assistance				\$1,300,000	\$1,300,000
State-based funded					
No. of projects assisted		1		2	3
Awarded assistance		\$4,900,000		\$37,000,000	\$41,900,000
Queensland					
ARENA-funded					
No. of projects assisted		1		4	5
Awarded assistance		\$950,000		\$5,240,000	\$6,190,000
State-based funded					
No. of projects assisted			2	2	4
Awarded assistance (rounded)			\$5,000,000	\$10,000,000	\$15,000,000
Victoria					
ARENA-funded					
No. of projects assisted		1			1
Awarded assistance		\$3,070,000			\$3,070,000
HESC Pilot Project					
Commonwealth assistance		\$50,000,000			\$50,000,000
State assistance		\$50,000,000			\$50,000,000
New South Wales					
ARENA-funded					
No. of projects assisted		1			1
Awarded assistance		\$7,500,000			\$7,500,000
State-based funded					
No. of projects assisted				1	1
Awarded assistance				\$3,500,000	\$3,500,000
Tasmania					
ARENA-funded					
No. of projects assisted					
Awarded assistance					
State-based funded					
No. of projects assisted				3	3
Awarded assistance				\$2,600,000	\$2,600,000
Total all States					
ARENA-funded					
No. of projects assisted	1	4	1	7	13
Awarded assistance	\$1,800,000	\$20,920,000	\$2,570,000	\$9,240,000	\$34,530,000
State-based funded (excluding HESC)					
No. of projects assisted		3	3	15	21
Awarded assistance		\$7,900,000	\$10,700,000	\$54,780,000	\$73,380,000
HESC Pilot Project					
Commonwealth assistance		\$50,000,000			\$50,000,000
State assistance (VIC)		\$50,000,000			\$50,000,000

Notes: Data is rounded. The Denham Hydrogen Demonstration Plant project in WA is counted twice - see footnote 12. South Australia includes the Australian Hydrogen Centre project (ARENA funded to SA-based AGN/AGIG); this project also received AUD\$500,000 in support under the VHPI and AUD\$120,000 from the South Australian Government. ACT is not shown - footnote 13.

Around AUD\$500 million of existing government funding programs remains to be awarded, including AUD\$370 million of financial support to be made available from ARENA and the CEFC:¹⁴

These larger amounts of financial assistance from ARENA/CEFC than previously provided are intended to support increased hydrogen electrolyser production capacities at the 10 megawatt (MW) level. This compares with the current levels of around 1MW or less. This scalability issue is addressed briefly in the next section.

Section Three: Current status of hydrogen projects

As at mid-December 2020, HyResource contains 56 hydrogen-related projects in Australia.¹⁵ Table 4 and Figure 1 show their disposition by State and life-cycle stage.

Table 4: Australia: hydrogen projects by state and life-cycle stage

	<i>Operating</i>	<i>Under Construction</i>	<i>Advanced Development</i>	<i>Under Development</i>	TOTAL
<i>Western Australia</i>	1	3	1	13	18
<i>Queensland</i>	1	1	2	13	17
<i>South Australia</i>		1		3	4
<i>Victoria</i>		2		3	5
<i>New South Wales</i>		1		2	3
<i>Tasmania</i>				5	5
<i>ACT</i>	1	1			2
<i>Unspecified</i>				2	2
TOTAL	3	9	3	41	56

Notes:

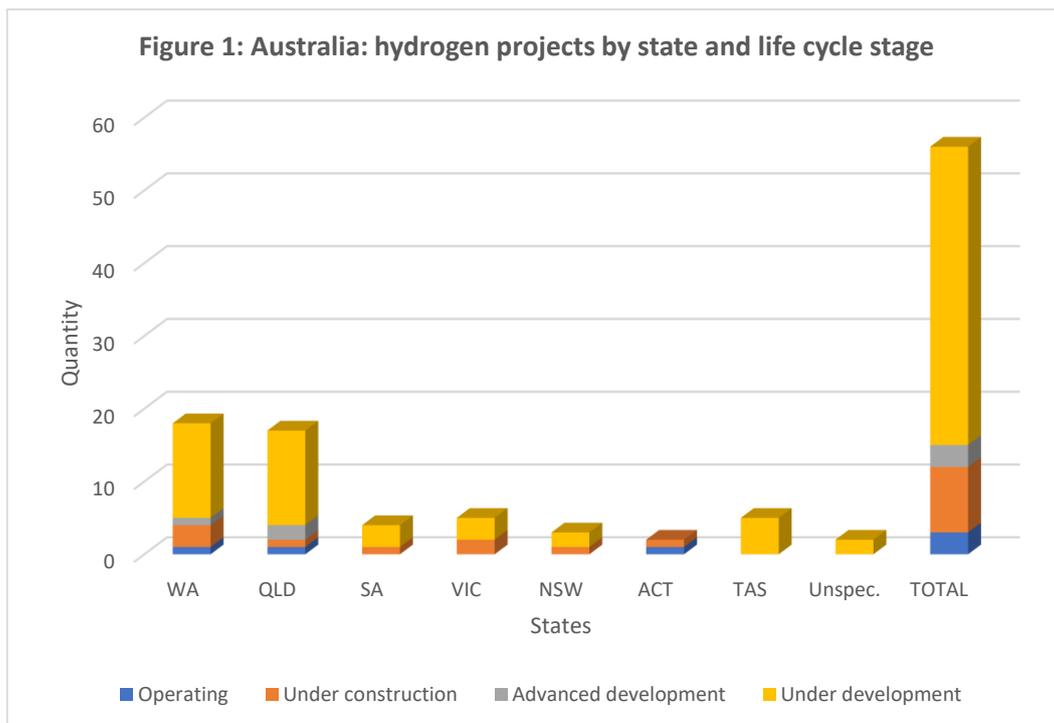
South Australia includes the Australian Hydrogen Centre project (though studies being conducted cover both South Australia and Victoria deployment opportunities); ARENA funding award to the project was to AGN/AGIG headquartered in South Australia (and this is chosen for convenience).

Unspecified includes projects that have Australia-wide coverage at this stage of their development.

Definitions used in classifying a project's status (or asset lifecycle stage) can be accessed via the HyResource [Projects \(Industry\)](#) web-page.

¹⁴ As the tabulation refers to existing programs, the amount of AUD\$500 million does not include allowance for monies that may become available to hydrogen projects from the earlier noted AUD\$1.62 billion in additional funding to ARENA or the AUD\$74.5 million in Federal funding for electric vehicle refuelling infrastructure, as specific amounts are unknown at present. Similarly, it also does not make allowance for new programs or expansions of existing programs that emerge through State or Territory Governments.

¹⁵ This figure is an underestimate as several proponents have asked that their projects not be included on HyResource at this time or projects are not sufficiently advanced to be reported publicly. Table 4 does NOT include the five New Zealand projects presently contained in HyResource.



Not unexpectedly, given the early stage of development of the (clean) hydrogen industry, the bulk of projects contained in HyResource are under development, with many yet to enter Front End Engineering Design (FEED) studies. On the basis of experiences of other industries, not all of these projects will progress (either at all, or as presently designed) to construction and operations.

Over 60% of hydrogen projects in Australia listed in HyResource (35 out of 56) are in Western Australia and Queensland.

Three projects are operating, nine are under construction and three are at an advanced development stage (considered to be within a few months of entering construction). Of this set of 15 projects, five are in Western Australia, four in Queensland, two in each of Victoria and the ACT, and one in each of South Australia and New South Wales.

Table 5 summarises key parameters from the 15 projects in the operating, under construction and advanced development life-cycle stages. Notable observations include:

- Total installed electrolyser capacity is around 5 MW (including allowance for redundancy), of which the largest single unit is the 1.25 MW electrolyser unit at the [Hydrogen Park South Australia](#) project (which as at mid-December 2020 is in the final stages of commissioning prior to entering operations).¹⁶
- Hydrogen production capacity levels come in many guises (per annum, per day, per hour) and with many underlying assumptions (e.g. on hours of operation per day, type of operation) and hence it is difficult to aggregate individual data points; however, a reasonable estimate (or sense of magnitude) is that the aggregated annual hydrogen production of all 15 projects is potentially over 300 tonnes.

¹⁶ Though the project with the potential for the most hydrogen production is the Hazer Commercial Demonstration plant in Western Australia, which is a commercial demonstration of the Hazer production technology that can convert methane feedstocks, through the use of an iron ore process catalyst, into hydrogen and synthetic graphite.

- The end-use applications associated with the larger projects are focussed on hydrogen in gas networks, hydrogen mobility and hydrogen in power use, and many projects have been designed with multiple end-use applications in mind.
- In terms of analysing project estimated cost and funding support, it is perhaps most appropriate to view this through the prism of percentage ranges (where data allows such analysis); six projects have funding support from government which is equivalent to 40-60 per cent of project cost, one project has support which is in the 20-30 per cent range, one project has support in excess of 90 per cent, one project has support of less than 10 per cent, and one project is to-date fully supported by the project proponent (as a testing facility, it is also the lowest cost project shown).¹⁷
- The project proponents tend to be mainly (though not exclusively) larger companies capable of supporting projects through the balance sheet and being able to accept risks associated with the project size. Proponents such as AGN/AGIG, ATCO, Jemena, Toyota, BOC, Fortescue Metals Group and a consortium of Japanese companies (involved in the HESC Pilot Project) account for the majority of the 15 projects shown in Table 5. One notable exception to this observation is the (smaller capitalisation) Hazer Group's [Commercial Demonstration Plant Project](#), capable of producing up to 100 tonnes of hydrogen per annum (as well as Graphite) and which is using bio-methane as a feedstock.
- Projects under construction are targeted to be operational in the period to 2022.

Looking forward beyond this first wave of projects about to become operational, the next evolution of the Australian hydrogen industry will involve a scale-up of electrolyser capacities.

The AUD\$70 million ARENA Renewable Hydrogen Deployment Round has shortlisted seven applicants to progress to the next stage to submit full proposals by January 2021. The short-listed applicants involve deploying 10 MW electrolysers, targeting various end uses including transport, gas injection, renewable ammonia production, power and industrial use. Four projects are based in Western Australia, and one each in Queensland, Tasmania and Victoria. It is ARENA's intent to support two or more of the shortlisted projects. Electrolysers of this capacity would be included amongst some of the largest in the world.

All applicants to this ARENA Round may also be considered for financing from the CEFC under its AUD\$300 million Advancing Hydrogen Fund, provided it met CEFC funding criteria.

The construction and operation of several electrolysers of this scale has considerable benefits in supporting wider-scale deployment of clean hydrogen technologies:

- It would provide a much clearer picture of the real costs of producing renewables-based hydrogen at commercial-scale.
- It would provide a catalogue of construction/operational lessons learnt with which to improve the performance of later projects at same scale and for incorporating into the development of larger scale facilities (including lessons on the efficacy of existing regulatory/permitting/skills availability for progressing projects at much larger scale).
- In combination, the above points would provide a robust indication to key stakeholders, including commercial financiers, of the opportunities and challenges associated with deployment of 10 MW or larger scale hydrogen projects in Australia.

This set of larger capacity projects can be expected to start becoming operational around the 2024 time-frame (assuming major funding program awards were to happen in 2021).

¹⁷ The HESC – Pilot Project is not included in these ranges as the estimated cost included in Table 5 is for both Australian and Japanese based costs but funding support is Australian based only.

Table 5: Hydrogen Projects in Australia - Operating, Under Construction, Advanced Development: Key Parameters

Project name and location	Status	Operations date	Main end-use	Electrolyser capacity	Hydrogen production capacity	Estimated cost (AUD)	Funding programs support (AUD)
Clean Energy Innovation Hub (WA)	Operating	2019	natural gas blending, power use	0.26 MW*	23 tonnes per annum	\$3,530,000	\$1,790,000
Hydrogen Test Facility - ACT Gas Network (ACT)	Operating	2018	hydrogen in gas networks	<.01 MW	-	\$300,000	\$0.00
Sir Samuel Griffith Centre (QLD)	Operating	2013	microgrid - power use	0.16 MW	-	-	-
Christmas Creek Renewable Hydrogen Mobility Project (WA)	Under construction	2022	hydrogen mobility	0.70 MW (x2)	180 kg per day	\$32,000,000	\$2,000,000
Hazer Commercial Demonstration Plant (WA)	Under construction	2021	Hydrogen mobility, power and industrial uses	biomethane feedstock	100 tonnes per annum	\$17,000,000	\$9,410,000
Hydrogen Energy Supply Chain - Pilot Project (VIC)	Under construction	2020/21	Export - liquid hydrogen	brown coal gasification / gas refining	1-3 tonnes	\$500,000,000	\$100,000,000
Hydrogen Park South Australia (SA)	Under construction	2021	hydrogen in gas networks, mobility	1.25 MW	20 kg per hour	\$11,400,000	\$4,900,000
Hydrogen Refueller Station Project (WA)	Under construction	2021	hydrogen mobility	0.26 MW*	-	-	\$1,000,000
Renewable Hydrogen Production and Refuelling Project (QLD)	Under construction	2021	industrial gas and mobility	0.22 MW	2,400 kg per month	\$4,180,000	\$950,000
Renewable Hydrogen Refuelling Pilot (ACT)	Under construction	2021	hydrogen mobility	0.075 MW	21 kg per day	-	-
Toyota Hydrogen Centre (VIC)	Under construction	2021	power use, hydrogen mobility	0.26 MW	60 kg per day	\$7,370,000	\$3,070,000
Western Sydney Green Gas Project (NSW)	Under construction	2021	hydrogen in gas networks, power, mobility	0.50 MW	53 tonnes per annum	\$15,000,000	\$7,500,000
Denham Hydrogen Demonstration Plant (WA)	Advanced development	2021/22	microgrid - power use	0.348 MW	13 tonnes per annum	\$8,900,000	\$8,300,000
Hydrogen Park Gladstone (QLD)	Advanced development	2022	hydrogen in gas networks	0.175 MW	20 kg per day	\$4,200,000	\$1,780,000
Spicers Retreats Ecotourism Demonstration (QLD)	Advanced development	-	microgrid - power use	-	-	-	Undisclosed

Note 1: * The projects are both located at the ATCO Jandikot Operations Centre in Perth and the installed electrolyser would supply both projects

Note 2: The estimated cost for the HESC - Pilot project is for both the Australia and Japan sections while funding support is for Australia only (excluding FEED study)

Appendix A: HyResource: Stocktake of major research funding initiatives used to support hydrogen supply chain 'research flow of funds' analysis (2017-2020)¹⁸

Program - ARENA:

Awarded amounts as included in the ARENA program funded project descriptions shown in HyResource (Research).

Program - Australian Research Council (ARC) Grants:

Amounts awarded as included in the ARC program funded project descriptions shown in HyResource (Research).

Program - Cooperative Research Centre (Grants):

Amounts awarded to approved CRC projects to date; project scopes of work are included in the project descriptions of the Grant Program based CRC's as shown in HyResource (Research); cash funding for approved projects is provided in confidence by each CRC.

Program - Cooperative Research Centre (Projects):

Awarded amount to the CRC-P project as included in the project description shown in HyResource (Research).

Program - CSIRO: Ammonia to Hydrogen Metal Membrane Separation Technology:

Estimated cost of the Technology Development Final Phase, as included in the project description shown in HyResource (Research).

Program - Partnerships - Hycel:

Awarded amount to the project as included in the project description shown in HyResource (Research).

Program - Partnerships - Hydrogen Energy Research Centre:

Investment amounts provided by the Providence Asset Group to the University of New South Wales, as included in the project description shown in HyResource (Research).

Program - Partnerships - Woodside Monash Energy Partnership:

Amounts awarded to approved projects to date under Theme 2 'New Energy Technologies'; project scopes of work are included in the project descriptions of the Partnership as shown in HyResource (Research), cash funding for approved projects is provided in confidence.

Program - Partnerships - MCH Research Tests:

Cash funding for two tests provided in confidence (see project description in HyResource – Research).

Program - Partnerships - Fortescue CSIRO Partnership:

Not included in analysis as flow of funds into specific elements of the supply chain is not known at present; an early priority is commercialisation of CSIRO's metal membrane technology.

Program - Partnerships - National Hydrogen Materials Reference Facility:

Not included in analysis.

On the basis of the above stocktake, a sample of near AUD\$72 million of major program R&D funding between 2017-2020 is analysed in Section Two from a supply chain 'flow of funds' perspective.

¹⁸ Major funding initiatives as listed (as at mid-December 2020) in the HyResource [Projects \(Research\)](#) web-page, and are for cash amounts.