

Observations on Green Hydrogen in Australia Projects, Technology and Feasibility

Andrew Williamson

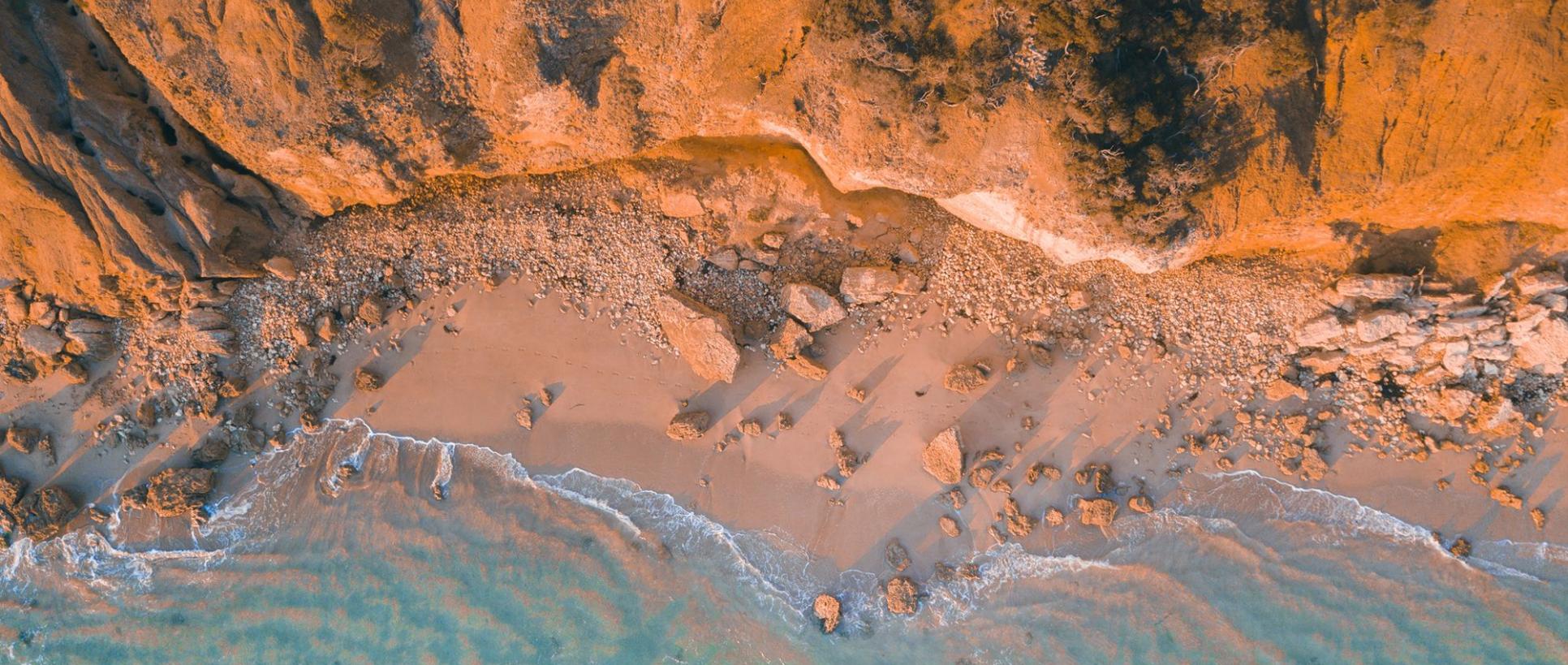
Knowledge Sharing Manager
Australian Renewable Energy Agency





Agenda

1. Introduction to ARENA
2. ARENA's hydrogen portfolio
3. Key project learnings
4. Next steps for hydrogen



ARENA acknowledges the traditional custodians of Country across Australia and their continuing connection to land, sea and community. We pay our respects to elders past and present.

ARENA's Purpose

ARENA is the Australian Renewable Energy Agency.

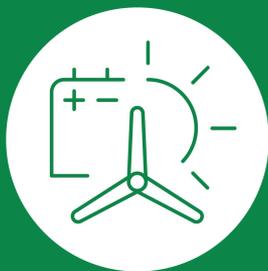
The Agency was established by the Australian Government in July 2012 .

Our purpose is to support the global transition to net zero emissions by accelerating the pace of pre-commercial innovation, to the benefit of Australian consumers, businesses and workers.

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OUR STRATEGIC PRIORITIES



OPTIMISE THE
TRANSITION TO
RENEWABLE
ELECTRICITY



COMMERCIALISE
CLEAN
HYDROGEN



SUPPORT THE
TRANSITION TO
LOW EMISSIONS
METALS



SCALE UP CCS &
REDUCE THE
COST OF SOIL
CARBON
MEASUREMENT



COMMERCIALISE CLEAN HYDROGEN

Our Focus

1. Reduce the cost of hydrogen produced from renewable energy
2. Research and development to demonstrate technologies that address technical challenges along the rest of the hydrogen value chain
3. Prove the technical feasibility and commercial viability of hydrogen use cases



INVESTED

\$1.83B



PROJECTS

618



VALUE

\$7.95B



INVESTMENT LEVERAGE

\$1:\$3.36



INVESTMENT BY TECHNOLOGY

BIOENERGY



\$131M

GEOTHERMAL

\$42M



GRID INTEGRATION

\$325M



HYBRID

\$111M



HYDROGEN

\$64M



OCEAN

\$44M



SOLAR PV

\$736M



SOLAR THERMAL

\$178M



STORAGE - BATTERIES/PHEs

\$195M



RECENT ACTIVITY



\$100M funding round to support the next generation of grid-scale batteries with advanced inverters

\$8.6M for a distributed energy resource orchestration pilot in WA

\$5M for Australia's largest electric bus fleet in NSW

\$3M for a hydrogen truck demonstration in Townsville, Qld

\$1.5M export hub for renewable hydrogen in Newcastle, NSW

RELEASED Australia's Bioenergy Roadmap to pave the way for Australia's bioenergy industry

INVESTMENT BY STATE

NT PROJECTS 8
INVESTED \$40M
VALUE \$82M

WA PROJECTS 41
INVESTED \$197M
VALUE \$1.87B

SA PROJECTS 55
INVESTED \$152M
VALUE \$607M

TAS PROJECTS 21
INVESTED \$40M
VALUE \$99M

QLD PROJECTS 64
INVESTED \$259M
VALUE \$2.01B

NSW PROJECTS 248
INVESTED \$862M*
VALUE \$2.58B

ACT PROJECTS 70
INVESTED \$71M
VALUE \$194M

VIC PROJECTS 111
INVESTED \$204M
VALUE \$510M

* Includes \$567 million contributed to projects inherited by ARENA in 2021.

INVESTMENT LEVERAGE ALONG THE INNOVATION CHAIN

STUDY	R&D
\$1:\$1.71	\$1:\$1.64
DEMONSTRATION	DEPLOYMENT
\$1:\$1.87	\$1:\$6.30

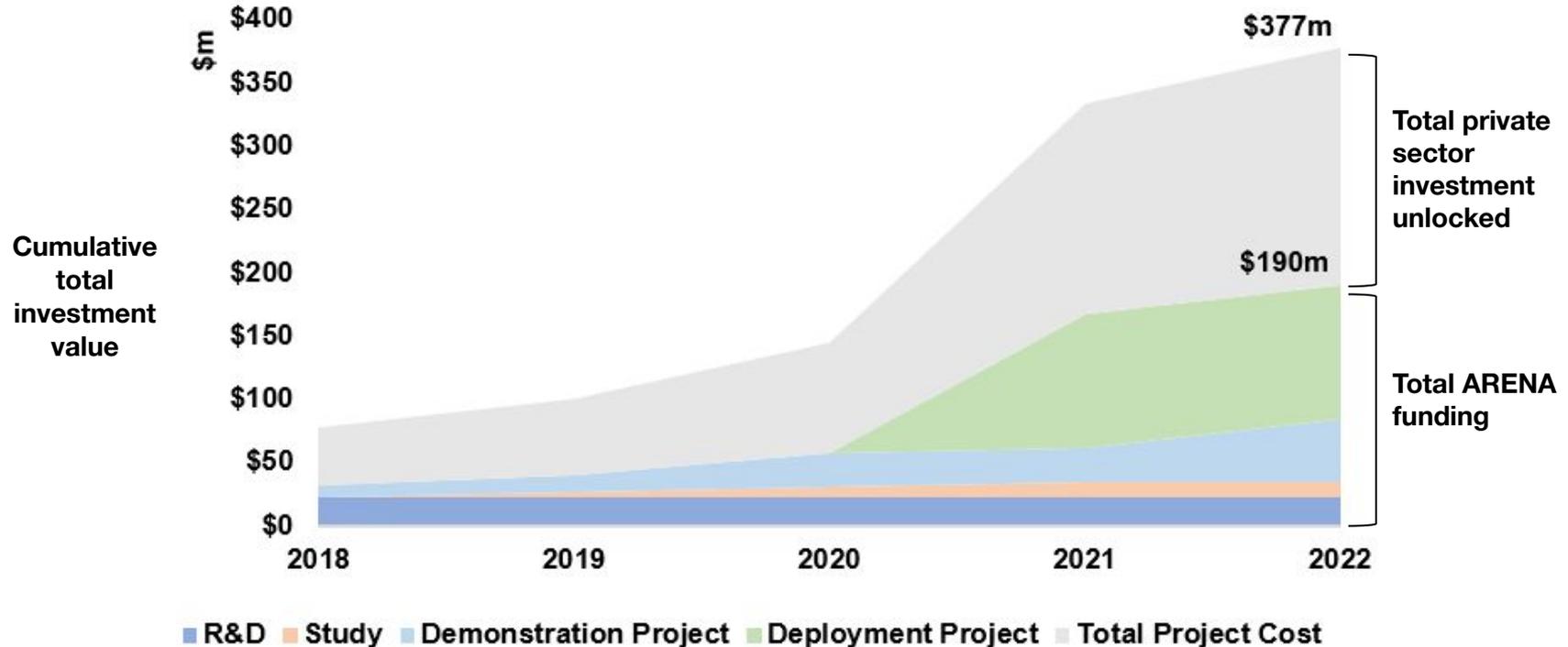
RECENT ENGAGEMENT



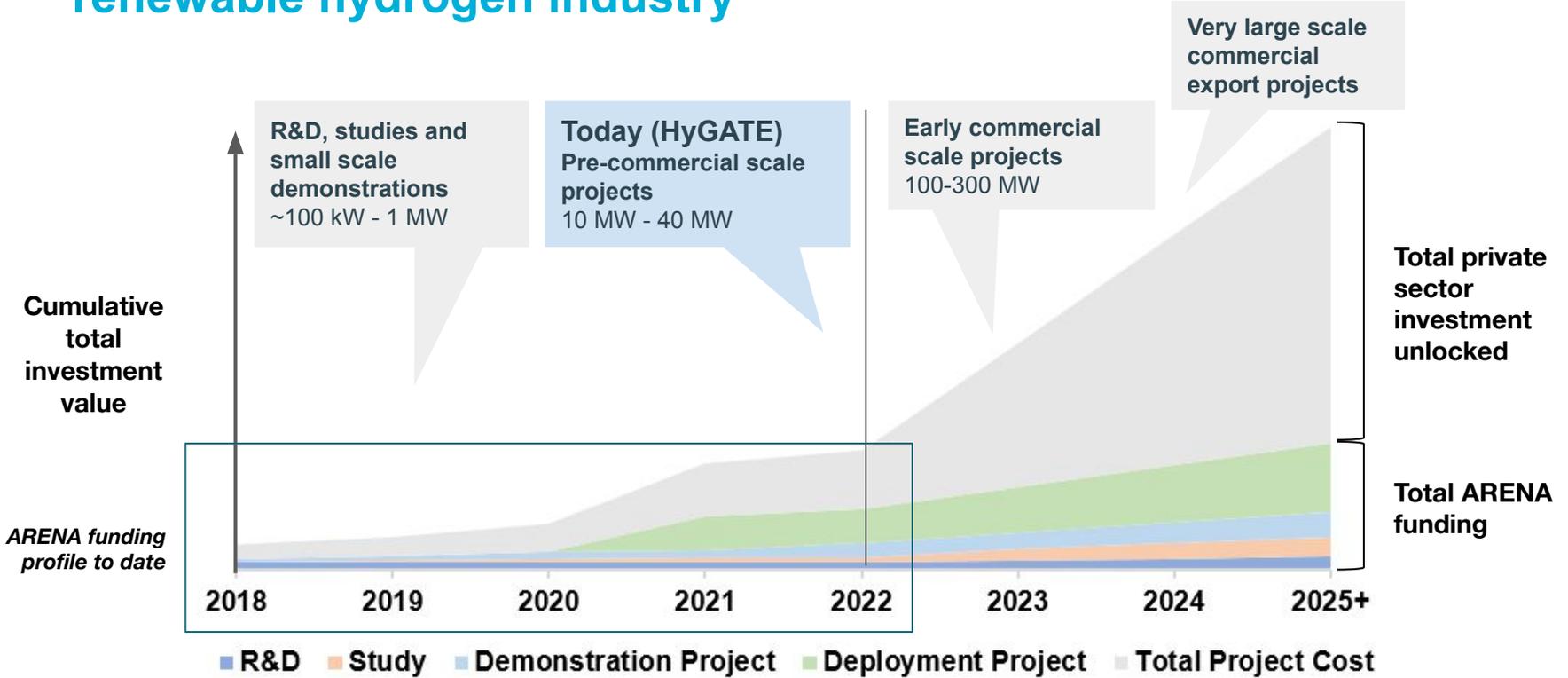
STARTUP EVENT @ COP26
Hosted a panel event featuring five of Australia's most promising clean energy startups. The event was attended by more than 300 people and livestreamed into the Australian Pavilion at COP26

HYGATE PARTNERSHIP
Announced a partnership to develop and deliver a German-Australian Hydrogen Innovation and Technology Incubator known as HyGATE

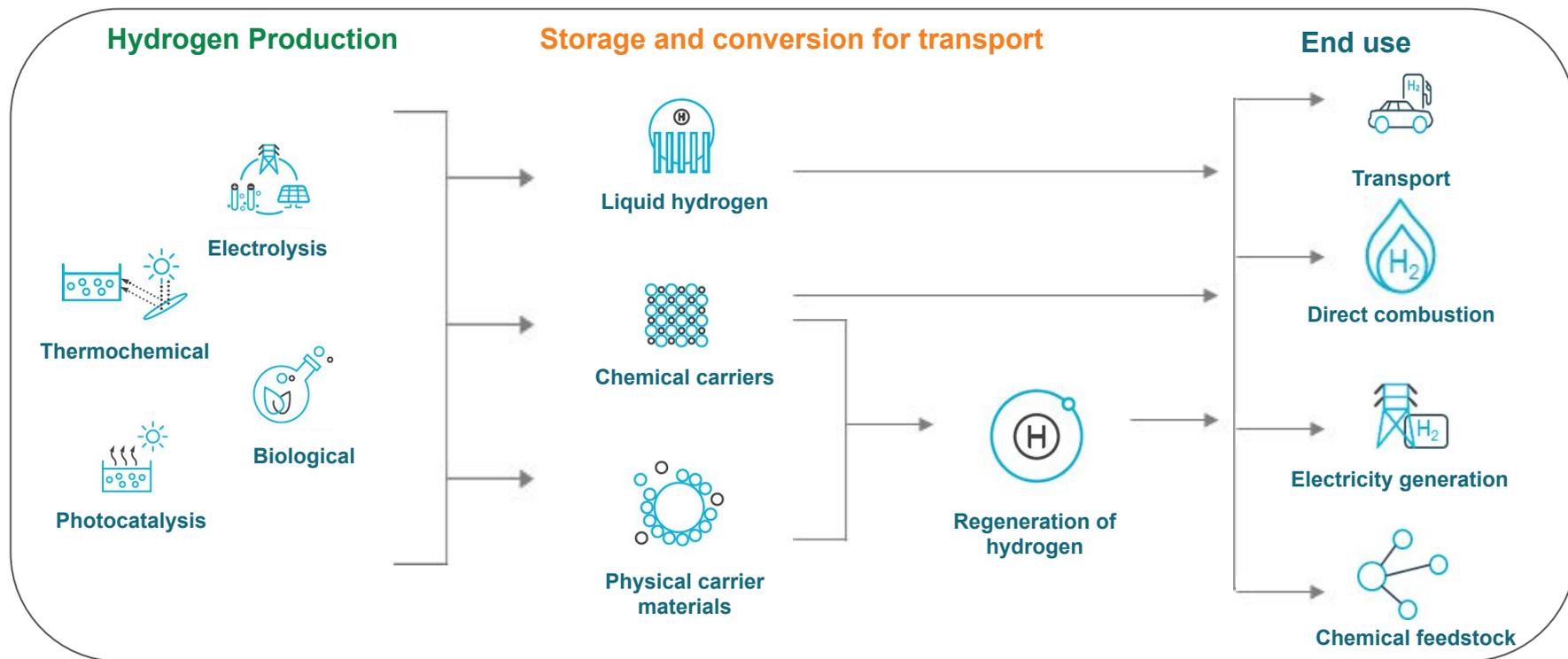
ARENA has committed \$190 million to 38 projects valued at \$377 million to seed Australia's hydrogen industry



Continued support is required to scale up the renewable hydrogen industry



The renewable hydrogen supply chain



ARENA's Hydrogen Journey

- 16 Research & Development Projects
 - 9 Feasibility Studies
 - 8 Demonstration Projects
 - 3 Large Deployment Projects
- + *a full pipeline of new project applications*



Toyota Hydrogen Centre of Excellence - \$3.1m



BOC Renewable Hydrogen and Refuelling project - \$950k



Yara Pilbara Renewable Ammonia Feasibility Study - \$995k



Hazer Plant Pilot Plant - \$9.41m



QNP Ammonia Plant - \$1.91m



Jemena Power to Gas Demonstration - \$7.5m



Stanwell Hydrogen Electrolysis Deployment Feasibility Study - \$1.25m



ATCO Hydrogen Microgrid - \$1.79m



BP Australia Study - \$1.71m

Hydrogen Research & Development

- In 2018, ARENA granted \$22.1 million to 16 projects under its Hydrogen R&D Funding Round

The 16 projects:

- targeted all parts of the supply chain
 - developed new approaches & optimised existing technologies
 - achieved world-beating performance
- Successful spin-offs that indicate commercial potential include:
 - **Hysata:** high efficiency electrolyser from University of Wollongong achieved 95% system efficiency
 - **Hydgene:** biological hydrogen from Macquarie University
 - **Jupiter Ionics:** green ammonia electrolyser from Monash University



Image credit: Hysata

Current ARENA-funded feasibility studies



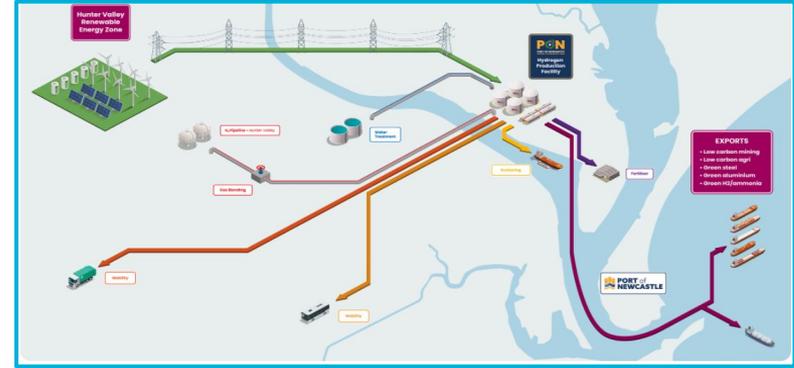
Central Queensland Hydrogen Project

Proponent: Stanwell

Location: Gladstone, Queensland

Capacity: ~300 MW

Outputs: Export on Liquefied H2 Ships



Newcastle Hydrogen Hub

Proponent: Macquarie Bank and Port of N'castle

Location: Newcastle, NSW

Capacity: Phased 40 MW up to 1GW

Outputs: Export, local fertiliser manufacturing, local mobility, local blending

YURI PROJECT IN THE PILBARA

Engie Renewables
Australia

END
USE



NH₃

CLEAN ENERGY INNOVATION PARK

ATCO Australia

END
USE



H₂

END
USE

HYDROGEN PARK MURRAY VALLEY

Australian Gas Networks



Conditionally approved \$103.3 million in funding to 3 commercial-scale hydrogen projects.



At 10 MW, the electrolyzers in these hydrogen plants will be among the largest built in the world.



These projects will help progress Australia's pathway to achieving the Australian Government's goal of 'H₂ under \$2'.



Project development

- Regulatory impediments
- Implications of scaled increase
- Technical expertise in Australia
- Vehicle availability
- Refueling infrastructure costs relative to EV

Commercial lessons

- Securing offtake is critical
- Commercial gap still exists for most use cases
- Uncertainty and risk in total project costs
- Bankability
- EPC and O&M arrangements
- Performance guarantees and warranties

System design learnings

- Balance of plant
- Capacity factor
- Electricity supply
- Storage / compression costs
- Transport and liquefaction costs
- Electrolyser CAPEX
- Stack lifetime and degradation
- DC / AC losses



Stanwell Hydrogen
Electrolysis Deployment
Feasibility Study -
\$1.25m



Yara Pilbara Renewable
Ammonia Feasibility Study -
\$995k

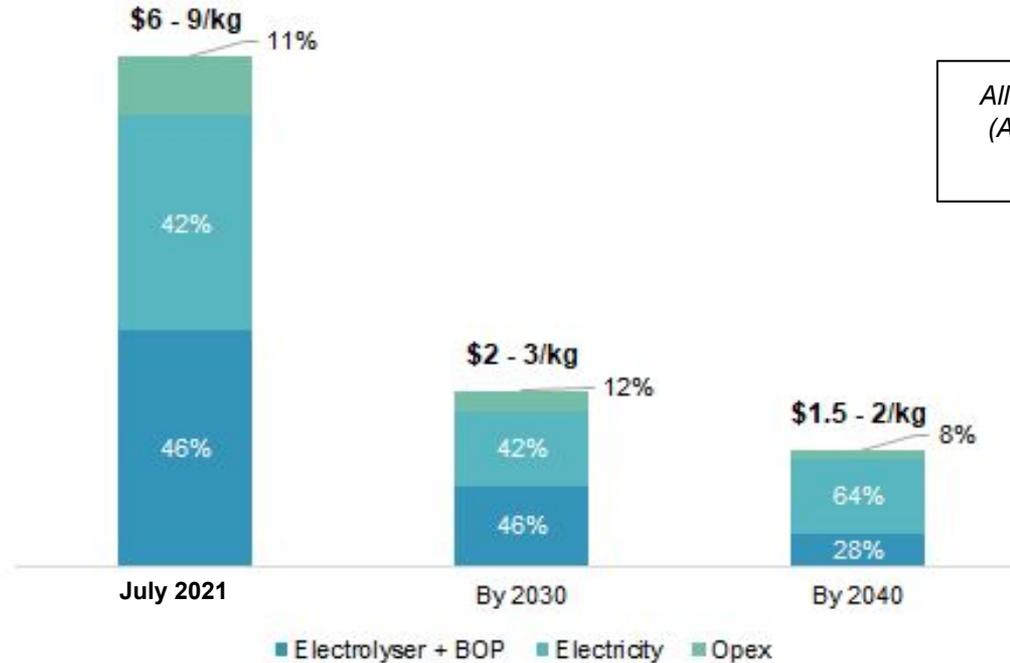


QNP Ammonia Plant
- \$1.91m



BP Australia Study -
\$1.71

Pathway to \$2 per kg (at farm gate)



All costs quoted in Australian Dollars
(AU\$1.00 = US\$0.75 = JPY91.66 =
€0.68 on 1st April 2022)

Source: ARENA analysis, July 2021; Bloomberg New Energy Finance, CEFC/Advisian Australian Hydrogen Market Summary May 2021; CSIRO GenCost 2020-2021 Final

Current Programs

ARENA currently funds hydrogen projects through the following programs:

Advancing Renewables Program

- Ongoing and open program
- Provide funding to projects under ARENA's strategic priorities

HyGATE Initiative

- An initiative under the Australia-Germany Hydrogen Accord
- Seeking to support projects to develop a hydrogen supply chain from Australia to Germany
- \$50 million Australian Government, €50 million German Government

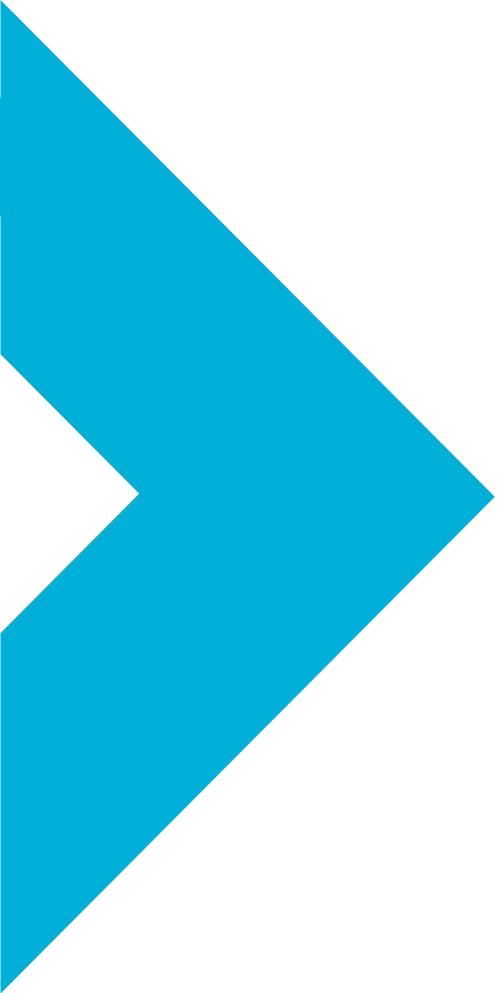
Future Fuels Program

- \$127.9 million to support the uptake and infrastructure required for zero emissions transport

Learn more about ARENA projects online

- Our **website** has a wealth of information about technologies and projects we fund. Visit arena.gov.au
- **ARENAWIRE** is our virtual newsroom with news and analysis about our funded projects, as well as videos and other content. Subscribe at arena.gov.au/blog
- Our **Knowledge Bank** is an open-source library of reports, studies and tools. Subscribe to our industry newsletter, **Insights**, arena.gov.au/knowledge-bank
- Our **Rewired Podcast** looks at the people and companies transforming Australia's electricity system to a future powered by renewables. Subscribe wherever you get your podcasts.





Thank you

www.arena.gov.au