



# Observations on Green Hydrogen in Australia Projects, Technology and Feasibility

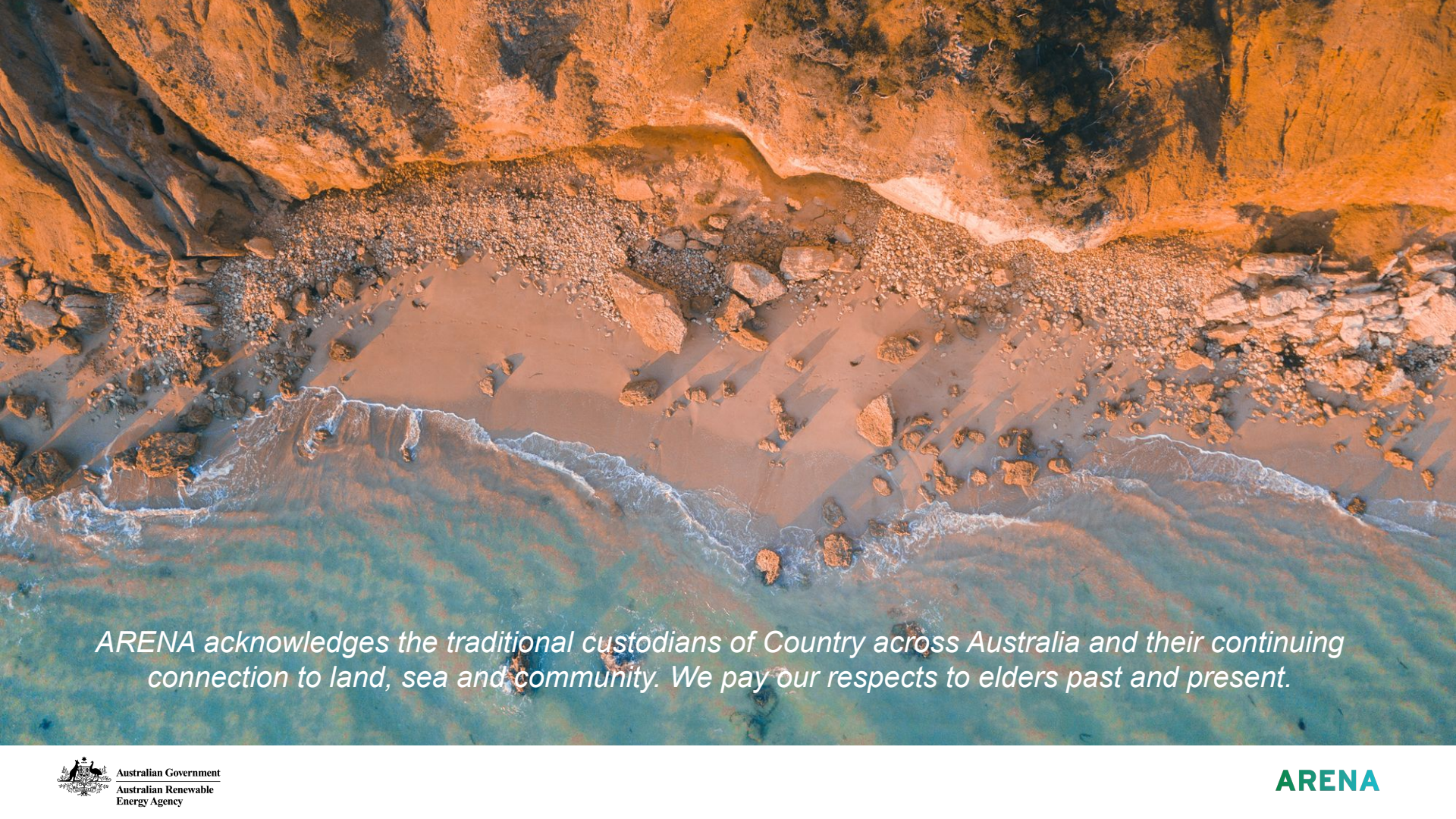
Andrew Williamson

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



An aerial photograph of a rugged coastline. The top half of the image shows a steep, eroded cliff face made of reddish-brown earth and rock. Below the cliff is a wide, sandy beach littered with numerous large and small rocks. The ocean waves are breaking onto the shore, creating white foam and a turquoise-colored water surface. The overall scene is captured in a warm, golden-hour light.

*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.

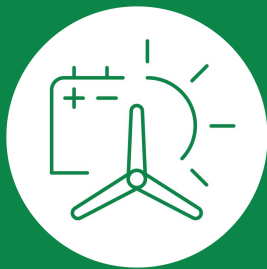
The Agency was established by the Australian Government in July 2012 .

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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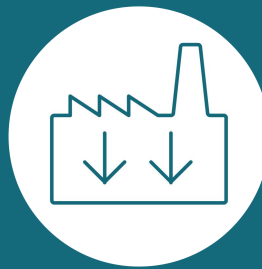
# OUR STRATEGIC PRIORITIES



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

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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



# AUSTRALIAN RENEWABLE ENERGY AGENCY

KEY STATISTICS 2012-2021

ARENA



## 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 2012.

## INVESTMENT LEVERAGE ALONG THE INNOVATION CHAIN

STUDY

**\$1:\$1.71**

R&D

**\$1:\$1.64**

DEMONSTRATION

**\$1:\$1.87**

DEPLOYMENT

**\$1:\$6.30**

## RECENT ENGAGEMENT



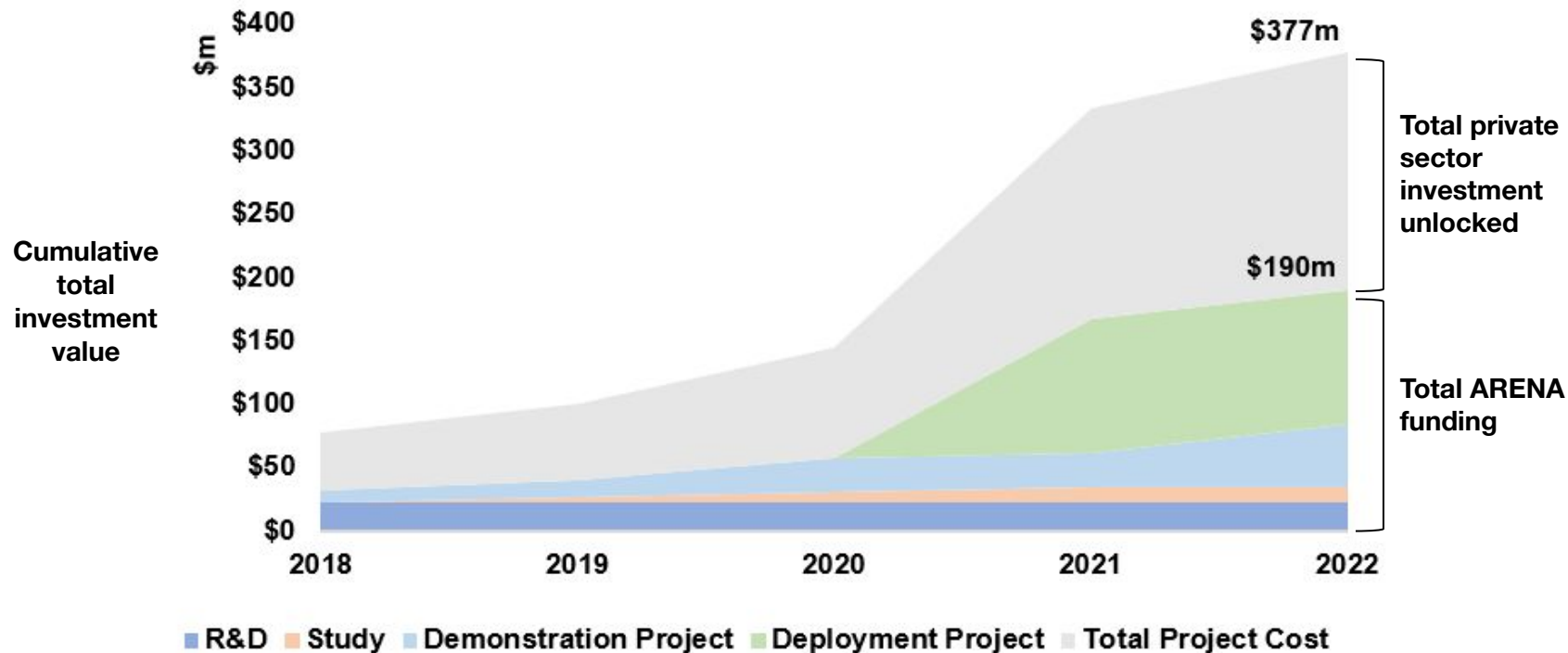
### STARTUP EVENT @ COP26

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

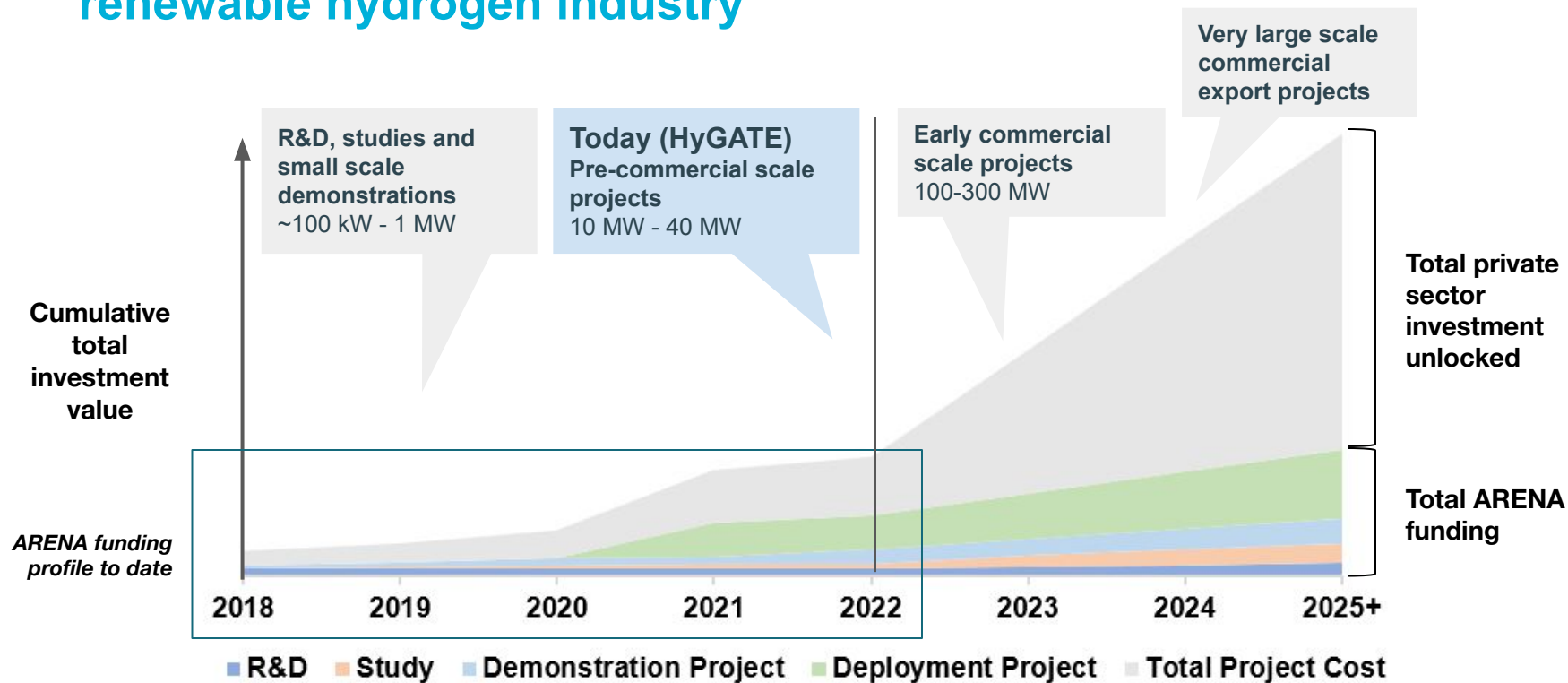
Announced a partnership to develop and deliver a German-Australian Hydrogen Innovation and Technology Incubator known as HyGATE

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

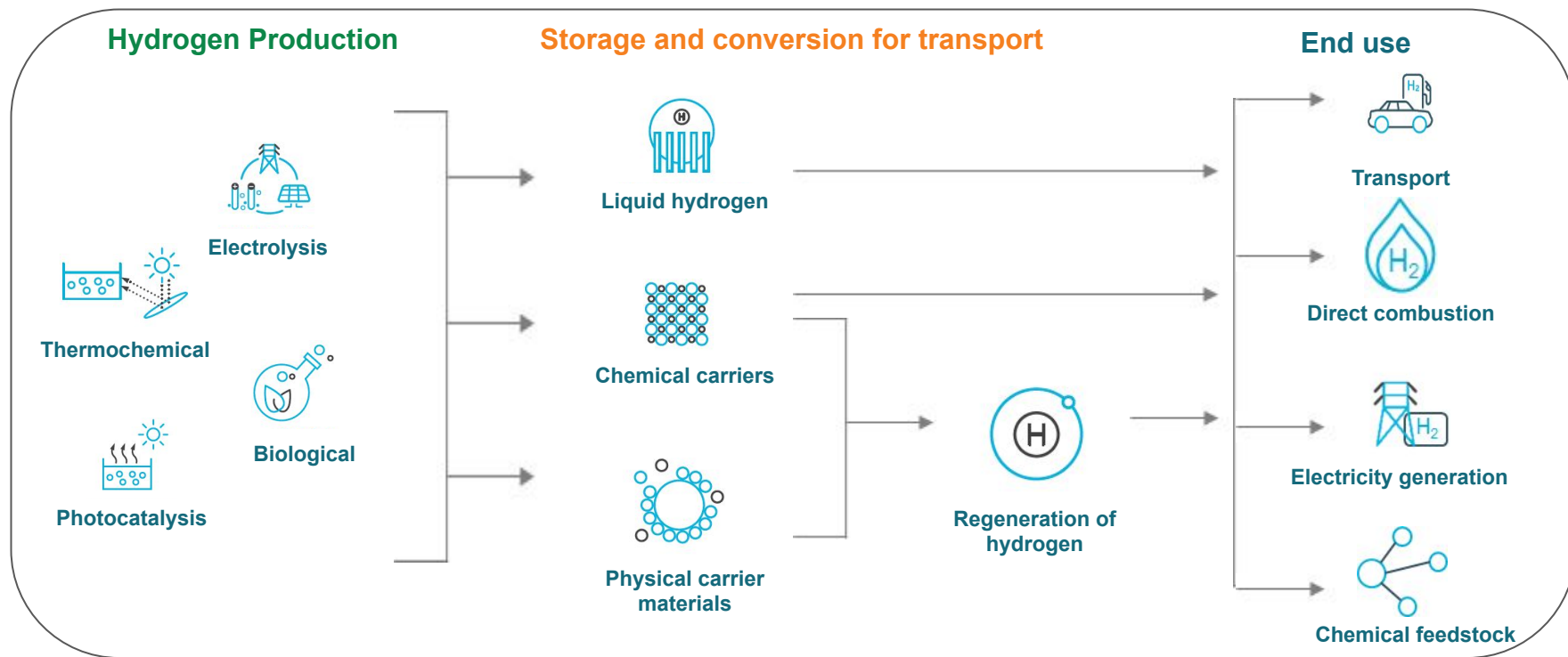




# Continued support is required to scale up the renewable hydrogen industry



# The renewable hydrogen supply chain

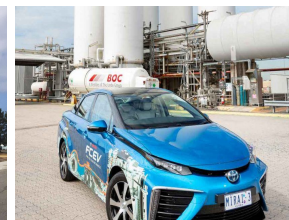


# ARENA's Hydrogen Journey

- 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



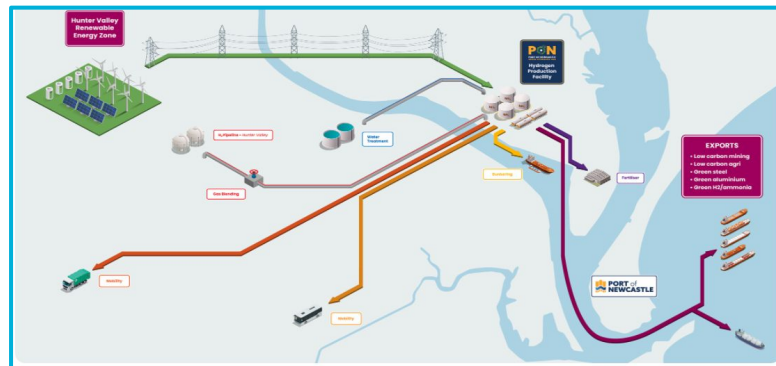
## Central Queensland Hydrogen Project

**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

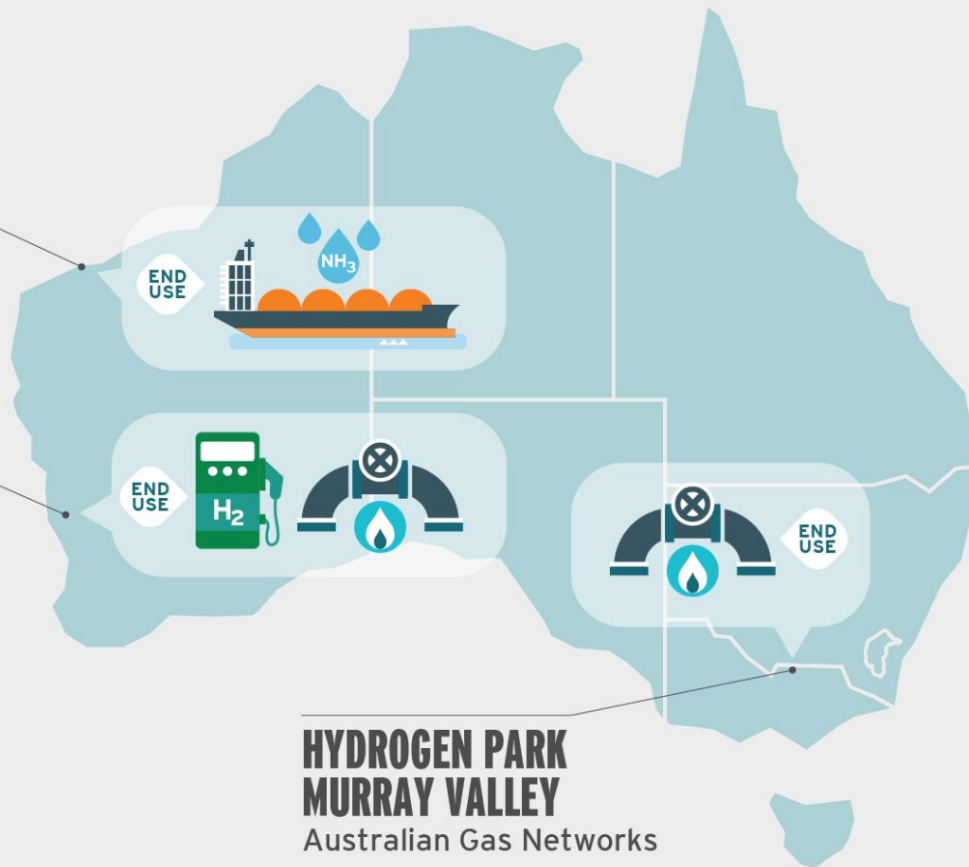
Engie Renewables  
Australia

## CLEAN ENERGY INNOVATION PARK

ATCO Australia

## 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 'H<sub>2</sub> 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



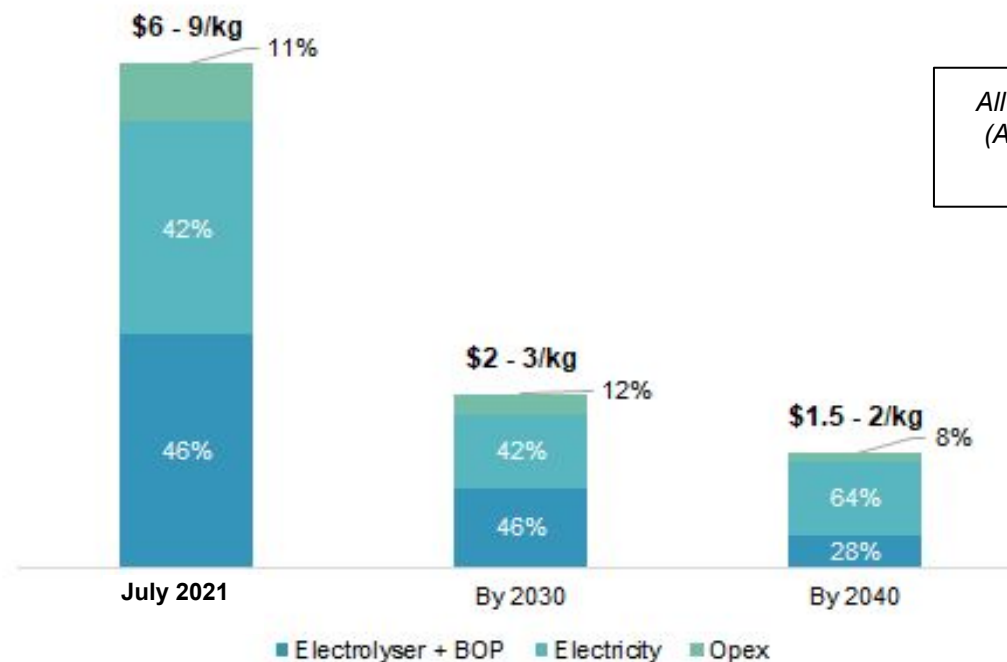
QNP Ammonia Plant  
- \$1.91m



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

Note: This analysis includes a subset of full applications for which detailed budgets, supplier quotes and other third party evidence was provided.

# 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](https://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](https://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](https://arena.gov.au/knowledge-bank)
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# Thank you

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