Ammonia’s role in a renewable energy future

Charlotte Rouse

ARENA

August 2019

ARENA's Purpose

ARENA is the Australian Renewable Energy Agency.

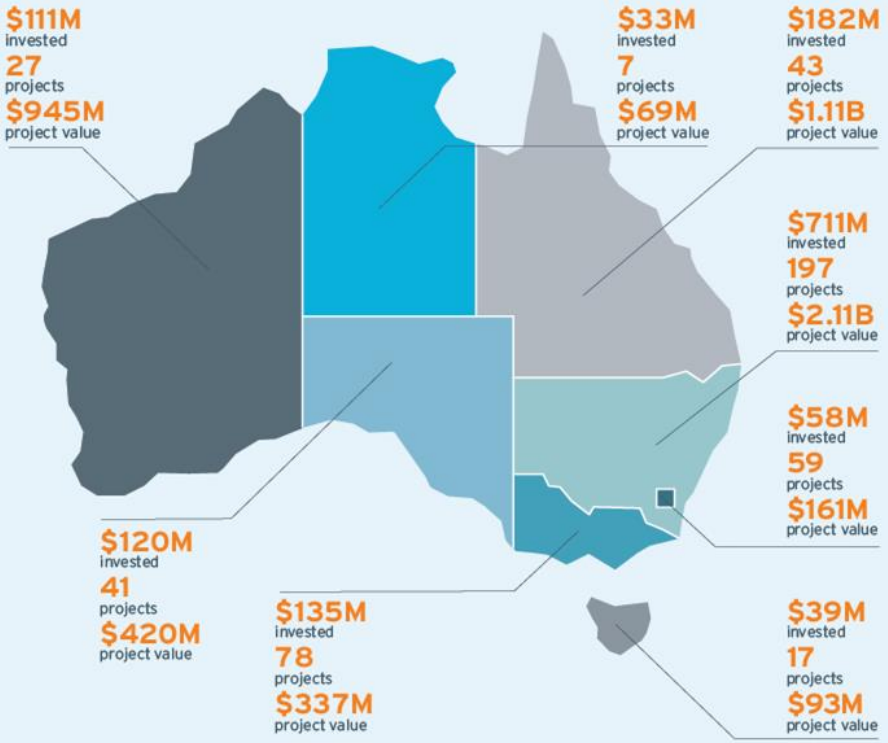
The Agency was established by the Australian Government in July 2012 to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy in Australia.

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

ARENA AT A GLANCE

$1.39B INVESTED **469** PROJECTS **$5.25B** VALUE **$3.86B** INVESTMENT LEVERAGE

SOLAR PV	GRID INTEGRATION	SOLAR THERMAL	HYBRID	BIOENERGY	STORAGE – BATTERIES/ PHES	OCEAN	GEOTHERMAL	HYDROGEN
$645M	$190M	$145M	$108M	$96M	$77M	$52M	$42M	$33M



$1:$2.36
Average investment leverage

Study $1:$1.55 ⇔ R&D $1:$1.71 ⇔ Demo $1:$1.85 ⇔ Deployment $1:$4.93
Investment leverage across the innovation chain

ARENA hosted a **Virtual Power Plant** workshop as part of its Knowledge Sharing mandate

8 projects announced Q1 2019 including:
$12M ESCRI Grid-scale battery
$10M Distributed Energy Resources projects
$3.1M Toyota Australia Hydrogen Centre
$9M Short-term Forecasting projects

A-Lab
15 collaborative events attended by **207** organisations
26 ideas funded

Investment Priorities

1 DELIVERING SECURE & RELIABLE ELECTRICITY

Delivering affordable low emission electricity solutions that keep the lights on.

Hydrogen as an energy storage medium; electrolysers as a flexible load

2 ACCELERATING SOLAR PV INNOVATION

Making solar PV more efficient and affordable through research and development.

Low cost renewable energy will be required for a hydrogen industry

3 IMPROVING ENERGY PRODUCTIVITY

Helping reduce energy cost and emissions in the transport, building and industry sectors.

Renewable hydrogen for transport and high-temp industry

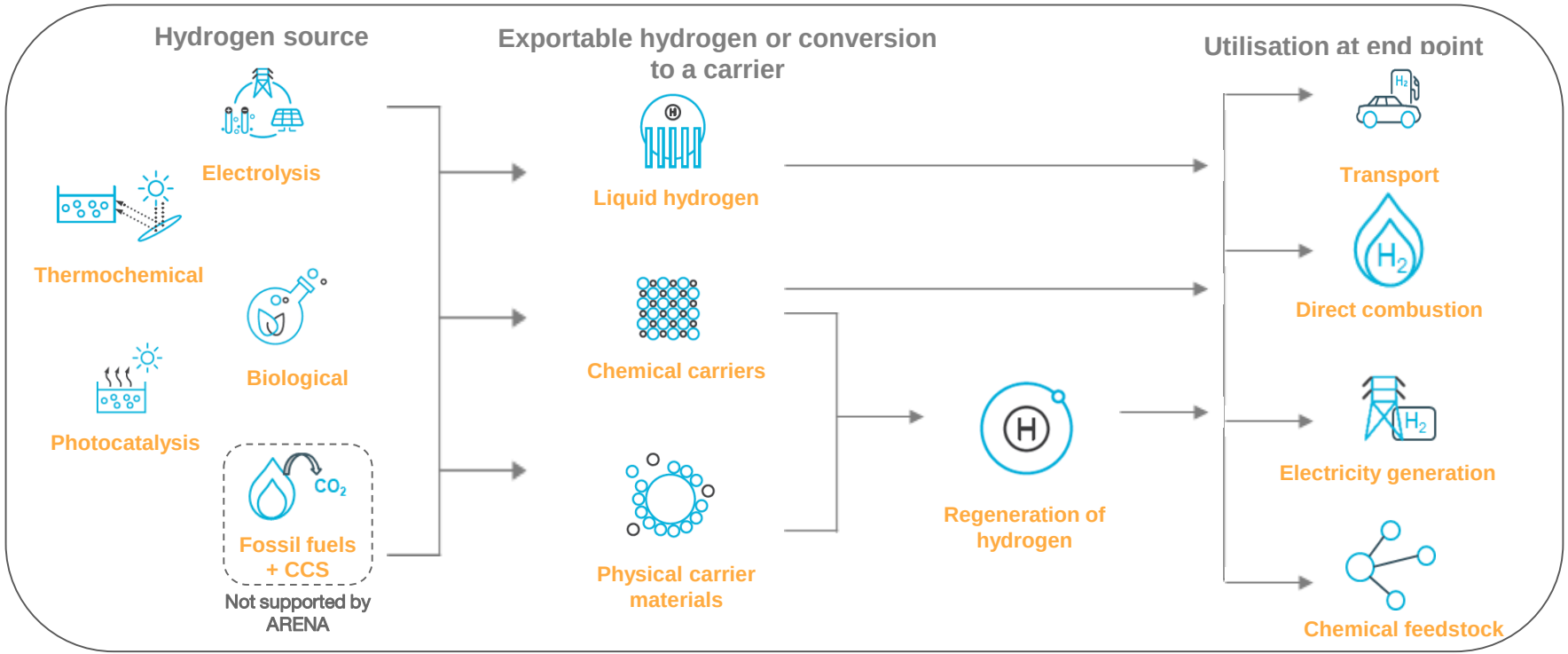
4 EXPORTING RENEWABLE ENERGY

Creating new, scalable export value chains in renewable energy.

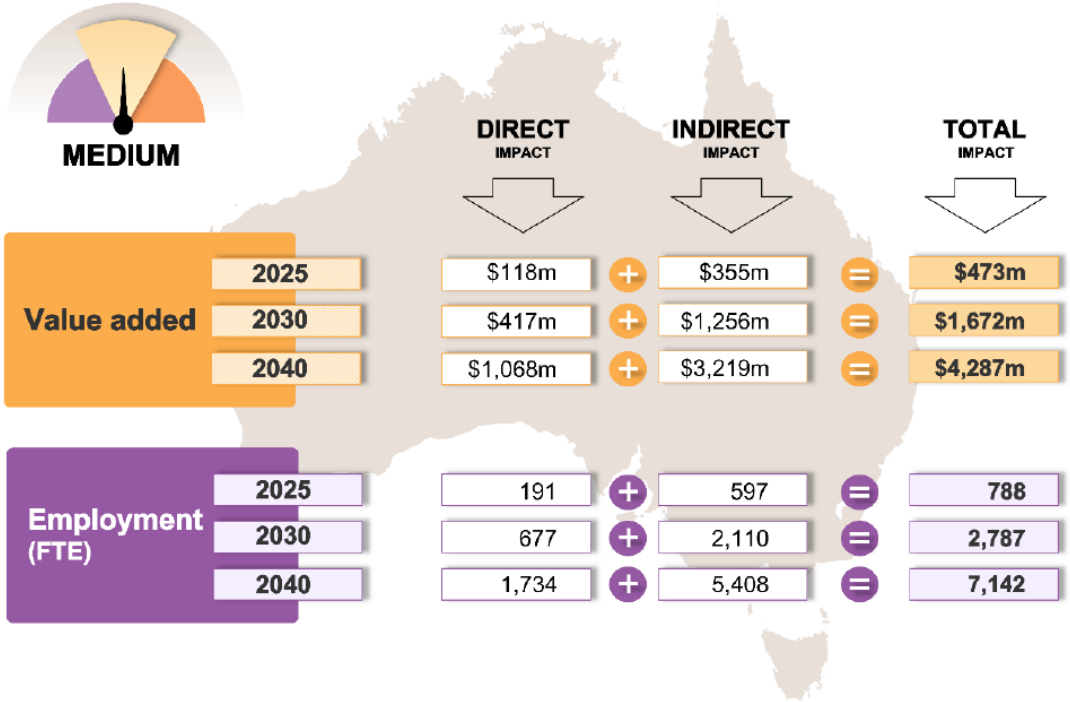
Exporting renewable energy as hydrogen

The renewable hydrogen export opportunity

The hydrogen export supply chain



A renewable hydrogen export industry is the big picture end-goal



- Global demand for hydrogen for energy could be over 4000 PJ by 2040 (>10,000 PJ in high scenario)
- Australia's exported share of this market is estimated to be ~4% (over 1.3 million tonnes per year)
- This could provide over $4 billion in economic benefits to Australia…
- … and save 11 Mt CO_2e per year in global emissions.

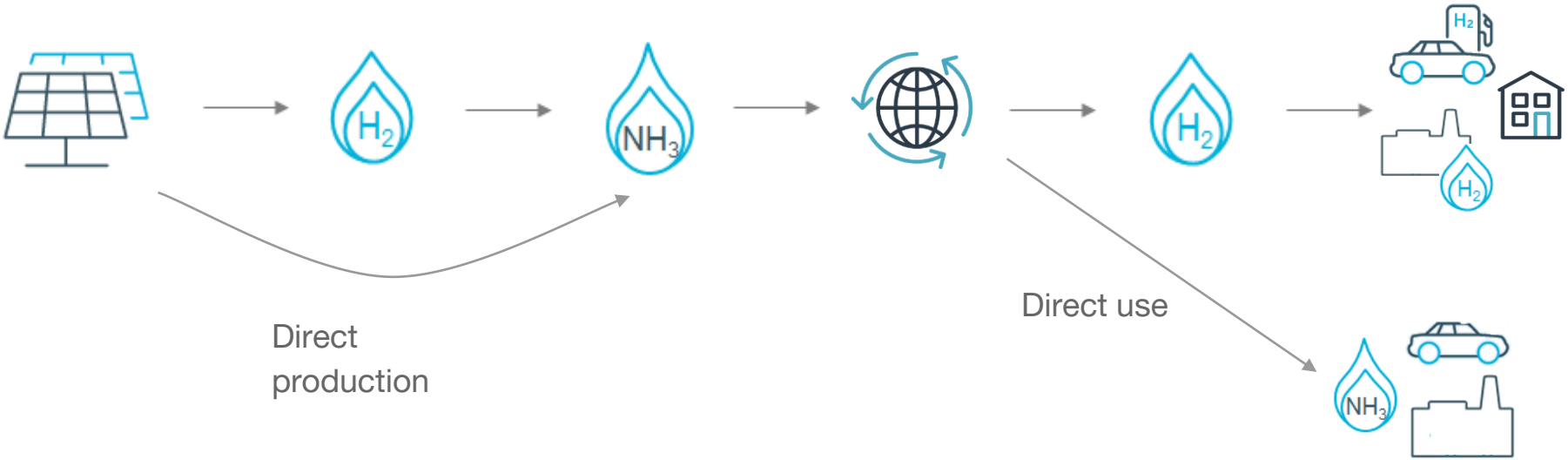
Source: Opportunities for Australia from Hydrogen Exports, ACIL Allen Consulting for ARENA, 2018.

Why Australia? Why now?

- Demand for renewable energy globally, with supply constraints in some countries
- Cost competitive, scalable renewable energy supply and high capacity factors
- Australia is an established energy exporter and has existing port infrastructure
- A pathway to a cost competitive industry is now foreseeable

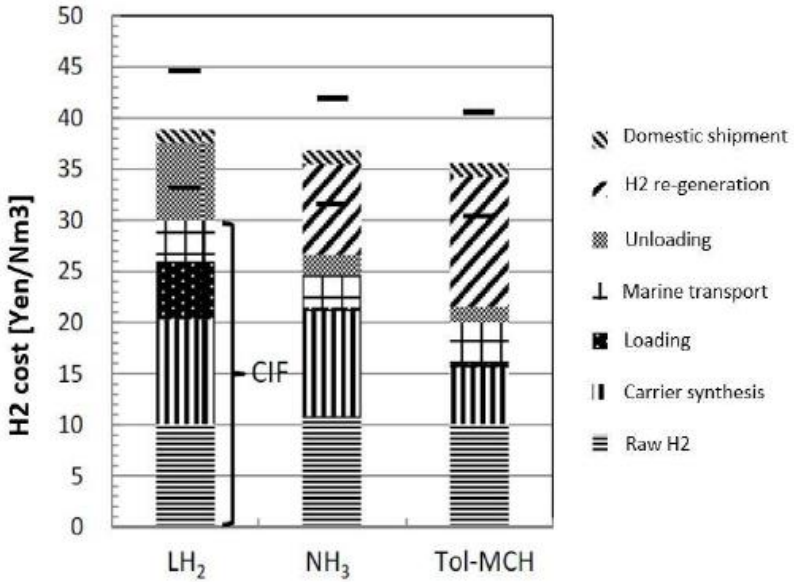
Ammonia as part of a hydrogen export supply chain

Ammonia adds conversion and reconversion steps to a supply chain….



… however is still a potential medium for exporting renewables

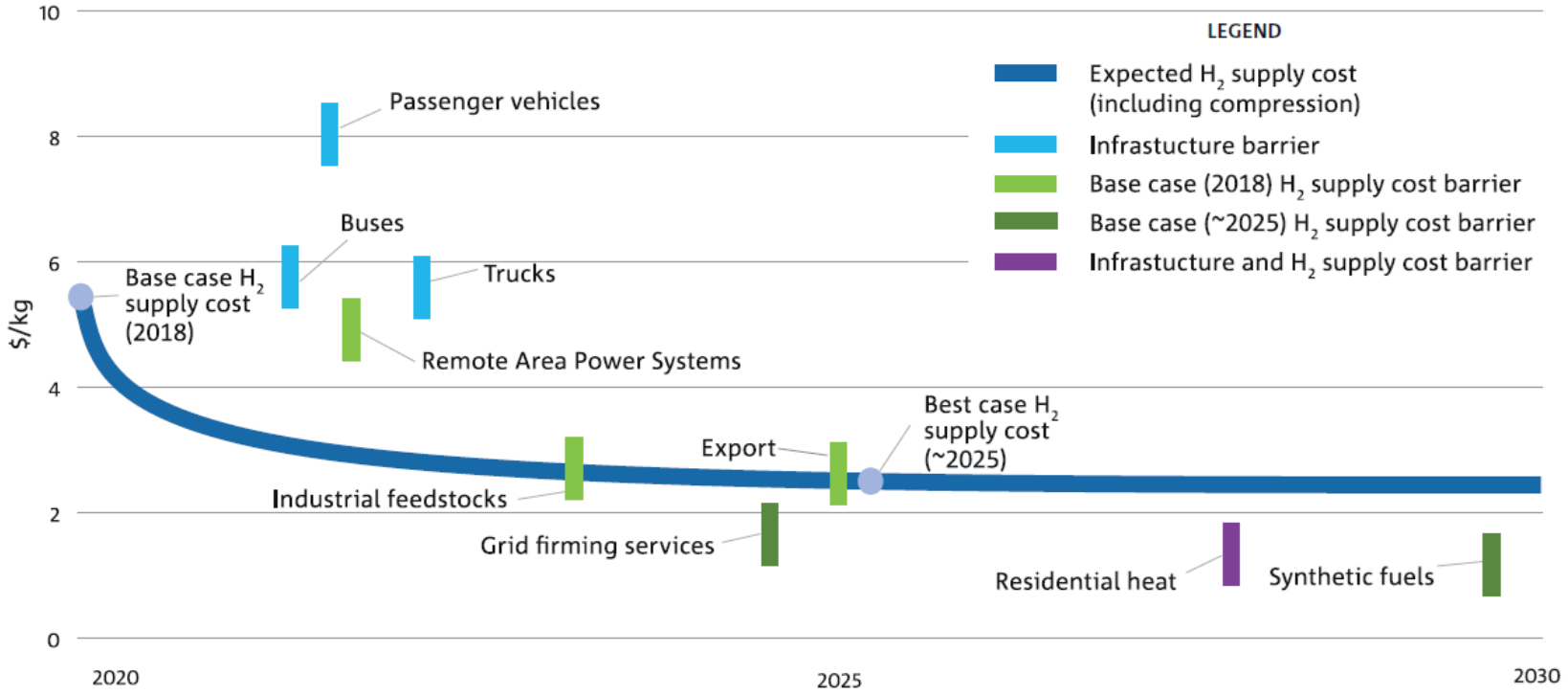
Estimated hydrogen supply costs in 2030 in Japan



Australian Government
Australian Renewable Energy Agency

Mizuno et al 2017, Economic Analysis on International Hydrogen Energy Carrier Supply Chains, Journal of Japan Society of Energy and Resources, 38 (3) 11-17

How can hydrogen production become cost competitive in different markets?



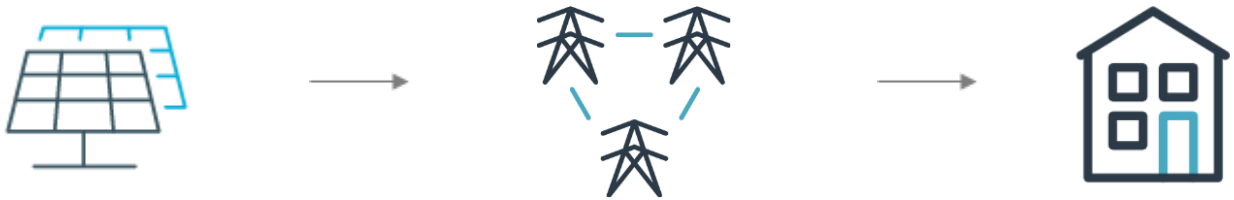
Australian Government
Australian Renewable Energy Agency

Source: CSIRO National Hydrogen Roadmap August 2018

Ammonia’s role in the domestic market

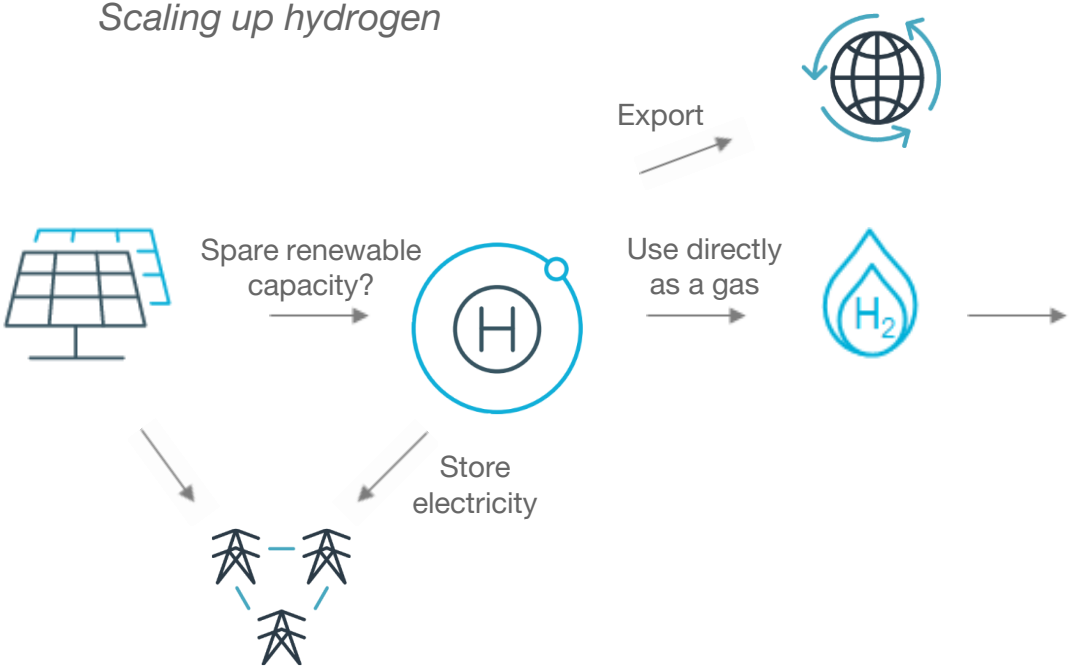
Hydrogen faces a chicken-and-egg challenge of matching infrastructure development with demand

Scaling up solar



Hydrogen faces a chicken-and-egg challenge of matching infrastructure development with demand

Scaling up hydrogen



Requires transformative technology uptake

Transport

Residential

High temp heating in industry and reductant in iron/steel making

Convert gas network to 100%

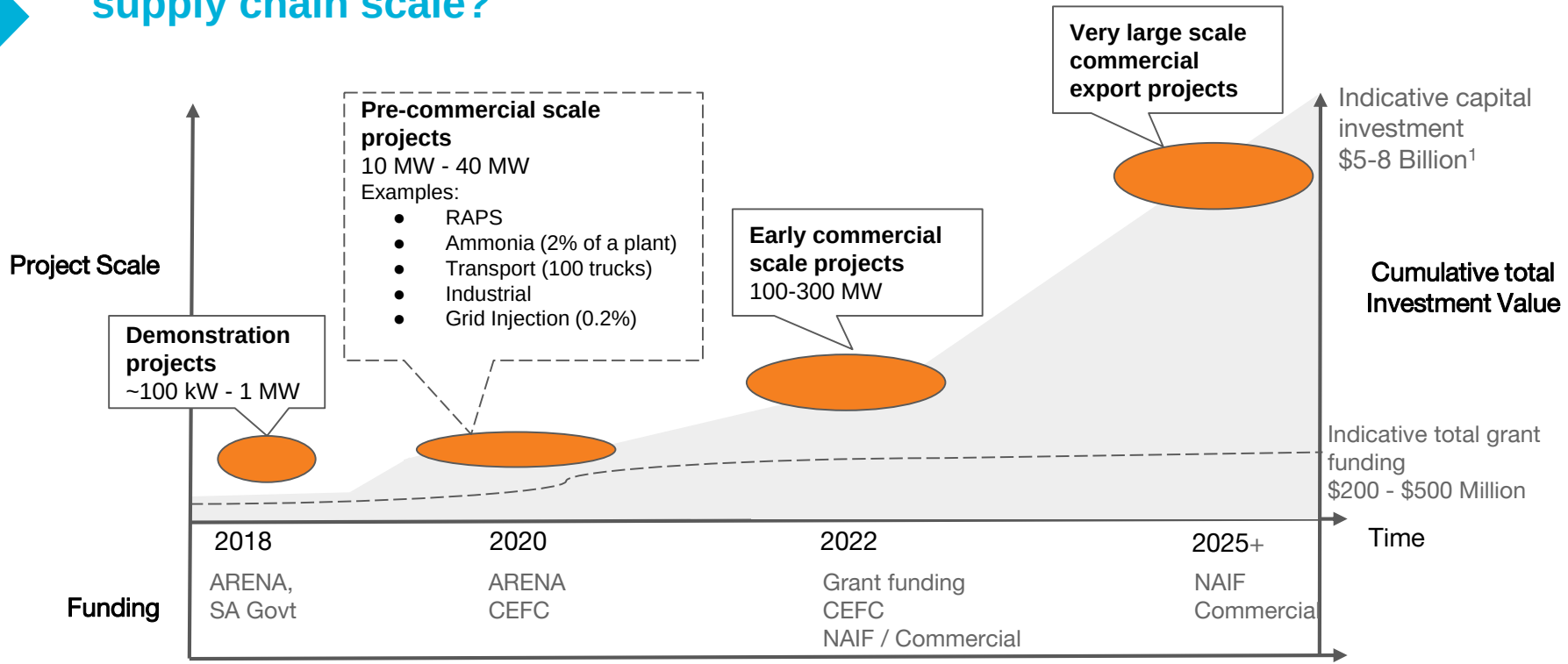
Can reach scale incrementally

Blend into gas network

Chemical feedstock

Ammonia

How can domestic projects help the hydrogen industry reach an export supply chain scale?



[1] Assumes cumulative 670,000 tonnes of hydrogen production, electrolyser investment of $1-1.5 million per MW and solar at $1-1.5 per watt - capacity factor of 50%; transport and storage costs of $0.7 - $1.0 billion.

Conclusions

- Ammonia is a potential carrier for the export of hydrogen
- The ammonia industry can also provide benefits in scaling up
- Pre-commercial scale ammonia production is a key step to scaling up to export
- Leveraging the existing ammonia industry can also help de-risk projects
- Focus should be on scaling up with the least amount of grant funding required
- Existing cost estimates for projects at scale are based on desktop analysis - there is a need for real projects
- Best opportunities are likely to be those leveraging existing infrastructure and supply chains to deliver commercialisation outcomes
- Projects that link existing demand with new demand will also be key

Thank you

www.arena.gov.au