3 April 2019

Alison Reeve
National Hydrogen Strategy Secretariat
Department of Industry, Innovation and Science
Canberra 2000 ACT

Via website: www.industry.gov.au/hydrogen

Energy Networks Australia's submission to the National Hydrogen Strategy request for information

Dear Ms Reeve

Energy Networks Australia welcomes the opportunity to provide this submission to inform the National Hydrogen Strategy.

Energy Networks Australia is the national industry body representing businesses operating Australia's electricity transmission and distribution and gas distribution networks, with 21 member companies providing more than 16 million electricity and gas connections to almost every home and business across Australia.

Our gas distribution businesses manage over five million connections to Australian households and businesses. The gas supplied through these networks provides 44 per cent of the annual energy consumption in homes.

Industry is focussed on reducing emissions from the end-use of gas and developed Gas Vision 2050 in early 2017. The document outlines three transformational technologies of hydrogen, biogas and carbon capture and storage so that the households and businesses that rely on gas can continue to do so while reducing emissions.

Since then, many hydrogen related activities have occurred within Australia, both at the national level, through individual state initiatives and in industry-led projects and R&D.

New hydrogen investment since 2017

Both industry and governments have invested in new hydrogen projects in the last 2 years. The table below provides an overview of this funding. More than $150m has been allocated towards hydrogen research, development and pilot projects, with more funding streams, such as the Victorian Hydrogen Investment Program and the Queensland's hydrogen industry development, being announced since then. There is also a significant amount of work addressing the role of hydrogen as a transport fuel which is not covered in our submission.

Business	Project Name	Location	Operational by	Total Project cost ($m)	Network injection	Appliance trial	Engagement	Regulation	R&D	FCAS	Mobility (vehicles)
Australian Gas Infrastructure Group	Hydrogen Project SA	SA	Oct 2019	11.4	✓		✓	✓		✓	✓
ATCO Gas	Renewable Energy Innovation Hub	WA	mid 2019	3.3	✓	✓				✓	
Evoenergy	Hydrogen Test Facility	ACT	Dec 2018	0.3		✓	✓		✓		
Jemena	Project H2GO	NSW	2020	15.0	✓		✓			✓	✓
Neoen	Hydrogen superhub	SA	TBC	TBC							
ARENA	Hydrogen R&D round	National	Aug-18	>22.1					✓		
CSIRO	Hydrogen Energy Systems Future Science Platform	National		>13.5					✓		
FFCRC		National	Nov 2018	92.0	✓	✓	✓	✓	✓		
TOTAL				**>157.6**							

Table 1: Funding announcements for hydrogen project since 2017 (excluding mobility)

Many of the R&D projects have commenced and the pilot projects are expected to be operational in the next 6 to 18 months.

Gas Vision 2050

The focus of decarbonisation has been on the electricity sector. At present, the majority of the hydrogen initiatives around the world are related to decarbonising the mobility sector. Over the long-term, gas networks will have their own decarbonisation journey. New fuels, such as biogas and hydrogen, have the potential to become mainstream and complementary energy solutions that will use existing energy infrastructure.

Biogas, for instance, can make use of landfill or agricultural and forestry waste to produce a net-zero emissions fuel.

Hydrogen can be produced from natural gas, from coal gasification or through electrolysis using off-peak renewables. Producing hydrogen from renewable energy does not produce greenhouse gas emissions and is one way of decarbonising the networks.

Hydrogen production from natural gas combined with carbon capture and storage has the potential to deliver a low cost and low carbon gas.

Both hydrogen pathways lead to emission-free energy, where hydrogen can then be used to complement natural gas in the gas network, providing reserve energy in the same way battery technology does, in a carbon-neutral, secure and cost-effective manner, while also providing inter-seasonal renewable energy storage.

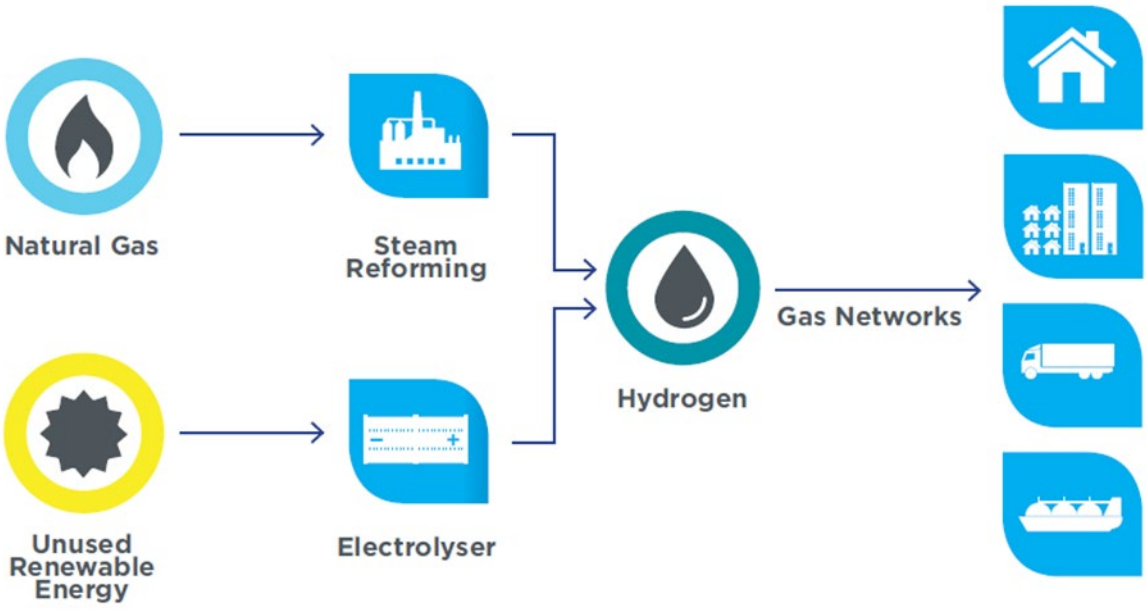


Figure 1: hydrogen pathways (Source: Gas Vision 2050.)

In March 2017, Gas Vision 2050 was launched by Australia's peak gas industry bodies and demonstrates how gas can continue to provide Australians with reliable and affordable energy in a low carbon energy future. This report is the next step in our gas journey and identifies opportunities for three transformational technologies to decarbonise gas. It reflects the ambitions of key organisations which represent Australia's gas sector. It shows that gaseous fuels have a pivotal role to play in Australia's low carbon future to 2050 and beyond.

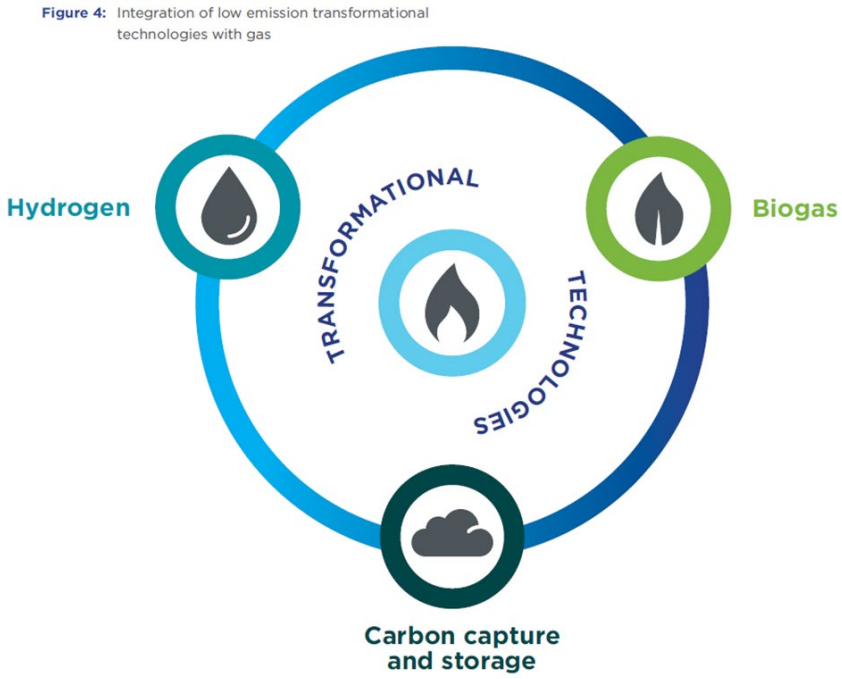


Figure 2: Transformational technologies (Source: Gas Vision 2050).

Our plan is for this Vision to be refined and further developed as the role of gas in Australia's energy mix continues to evolve. Further work that industry has supported since the launch of the vision is outlined below.

The document is available from: www.energynetworks.com.au/gas-vision-2050

National level hydrogen activity

National Hydrogen Strategy

In December 2018, COAG Energy Council endorsed the development of a National Hydrogen Strategy, to be delivered to COAG EC by the end of 2019.

It was also agreed that three kick start projects would commence in parallel to the development of the strategy. Energy Networks Australia and its members are strongly involved in the project to allow up to 10 per cent hydrogen in the domestic gas network, both for use in place of natural gas and to provide at-scale storage for hydrogen.

The recommendation to develop a national hydrogen roadmap was based on a report produced by the Chief Scientist in August 2018. The report described the economic opportunity for hydrogen especially as a new energy export market supported by a strong domestic market.

National Hydrogen Roadmap

The National Hydrogen Roadmap was launched on 23 August 2018. The Roadmap provides a blueprint for the development of the hydrogen industry in Australia, by informing investment so the industry can scale in a coordinated manner.

The competitiveness of hydrogen in a range of applications was assessed in the Roadmap, as shown below. This indicates that hydrogen will be competitive as a replacement fuel for vehicles in the early 2020's but that there is an infrastructure barrier that will need to be addressed.

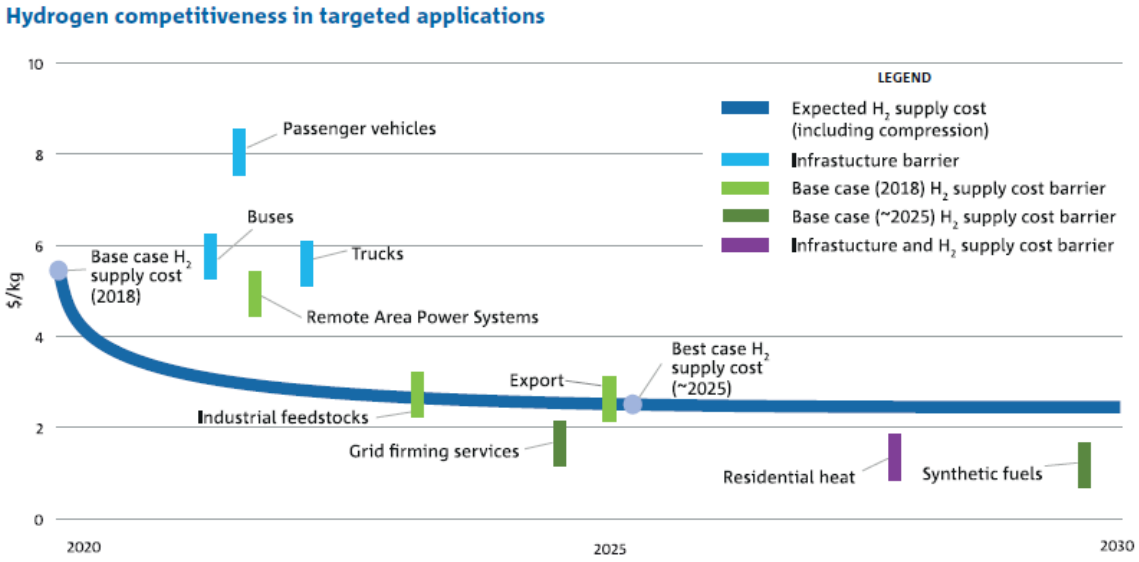


Figure 3: Hydrogen competitiveness (Source: National Hydrogen Roadmap (2018)).

The case for networks and synthetic fuels is more challenging. The supply cost barrier arises as the work by CSIRO did not account for a potential carbon benefit of the use of hydrogen instead of gas. As all hydrogen pathways identified by CSIRO were low-emissions (for example they considered renewables or fossil fuel feedstocks with CCS), the hydrogen produced would result in lower greenhouse gas emissions for residential heat applications. The benefit of the lower emissions was not counted in the CSIRO modelling work and it is expected that this may bridge the cost gap shown in Figure 3.

ARENA: Opportunities for Australia from Hydrogen Exports

ARENA published a report by ACIL Allen on export opportunities.

This report assesses the potential hydrogen export markets and the economic benefit to Australia in terms of value added and new jobs created under a range of different scenarios.

ARENA has since then also announced over $22.1 million of R&D funding towards hydrogen projects that support the export of hydrogen. Victorian universities[1] were awarded a total of $5.36 million for hydrogen R&D projects.

Integrating hydrogen into the NEM

There is significant scope for hydrogen to offer sector coupling as it creates opportunities in the mobility, the electricity as well as the gas sectors. In the NEM, hydrogen production from surplus renewables (referred to a power to gas) creates opportunities where surplus renewable energy could be converted to hydrogen and then stored in gas networks. This could later be used as a gaseous fuel to provide heat or could be reconverted to electricity through gas turbines or fuel cells. The energy could also be stored seasonally allowing energy shifting from summer to winter.

Electrolysers that produce hydrogen are very responsive and can be brought up to full capacity in a few seconds. The integration of this technology as a distributed energy resource needs to be considered in current work by AEMO and Energy Networks Australia on Open Energy Networks. A unique feature of electrolysers/ fuel cell combinations is that they can effectively act as a battery, but with geological gas storage can provide very large storage capacities over a long period of time.

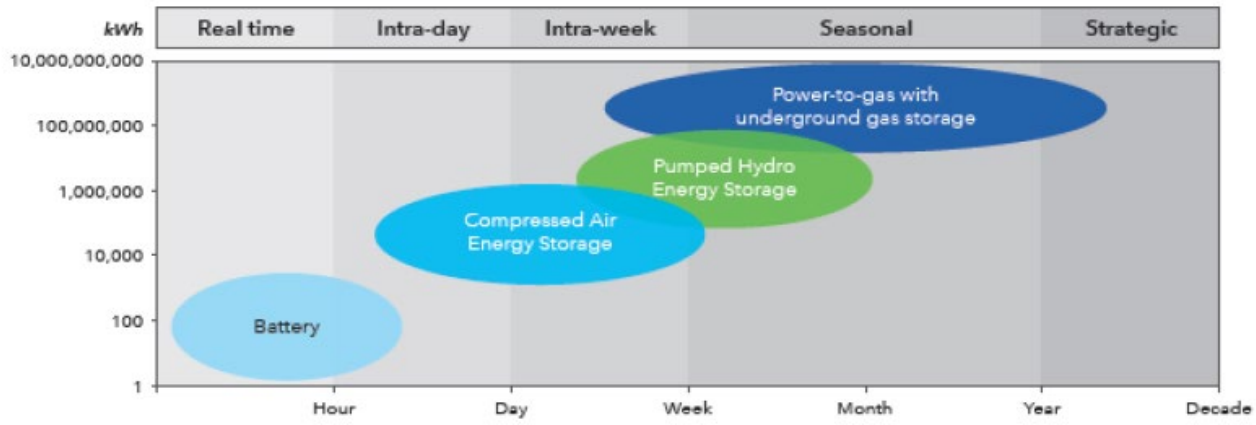


Figure 4: Storage capacities and timeframes of different energy storage technologies (Source: Oxford energy insight 39)

[1] The University of Melbourne, Monash University and RMIT University

State based programs

There are numerous hydrogen pilot projects around the country, as shown below. This does not include the R&D activity underway around the country, and supported by ARENA or Future Fuels CRC (see below).

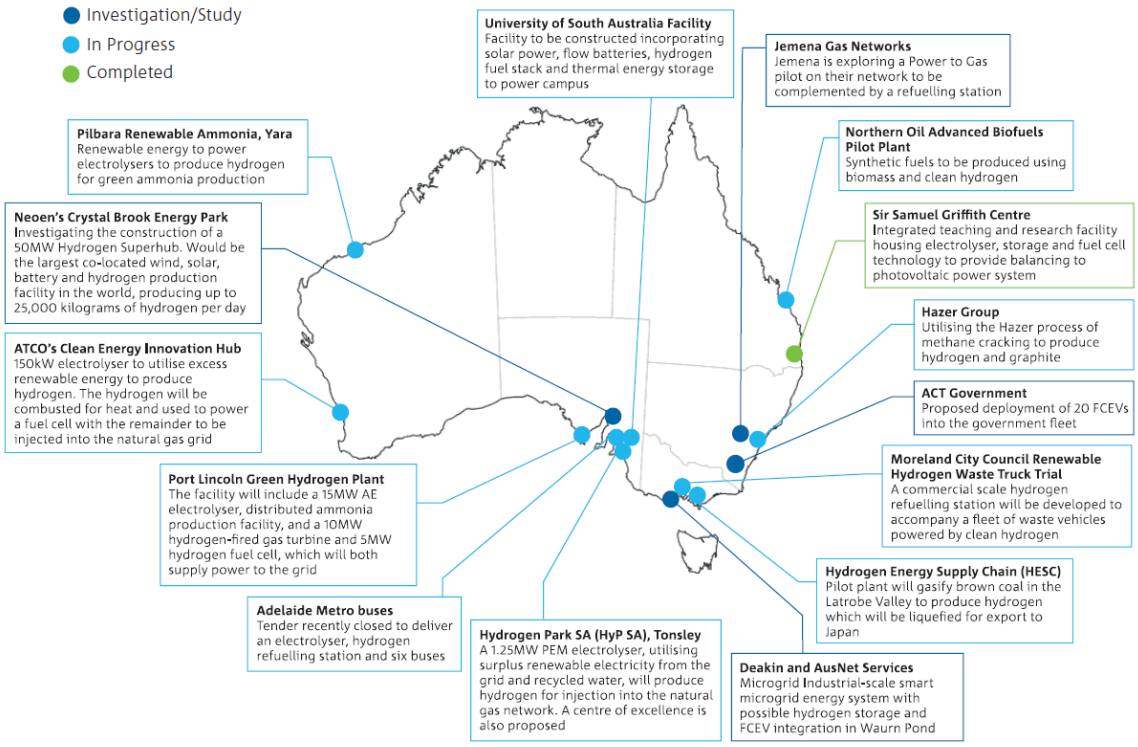


Figure 4. Summary of current Australian demonstration projects

Figure 5: National hydrogen activity (Source: National Hydrogen Roadmap (2018)).

The South Australian government has supported four pilot projects as part of its $150 million Renewable Energy Technology Fund. The four hydrogen projects supported to date demonstrate a broad range of technologies applicable to hydrogen including hydrogen production, conversion to export fuel, injection into networks, use as a transport fuel and support to the electricity network. The Australian Gas Infrastructure Group project intends to generate hydrogen from excess renewable energy and inject that into the gas network as low levels. These projects are currently in the design and commissioning stages.

The Western Australian Government hosted a renewable hydrogen conference on 31 August 2018. The government announced they would establish a Renewable Hydrogen Council. The ATCO Clean Energy Innovation Hub is under construction in WA and is expected to be completed mid-2019.

Jemena announced its H2GO Project in late 2018. This $15 million project will use international technology to convert solar and wind power into hydrogen gas, which will then be stored for use across the Jemena Gas Network in New South Wales.

Evoenergy, in the Australian Capital Territory, has launched a pilot scale laboratory to test network components, operating procedures and appliances with changing hydrogen mixtures. This project was launched in December 2018 and is located at CIT in Fyshwick. Locating this at the trades college allows practical skills to be gained by plumbing and gas fitting apprentices.

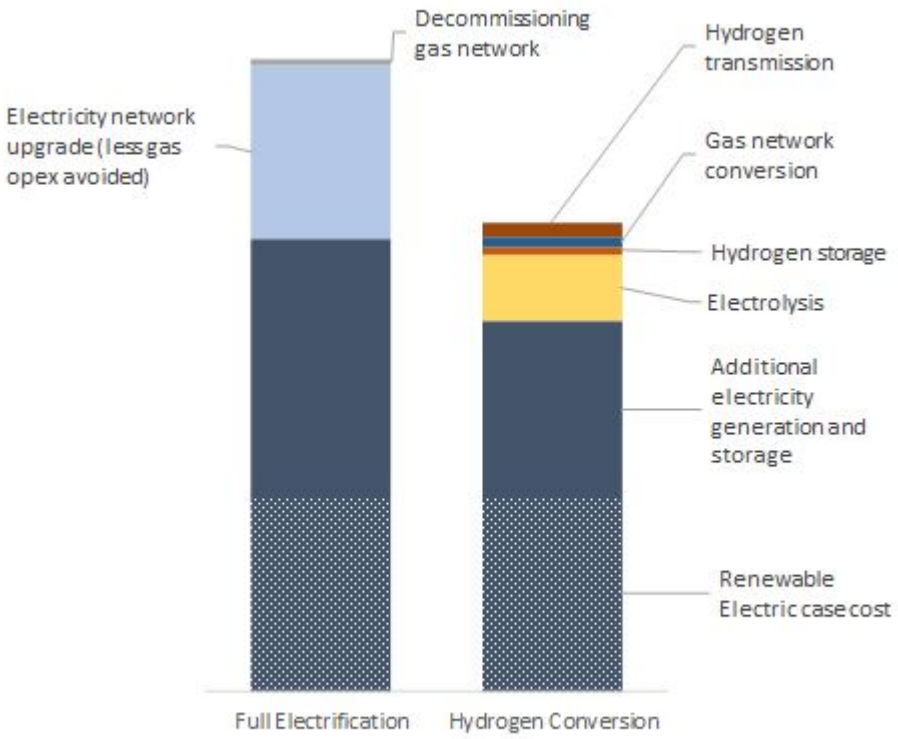
The Victorian Government is supporting a project to export hydrogen to Japan using Victoria's brown coal resources. The project is being led by Kawasaki Heavy Industries. The pilot scale project aims to deliver hydrogen to Japan in 2020/21. Operation of the commercial scale project is expected to begin in the 2030s.

Hydrogen is a lower cost alternative

Gas networks play a key role in providing energy to Australian homes and businesses especially for providing heating, cooking and hot water services. The national infrastructure is able to deliver gas at times of high demand during winter. The important role of gas networks is internationally recognised, through the development of projects like the conversion of gas network[2] in the city of Leeds in Northern England to hydrogen.

A study[3] by the Australian Gas Infrastructure Group and supported by Deloitte Access Economics showed that the capital investment of decarbonising the gas network in Victoria through the use of hydrogen was 40 per cent cheaper than the option where the gas load was fully electrified.

[2] https://www.northerngasnetworks.co.uk/wp-content/uploads/2017/04/H21-Executive-Summary-Interactive-PDF-July-2016-V2.pdf
[3] https://www.energynetworks.com.au/news/energy-insider/hydrogen-powered-future-tops-full-electrification



Source: AGIG analysis and Deloitte energy market model.

Figure 6: Comparison of hydrogen and electrification conversion costs (Source: AGIG (2018))

While several simplifying assumptions (many of which favoured the electrification scenario) were made to reduce the complexity of the modelling task, the results suggest we should be working on the hydrogen conversion decarbonisation pathway.

Future Fuels CRC

In support of Gas Vision 2050, the Future Fuels CRC will enable the Australian gas industry to provide a competitive, low carbon energy alternative for residential, commercial, industrial and transport sectors to complement and support intermittent renewable electricity generation. With CRC investment, Australia could lead in this emerging field and benefit from resulting technology and knowledge.

The FFCRC has over $92 million of resources over the next 7 years to deliver targeted research in support of Gas Vision 2050. It will deliver research through 3 programs:

- Future Fuels Technologies, Systems and Markets
- Social Acceptance, Security of supply and Public Safety
- Network Lifecycle Management.

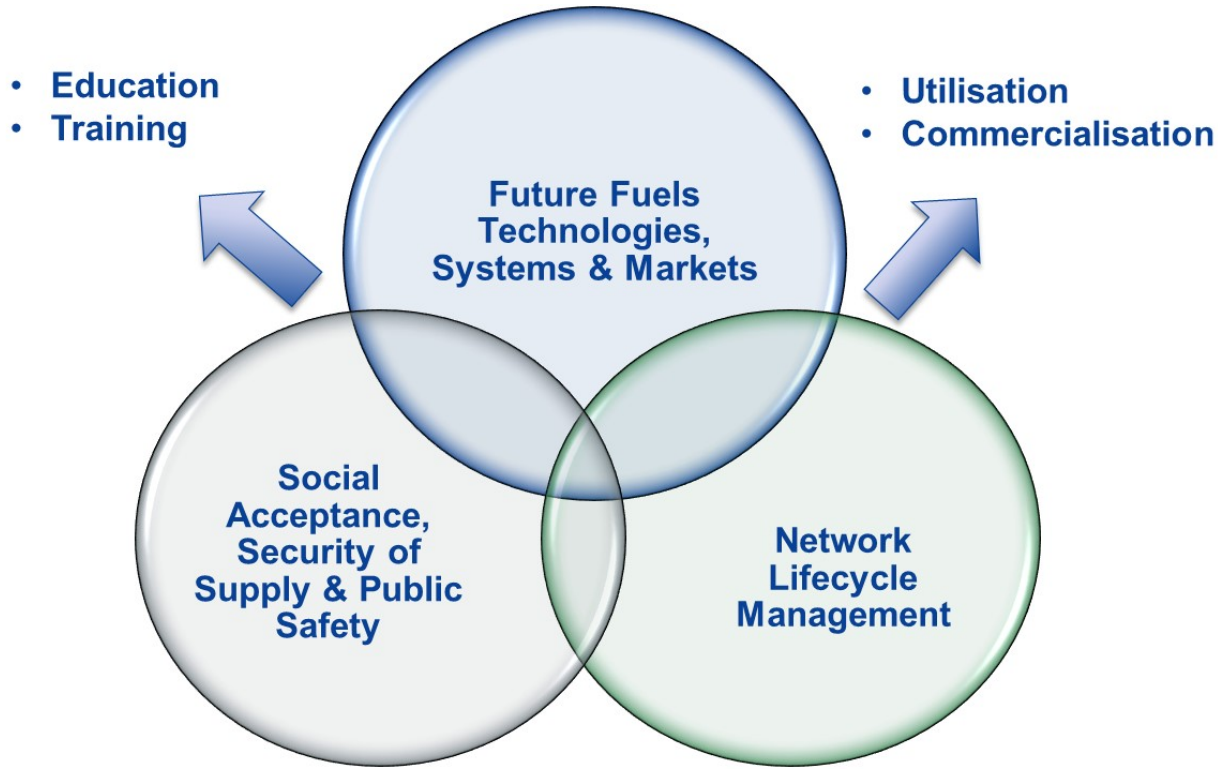


Figure 6: Future Fuels CRC Research Programs (Source: Future Fuels CRC (2018))

CRC research will provide knowledge for the public, industry and government to make informed decisions in respect to our energy future. An initial round of 12 projects has been approved by the Future Fuels CRC board in December 2018 and these projects commenced in early 2019. Additional projects will be approved during the year

The FFCRC is also involved in the "gas network blending" kickstart project as part of the national hydrogen strategy.

Near term opportunities

As noted above, there is significant activity across Australia in exploring the potential of hydrogen, both as an export opportunity but also as a domestic opportunity to supplement natural gas injected in networks or through providing an alternative to petrol vehicles.

Gas is an essential part of Australia's economy and it will continue to be vital into the future. However, there is broad acceptance that the energy sector needs to be decarbonised. The challenge is ensuring we do this at least cost to customers and making best use of our existing resources is the answer. Australia's gas pipeline infrastructure is immensely valuable not only as a distributor of energy, but as potential energy storage equal to six billion Tesla PowerWall batteries. Utilising this

infrastructure and taking advantage of hydrogen technologies to decarbonise gas offers enormous potential.

We welcome the ongoing opportunity to be involved in the development of the National Hydrogen Strategy. I have attached our responses to the key policy questions identified in the Request for Information.

If you have any other queries, please contact Dr Dennis R Van Puyvelde, Head of Gas on dvanpuyvelde@energynetworks.com.au or on 02 6272 1548.

Yours sincerely,

Andrew Dillon

CEO

Energy Networks Australia response to the Key Policy Questions

Key Policy questions	Energy Networks Australia Response
What do you think as the two or three most significant recent developments in hydrogen?	The transition to hydrogen appears to be driven by global drivers to reduce greenhouse gas emissions. There are three areas where this is prominent. 1) Mobility. The use of hydrogen as a transport fuel appears to be the biggest commercial driver for hydrogen at the moment. There is a lot of activity in the Northern hemisphere in implementing hydrogen refuelling stations and setting targets to achieve hydrogen fuel cell vehicles. Many of the major car manufacturers have fuel cell vehicles as part of their offerings, although many of these vehicles are not yet available in Australia. Besides passenger vehicles, hydrogen is also being demonstrated in trucks, trains and shipping. 2) Energy storage. Hydrogen is seen as an energy storage medium that can absorb surplus renewables and store that over long periods of time. The storage opportunity offered by hydrogen is complementary to other storage mechanisms in the electricity sector such as battery storage. 3) In networks. Hydrogen – as a clean fuel – presents an opportunity for gas networks to decarbonise. Hydrogen can be used in conjunction with biogas. There are a number of projects and trials globally to consider both the use of pure hydrogen, as well as the use of hydrogen to form renewable methane, in gas networks.
What are the most important safety issues to consider in producing, handling and using hydrogen in Australia?	Hydrogen as a mobility vector appears to be a technology that is well developed and has appropriate safety measures involved. The key safety issue to better understand is how pure hydrogen can be used as a replacement fuel for natural gas. Hydrogen has different combustion characteristics and these need to be better understood. Significant work at the UK's HyHeat project and through

	Australia's FFCRC is investigating how appliances will function with the conversion to hydrogen. The project in FFCRC is investigating how existing appliances will operate with blends of up to 10% hydrogen and then will also test the implications of increasing the blend to higher concentrations to identify potential appliance modification that may be required when using pure hydrogen.
What environmental and community impacts should we examine?	For hydrogen to be considered a clean fuel, it is important to better understand its environmental credentials including the pathway chosen to produce hydrogen. This environmental assessment should include things such as greenhouse gas emissions and the use of toxic and/or rare materials (eg catalysts) during the production, transport and use of hydrogen. The opportunity that hydrogen presents should be clearly articulated to the community, who should be actively engaged in the process of converting to new energy systems, rather than having it done to them. The ARENA report "The Australian Public's perception of hydrogen for energy" makes useful recommendations that could be adopted to engage the community and stakeholders. Modifying infrastructure impacts on communities and households, as has been seen by the roll out of the NBN. One of the projects currently underway at FFCRC is to better understand the community's response when infrastructure is upgraded (eg NBN, VHS to DVD, Towns gas to natural gas, etc) and to learn from those earlier experiences.
How can Australia influence and accelerate the development of a global market for hydrogen?	Australia has strong energy export industries with partner countries in the Asia Pacific region. Australia is typically a technology adopter from overseas and in the technology space (eg fuel cells, vehicles, electrolysers) it is highly likely that Australia will continue to be an adopter of overseas technology. The role for Australian industry is to adopt this technology and ensure it can be used in conformance with local regulations.

What are the top two or three factors required for a successful hydrogen export industry?	Australia could learn from other successful export markets and adopt those lessons. In particular, a successful hydrogen industry would need to recognise both the roles of hydrogen as an export opportunity as well as the domestic use of hydrogen in mobility, in gas networks, to support the electricity system and in industry. It is likely that the best way to grow a hydrogen export industry in Australia is to first grow the domestic use of hydrogen. While the east coast LNG industry is seen as a success by gas producers, there are many industrial domestic users that have raised concerns regarding price and availability of gas due to linking domestic gas supply to the international market. As an exporting nation, Australia will need to develop large scale storage facilities. Geological storage of hydrogen could be an opportunity for Australia to take an international leadership role.
What are the top two or three opportunities for the use of clean hydrogen in Australia?	Early opportunities for the use of clean hydrogen is to demonstrate the use of hydrogen across the economy. This may include government procurement or incentives for hydrogen fuel cell vehicles to also support the enabling infrastructure. This will build a base for fuel cell vehicles and allow the community to become familiar with it as a complementary technology to EVs. The use of clean hydrogen in networks could be encouraged via a green gas injection policy and/or financial incentive. This would support a scale of hydrogen production capacity to be built with the level to be absorbed by gas networks and once at scale, some of this could then be diverted to the mobility or export sectors. A major opportunity is enabling greater linkages and resilience across the mobility, electricity, gas and industry sectors. In electricity, hydrogen production from surplus renewables leads to significant energy storage potential in gas networks. The energy could

	also be stored seasonally allowing energy shifting from summer to winter. Electrolysers are very responsive and integration of this technology as highly flexible load creates opportunities to increase utilisation of the electricity system.
What are the main barriers to the use of hydrogen in Australia?	Hydrogen in Australia is in its infancy. As demonstrated overseas, the technology to produce and use hydrogen in mobility is well accepted and operating as expected. The critical factor will be ensuring that the production and use of hydrogen continue the journey down the cost curve to ensure its competitiveness. At this stage there do not appear to be many legislative barriers to the use of hydrogen within Australia, the main requirement being that when blending hydrogen into gas networks, that it is done to ensure the gas mixture still operates within the range of natural gas supplied via the network.
What are some examples of where a strategic national approach could lower costs and shorten timelines for developing a clean hydrogen industry?	Lessons from earlier government initiatives such as the National CCS Flagships and the Clean Energy Initiative should be considered when developing a national approach to developing a clean hydrogen economy. In particular, while a national strategy could offer the potential to shorten timelines, it should be recognised that major projects, such as major hydrogen production or export facilities will take may years to build. Key lessons from earlier strategies would be to ensure the level of government funding offered is adequate to cover the commercial gap with these early projects and that they do not set unrealistic timelines.
What are Australia's key technology, regulatory and business strengths and weaknesses in the development of a clean hydrogen industry?	Australia appears to be behind the northern hemisphere in hydrogen production technologies. Our obvious advantage appears to be that we have very large renewable resources in the form of wind and solar, that could offer an opportunity to produce renewable hydrogen at competitive prices for exports. Developing that as a business model, linked to growing the domestic market and the storage capacity of

	hydrogen, would be a priority that could see Australia take advantage of a global hydrogen industry.
What workforce skills will need to be developed to support a growing hydrogen industry?	The existing electrical, gas and plumbing work force contains many of the skills needed for a hydrogen industry. However, processes and practices may need to be modified to ensure the ongoing safe operation of gas networks. For example, network repair processes may need to be modified to allow for the different characteristic of hydrogen. This is being promoted through the location of the Evoenergy pilot project at CIT in Fyshwick and the AGIG Tonsley pilot plant at the Tonsley Innovation District in SA. As part of a national strategy, a subgroup should be established to identify the workforce implications, and standards used by these workforce to design, build and operate hydrogen machinery.
What areas in hydrogen research, development and deployment need attention in Australia? What are` the gaps in our knowledge?	There is significant opportunity to improve hydrogen technologies. The majority of research effort around the world appears to focus on lowering the cost of hydrogen production technologies. While this is important, there are other areas in the hydrogen supply chain where RD&D is also required. FFCRC has three research programs that address: • Future fuels technologies, systems and markets, • Social acceptable, security of supply and public safety, and • Network lifecycle management Gas network members of Energy Networks Australia are investing in demonstrating the use of hydrogen in networks. These projects will highlight how hydrogen can be produced, transported and used in Australian gas networks. They will also test the role of hydrogen as an integrator between electricity networks, gas networks and mobility. Ensuring the FFCRC research progresses and informs the development of a domestic market for hydrogen should be a focus area for the national strategy.