31 July 2019

Alison Reeves

National Hydrogen Strategy Taskforce
Department of Industry, Innovation and Science
Canberra ACT 2600

Via email: hydrogen@industry.gov.au

Energy Networks Australia's submission to the National Hydrogen Strategy Issues Papers

Dear Ms Reeves

Energy Networks Australia welcomes the opportunity to respond to the National Hydrogen Strategy (Strategy) Issues Papers.

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 to homes around the country.

To date, the focus of decarbonisation has been on the electricity sector. Over the longer-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.

Gas Vision 2050 outlines industry's journey to decarbonise the use of natural gas in homes, businesses and industry. Since the launch of the document in March 2017, many hydrogen related activities have commenced. Energy Networks Australia believes that hydrogen represents cross sectoral opportunities, where existing infrastructure can be utilised to support domestic and export industries.

Our responses to the questions in the issues paper are focussed on scaling hydrogen, attracting investment and the role of hydrogen in gas and electricity networks (issue papers 1, 2, 6 and 7 respectively). To facilitate the commercialisation of hydrogen, Energy Networks Australia recommends that:

- Hydrogen represents many cross sectoral opportunities that need to be better understood. For example, is there an opportunity for gas networks to support early hydrogen production projects, which can inject into networks delivering renewable gas for customers? Once built to certain scale, can this hydrogen be diverted to high value markets such as mobility and export? The issues papers recognise common elements in different sectors such as training and/or certification of hydrogen but do not adequately focus on potential cross-sectoral opportunities that could create multiple commercial opportunities for hydrogen.

Energy Networks Australia recommends that the Strategy considers these opportunities.

- Hydrogen, especially renewable hydrogen, links the electricity, gas and mobility sectors. This linking and the potential for hydrogen as an export fuel may require additional investment in infrastructure between energy resources and demand centres (e.g. cities or export facilities). The role of hydrogen as a mobility fuel also creates opportunities for this fuel to be delivered by the natural gas network, instead of the current transport fuel delivery mechanism of trucking. The Strategy could consider how these different networks could be optimised to ensure sector coupling opportunities.
- The 10 per cent kick start project has identified that there are no significant regulatory and technical barriers for injecting up to 10 per cent hydrogen in gas distribution networks. The report has also identified a range of issues for injecting higher volumes of hydrogen that could be considered by the Strategy.
- For many applications, the use of hydrogen is not an economic option at the moment. As clearly illustrated by other low carbon technologies, such as solar PV, the cost of the technology decreases with increases in the total capacity of that technology installed (not just the time). Similar cost reductions can be expected for renewable hydrogen production. To incentivise the build-up of capacity of hydrogen will require a form of incentive to send the right signal to industry and end-users to invest in hydrogen technology. The Strategy could highlight the role of incentives and the need for these in different applications of hydrogen. For example, an incentive to lower the cost of production may be required for hydrogen to be used in industry while an incentive for refuelling infrastructure may be what is required in the mobility sector.
- It is readily recognised that conversion to 100 per cent hydrogen in networks may require upgrades to some infrastructure and most appliances. An alternative approach is to produce renewable methane using renewable hydrogen and then using that renewable methane as a complement to natural gas. The major benefit is that renewable methane behaves the same as natural gas but does not require the upgrades to infrastructure and appliances, or industrial processes. A least regrets action is to pursue the development of renewable hydrogen with renewable methane as a potential option being considered. The Strategy could acknowledge the potential role of methanation as a means to decarbonise gas.
- Related to the above points, targeted investment has demonstrated major cost reductions. An Australian example is ARENA's focussed investment round on large scale solar photovoltaic projects from 2015. Through this program and other international cost drivers, the cost was reduced from $135 per megawatt hour (MWh) in 2015 to an expected $44.50 – $61.50 per MWh in 2020[1]. The Strategy could consider whether focussed investment in large scale hydrogen production technology, similar to ARENA's funding round, could accelerate the commercial viability of hydrogen projects, and the opportunity for exports.

[1] https://arena.gov.au/renewable-energy/large-scale-solar/

- While the focus of the National Hydrogen Strategy is on hydrogen, there are other fuels that could be applied to achieve deep emission cuts. This includes biomethane, or renewable methane as mentioned above. The Strategy should be cognisant that the focus of industry is on decarbonisation and that a wide range of potential options are under consideration.
- Hydrogen is recognised as a fuel with many potential applications. However, many of these are commercially uncompetitive at the moment. The Strategy should encourage further applied RD&D in hydrogen production, transport and use technologies as this may lead to cost reductions resulting in faster and greater deployment of hydrogen.

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

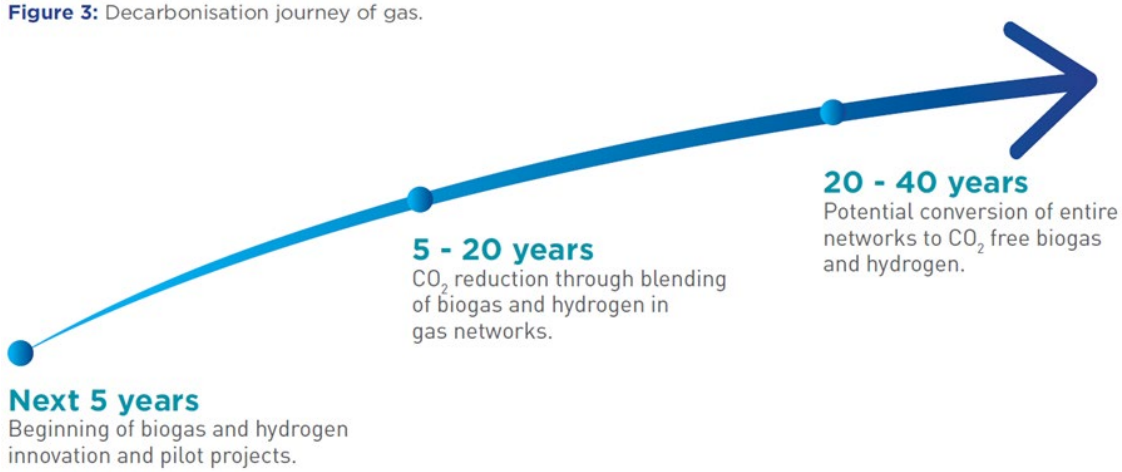
Response to questions

ISSUES PAPER 1: HYDROGEN AT SCALE

General Comments:

- Hydrogen is a very flexible fuel with a broad range of applications. Identifying the scale of hydrogen, and the timing of when this scale is required, is a key part of the Strategy, and could consider the domestic (in gas networks, mobility, or for industry) and export roles of hydrogen.
- The gas industry has developed a strategic plan – Gas Vision 2050 – with the aim to decarbonise gas in line with Australia's long-term decarbonisation targets. The decarbonisation pathway involves the use of hydrogen, biogas and carbon capture and storage.
- The pathway, illustrated below, involves testing and developing renewable gas technology through applied research and pilot projects out to 2022. Our network businesses are currently progressing four hydrogen trials around the country with two already operational, and the other two expected to be operational by mid-2020's. The learnings from these projects can assist larger scale deployment.

Figure 3: Decarbonisation journey of gas.



- This pilot scale phase will be followed by blending renewable gas into networks at larger scale. The National Hydrogen Strategy is considering an injection target of 10 per cent by 2030. Beyond the mid-2030's, large scale conversion of gas networks can be carried out to achieve 100 per cent renewable gas by mid-century.
- A 10 per cent target for gas networks around the country would represent approximately 5 PJ of gas. This corresponds to a total capacity of electrolysers of around 1 GW to be designed, financed, approved, built and operated between now and 2030.
- All the energy supplied by gas networks to households and businesses in 2017/18 was 155 PJ. A similar amount is provided to industry, power generation

ISSUES PAPER 1: HYDROGEN AT SCALE	
and as feedstock to industrial processes. Replacing all of this with hydrogen will require a long-term plan. » The Strategy should provide guidance on: – The level of hydrogen that can be realistically achieved by 2030 and the priority sectors. – A pathway to 100 per cent hydrogen in the domestic market and as an export fuel.	
Question	**Energy Networks Australia Response**
1. What scale is needed to achieve scale efficiencies and overcome cost barriers?	» The scale of hydrogen required depends on the application. – Todays best prices, even at the 100 MW scale, can't compete with natural gas. At this scale, hydrogen will still be 35 per cent more expensive. Parity can be achieved with a further reduction in renewable energy costs and improvements in electrolysers. – In some applications (e.g. train lines), the role of hydrogen is already established (e.g. the new proposed hydrogen train routes in Europe instead of electrification). – In other applications, such as gas in networks, the rate at which the technology is deployed will affect the rate at which costs come down. A faster deployment supported by a target will reduce the cost quicker and achieve those scale efficiencies. » Appliance conversion will be a major undertaking. At the moment, there are over 11 million gas appliances in Australia and total gas connections continues to grow. Suitable replacements for these appliances are being developed overseas but converting and/or replacing appliances to run on 100 per cent hydrogen will be a major logistics exercise, spanning many years. » In all cases, building the scale of hydrogen will lead to cost reductions, resulting in more applications becoming commercially viable.
2. What approaches could most effectively leverage existing	» Using existing infrastructure to build scale will minimise the cost for new investment. A key finding is the 10 per cent kickstart report as part of the National

ISSUES PAPER 1: HYDROGEN AT SCALE	
infrastructure, share risks and benefits and overcome scale-up development issues?	Hydrogen Strategy that indicates there are no significant factors restricting the injection of up to 10 per cent hydrogen in gas networks. Using this infrastructure allows a vast amount of renewable hydrogen production to be built. » A range of cross sectoral approaches could be considered. – For example, an initial focus could be to build scale of clean hydrogen production by blending it in networks to build scale. Once scale is developed, some of this hydrogen could then be diverted to exports or mobility, which would then build more scale resulting in more commercial opportunities for hydrogen being realised.
3. What arrangements should be put in place to prepare for and help manage expected transitional issues as they occur, including with respect to transitioning and upskilling the workforce? How do we ensure the availability of a skilled and mobile construction workforce and other resources to support scale-up as needed?	» The existing plumbing and gas fitting workforce is skilled in working with natural gas. While additional training may be required to expand their skillset to include hydrogen, this will not be a major retraining exercise.
4. What lessons can be learned from the experience of scaling up supply chains in other industries?	» It should be recognised that there have been significant number of "cowboy" operators misleading customers and installing unsafe/ uncompliant systems for roof top solar and small-mid scale solar. Adequate regulation and standards will be required to avoid incidents and leaving system owners out of pocket from un-checked installers.
5. When should the various activities needed to prepare for hydrogen industry scale-up be completed	» As with any scale up of industry, this takes time and the Strategy should recognise that scaling up the role of hydrogen will take decades. As an example,

ISSUES PAPER 1: HYDROGEN AT SCALE	
by? What measures and incentives are needed to achieve these timings?	Australia's LNG export industry took many years to develop. » The Strategy should not set unrealistic target for 2030.

ISSUES PAPER 2: ATTRACTING HYDROGEN INVESTMENT	
General Comments: » There is a clear gap in policies to reduce emissions from energy used in mobility and heat. » Appropriate policy support is needed to transition current fossil fuel energy sources to renewable sources to ensure that consumers can continue to utilise the services of heat and mobility while at the same time reducing the associated greenhouse gas emissions. » For network businesses, investments in hydrogen are not recognised as a requirement under the national gas and national electricity laws. Changes to the regulatory framework would be required to allow these businesses to make larger investments to scale hydrogen and be able to recover those investment costs. » Energy Networks Australia is developing a draft policy mechanism that could be adopted to support the injection of renewable hydrogen in gas networks.	
Question	**Energy Networks Australia Response**
1. What changes to existing government support and additional measures are needed to: • commercialise and scale up the hydrogen industry? • ensure an appropriate balance between export and domestic demand?	» A Renewable Gas Target which encourages development of many aspects of the renewable gas industry, such as production, transportation, storage and exports will accelerate commercialisation and scale within the hydrogen industry. » Domestic and export markets are interrelated. The capacity to produce, transport and store hydrogen will deliver benefits to both domestic customers and export markets.
2. How do we ensure an attractive investment	» Many, if not most, commercial investments to develop and grow the hydrogen market will be long-term in nature.

ISSUES PAPER 2: ATTRACTING HYDROGEN INVESTMENT	
environment for private sector finance? Which methods would be most effective in leveraging maximum private sector finance and which activities should governments prioritise with limited funds? How should these methods change over the short, medium and long term?	» For long-term investments to be made, investors must have confidence that their investments will not be subject to additional undue regulatory or political burden, such as those uncertainties that are concerning Australian domestic.gas producers » To foster the required confidence, establishing long-term, legislated policies which support investment in a growing domestic or export hydrogen market is paramount.
3. What level of domestic market support is needed to achieve COAG Energy Council's ambition of being a major global player in hydrogen? In particular, what types of support will best provide the necessary domestic skills and capabilities and ensure domestic markets are available in the event that international markets do not emerge as quickly or as extensively as expected?	» Domestic skills and capabilities will be developed naturally as the hydrogen industry progresses development and should not be the focus of Government policy. » As AGIG describe, domestic market development builds capacity, skills and transportation capability which also benefits export markets. Growing export markets builds demand for production, which assists domestic markets. » To be considered as a potential exporter of hydrogen, Australia needs to demonstrate that we can scale up quickly to meet demand at a competitive rate. This means large renewable hydrogen plants 100MW or larger. There are a number of domestic applications that can take this that volume of hydrogen, for example ammonia nitrate production or injection into gas networks for domestic gas use. By supporting one or more such initiative will raise Australia's profile in this space and enhance the potential for it to be seen as a capable exporter. » Domestic and export markets will be best assisted by Government assistance to develop more competitive production and transportation capability.
4. What market and revenue designs and settings will best allow for sustainable	» No response provided.

ISSUES PAPER 2: ATTRACTING HYDROGEN INVESTMENT	
growth of the hydrogen industry and an appropriate level of benefits flowing back to the Australian public?	
5. What market signals and settings are needed to capture hydrogen's sector coupling benefits? When should these market signals and settings be applied?	» Sector coupling already exists in the market as gas plays a key role to support the variable generation from renewable energy. Hydrogen can continue this role and also expand its role as a distributed resource (for hydrogen production) that can be switched on and off to follow demand curves. » Market signals for sector coupling exist within the NEM already when electricity prices are low due to an abundance of renewable generation. A proper functioning market should send (long-term) price signals that enable investment in storage and ancillary services through which hydrogen can deliver value. » Commercial opportunities to leverage sector coupling benefits will become more appealing as production and transport productivity is achieved as well as when domestic and export markets are further developed.

ISSUES PAPER 3: DEVELOPING A HYDROGEN EXPORT INDUSTRY	
General Comments: » The NHS should recognise there is a balance between hydrogen exports and the development of a domestic market. » Lessons from the tightening East Coast gas supply and the linkage of that market to the global market through LNG projects should be learnt at this early stage.	
Question	**Energy Networks Australia Response**
1. How do we best position and sell the benefits to international partners of	» No response provided.

ISSUES PAPER 3: DEVELOPING A HYDROGEN EXPORT INDUSTRY	
investing in Australia's emerging hydrogen industry?	
2. How could governments support the cost competitiveness of Australia's hydrogen exports?	» No response provided.
3. What could governments do to encourage commercial offtake agreements for export?	» No response provided.
4. How do we balance our global competitiveness with ensuring all Australians benefit when considering the collection of government revenues from hydrogen exports?	» No response provided.
5. What can (or should) be done to ensure an appropriate balance between export and domestic demand?	» No response provided.
6. How ambitious is the target of fulfilling 50% of Japan and Korea's hydrogen imports by 2030?	» The strategy should quantify what this means in terms of total amount of hydrogen produced. What is the scale of this and how does it compare to the scaling of the LNG export industry? Building up industries to significant scale takes time. » It may be pertinent to consider if Japan and South Korea will want 50% of their hydrogen coming from a single

ISSUES PAPER 3: DEVELOPING A HYDROGEN EXPORT INDUSTRY	
	country by 2030? For energy security reasons they may want greater diversification of supply. » The Strategy should also be cognisant of other national and or state based targets and how those could affect meeting the fulfilment of an export target. For example, the Interim Emissions Reduction Targets for Victoria (20121 – 2030) considers a renewable energy target of 45 to 60% by 2030. The impact of a State based target of that magnitude should be considered when export targets (also based on renewable energy) are added. » As mentioned above, a target of 10 per cent (by volume) of residential gas in Australia would represent around 5 PJ of energy and require close to 1,000 MW of electrolyser capacity?

ISSUES PAPER 4: GUARANTEES OF ORIGIN	
General Comments: » A guarantee of origin will be required to enable the capturing of value from the lower carbon footprint of hydrogen and other renewable natural gases. It is important that the Guarantee of Origin (GOO) scheme is credible, adaptable and usable » This guarantee will be important in carbon accounting markets.	
Question	**Energy Networks Australia Response**
1. When should Australia aim to have a guarantee of origin in place? Why is this timing important?	» Internationally – when Australia export hydrogen as a clean fuel and the export partners use this hydrogen to reduce their domestic greenhouse gas emissions. » Domestically – to allow Australia to use hydrogen as a clean fuel to meet our international greenhouse gas emissions obligations. – This will be required by mid to late 2020s, when gas distribution networks are scheduled to inject renewable hydrogen into their networks.
2. What would be the best initial scope for a guarantee of	» The scope of the scheme should initially be: – restricted to gas networks as mass balance and metering is currently built in, it can be expanded to other methods at a later stage.

ISSUES PAPER 4: GUARANTEES OF ORIGIN	
origin? Why? Should there be two separate schemes for international and domestic requirements?	– The domestic scheme should be the initial priority as if it is built in compliance with an international standard such as BS EN 16325 (as per Green Gas UK) it can be interfaced with export markets at a later stage. – It should be flexible such that it can be adapted to different sources and changing requirements, such as interfacing with export markets.
3. Beyond the University of Queensland report referenced above, and published hydrogen strategies from Japan and Korea, what intelligence on consumer and market preferences is available to inform an Australian guarantee of origin?	» No response provided.
4. Should a guarantee of origin have an eligibility threshold? If yes, what should it be based on?	» Yes, but there has to be a compromise between creating a high compliance cost and ensuring credibility. Therefore, we would propose that a maximum level of gCO_2 per GJ (or MWh) is required to ensure that the source is eligible. Then producers can receive a GOO for injecting gas from that source if they meet source rules, without each having to undergo full carbon assessments.
5. Who is the most appropriate body to develop and maintain criteria for a guarantee of origin and administer certification? Why?	» The scheme should be managed by an independent body, potentially the Clean Energy Regulator. This is to ensure adaptability, independence, innovation and reduce compliance costs » The Clean Energy Regulator already administers the Renewable Energy Target, the Emissions Reduction Fund, the Safeguards Mechanisms and the National Greenhouse and Energy Reporting. The certification and guarantee of origin is similar to the schemes administered by the CER so it may be best placed to also administer a certificate scheme for hydrogen – at different emission levels.

ISSUES PAPER 4: GUARANTEES OF ORIGIN	
	However, the compliance requirements of meeting the current programs is high and a new scheme for hydrogen should not duplicate that level of complexity, unless necessary. » For exports, an agency would need to align the certificates and guarantees of origin with other international schemes, especially those of our trading partners.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS FOR SAFETY AND ENVRIONMENTAL IMPACTS	
General Comments: » While the focus of the National Hydrogen Strategy is on hydrogen, there are other fuels that could be applied to achieve deep emission cuts. This includes biomethane, or renewable methane as mentioned above. The Strategy should be cognisant that the focus of industry is on decarbonisation and that a wide range of potential options are under consideration. » The community's concern will be around reducing emissions from the use of natural gas, and may be less concerned about whether this is achieved through the use of hydrogen, biomethane or renewable gas. .	
Question	**Energy Networks Australia Response**
1. Do existing regulations adequately manage the potential carbon emissions of a large-scale national hydrogen industry?	» No response provided.
2. What are the main community concerns about the use of CCS? How can we better manage these concerns and potential CCS	» No response provided.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS FOR SAFETY AND ENVRIONMENTAL IMPACTS	
projects in regional areas?	
3. What are the risks about using desalination plants or water recycling facilities to produce water for electrolysis?	» A recent report by Jacobs "Hydrogen economy" concluded that using recycled water is a more sustainable way to produce hydrogen. They also noted that the volume of fresh water needed to support a hydrogen economy (both for exports and domestic markets) would only require a trivial amount of water compared to the 11 trillion litres of water used by Australia's agricultural industry. » Integrating a hydrogen production facility with a wastewater facility also creates opportunities for utilising waste heat and potentially producing renewable methane.
4. How can we best balance the water and land use requirements for environmental, agricultural, community and hydrogen production uses?	» Selecting locations for hydrogen production facilities will require the balancing of the different resources required. This will require an understanding of the demand for hydrogen, how that hydrogen is going to be transported from its source of production to its market (e.g. pipeline, trucking or injecting directly into distribution networks), and the input for producing that hydrogen (e.g. electricity, water, natural gas), and possible also the infrastructure required if CCS is involved in the hydrogen production process.
5. Hydrogen production projects will require significant project and environmental approvals at the local, state and federal level. What approaches could help to manage these approvals to facilitate industry development while providing suitable environmental and natural resource protections and	» Approval processes for major projects are already well developed although may differ by jurisdiction. » An additional measure for hydrogen projects would be their role in reducing greenhouse gas emissions and the export opportunities these projects can create leading to increased jobs.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS FOR SAFETY AND ENVRIONMENTAL IMPACTS	
managing community expectations? When do these approaches need to be in place by?	
6. What are the most important standards and regulations to have in place to ensure a safe hydrogen industry and address the community expectations?	» Many of the existing standards and regulations are applicable to hydrogen. These are being reviewed to identify any gaps in knowledge. » Standards Australia has established a local committee to mirror the work at the International Standards Organization on hydrogen standards. – Some gaps in current standards have been identified and these are being worked through by the ME93 working group to address these and how best to update existing standards as well as adopt/mirror international standards.
7. As an individual, how would you like to be engaged on hydrogen projects? Which aspects would you like to be kept informed of? Which aspects would you like to be consulted on? Are there any types of issues or challenges that you, or affected communities, would want to be a part of formulating solutions and recommendations?	» No response provided.
8. What are the best ways of engaging diverse	» Gas distribution networks are actively engaging communities.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS FOR SAFETY AND ENVRIONMENTAL IMPACTS	
communities in regional and remote areas?	» Network businesses are currently developing a range of pilot projects that will inject hydrogen into the gas network. Engaging with the local communities is a major component of these projects to ensure community acceptance. » Infrastructure businesses have a good track record of engaging with regional and remote communities, for example Jemena and its Northern gas Pipeline. » The energy industry has adopted *The Energy Charter*. This is focused on embedding customer-centric culture and conduct in energy businesses to create real improvements in price and service delivery, through commitment to the Five Principles: – We will put the customer at the centre of our business and the energy system. – We will improve energy affordability for customers. – We will provide energy, safety, sustainability and reliability. – We will improve the customer experience. – We will support customers facing vulnerable circumstances
9. What role could an industry code of conduct play in gaining community support for hydrogen projects? What community engagement principles would you like to see in an industry code of conduct?	» There are many things to be learnt from the upstream industry's development of the coal seam gas industry. These lessons should be included in an industry code of conduct. » The Energy Charter is supported by many energy businesses involved in the hydrogen value chain.
10. What governance structures (such as legislation and regulation) would the federal, state and local	» No response provided.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS FOR SAFETY AND ENVRIONMENTAL IMPACTS	
governments need to put in place for a large scale hydrogen facility?	
11. What further lessons can we learn from the mining, resources and renewable energy sectors about establishing and maintaining community support?	» No response provided.

ISSUES PAPER 6: HYDROGEN IN THE GAS NETWORK	
General Comments: » Gas distribution networks are a key enabler to the scale up of the hydrogen industry. » Networks are considering the role of hydrogen as well as biomethane and renewable methane to provide carbon free fuel to customers. » A low level of hydrogen injection into the networks can result in a strong signal to building up scale of the hydrogen supply industry. It is expected that injection of around 10 per cent hydrogen into networks can be done safely without raising any concerns about natural gas usage by households. [See 10 per cent kickstart project report by GPA Engineering]	
Question	**Energy Networks Australia Response**
1. Which existing gas distribution networks or stand-alone systems are 'hydrogen ready' and which are not? What safe upper limit applies? Does this readiness	» Australia's gas distribution networks are mostly constructed of plastic materials that are compatible with hydrogen. Earlier towns gas networks were constructed using cast iron and these have been replaced over the time to improve operational performance and enhance safety. It is expected that the full conversion to plastic networks will be completed by the mid 2020's. – Networks are effectively ready and individual network operators would be best placed to provide detailed

ISSUES PAPER 6: HYDROGEN IN THE GAS NETWORK	
include meters, behind-the-meter infrastructure, and appliances?	information about the extent of the conversion process for their network. » Gas fitting behind the meter in homes is covered by *AS/NZS5601.1:2013 Gas Installations*. Given the low pressure environment, it is expected that home gas installations will operate safely with hydrogen blends. » It is expected that existing gas appliances can continue to be operated safely and efficiently when blending up to 10 per cent hydrogen into the network. Beyond this, some appliance modifications may be required to ensure they continue to operate safely and efficiently. – Work is currently underway by Future Fuels CRC to test appliances up to 10 per cent hydrogen. – Appliance development work is being carried out in Australia and overseas to ensure appliances can operate with high levels of hydrogen.
2. What is the potential to have a test project of 100% hydrogen use in a small regional location and where?	» Establishing new 100 per cent hydrogen developments and transferring parts of existing networks to 100 per cent hydrogen are logical steps towards full hydrogen adoption. » Gas network businesses are able to provide details regarding sections of their network, or regional networks, that are fully compliant with converting to 100 per cent hydrogen. » To demonstrate a conversion of a regional town to 100 per cent hydrogen will require suitable appliances to be available and the safety regulator to be engaged to approve such a project. » To facilitate approvals from the regulator, network businesses could adopt industry best practices from overseas activity and adopt those standards if approved by regulators. » Hydrogen based micro grids could likely become commercially viable by 2030, a number of trials under different conditions should be supported to assist in identifying and resolving key issues preventing wider adoption. A recent example is an announcement by a housing developer in Aberdeen, Scotland to include 30 hydrogen fuel cell homes in its latest development. (https://www.h2-view.com/story/first-for-scotland-plans-submitted-for-hydrogen-powered-homes/)

ISSUES PAPER 6: HYDROGEN IN THE GAS NETWORK	
3. Which standards and regulations can be harmonised across jurisdictions considering the different structures and market settings (e.g. safety, codes of practice)?	» Australian Standards (AS4645 – Gas Distribution Networks) are already in place. These standards provide best guidance to construct, operate and manage gas distribution networks covering all materials in those networks. » This standard was last reviewed and updated in 2018. » The standard is the best vehicle to make amendments to networks protocols when changing the gas blend from natural gas, to a hydrogen blend and then to 100 per cent hydrogen. » Similarly, standards for behind the meter and appliances are already in place and will need to be modified for changing network fuel compositions.
4. What roles should government and industry play in addressing any consumer concerns and building social acceptance?	» Network businesses are effectively engaging with the community through current pilot projects. This engagement will potentially identify community concerns. » In particular, the Strategy should be informed by the work of the Future Fuels CRC – a joint initiative by government and industry. The FFCRC has a research program focussed on addressing consumer concerns and building social acceptance. The research program has a number of active projects to better understand the community's reaction to changing infrastructure requirements and to better understand the community's perceptions on converting to renewable gas.
5. How could the actions included in Table 2 be improved? Are there other actions that should be added?	» Many of these activities listed in Table 2 in the report are already underway through industry-led pilot projects and industry-led R&D via Future Fuels CRC. » Some specific notes: – Hydrogen blending will need to be allowed by the mid 2020s to enable current pilot projects to be able to inject into networks, therefore, this should be brought forward to the 2020-2022 timeframe. – Appliance readiness should be conducted in collaboration with manufacturers. The priority should be to establish the achievable hydrogen concentration with existing appliances, then establish requirements for higher percentages. It is important for social license that changes to appliances are sufficient to support renewable gas used in networks, which may not necessarily be 100 per cent hydrogen.

ISSUES PAPER 6: HYDROGEN IN THE GAS NETWORK	
	– The potential path to 100 per cent hydrogen should be better understood through both trials and demonstrations. The focus of the actions should be on understanding the costs and benefits of transition to a low carbon gas network rather than greenfield 100 per cent hydrogen projects. » Industry is leading a number of pilot projects that will provide relevant information to the activities in Table 2. Individual network businesses will be able to provide additional information. » ARUP has recently produced a report for a timetable for conversion in the UK. The UK is generally understood to be around 5 years ahead of the rest of the world in terms of decarbonising their gas networks. Their roadmap is a good reference source for the Strategy. » https://www.arup.com/perspectives/publications/research/section/establishing-a-hydrogen-economy-the-future-of-energy-2035

ISSUES PAPER 7: HYDROGEN TO SUPPORT ELECTRICITY SYSTEMS	
General Comments: » Clean hydrogen from electrolysis interacts with the electricity system in a number of ways. – Firstly, as a major and flexible load, it can be used as a demand response to provide stability to the network at both the transmission and the local network levels. – Secondly, as a supplement or replacement for natural gas, it will ensure that seasonal heating currently supply by gas can continue to be met by a gaseous fuel resulting in optimised use of energy infrastructure. – Thirdly, as a long-term storage option, it has the potential to generate electricity through either turbines or fuel cells at times of low variable renewable energy generation. – Fourthly, hydrogen as a mobility fuel will reduce the impact of electrification of mobility on the grid.	
Question	**Energy Networks Australia Response**
1. How can hydrogen production best be	» The strategy should highlight the potential opportunities for the hydrogen and electricity systems to connect. In particular, it could promote the integration of

ISSUES PAPER 7: HYDROGEN TO SUPPORT ELECTRICITY SYSTEMS	
integrated with current electricity systems (for instance, should large-scale hydrogen production be connected to current electricity systems)? Are there barriers or risks to integration that need be addressed in the Strategy?	electrolysers into electricity networks with high penetration of renewables as load balancing systems. » The Integrated System Plan (ISP) is the integrated plan for strategic transmission infrastructure across the National Electricity Market (NEM). Emissions policies and renewable energy subsidies, renewable energy hubs and demand centres play an important role and have a critical impact on modelling and the results of a co-optimised plan. All state and federal government policies that impact the NEM such as various trajectories of renewables should be documented by COAG and formally provided to AEMO for use in the ISP assumptions and modelling. » The Strategy should be cognisant of the national planning approach for electricity transmission, and the implications this can have for integrating large scale hydrogen production facilities into the energy system.
2. What, if any, future legislative, regulatory and market reforms are needed to ensure hydrogen supports, rather than hinders, electricity system operation and delivers benefits for consumers (for example by reducing demand during high price events)? What is the timeframe, and priority, for these changes?	» The production of hydrogen via an electrolyser represents a significant load. Electricity Networks would want such a process to be defined as "load". In Europe there is a push for hydrogen production via an electrolyser to be exempt from import charges (as part of lobbying on storage). » In the UK OFGEM have just released guidance on the regulatory treatment of storage that would exclude hydrogen production from the exemptions on import charges that would apply to electricity storage. The OFGEM work includes a definition for electricity storage. Where electrolysed hydrogen was stored and then subsequently converted back to electricity (at the same location) this could be classed an "electricity storage facility" under the UK regulations (electricity in-storage-electricity out). » Hydrogen production via electrolysers represents an important "footroom" service. This is where electricity demand is increased to better match (excess) generation. Footroom is an established demand response service in the UK and helps resolve the minimum demand problem (belly of the so-called duck curve). Demand response services are poorly utilised in Australia. There is a lack of experience of using demand response to manage the Australian electricity system (at all scales, Distribution and Transmission), while in the UK and USA demand side response provides critical system balancing services. The

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	proposed rule changes for demand response in the Wholesale market may help, but the lack of support (e.g. proposed ENA rule change for TNSP DMIS/DMIA scheme) for innovation funding for networks to develop the contractual, technical and market arrangements for large-scale demand response is preventing the deployment of non-network options (NNO) – and the production of H2 from electrolysers is a NNO
3. Do current market frameworks incentivise the potential value of hydrogen to support electricity systems? What initiatives or changes required?	» See above on demand side response and footroom.
4. Do current market frameworks allow for sector coupling and interactions between different markets that may result from hydrogen production (such as the interplay between gas, electricity, and transport sectors)? If not, what changes are required?	» https://www.aemc.gov.au/news-centre/media-releases/wholesale-demand-response-mechanism-extended-more-consultation » AEMO ISP may not incorporate hydrogen opportunities. As mentioned under Q2, hydrogen presents many opportunities that could be either considered as competing with hydrogen, or supporting it. » Electric vehicles are yet to be deployed at scale in Australia.
5. What factors should be considered when selecting pilot and demonstration projects? How can government best	» Australia already has a number of pilot projects underway (see response to section 6). » The next phase should be on scaling up the production of hydrogen to reduce its cost. Government could support through appropriate incentives, for example a renewable gas injection target providing an incentive for energy of renewable gas injected into the gas network. Additional

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support pilots and demonstrations?	support in the form of competitive grants would reduce the entry cost and share the risk to capital intensive projects between industry and government. » This is similar to the Renewable Energy Target and then the focussed support by ARENA on large scale solar PV projects.

ISSUES PAPER 8: HYDROGEN FOR TRANSPORT	
General Comments: » Australia will be a follower in fuel-cell vehicles, especially for passenger vehicles. » There are a number of unique opportunities available for Australia in hydrogen mobility, for example the role in long distance freight via railway or the use of hydrogen at remote mining sites.	
Question	**Energy Networks Australia Response**
1. What groups or companies could lead a consortium approach to building refuelling infrastructure?	» Networks should be involved in these consortia as in the longer term, these networks may be able to provide hydrogen fuel to the refuelling infrastructure compared to the current role of providing fuel via refuelling trucks.
2. What groups or companies could coordinate procurement of hydrogen cars, buses and ferries?	» Large fleet users could support the role of hydrogen through selective procurement of hydrogen for fleet vehicles. For example, governments could select hydrogen buses at the next tender stage and as such support the development of hydrogen production and refuelling infrastructure. Large fleet users that return to base, e.g. couriers or taxis, could also lead to increased hydrogen scale. » The National Hydrogen Roadmap indicates that the cost of hydrogen for these applications is commercially competitive.
3. Other than emissions limits and procurement policies, how could government actions (federal,	» No response provided.

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state or local) support private investment in vehicles and infrastructure?	
4. How can governments and industry reduce the financial, technology and operational risks of purchasing new technology vehicles?	» No response provided.
5. What are some ways hydrogen vehicles could be showcased and demonstrated to the community at large?	» Toyota has demonstrated its fuel-cell vehicle technology through a round of lending a series of its vehicles to local council and businesses in Victoria. This results in increased exposure of the technology. » Globally, a wide range of mobility is being demonstrated including buses, trains, trucks, and shipping. These back to fleet vehicles demonstrate how these vehicles can be used while at the same time increasing the supply for hydrogen, and subsequently reducing its production cost, which results in other applications becoming commercially viable.
6. What are the key enablers and realistic timelines for a transition to: • Hydrogen-fuelled buses? • Hydrogen-fuelled passenger ferries? • Hydrogen-fuelled long-distance freight (including heavy trucks, trains and long distance shipping)?	» Many of these vehicles are commercially available on the international markets. Gaining Australian certification may be a limiting factor. Certification of refuelling infrastructure will also be required. » Buses, ferries, freight and shipping all benefit from returning to depots where refuelling stations could be placed. Similarly, forklifts and other on site vehicles are location specific so a local refuelling station could be used to provide hydrogen for those vehicles. » Mining vehicles provide another opportunity to demonstrate the role of hydrogen. » Light vehicles are more challenging as their movements are less restricted so that they are not suitable to be refuelled at depots compared to return-to-base fleets. » It appears that hydrogen vehicles are available commercially in other countries but that Australia does

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• Hydrogen-fuelled forklifts and ancillary vehicles? • Hydrogen-fuelled light vehicles?	not have any hydrogen vehicles available for purchase. This is likely a reflection of the lack of infrastructure (which in its own way is a reflection of no demand since no vehicles are available).

ISSUES PAPER 9: HYDROGEN FOR INDUSTRIAL USERS	
General Comments: » Industrial customers use large volumes of gas for either or both energy or as a feedstock. In many opportunities such as fertiliser, being able to use hydrogen instead of natural gas may be beneficial to the process. Providing hydrogen to a few industrial plants appears to be an easy way to develop a very large production capacity of renewable hydrogen that may reduce the production cost overall.	
Question	**Energy Networks Australia Response**
1. Hydrogen as a chemical feedstock. • Other than using hydrogen or carbon capture and storage, are there other ways to reduce emissions from the manufacture of metals, particularly steel manufacturing?	» No response provided.
2. Hydrogen for industrial heat • What other energy sources	» No response provided.

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are industrial users considering to reduce emissions from their industrial heat processes, and how cost-competitive are they compared to the fuel currently used?	
3. Supplying clean hydrogen for industrial users • What would industrial users of hydrogen need from a hydrogen supply network? • Are there locations around Australia where there is an existing or potential demand for hydrogen from industry that are close to renewable energy or carbon capture and storage resources?	» Some businesses are keen to buy green gas but there is no market mechanism in place to do so. » A renewable gas target would allow businesses to purchase green gas injected into the network. This would be an incentive for renewable hydrogen production.
4. Technical considerations in	» No response provided.

ISSUES PAPER 9: HYDROGEN FOR INDUSTRIAL USERS	
transition to clean hydrogen • What would a conversion to clean hydrogen look like in your industry, in terms of timing, effect on production, equipment changes? • What existing sites might be suitable to demonstrate industrial use of clean hydrogen? • Does existing equipment in industrial heating applications have the technical capability to handle increased NOx emissions?	
5. Hydrogen safety and regulation for industrial users • Are there examples nationally and internationally that illustrate best practice for industrial hydrogen	» No response provided.

ISSUES PAPER 9: HYDROGEN FOR INDUSTRIAL USERS	
safety regulation and handling expertise?	
6. Role for governments in supporting a transition to clean hydrogen • Are there any gaps in the existing mechanisms for government support for Australian industry to transition to hydrogen?	» No response provided.