Dr Alan Finkel AO
Chairman, Hydrogen Strategy Group
COAG Energy Council
Australian Government

05 April 2019

Hydrogen Energy Supply Chain (HESC) Project submission to the COAG Hydrogen Working Group's initial request for information

Dear Dr Finkel,

The Hydrogen Energy Supply Chain (HESC) Project Partners are grateful for the opportunity to provide input to the key policy questions that the Hydrogen Working Group is considering, and to provide comment on its planned approach for the development of a *National Hydrogen Strategy* for Australia.

This work is of critical importance to the burgeoning hydrogen industry and will provide the framework and confidence for investment in new technologies. As a first-mover project of international significance, we believe that the HESC Project should be a key factor in the development of a National Hydrogen Strategy. Indeed, it has the largest, near term commercial potential to lay the foundation of a hydrogen export industry in Australia and sow the seed for the adoption of hydrogen domestically.

The HESC Project is aiming to deliver liquefied hydrogen to Japan and establish an integrated commercial-scale hydrogen supply chain that encompasses production, transportation and storage. It is underpinned by Japan's *Basic Hydrogen Strategy* which sets out a number of targets, including the establishment of international hydrogen supply chains around 2025-2030. The HESC Project is living proof of the ground-breaking endeavours that can be generated out of comprehensive and well-targeted hydrogen policies.

As a consortium of highly reputable companies with expertise across the entire hydrogen supply chain, we, the HESC Project Partners, have accumulated a wealth

of insights, skills and technologies that can be leveraged in the development of an Australian *National Hydrogen Strategy*.

The delivery of the pilot HESC Project in Australia is coordinated by Hydrogen Engineering Australia (HEA), a consortium of reputable businesses with complementary technological and commercial expertise, working together for the realisation of the first global supply chain for hydrogen. Indeed, each Project Partner has a rich and longstanding association with hydrogen:

- Kawasaki Heavy Industries (KHI) – has long-standing experience in the design and construction of specialised liquefied hydrogen storage tanks, a ground breaking hydrogen liquefaction plant, and a world-first one hundred per cent hydrogen gas turbine;
- Electric Power Development Co., Ltd (J-POWER) – is a globally recognised leader in coal gasification technology. They are Japan's most important electricity provider with more than 90 power stations around Japan and over 60 years' experience;
- Iwatani Corporation – has mastered the handling and supply of hydrogen, being a leading hydrogen supplier in Japan with over 75 years of experience handling hydrogen, and only producer and supplier of liquefied hydrogen in Japan;
- Marubeni Corporation – is a leading trading house and has honed an extraordinary acumen for trading new commodities and developing infrastructure investment opportunities; and
- AGL – operates Australia's largest electricity generation portfolio and plays an important role in the development of hydrogen production for the HESC Project.

In recognition of the valuable and diverse experience that each Project Partner can offer the Hydrogen Working Group, enclosed is a joint submission from the Japanese HESC Project Partners, together with AGL's separate submission.

While the two submissions may focus on different aspects of your request for information, the HESC Project Partners stand united in supporting efforts to address the key issues that the hydrogen strategy should consider in order to realise the full hydrogen potential in Australia. These issues include, *inter alia*, driving investment through clear policy direction, addressing safety concerns, improving the cost

competitiveness of hydrogen vis-à-vis traditional fuels, creating hydrogen demand through regulatory and market incentives, and developing the infrastructure needed to service such demand and export opportunities.

We also commend the COAG Energy Council's principle for the *National Hydrogen Strategy* to be technology-neutral. Projects with hydrogen produced from fossil fuels, coupled with Carbon Capture and Storage (CCS) technologies, will help the industry develop hydrogen technology at scale, cost effectively in the short-term, and allow us to transition to renewable hydrogen in the long-term.

The *National Hydrogen Strategy* will shape the Australian hydrogen industry for decades to come, and we look forward to collaborating closely with the Hydrogen Working Group to ensure it is robust now and into the future.

Dr Finkel, we hope our responses to the key policy questions in the enclosed submissions help inform your approach to the development of a *National Hydrogen Strategy*, and we look forward to contributing to future rounds of public consultations.

Yours sincerely,

The HESC Project Partners

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Enclosures

- *Japanese HESC Project Partners joint submission*
- *AGL submission*

Submission to National Hydrogen Strategy Taskforce

April 2019

National Hydrogen Strategy: Submission
Executive Summary

- The HESC Japanese Project Partners, Kawasaki Heavy Industries, Ltd. (KHI), Hydrogen Engineering Australia Pty Ltd (HEA), Electric Power Development Co., Ltd. (J-Power), Iwatani Corporation (Iwatani) and Marubeni Corporation (Marubeni) welcome the opportunity to make this joint submission to the National Hydrogen Strategy Taskforce.
- We believe hydrogen can truly help the world with our significant decarbonisation challenges.
- We have committed significant investment in the development of hydrogen-related technologies and business over the last decade. We are doing this for our future generations because it makes sense, both commercially and morally.
- The vision of a hydrogen society is being pursued by the Japanese Government and industry, of which we are proud to be among the leaders.
- Given the scale of the decarbonisation challenges ahead of us, hydrogen will have to be low emissions and the pathway towards renewable hydrogen will inevitably need to include fossil fuel hydrogen, with Carbon Capture and Storage (CCS). It is vital we manage absolute emissions.
- A central element of our hydrogen strategy is the Hydrogen Energy Supply Chain (HESC) Project, which aims to convert Victorian brown coal into liquefied hydrogen for export. This world-first demonstration of an entire supply chain provides significant opportunities for both Australia and Japan in technology, innovation, economic development, investments and diplomatic relations by unlocking the value of Australia's abundant and diverse natural resources.
- We are at a critical juncture now that we have a global positive momentum towards hydrogen. With supportive policies at national, regional and local levels, we are confident that the hydrogen society will become a reality sooner than market analysts indicate.
- The size of the prize for Australia, both from an export and domestic industry development perspective, is significant enough for its governments and society to consider the hydrogen opportunity.
- A critical policy element for the emergence of a hydrogen industry (and society in Japan) is the long-term consistency and policy stability for hydrogen. We very much welcome both the Coalition and Labor's vision and supportive policies on hydrogen in Australia. We would like to see the maintenance of this bipartisan spirit.
- We would welcome the opportunity to discuss our submission in more detail with the Chief Scientist and the Taskforce so we can accelerate the deployment of hydrogen across multiple sectors, both in Australia and Japan.

- **Q1. What do you think are the two or three most significant recent developments in hydrogen?**

  - The release of the Japanese Government's Basic Hydrogen Strategy in December 2017, focusing on the materialisation of a "Hydrogen Society" around 2030. This would create one of the largest potential export markets for Australia's hydrogen products.

  - The launch of the world-first international liquefied hydrogen supply chain project, the HESC project, in Australia.

  - The successful demonstration of a world-first 100% hydrogen gas turbine supplying electricity and heat in an urban area, achieved by a Japanese consortium, including KHI, in Japan in April 2018.

  - The establishment of the Hydrogen Council in January 2017 and their seminal research work in the global hydrogen opportunity (two studies published so far).

  - The launch of Toyota's Mirai in December 2014 and the growing momentum for Fuel Cell Vehicles (FCVs) around the world.

- **Q2. What are the most important safety issues to consider in producing, handling and using hydrogen in Australia?**

  - At a high-level, a social licence for hydrogen has to be earned with the community for hydrogen to have legitimacy. We see safety as a subset of the broader social licence for hydrogen.

  - Misperceptions around hydrogen safety still persist amongst some members of the public. Handling of hydrogen in gaseous and liquid forms have occurred for decades with positive safety records.

  - Technical Australian regulations and standards in relation to safety will need to be developed and aligned with international codes. Safety should be the primary goal whilst pursuing the cost competitiveness of the technology.

  - At a more technical level, a proper understanding of the properties of hydrogen is essential for safety and prevention of a hydrogen explosion is a central area of focus.

National Hydrogen Strategy: Submission Q&A 2 (Cont'd)

- We will continue to undertake safety studies for a number of hydrogen technologies we are involved with. We have identified the following areas as priority for investigation:
    - Experiment for the characteristic of hydrogen gas self-ignition;
    - Experiment for the characteristic of backfire in ventilation line;
    - Measurement of hydrogen concentration distribution in the evaporating gas with vapor cloud from liquefied hydrogen;
    - Hydrogen gas measurement sensor/detector;
    - Experiment on the characteristic of displacing (piping blow method);
    - Measurement of hydrogen ignition energy and flame propagation velocity with various concentrations in the atmosphere; and
    - Hydrogen fire extinguish method.
- As we deliver the HESC Project, we believe Australian research organisations could contribute to this area. We are currently discussing with potential Australian research organisations joint R&D opportunities. This type of practical know-how exchange between Japan and Australia requires funding commitment from Australian research organisations and governments.

- **Q3. What environmental and community impacts should we examine?**

  - As long as emissions are taken care of, hydrogen production could come both from fossil fuels coupled with CCS (or Carbon Capture, Utilisation and Storage (CCUS)) and purely renewables plus electrolysis.

  - Continued advancements of the technical, commercial, financial and social licence aspects of CCS will be fundamental for hydrogen in Australia, in particular for large-scale projects.

  - In order for the HESC to proceed to a commercial scale and produce clean hydrogen, it is imperative that a CCS solution is developed in parallel with the HESC pilot. The Australian and Victorian Government's *CarbonNet Project* is developing a CCS network in Gippsland which will provide this solution.

  - Hydrogen is inherently cleaner and safer than existing similar commodities, but it is not well known. It is important to educate people about hydrogen's capabilities and safety track record.

  - Community impacts of large-scale hydrogen energy deployment are likely to be similar to energy infrastructure projects built or underway in Australia. We expect hydrogen to provide much better environmental outcomes than other commodities Australia already exports.

  - With regard to benefits to Australia, a new hydrogen industry has the capacity to generate new employment and skills for the community, stimulating the regional economy. It is important to raise awareness of such regional benefits to bring local stakeholders on board to our common hydrogen journey.

- **Q4. How can Australia influence and accelerate the development of a global market for hydrogen?**

  - By assisting with the commercialisation of hydrogen. We acknowledge that there is still a gap between pilot and commercial projects. This is largely due to the 'chicken and egg' dilemma of having markets, products and associated infrastructure, all at the same time.

  - We believe there is a need for the Governments of Japan and Australia to work together with industry to create initial demand for hydrogen in both countries and hence the associated infrastructure and supply chains.

  - We see this exercise of market development to be of significant importance, in particular at the earlier stages of a new industry.

  - Australia has a lot to leverage from its experience in developing an LNG industry almost 40 years ago. We see a lot of similarities between liquefied hydrogen and LNG. Australia could look into its outstanding track record in developing an industry from scratch and becoming one of the largest exporters of LNG.

  - For development of a global market for hydrogen, it is necessary for Australia to show that hydrogen could be produced and supplied stably, safely, sustainably and affordably in Australia. Therefore, it is important for Australia to lead and accelerate some international supply chain demonstration projects at pilot scale as well as semi-commercial scale.

  - We have considered the following initiatives could assist in bridging the commercialisation gap:

    1. Underwriting of the first shipment of hydrogen exports and specific first-of-a-kind project risks such as long-term carbon storage.

    2. Royalty holiday period for first hydrogen exports.

    3. Streamlined, integrated, approvals and regulations pathway for hydrogen international supply chains.

    4. Adoption of more stringent emissions standards for internal combustion engines over time.

    5. Establishment of an ASPAC Hydrogen Hub in Australia to work as a reference for international hydrogen trading.

    6. Joint Japanese-Australian funding and financing support for hydrogen supply chains between the countries.

7. Support with feasibility studies and independent verification of environmental value to be attributed to price of landed hydrogen in Japan to be considered on equal footing with LNG's.

8. Support specific industry-led hydrogen feasibility studies for mining applications, mobility (trains, heavy and light vehicles, shipping, drones), energy storage and industrial use, including hydrogen ecosystems.

- Deepen bilateral arrangements for cooperation on R&D and international hydrogen trade, including incentive provisions in the *Japan-Australia Economic Partnership Agreement* for hydrogen.

- R&D cooperation in core technology between Australian research organisations, such as CSIRO, universities and leading Japanese technology companies would increase Australia's influence in a global market of hydrogen. In addition, establishment of relevant laws and regulations which stimulate hydrogen demand (for example, regulations which allow injections of hydrogen to natural gas pipelines as mentioned below) would make Australian influence stronger.

- Joint, pro-active governance arrangements to monitor progress on bilateral cooperation on hydrogen, including technology promotion.

- **Q5. What are the top two or three factors required for a successful hydrogen export industry?**
  - Community acceptance of hydrogen usage and hydrogen production.
  - Regulatory framework that stimulates hydrogen exportation and drives a competitive hydrogen market.
  - Relevant infrastructure such as export port, hydrogen pipeline and CO2 solution (such as CCS (*CarbonNe*t Project)).
  - Stability of supply, abundance of resources, and cost competitiveness are key drives for successful export business. Uninterruptible, plentiful, and safe supply of hydrogen would be of utmost importance for consumers.
  - Government support to make an export industry bankable, such as incentives including tax benefits for exporters to motivate competitive pricing of hydrogen against LNG and relevant arrangements that grant legal, tax and fiscal terms stability to exporters/investors covering the whole project life.
  - Consistent long-term government policy setting for hydrogen.
  - We believe in the principle of technology neutrality. Discrimination between technologies will not lead us to the best transition outcomes. We should look at hydrogen as part of a multitude of solutions to deal with decarbonisation of the energy, transport and industrial sectors. From a policy perspective, we suggest the Taskforce consider the following specific initiatives to address technology neutrality:

    1. CCS enablement through removal of the barriers/prohibitions under the *Offshore Petroleum and Greenhouse Gas Storage Ac*t, and the *Clean Energy Finance Corporation Act.* It is important that these barriers are removed without further delay.

    2. Certification of origin for different hydrogen ‘products’ that take into account total emissions throughout the supply chain: e.g. *Hydrogen - Australian Made Low Emissions/Zero Emissions*.

- **Q6. What are the top two or three opportunities for the use of clean hydrogen in Australia?**
  - Injecting hydrogen into existing natural gas pipelines including supplying home use.
  - Power generation for demand response with hydrogen fueled gas turbine and/or gas engine especially at off grid area.
  - Mobility (fuel for vehicle, railway (replacement of diesel train), tram, long-distance track and bus).
  - Power to Gas process converting surplus renewable energy into hydrogen gas that allows for the storage of energy.
- **Q7. What are the main barriers to the use of hydrogen in Australia?**
  - One of the main barriers is uncertainty of policy and a future market, which result in hesitation of investment. Strong leadership of governments is required.
  - Hydrogen cost is one of the main barriers. Until the hydrogen market is mature and hydrogen becomes more affordable, some incentives for the use of hydrogen may be required. This needs to be seen in the context of a broader economic development opportunity for Australia.
  - The Japanese Government has developed the Basic Hydrogen Strategy and Roadmap to tackle cost reduction in hydrogen technologies. We expect cost reduction to come from scale (larger volumes and manufacturing). However, achieving cost reductions in gasification, liquefaction and transportation technologies still require further R&D and efficiency improvements.
  - We understand cost reduction of hydrogen technologies is front of mind for the Taskforce and policy makers around the world. Potential policy initiatives that could be investigated include:
    1. Increase in Federal-State funding partnerships for demonstration projects that have a clear pathway to commercialisation, with a specific funding envelope for hydrogen technologies and R&D (hydrogen production, transport and applications).
    2. Consideration of special treatment for hydrogen projects for R&D incentives for the next 10 years to kick-start the industry.

- **Q8. What are some examples where a strategic national approach could lower costs and shorten timelines for developing a clean hydrogen industry?**

  - The HESC pilot project is a good example as a strategic national approach, which aims to demonstrate mainly technological development and the full integration of a end-to-end international supply chain for hydrogen.

  - Similar, large-scale projects with an aim to lower costs and shorten development timelines will help to accelerate commercialisation of hydrogen – at domestic and international levels. This, in turn, provides the right signals for industry to continue to invest in hydrogen technologies, business models and commercial projects.

- **Q9. What are Australia's key technology, regulatory and business strengths and weaknesses in the development of a clean hydrogen industry?**

  - There are significant natural resources for hydrogen production in Australia: solar, wind, fossil fuels with adequate CCS sites.

  - Experiences and skills in LNG projects to be applied to liquefied hydrogen projects.

  - Complicated regulatory approval system, high labour cost and lack of strong energy policy are relative weaknesses of the Australian context.

  - Hydrogen derived from fossil fuels with CCS seems to be necessary to kick-start the development of a hydrogen industry given its potential for a quick scale-up, technical readiness and cost effectiveness, in the direction of a commercial phase targeted in the 2030s. In order to make it happen, amendments to relevant legislative instruments to CCS shall be required.

- **Q10. What workforce skills will need to be developed to support a growing clean hydrogen industry?**

  - As liquefied hydrogen is quite new to Australia, workforce skills for construction and operation of liquefied hydrogen facilities safely and effectively need to be developed.

  - In order to manage the above workforce, specialists and experts also need to be educated, trained and developed. Through our dealings with the HESC, we believe Australian research organisations could contribute to this area. We are currently discussing with potential Australian research organisations and education partners a program to stimulate hydrogen technologies for prospective Masters and PhD students. This is likely to involve classroom lectures, industry placement in Japan, placement and training at the HESC Victorian facilities and scholarships. This type of practical know-how exchange between Japan and Australia requires funding commitments from Australian research organisations and governments.

  - Currently, there is no training or education program available. We are pleased to contribute to training or education, but no appropriate supporting program (including funding) is available. We would suggest the Australian Government to consider establishing a hydrogen education and training funding program.

- **Q11. What areas in hydrogen research, development and deployment need attention in Australia? Where are the gaps in our knowledge?**

  - Almost all technologies required for hydrogen production, transportation and use are already technically proven. However, further developments in manufacturing, engineering and deployment is required in order to achieve the necessary cost reductions. It is important for Australia to consider its competitive position in the global landscape, show leadership by intensifying international engagement and accelerate international supply chain demonstration projects at pilot scale as well as semi-commercial scale.

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28 March 2019

National Hydrogen Strategy – Discussion Paper

AGL Energy (**AGL**) welcomes the opportunity to make a submission in response to the Hydrogen Strategy Taskforce's National Hydrogen Strategy Discussion Paper (**Discussion Paper**) released on 1 March 2019.

AGL is one of Australia's largest integrated energy companies and the largest ASX listed owner, operator and developer of renewable generation. Our diverse power generation portfolio includes base, peaking and intermediate generation plants, spread across traditional thermal generation as well as renewable sources. AGL is also a significant retailer of energy, providing energy solutions to around 3.5 million customers throughout eastern Australia.

In addition, AGL is continually innovating our suite of distributed energy services and solutions for customers of all sizes. These behind-the-meter energy solutions involve new and emerging technologies such as energy storage, electric vehicles, solar PV systems, digital meters, and home energy management services delivered through digital applications.

The commitment by the COAG Energy Council in December 2018 to establish a dedicated working group, chaired by the Chief Scientist Dr Alan Finkel, is a welcome step in progressing the development of a clean, innovative, and competitive hydrogen industry that may create significant opportunities to further integrate energy markets with emissions reduction obligations, provide alternative energy sources for customers, and provide significant value to Australia's economy through both export revenue, domestic industrial development and mobility fuels.

The benefits of hydrogen as a fuel source are clear if they can be realised at low cost. Hydrogen is universally abundant, and when used as a fuel source produces no environmentally harmful emissions. However, while technologies to isolate hydrogen has been available for a considerable period of time, the cost to do so has not yet proven competitive against other energy sources.

The Hydrogen Strategy Group's briefing paper *Hydrogen for Australia's Future*, presented to the COAG Energy Council in August 2018, and the CSIRO's *National Hydrogen Roadmap* provide useful overviews of these issues along with the current status of hydrogen production technologies and the challenges and opportunities associated with expanding this production in Australia.

As a participant in the Hydrogen Energy Supply Chain (**HESC**) project, AGL is already well aware of these technical and operational challenges, and advanced in its consideration of the value of developing a hydrogen supply chain.

The HESC project is a world-first initiative where brown coal from the AGL Loy Yang mine will be converted to gaseous hydrogen at the Loy Yang Complex and then transported by road to a liquefication terminal at the Port of Hastings. The gas will then be shipped to Japan for use predominantly in the transport industry.[1] AGL's support for the pilot project includes land, energy and water for the plant and up to 160 tonnes of brown coal. With support from the Australian, Japanese, and Victorian governments, the HESC Project includes leading Japanese energy and heavy industries corporations including Kawasaki Heavy Industries, J-Power, Iwatani, and Marubeni Corporation.

During commercial operations, HESC will require a Carbon Capture Utilisation and Storage (**CCUS**) solution. CCUS will not be a feature of the HESC pilot phase, due to the low volumes of carbon dioxide involved, which is equivalent to the annual emissions of about 20 cars. Carbon offsets will instead be used to mitigate emissions for the pilot phase. However, if the pilot is successful, CCUS will be an essential component of the commercial phase, a factor which has been recognised by both the CSIRO and Hydrogen Strategy Taskforce's discussion papers.

While AGL is involved in the production of hydrogen from brown coal, we are also interested in how hydrogen could support existing electricity and natural gas markets and assist in meeting Australia's international commitments to reduce emissions. As noted by the *Hydrogen for Australia's Future* briefing paper, electricity requirements for hydrogen production from electrolysis could provide a useful level of demand for low-cost generation that is not being dispatched into the grid. We look forward to working with the group to expand the knowledge regarding opportunities in this sector.

Similarly, we note the initial discussions regarding the replacement of natural gas with hydrogen in the existing gas supply chain. In our view, the partial replacement of the existing natural gas supply chain with hydrogen may be an effective way in both introducing additional gas supply and reducing emission, but we consider that more work needs to occur to understand the full costs and implications of such a concept.

Even so, we consider that the value of these opportunities to the Australian economy and energy security are considerable and therefore worth exploring in some detail. We therefore look forward to continuing to work with the Hydrogen Strategy Taskforce to further develop and inform the direction of the roadmap.

We have provided responses to the specific questions posed by the Department in the body following this letter.

Should you have any questions in relation to this submission, please contact Aleks Smits, Manager Policy & Research on 03 8633 7146, or myself on 03 8633 7252.

Yours sincerely,

Eleanor McCracken-Hewson

Senior Manager Policy, Research & Stakeholder Engagement, AGL Energy

[1] For more information on the HESC project, see https://hydrogenenergysupplychain.com/

Key Policy Questions

What do you think are the two or three most significant developments in hydrogen?

Internationally, Japan and Korea's plans to realise a Hydrogen Society so as to meet their Paris Climate Targets have prompted and fostered significant government and private sector research into the creation and utilisation of hydrogen. These developments extend, but are not limited to, the following:

- Fuel cell development and utilisation
- Hydrogen to power or power to Hydrogen
- Hydrogen transport and liberation (within ammonia or in a condensed phase)
- Mobility solutions

Domestically, AGL is proud to be partnering with KHI, JPower, Iwatani, Marubeni, the Australian Commonwealth and Victorian Governments to pilot the world first Hydrogen Energy Supply Chain. The project has the potential to realise hydrogen production at a scale that is likely to be competitive to alternative sources. Whilst the consortium acknowledges the need for Carbon Capture Utilisation and Storage (CCUS) during a commercial phase, projects like HESC offer, at scale, immediate air emission reductions and are likely to be materially important to a future hydrogen industry, and meeting climate policy objectives.

What are the most important safety issues to consider in producing handling and using hydrogen in Australia?

Safety considerations by gas facilities are generally well managed, however within Australia the absence of specific, suitable and complete hydrogen Standards are likely to hold the development of the industry back.

By way of example, the introduction of alternate fuels (such as phasing out of lead-based petroleum, or the introduction of ethanol blends or LPG) required concerted research, the development of Standards and their application within multiple industrial and transport sectors.

AGL urges the Department to focus on the development of appropriate regulation and Australian, but ideally, International Standards to support the development of a complete supply chain of safe generation, transport, handling and utilisation of hydrogen and management of associated waste streams.

What environmental and community impacts should we examine?

AGL believes that safety and environmental impacts should be a primary consideration when considering the manufacturing and utilisation of hydrogen. Our communities should feel confident and comfortable with hydrogen generation, storage, transport and utilisation.

Again, AGL urges the Commonwealth to work with industry leaders to develop appropriate regulation and Australian, and ideally International, Standards to support the complete supply chain of safe generation, transport, handling and utilisation of hydrogen and associated by-product streams.

How can Australia influence and accelerate the development of a global market for hydrogen?

For Australia to capitalise on a global hydrogen market it must either develop cost effective hydrogen technologies (generation, transport, handling or utilisation) for export and/or facilitate or develop suitable marine hydrogen transport.

Hydrogen may be a similar development pathway to LNG in the late 1970s and 1980s. Technological advancements in the shipping of LNG unlocked the commodity to become a truly global energy commodity. Ocean-going transportation of hydrogen therefore remains an outstanding issue to consider for the acceleration of a global hydrogen market.

What are the top two or three factors required for a successful hydrogen export industry?

AGL believe that confidence in the cost, safety, reliability, and availability of supply are required for a successful industry:

- Costs must be equal to or better than substitute fuels.
- Hydrogen and associated waste products must be produced, stored, transported and utilised in a safe manner.
- Hydrogen must be available in volumes that enable it to underpin its role within an export industry.

What are the top two or three opportunities for the use of clean hydrogen in Australia?

There are many opportunities for the use of clean hydrogen within Australia. Whilst the term “clean hydrogen” is yet to be formally defined AGL interprets this a CO_2 free or CO_2 managed hydrogen. Whilst the industry is in its infancy, AGL believes there is medium-term potential for hydrogen in areas including the following:

- As a supplementary de-carbonising gas within the national gas grid;
- Within the transport sector (Hydrogen Fuel Cell Vehicles)
- As an energy storage solution for time lapsed distribution; and/or
- Large industrial users may have an interest in the direct sale of hydrogen (as a feedstock), rather than current supplies being blended with natural gas.

What are some examples where a strategic national approach could lower costs and shorten timelines for developing a clean hydrogen industry?

Whilst there are many lessons to be learned from the development and implementation of past national and state approaches including though not limited to approaches for transport fuel replacements and the Renewable Energy Target, AGL believes that a national approach to funding and promotion of such a scheme, supported by COAG, is essential to the development of this industry. A clear, unambiguous and nationwide policy has the potential to achieve reduced costs and timelines for developing the industry by:

- Pooling R&D resources
- Facilitating development of safety and technical standards
- Supporting alignment of incentives and trajectories of technology and business model development.

What workforce skills will need to be developed to support a growing clean hydrogen industry?

Hydrogen, as an energy carrier, has the potential to append to, disrupt and/or change Australia's energy and mobility sectors. As a result AGL considers that elements of our secondary and tertiary educational curriculum need to reflect this diversification/disruption potential within the traditional frameworks. AGL envisions that Australia's workforce would need to develop skills along the hydrogen value chain, including generation, transportation, exports and end use facilities (including upgrading appliances or infrastructure, and educating users).