[redacted]

From: no-reply@mbie.govt.nz
Sent: Friday, 25 October 2019 4:55 p.m.
To: [redacted]; Hydrogen
Subject: Hydrogen green paper - submission
Attachments: Online-submission-form-uploadsHydrogen-green-paperAurecon-submission-NZ-Hydrogen-strategy-2019.pdf

Submission on Hydrogen green paper recevied:

Introduction
Name

Allen Keogh

Email

Allen.Keogh@aurecongroup.com

Business name or organisation (if applicable):

Aurecon New Zealand Limited

Position title (if applicable):

Technical Director

Is this an individual submission or on behalf of a group or organisation?

Behalf of group or organisation

Please give the name of the group or organisation this submission is on behalf of.
What is the role of Government in developing hydrogen for storage and distribution?
What are the challenges for using hydrogen for storage and distribution?
What are the opportunities for using hydrogen for storage and distribution?
What is the role of Government in developing the complementary role of electricity and hydrogen?
What are the challenges for achieving this complementary role of electricity and hydrogen?
What are the opportunities for this complementary role of electricity and hydrogen?
What is the role of Government in supporting hydrogen use for the transport sector?
What are the challenges when using hydrogen for mobility and transport?
What are the opportunities for using hydrogen for mobility and transport?
What is the role of Government in encouraging the use of hydrogen for industrial processes including process heat supply?
What are the challenges for using hydrogen in industrial processes?
What are the opportunities for the use of hydrogen in industrial processes?
What is the role of Government in encouraging hydrogen uptake for decarbonisation of our natural gas uses?
What are the challenges for hydrogen to decarbonise the applications using natural gas?
What are the opportunities for hydrogen to decarbonise our gas demand?
What is the role of Government in producing hydrogen in sufficient volume for export?
What are the challenges for hydrogen if produced for export?
In addition, we welcome your feedback about the opportunities of hydrogen to Māori and how this will support their aspirations for social and economic development.
What are the opportunities for hydrogen if produced for export?
If you wish to, you can attach a document to this submission.

Aurecon-submission-NZ-Hydrogen-strategy-2019.pdf - Download File

Use and release of information
We intend to upload submissions to our website at www.mbie.govt.nz. Can we include your submission on the website?

Yes

Can we include your name?

Yes

Can we include your email address?

Yes

Can we include your business name or organisation?

Yes

Can we include your position title?

Yes

Can we include the group or organisation your submission represents (if submitting on behalf of a group or organisation)?

Yes

If there are any other parts to your submission that you do not want public on the website please note them below:
OIA warning
If there is information in your submission that you wish to remain confidential, please note them below:

Aurecon New Zealand Limited
Spark Central
Level 8, 42-52 Willis Street
Wellington 6011

PO Box 1591
Wellington 6140
New Zealand

T +64 4 472 9589
F +64 4 472 9922
E wellington@aurecongroup.com
W aurecongroup.com

25 October 2019

Ministry of Business, Innovation & Employment
Aurecon submission for public consultation

By electronic form

Aurecon has read the Hydrogen Green Paper "A vision for hydrogen in New Zealand" published in September 2019 by MBIE and is pleased to provide this submission for the consultation process. We would like to congratulate MBIE on preparing a well thought out and digestible document to stimulate debate on the hydrogen opportunity.

Aurecon submitted a paper to the COAG Hydrogen Working group for the Australian National Hydrogen Strategy, sharing our views and considerations on the key factors that are most likely to impact the transition to a lower carbon economy in Australia. While New Zealand presents unique features and laid its unique path towards a net zero carbon economy by 2050, there are lessons to be learnt and similarities with our neighbours to leverage, in order to be successful in this journey. Australia is a step ahead of New Zealand in hydrogen and also now in bulk wind and solar power and many other advancing renewables solutions thanks to government targets and funding over the past few years.

For this reason, Aurecon is pleased to share its COAG submission on hydrogen to help frame the New Zealand National strategy.

The executive summary of the attached paper summarises five key priorities:

- Incentivise technology companies
- Facilitate collaboration in projects
- Coordinate a "Whole of Government" approach
- Assist local communities
- Tell the story and tell it well.

Despite the differences between the New Zealand and Australian economic and industrial context, the relevance of these principles echoes loudly across the Tasman. The focus on the narrative regarding the ability to play a leading global role in the hydrogen sector, as well as the emphasis on the role and inclusion of local communities all along the journey, is as true for New Zealand.

In the context of New Zealand, the H2 Taranaki Roadmap and the other private initiatives under development in New Zealand represent positive examples of convergence between global and local technical and technological expertise, existing infrastructure and available resources. We see the potential learnings of these initiatives.

Aurecon is also in the process of publishing an in-depth analysis on the status of hydrogen in the transport sector in Australia for the COAG Working Group for hydrogen transport. This document is based on comprehensive research and international case studies to understand risks and overcome barriers to the opportunity of using hydrogen for transport, and provides advice on prospective use cases and commercial models for the uptake of hydrogen in transport.

As a relatively nascent opportunity, the use of hydrogen in transport presents a number of risks and barriers that need to be navigated in order to unlock the benefits the technology can provide. Aurecon identified the following key challenges, which will be addressed in the upcoming publication:

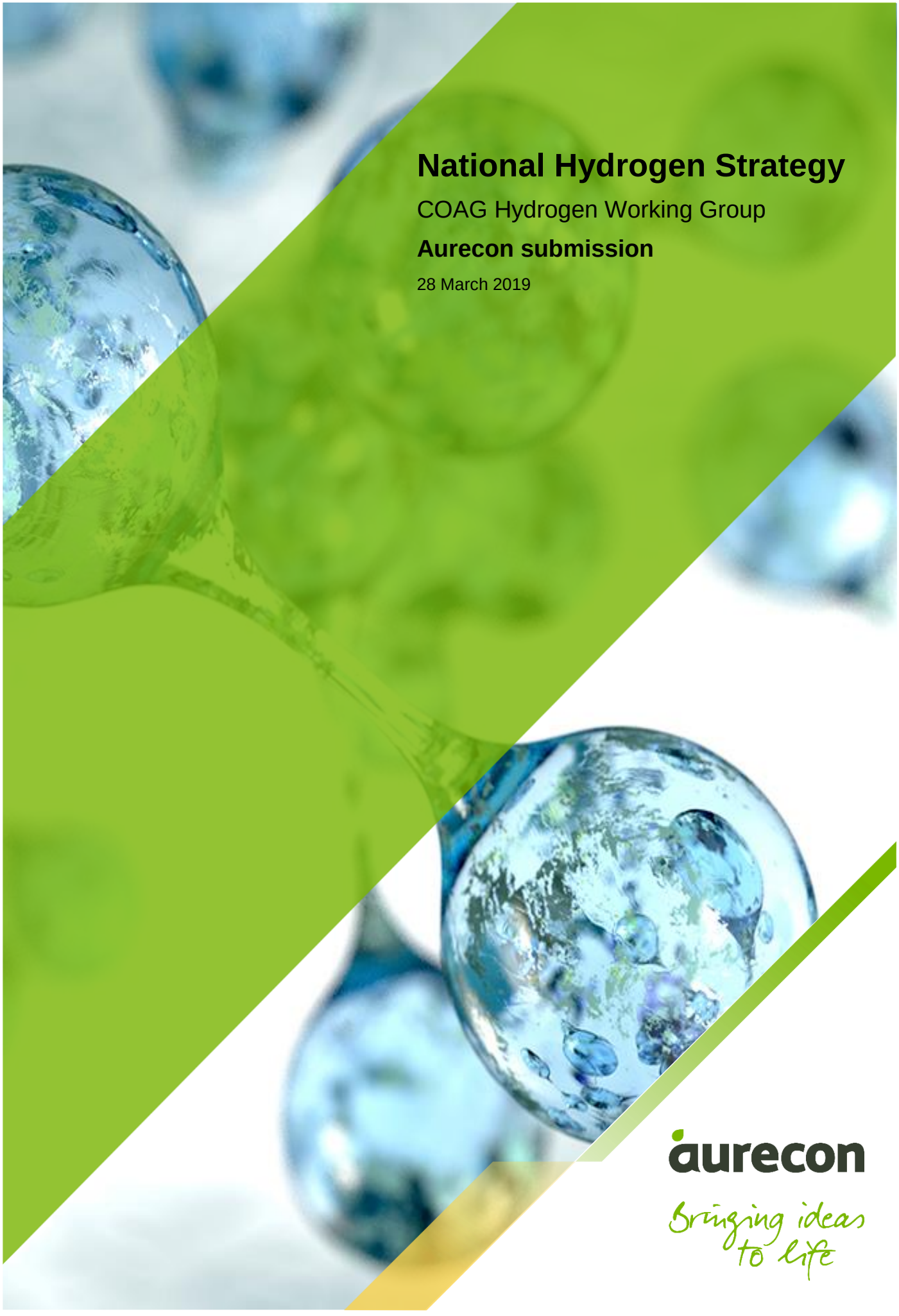
- **Fuel and refuelling infrastructure**. The ability to refuel hydrogen vehicles will be one of the important pillars underpinning the success of any pilot, trial, or commercial roll-out. The end-to-end supply chain requires consideration for a number of factors. The location of refuelling sites, and their ability to be accessible, will be of particular importance for the initial pilots and trials. Return-to-base fleets represent a more compelling opportunity than national filling infrastructure.
- **Vehicle supply**. Globally, there are only a few models of hydrogen fuel cell vehicles that are in production and available for purchase. The availability of fuel cell vehicles in New Zealand is further restricted, by the availability of Right Hand Drive (RHD) variants hence it is expected that the New Zealand market will not have hydrogen vehicles available for out-right purchase until 2020.
- **Cost competitiveness**. Fuel cell Electric Vehicle (FCEV) technology is generally more expensive to purchase than traditional technology and alternatives such as Battery Electric Vehicles (BEVs). This is largely driven by the high cost of production and the limited number of suppliers. As more manufacturers enter the market, these costs are expected to reduce, as demonstrated by BEVs.

We are grateful for the opportunity to provide this response on the Green paper and hope it will contribute to stimulate discussion and build confidence in the next steps to implement the Hydrogen roadmap in New Zealand.

Please note that none of our submission constitutes commercial in confidence material and we consent to this submission being published

Kind regards,

Allen Keogh
Technical Director



National Hydrogen Strategy

COAG Hydrogen Working Group

Aurecon submission

28 March 2019

aurecon

Bringing ideas to life

Executive summary

At Aurecon, we work with clients who are active across the full spectrum of the energy supply chain.

Our work sees us engage a wide range of stakeholders from technology providers and contractors through to communities, regulators and policy makers. As such, we are in a unique position that touches each of the elements that impact the transition to a lower carbon economy and the potential of hydrogen in the context of a National Hydrogen Strategy for Australia.

Many of our clients anticipate a future energy market in Australia that consists of increasingly distributed sources of supply both for power and gas. Many of our clients also believe that the domestic energy market will increasingly electrify where possible, in particular as the light vehicle fleet is expected to switch from petrol and diesel engine vehicles. With Australia's relatively small market for electricity on the one hand, and almost unparalleled access to natural resources on the other, the potential for hydrogen to underpin a significant wave of future export revenue and natural gas alternatives for industry is significant.

For many energy market participants, not just in Australia but globally, the re-emergence of interest in the hydrogen economy is less of a priority. The advent of low cost lithium ion battery energy storage devices, both at household and utility scale, is believed by many participants to have put paid to the question of whether hydrogen will emerge as a competitive and compelling alternative energy carrier. We are asked: what has changed and why will it be different this time around? To answer that question, power and transport industry specifics need to be considered within the global energy and commodity market context.

In Australia, we have access to world class renewable energy resources that far outweigh our ability to utilise them for our own purposes. This is a similar story with other commodities: Australia exports around 80% of our annual coal production; almost 100% of our annual iron ore; 100% of our uranium; and around 60% of our wheat crop[1]. For countries that do not possess the endowment with sunshine, wind and bioenergy, the possibilities of expanding our export and balance of trade to include renewable energy is immensely attractive. This is particularly so for our existing partners in energy coal and iron ore – principally Japan, China, South Korea[2].

While these nations may have regions wherein solar and wind or other forms of renewable energy are bountiful, Australia's sparse population, available land area, potential supply of water – including via desalination for coastal based export projects – provides us a potentially sustainable competitive advantage and a material marketing differentiator in a world where long term, hydrogen's share of world energy consumption becomes significant. This context and the critical importance of diversifying our export revenue base away from fossil fuel intensive commodity exposure over time is the first and potentially most important factor in developing a National Hydrogen Strategy. It's the 'why'.

Which leads to what we believe is the second most important factor in developing a National Hydrogen Strategy – which is the 'what' and refers to the two key requirements for low cost and scalable production of hydrogen, which are electricity and water. For the production of hydrogen, on a scale that meets the guiding strategy development principle of being *bold and ambitious,* power and water requirements are material[3]. The critical success factor in ensuring access to reliable and low cost power and water supply without downstream impacts on domestic power and water consumers, is fact based, timely and transparent stakeholder engagement.

For Australia to develop a successful hydrogen industry, Aurecon advocates pursuing a suite of government initiatives to ensure a successful holistic approach that see our technological, commercial and industrial interests enabled to take an appropriate level of risk at the right time. This includes the following priorities and principles:

[1] Dept of Industry, Innovation and Science; Resources & Energy Quarterly Dec 2018; Dept of Agriculture and Water, Fact Sheet Jan 2018
[2] Minerals Council of Australia, Commodity insights, June 2018
[3] Aurecon presentation to Australian Domestic Gas Conference Hydrogen Day, 7 March, showing indicative volume of energy for a notional 40MTpa export industry is 10 x the current National Electricity Market annual demand (approx. 2000TWh) and around ~250GL/year of water (equivalent to total annual QLD great artesian basin water extraction volume). 40MTpa is approx. 10% of forecast total additional global market for hydrogen according to World Hydrogen Council, 2018. Is it 'bold and ambitious' enough?

- **Incentivise technology companies** – establish a focus on technology as the enabler to a green hydrogen economy and leverage the nation's tertiary education institutions into demonstration projects on both the supply (cost) and demand (revenue) side.
- **Facilitate collaboration in projects** - the inefficient duplication of resources and effort between parallel and competing projects has become somewhat of a hallmark in Australia's recent history of developing and delivering major energy projects. A coordinated and unified approach focussing on optimum long-term market outcomes over short term milestones, and an approach that demonstrates to the many and varied potential markets for hydrogen – power, light vehicle fleet, heavy vehicles, industrial fuel switching – is key.
- **Coordinate a** "**Whole of Government" approach** – an effective pathway to developing a hydrogen industry must see a meeting of industrial, agricultural and climate policy to create a seamless and long term plan for each State and Territory. This must be linked to the various government's renewable energy and carbon trajectories; public transport services and infrastructure delivery as well as long term export revenue opportunities from coal, minerals and natural gas exports.
- **Assist remote and regional communities** – prioritise fringe of grid and remote locations to deliver efficient outcomes at the demonstration scale for power-hydrogen-power opportunities may provide quick wins and maximise early learnings. For example, these types of facilities could lower network losses, displace local liquid fired generation and make demonstration projects more competitive in the local context.
- **Tell the story and tell it well** – the narrative regarding our ability as a nation to play a leading global role in the hydrogen sector is compelling. This is particularly so for remote and regional communities where uncertainty regarding the future of energy and mining projects, urbanisation and drought have huge social impacts.

We are grateful for the opportunity to provide this response and commend the Taskforce for its clear exposition of process and outcomes in proceeding towards a National Hydrogen Strategy. Please note that none of our submission constitutes commercial in confidence material and we consent to this submission being published.

28 March 2019

Dr Sam Button

Global Leader, Future Energy

Sam.Button@aurecongroup.com

Contents

Aurecon's response to Key Policy Questions

Aurecon's responses Key Policy Questions

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

Interest in hydrogen as a means of decarbonisation while maintaining energy security has recently re-emerged for global economies. Japan's desire to move away from nuclear power generation without sacrificing energy security has spurred its commitment to become the world's first 'Hydrogen Society'. South Korea has followed suit with its own ambition to transition to a hydrogen economy. At a smaller scale, the city of Leeds in the UK has a similar aspiration with its H21 Project.

The growing global support led to the formation of the World Hydrogen Council, now supported by some 33 multinational corporations across the hydrogen, oil and gas, transport, power and technology research sectors alongside a further 20 corporations within the value supply chain. The appetite to develop global supply chain networks provides an opportunity for hydrogen development to underpin a long term and valuable export market supply, particularly in Australia, which to date has not existed.

These are two significant recent developments on the demand side and help provide confidence for Australia in answering the question: will demand for hydrogen emerge and to what extent (and when)?

On the 'supply side', recent advances in technology and the performance of these in the context of various elements in the hydrogen supply chain – from electrolysis, fuels cells, longer term storage and transport – have provided clearer pathways to the necessary reduction in equipment lifecycle (capital and operating) costs. In Australia in particular, the rapid decline in the costs of utility scale solar projects, the emergence of grid scale battery technology to provide a range of benefits to not just renewable energy projects but the network operations, provide an analogue to what could be possible with hydrogen, in support of the question: will the technology challenges be overcome and can the cost structure decrease such that hydrogen will be a viable alternative fuel?

Closer to home, the progress made in demonstration projects both in the transport sector (including the ACT government hydrogen bus trials), power market (including SA's Renewable Technology Fund support for network connected hydrogen projects) and gas networks (including ARENA's support for NSW and WA trials) is highly encouraging. As these projects come online and achieve commercial operation, their ability to demonstrate a range of operational and specifically customer focussed benefits will be significant for the industry.

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

The production and storage of hydrogen is not a new development per se, given that hydrogen has for decades been used at power station facilities as a cooling medium for generators and in industrial / petrochemical facilities using conventional production methods. Community perception around safety of hydrogen production, storage, refuelling facilities, and infrastructure is, however, something that will require careful management as part of a project by project stakeholder engagement and awareness processes in parallel with the project development.

One of the ways to increase the growth of the hydrogen industry is to shift community perception of hydrogen as a highly dangerous fuel source to one where hydrogen risks are recognised and adequately managed. For example, consumers are comfortable using petrol or diesel vehicles despite the flammability risk of these fuels, and risk warnings at petrol stations are one way of ensuring the key risks of refuelling are managed.

Transparency and open acknowledgement of the risks – but also clear mitigation measures – are likely to best create an environment where an emerging industry can build and consolidate a social licence to operate.

Established planning, regulatory and safety in design requirements such as the following are in all cases applicable to managing hydrogen production and storage projects and require highlighting:

- WorkSafe Australia requirements for Major Hazard Facility to be considered as applicable for hydrogen storage volumes on site and implementing the operating requirements associated with such a facility
- Functional safety of Facility in accordance with recognised international standards for safe operation
- Hazardous area zoning and classification for design and installation of electrical plant, systems, components in potential areas of hydrogen venting/leakage in accordance with recognised standards
- Leak detection and isolation measures
- Clearance between Facility and nearest neighbours depending on type (eg public infrastructure, etc) in accordance with planning requirements and international standards/guidelines
- International experience as applicable to the particular project / development can also be applied including relevant codes and standards.

It should be noted that if risk perception is the sole driver of the community engagement process, there is a chance that, if not properly understood, investigated and managed, heightened community risk perceptions could lead to over-regulation and standards imposed on hydrogen and related infrastructure that are not relative to the inherent risk. The outcome of such over regulation would be to impose significantly prohibitive costs for an emerging industry.

3 What environmental and community impacts should we examine?

We expect that the primary technology for the production of hydrogen for export will be the electrolysis of water, that is, using electricity to ‘split’ water molecules into hydrogen and oxygen.

The sourcing of this water presents a potentially significant community and stakeholder engagement challenge, and if not managed carefully, potentially discrete environmental challenges depending on the location of the electrolysis facility.

It is important to recognise that regions identified as having large renewable resources tend to be either lacking in surface water or are in competition for water with agricultural demands. Desalination provides an opportunity for water supply, particularly in coastal regions proximate to ports for export and where, for most capital cities in Australia, large scale desalination facilities already exist. The energy demand for desalination and the operating costs, however, are high and therefore priority areas for demonstration projects should be focussed on sustainable and ‘ethical’ supply of suitable fresh water supplies which require minimal if any treatment prior to electrolysis. Groundwater resources are a possibility in most areas, particularly in Queensland and North West Western Australia, and the risk of overuse, depletion and competition for water need to be carefully addressed by proponents prior to projects proceeding.

This is especially true for current agricultural demands, and those in drought-affected or drought prone areas. The risk of loss of social license for hydrogen production as it relates to water supply – before the industry can reach scale – could be exacerbated to the extent that a preference or greater policy support be provided to hydrogen over say, agricultural practices when it comes to water access.

Similarly, in respect of the electrical energy requirement for hydrogen: any energy project development that occurs rapidly and at significant scale has the potential to negatively affect surrounding communities. Inflation (and subsequent deflation) of local real estate, loss of the sense of community due to worker influx, difficulty in attracting employees for non-industrial labour and local price inflation are examples of the potential negative impacts often experienced in communities where development is not adequately managed or where social impacts are underestimated. Early, often and ongoing community engagement can assist in mitigating the risk of negative community impacts and to ensure development occurs in a way that optimises the benefits for all stakeholders.

Widespread support cannot be assumed and the presumption that community engagement and backing will be immediate and forthcoming is fraught with risk. Lessons abound in ways government, industry and communities have worked well in Australia on various large scale projects over the years, and similarly, where they haven’t worked well. Ensuring that lessons have been learned from what hasn’t worked well in

the past and how mistakes can be avoided in the case of advancing a hydrogen economy should be a key part of the National Hydrogen Strategy.

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

Like the development of any industry in its emergent form, there are roles for Government in either or both supply side or demand side.

On the supply side, the Government might provide support via initiatives aimed at reducing the risk of developing the underpinning industrial infrastructure for hydrogen as an energy carrier. This can be in the form of, by way of example:

- Clear regulatory frameworks to govern the industry, in particular in respect of safety and design risk
- Support for international technology providers to partner with local developers / technology *deployers* in navigating the approvals and stakeholder engagement process for new projects
- Major Project Status (or equivalent) support for material scale developments
- Grant funding to defray capital or operating costs (including in cooperation with Federal Government entities such as ARENA) and derisk the 'integration' element of power to hydrogen (to power) projects.
- Access to lower cost or more competitive financing to assist in funding small scale technology trials that have difficulties in obtaining debt or equity (including for example, in cooperation with the Clean Energy Finance Corporation).

Demand side measures are arguably more compelling for project developers and those looking to scale up production, especially in the context of providing support to access competitive and low cost financing.

Aurecon's experience via our network of contacts with established and emerging players, suggests that while hydrogen production and storage technology is proven at small scale, the ability to deploy at a fully commercial scale - where equipment supply, power purchase (if required) and project certainty can be most competitive – are oftentimes constrained by the lack of demand stimulus.

Therefore, possible roles for the Government in supporting the hydrogen industry on the demand side include facilitating long term off-take agreements for hydrogen gas supply to existing market participants (industrial gas users, gas pipeline operators, natural gas exporters etc) or committing to a longer term off-take for hydrogen gas supply itself for its own facilities / usage on a set of criteria over time that minimise risk to Taxpayers. An analogue for this support is the recent ARENA solar funding round which we believe forms a solid basis for a targeted and near term federal government initiative.

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

As we've described in our responses to other questions posed by the taskforce, on the demand side, a critical success factor is ensuring that our long term trading partners for energy commodities such as thermal coal and liquified natural gas – principally Japan, China, South Korea – are engaged and progressing with their domestic energy market transformation in favour of hydrogen.

On the supply side, significant volumes of low cost power and water are required, as well as competitive construction and operational environments that reduce capital and operating cost exposures.

Careful consideration therefore need to be given to the location of export facilities to take into account these three factors:

1. Proximity to a near-field export partner who has demand for the product
2. Access to low cost and sustainable power and water sources
3. Location that facilitates competitive capital cost (access to labour and equipment) and ongoing operations (skilled workforce)

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

The total hydrogen supply chain is extensive, suggesting there are multiple further opportunities for economic growth should hydrogen production commence at scale. A number of industries rely on hydrogen as a feedstock, the largest of which are the production of ammonia and steel. While steel manufacturing has largely moved out of Australia in recent years due to difficulties in competing in price internationally, a new opportunity could be created to supply low emission steel and indeed green ammonia, both for Australia and overseas.

The opportunity also exists to further develop or manufacture energy conversion technologies such as electrolysers and fuel cells, technologies whose manufacturing is currently limited to a select few nations who have had concentrated efforts on hydrogen development. Using a 'demand stimulus' locally, whether that be by supporting hydrogen in transport, manufacturing or the power sector, and tying funding support to the relocation of operations for a global supplier of technology to Australia, could be one avenue for driving commercial development and enhancing local R&D outcomes.

The application of hydrogen to remote and energy intensive operations such as mine sites also presents a significant opportunity for the mining sector to decarbonise and in some instances may reduce costs. A number of operations currently rely on fossil fuel generators which can be costly to supply. Alongside this could be the potential to increase exploration and development efforts for those technologies commonly used in hydrogen operations, for example platinum and associated platinum group elements. The concept of focussing efforts on the 'whole of supply chain' and ensuring our other natural competitive advantages in mining and minerals are engaged in the hydrogen conversation is part of the 'whole of Government' approach that is required, given various States and Territories have different natural competitive advantages.

Finally, there are a number of locally congested regions in not just the east coast electricity market but in the various markets located in Western Australia. Expanding the volume of renewable energy in some of these locations is not an option due to grid constraints, loss factors, and the stable operation of the networks. Using clean hydrogen as a locally generated energy carrier (generated at site by those projects 'at risk' of not being able to sell their electricity) and storing it to then generate (either by fuel cell or combustion) dispatchable energy at other times when the grid is not constrained, could lead to overall better outcomes for all projects in those regions or sub-regions and provide the impetus for additional energy project investment.

7 What are the main barriers to the use of hydrogen in Australia?

The key challenges to development of a clean hydrogen industry relate to the nature of the investment landscape for hydrogen. Hydrogen is an energy carrier and as such, is not an 'energy source' but a means of transporting / transmitting energy from one location (or form) to another. Like electricity, which must be produced from a source of energy, the competitiveness of hydrogen supply relates to a number of factors inherent to its production.

Most people think of hydrogen sourced from the electrolysis of water, whereby a water molecule is split into hydrogen and oxygen, with the hydrogen stored or transported such that it can be recombined 'on demand' either via combustion or via fuel cells to produce heat or electricity respectively. This is not the only source of hydrogen however.

Other sources of hydrogen include bioenergy and of course, fossil fuels ie hydrocarbons in the form of coal, liquid (eg oil) or gas (ie natural gas). In the case of these sources of hydrogen, the relative carbon impact of hydrogen production is dependent on the fuel source (including from bioenergy) while in the case of electricity, how that electricity is produced (ie from either fossil fuel generation or renewable resources such as solar and wind).

Therefore, one of the key challenges to the development of a hydrogen innovation system is market knowledge of how hydrogen is sourced, stored, transported and ultimately used. Differentiating between 'clean' or 'green' hydrogen and other forms, and justifying why it should be chosen over others is important.

A fundamental view on the importance of hydrogen *for the customer* is a key gap / barrier to greater focus and attention on it as a fuel source. Parties seeking to develop the industry must make a compelling argument as to how it will benefit customers – be they industrial, commercial or residential gas or electricity customers – as well as other stakeholders and value chain participants such as electricity generators, transmission and distribution companies.

Building on this first challenge / element therefore the main barriers to the use of hydrogen include:

- **Market knowledge / stakeholder education** – including expectation management about what issues hydrogen as an energy carrier can address in the current energy market context for Queensland and Australia
- **Availability of hydrogen production technology at a scale that can be competitive with other forms** – specifically equipment such as hydrogen electrolysers for production from electrolysis of water versus existing fossil fuel methods (methane steam reforming or coal gasification). Key factors include electricity price, capital cost of equipment and round trip efficiency (eg 30-35% ratio of "power-in" to "power-out" versus >80% for lithium ion batteries versus 60-70% for pumped hydro energy storage). These are notable areas to optimise or improve over time to reduce the gap
- **Stakeholder acceptance of ability of hydrogen and natural gas industries to co-exist and share infrastructure such as pipelines** – while it is generally accepted that hydrogen injection into gas transmission lines is achievable in the current technical context in Australia, Aurecon's view is that it is not widely accepted among key industry participants that existing gas distribution infrastructure is able to accept appreciable quantities of hydrogen gas at the current time.

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

Aurecon would like to reference here two examples of how the combination of clear objective and supportive regulatory environment was able to drive successful processes and outcomes at a national level.

The first is the Australian Renewable Energy Agency (ARENA) run large-scale solar investment programme.

In order to accelerate the deployment of large scale solar, ARENA's funding round called for projects to come forward and request capital grants tied to those projects meeting a discrete target for the cost of energy.

The target price was transparent, common financial models were used for evaluation purposes, and the co-investment pulled forward enabled almost 500MW of utility solar projects to be deployed. In the Australian context, this funding round achieved two key outcomes:

- It gave power purchasers (the off-takers) on the demand side confidence in the ability of projects to deliver the energy they required, at an agreed price and volume, ensuring familiarity with the 'product' from a utility solar farm
- It gave the construction contracts the confidence to take the appropriate risks at the appropriate time around engineering design, procurement and delivery, which in turn enabled the financing community to better understand the inherent 'integration' risks associated with large and complex projects.

This has enabled the industry to dramatically lower the price of energy from a utility solar farm from almost $200/MWh in 2013 to $135/MWh (the target under ARENA) in 2015 and to levels approaching $50/MWh and below in 2019.

A second relevant analogue demonstrating where lowering costs and shortening timeframes can be achieved with a coordinated approach is the Queensland Gas Scheme, introduced in 2005. With the express aim of increasing the percentage of gas fired generation in the state, accredited gas fired generators were able to create Gas Electricity Certificates (GECs) for each MWh of eligible gas fired power they produced.

This scheme gave natural gas exploration companies additional confidence in undertaking the costly and risky early exploration phase in the gas supply chain, in order to meet what was then an equivalent target of around an additional 1,000 MW of gas fired generation.

By creating a strong demand signal, the supply side was able to plan and methodically take appropriate risks at the appropriate time. This led to a number of exploration companies making investments to secure, explore and ultimately deliver coal seam methane production, which in turn led to the realisation of a significant resource base for coal seam methane within the state.

This arguably created the supply side conditions such that international market demand for liquified natural gas (LNG) from coal seam methane was able to be realised with long term supply agreements executed. This in turn drove the delivery of the valuable pipeline and export terminal infrastructure within the state.

While a number of lessons have been learned regarding competition for resources and staff, and the impacts of a lack of collaboration and coordination across the various parties involved in delivering these assets, it could be argued that the 'realisation' of Queensland's vast natural gas resource base was sparked by the introduction of GECs as a means of diversifying its electricity mix.

The possibilities that might arise in the pursuit of a national approach to hydrogen – via industrial, transport, power market support mechanisms – could deliver similar upside potential if well planned and executed.

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

Given Australia's proven ability to demonstrate the value of our commodity exports, and channel them to global markets, our strength in marketing and delivering 'product' to customers is an important consideration in understanding where we start in the competitive landscape.

Our local industries, too, have proven ability to – when the rules and regulations are known – deliver on key targets that are set. One particularly relevant case is the federal Renewable Energy Target (RET), being a certificate trading scheme that sets obligations on retailers and certain customers of electricity to deliver against known targets for annual and overall renewable energy volumes. Australia is on track to deliver against what was, at the time and until as recently as 2014/2015, an extreme logistical challenge in terms of managing the installation of GW worth of wind and solar farms. Yet with just over a year to go until the 2020 deadline, the industry is on track to achieve and ultimately exceed its requirement. The ability of Australian commercial interests to deliver on development targets is a key strength and in the event of credible targets being set for a 'hydrogen industry' we have confidence that these interests can mobilise to achieve, if structured well with clear obligations.

The key challenge to development of a clean hydrogen industry, further to those specific challenges already outlined in our submission, will be aligning on a credible and tangible end goal, with an achievable pathway that does not adversely position existing or competing interests such as hydrogen production from conventional means (often referred to as 'blue hydrogen' or hydrogen from steam reforming of natural gas). However, we do commend the plan outlined by the Taskforce for providing clear visibility of the milestones and timing of this process.

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

Australia has a deep skills base in conventional mining, minerals processing, bulk handling and export industries, with this skills base mixed depending on the State, Territory or sub-region. Australian companies have the necessary commercial and trading expertise to support international engagement in order to develop the export demand channels required. Given the material build experienced in the Australian renewable energy industry this last decade, as well as the ability of the various networks to integrate and operate these plant, Australia's expertise in the power industry is particularly current and relevant.

The associated training to grow a sustainable hydrogen industry in Australia will be based around the specific regions in the nation where hydrogen is produced, that production method (be it electrolysis or other) and ultimately the end use for hydrogen itself. These are envisaged to include:

- Technical skills/technology understanding for electrolyser plant and equipment design, including based on international supplier offerings
- Operation and maintenance skills for the hydrogen production plant and associated infrastructure
- Technical skills/technology understanding for fuel cells and design, including based on international supplier offerings as well as operation and maintenance
- Technical skills/technology understanding for ammonia plant and equipment design (note, if exporting hydrogen in this form), including based on international supplier offerings
- Maintenance and servicing skills of hydrogen vehicles and associated refuelling stations
- Major project management and integration skills given hydrogen's multi-dimensional role across not just the power and gas but transport sectors.

Working with industry and higher education institutions to ensure that relevant training includes a hydrogen component to engineering degrees, as well as on the job training for specific operation and maintenance requirements / skills diversification for the many employees presently employed in the power and utilities sector will also be critical.

11 What areas in hydrogen research, development and deployment need attention in Australia? Where are the gaps in our knowledge?

In our response to prior questions, we have highlighted that one of the key challenges to deployment of hydrogen projects is the cost competitiveness of hydrogen as an energy carrier.

In the case of hydrogen produced via electrolysis of water, these factors can be described as: the price of electricity input, capital cost of the equipment and the cycle roundtrip efficiency relative to other forms of production, storage and recombination.

The gaps in our knowledge primarily relate to the integration of the various 'elements' in the hydrogen supply chain, that is, how projects are brought together through production, storage, transport and delivery to the customer (as fuel or via power).

Aurecon is not typically involved in the research and development space as it relates to novel technologies for production, storage or transport of hydrogen. With Australia's history in mining and minerals processing research and development, we believe a significant opportunity exists to understand how the existing and emerging commodity supply chain for hydrogen production and storage (specifically, the requirement for metals and other materials for componentry manufacture) presents a key gap that plays to our strengths.

Document prepared by
Dr Sam Button
Sam.Button@aurecongroup.com

Aurecon Australasia Pty Ltd
ABN 54 005 139 873
Level 5, 116 Military Road
Neutral Bay NSW 2089
PO Box 538
Neutral Bay NSW 2089
Australia

T +61 2 9465 5599
F +61 2 9465 5598
E sydney@aurecongroup.com
W aurecongroup.com

aurecon

Bringing ideas to life