[redacted]

From: no-reply@mbie.govt.nz
Sent: Friday, 25 October 2019 4:50 p.m.
To: [redacted]; Hydrogen
Subject: Hydrogen green paper - submission

Submission on Hydrogen green paper recevied:

Introduction
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Position title (if applicable):

Process Engineer

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

Individual

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?

The Government will need to review the Gas Act and all associated regulations to include hydrogen-specific regulation. It also needs to develop communication regarding pipeline easements as well as incentivise R&D into pipeline materials, liquefaction technologies, compression efficiency, underground storage, etc.

What are the challenges for using hydrogen for storage and distribution?

There is a reference (pp. 45) to transferring hydrogen “using the existing natural gas transmission and distribution pipeline network” and this is “based on international trends”. This is an oversimplification of the technical issues of such a task, and it is misleading to suggest that this is simply happening overseas.

Publicly-available references to the existing NG transmission pipeline suggest the highest allowable working pressure of some sections is 67 barG (MBIE, 2012); the energy density at this pressure is impractically low for high-purity. For reference, a typical hydrogen FCEV would require ~300 barG and any long-range heavy vehicle would be in the range of ~700 barG. The Gas Act defines a gas transmission line as that with a pressure exceeding 20 barG – this suggests that distribution pipelines must be rated at or below 20 barG, further influencing the technical feasibility of simply repurposing the pipelines.

Overcoming the pressure/energy-density issue would require potential solutions such as point-of-use compression (highly energy-intensive, capex-heavy, and opex-restrictive) or in-depth work to rerate some 2,500 km of transmission and 20,000 km of distribution lines. It is possible that the existing network is not suitable for this application at all, requiring full replacement. Other major issues which affect a safe and useful repurpose of the pipelines include factors such as ensuring material compatibility between the pipe and the completely different fluid, the long- and short-term effects on end-user appliances such as cooking hobs and gas-heated water equipment, the differing risks of fire and explosion by comparison to NG, the suitability of recompression equipment along the line, and the technical difficulty of odourising hydrogen compared to simple addition of mercaptans to NG.

In addition to the technical issues, key political drivers will also influence any repurpose of the line. The fact that the entire network is privately owned notwithstanding, there are major end-users who use natural gas as a non-energy carrying substance – i.e. as a chemical feedstock for producing added-value products. In a few instances, the added-value product is pure hydrogen, so minimal pushback can be reasonably expected; however in most cases the additional products produced in the synthesis gas (carbon-based compounds) are also required.

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MBIE. (2012). Review of the Maui Pipeline outage of October 2011. Wellington, NZ: Author.

What are the opportunities for using hydrogen for storage and distribution?

There are potential commercial interests to be gained from positioning new production facilities close to points of hydrogen use. For example, establishing joint ventures between companies to create refuelling stations along major trucking routes while encouraging the commercial uptake of renewable technologies by businesses already producing hydrogen by non-renewable methods.

What is the role of Government in developing the complementary role of electricity and hydrogen?

The Government needs to implement targeted policies to stimulate the demand for growth of hydrogen and the phase-out of the carbon-based fuels it is intended to replace. Government is also responsible for ensuring the country does not become solely dependent on electricity (as discussed in response to Question 2b) and therefore incentives should be put in place to encourage further R&D into emerging technologies for the production of hydrogen from sources other than electrolysis. There is an opportunity to begin discussions for other green alternatives to SMR of natural gas other than electrolysis, such as SMR of biogas for example.

Any reulgations and targets specific to hydrogen production and infrastructure should also, wherever practicable, align with best practice global standards. This should be uniform with other nations, particularly those to whom NZ plans to export to (or even compete internationally with).

The Government should also provide an avenue for educating the general public on hydrogen. It is concerning that in the 90 page Green Paper, safety is simply glossed over in a few paragraphs on Page 56. There should be a strong emphasis on public education around safety, but particularly with reference to familiar compounds such as the flammability of petrol at fuel stations or the explosion risk of natural gas in the kitchen – the goal is obviously not scaremongering, but simply discouraging complacency while providing general peace-of-mind from normalising the substance.

In addition to safety education, the Government should also develop engagement plans and undertake demonstration projects to showcase hydrogen and ensure communities understand all aspects of its use.

R&D into the technical viability, safety, and economic implementation of new CCS technologies should also be incentivised and its importance to consumers be highlighted.

What are the challenges for achieving this complementary role of electricity and hydrogen?

Saying that electricity and hydrogen "complement" each other is a misrepresentation of the relationship between the two. Neither are primary energy sources – on just this basis alone, it is not appropriate to suggest a reliable energy economy can exist based only on the two.

Primary energy sources are independent – for example, wind, solar, geothermal, natural gas, crude oil, coal, etc. Electricity is a secondary source, requiring generation from any one, or mixture, of the above. Throughout the Green Paper, electrolysis is identified almost exclusively as the method by which the country can produce green hydrogen – making it a tertiary source of energy. Following this logic, it is more appropriate to say the aim of this pathway is to invest exclusively in renewable electricity, with hydrogen being a by-product utility.

I strongly support the drive for renewable electricity and recommend continuing investment in diversifying its production methods. However, it is not responsible of the Government to narrow the economy's energy dependence down to a single point anywhere in the supply chain. If only the suggested pathway is followed, a bottleneck for the entire economy will be the National Electricity Grid.

Should any reliability issue in the grid arise, hydrogen will not be an alternative as this question suggests – further to the pipeline repurposing limitations discussed in response to Question 1b, supplementing a downed grid would require local infrastructure to produce electricity from stored hydrogen. This begs the question of why we are not considering other common gases as potential energy vectors.

For example, air could be used in the same way for reverse-production of electricity as suggested for hydrogen turbines. Air is more easily sourced, it is not explosive, it does not pose an asphyxiation risk, and air compressor equipment and technical know-how for servicing/maintenance are more readily available. Liquefaction of air is also already a common practice for producing pure oxygen and nitrogen for many existing industries – again, technical experience and equipment are already available.

For hydrogen to be, at least in part, independent of electricity, further investment will be required in alternative methods of its production. Around 95% of the world's hydrogen production is from a mature technology known as steam methane reforming (Arup, 2016); the process is efficient and expertise for operating and optimisation already exists in New Zealand. For a transition to a hydrogen-based economy, the existing technology using natural gas (or similar) will almost certainly be required to reach useful volumes and drive growth. This process should be maintained, however it does not strictly need to be net carbon-emitting.

SMR and subsequent water gas shift reactions can be coupled with carbon-capture to reduce or eliminate carbon emissions; this is an obvious first step to phase in bulk hydrogen production. Going forward, phasing out natural gas as the feedstock is possible if opportunity is given to alternative production of methane. Methane can be produced both chemically and biologically from fully sustainable raw materials; for example, biomethane can be produced by anaerobic digestion of municipal waste and dairy shed effluent while other waste, such as from landfill, can be gasified to create methane-rich producer gas. There even exits potential to clean up other areas of the environment; for example, algae can be used to reduce nitrates in natural waterways then collected for anaerobic digestion to produce methane – CO2 subsequently produced during SMR can then be reintegrated as a feedstock for new algae and the anaerobic digestion process.

Further research and scale-up of technologies for alternative methane production for SMR is strongly recommended in addition to simply relying on electrical production of hydrogen. If appropriately incentivised, SMR production from "green methane" could be net-zero carbon emitting or potentially even net-negative. A social push to stop demonising methane and encourage learned thinking rather than polarising conjecture will be required if the country is to realise its considerable economic potential and environmentally-friendly benefits.

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Arup. (2016). Five minute guide to hydrogen. London, UK: Author.

What are the opportunities for this complementary role of electricity and hydrogen?

On Page 64 of the Green Paper, lifecycle analysis is addressed. Unfortunately, it appears to suggest that complexity for analysis of different hydrogen production and uptake routes is a bad thing. Complexity should not be a demotivating factor – this is the opportunity for New Zealand Inc. to gain a competitive advantage over other global players.

What is the role of Government in supporting hydrogen use for the transport sector?

A clear, consistent and objective definition needs to be given for the types of hydrogen, not the subjective and ambiguous green and brown (or subsets of brown: grey and blue). A quantifiable system needs to be in place in order for consumers of hydrogen transport fuel to understand the effect that filling their tank has on the environment; provide a Guarantee of Origin system.

I recommend following the CertifHy project brackets for relative carbon emissions per energy unit basis. A trucking company, for example, which wants the public to be aware of its environmentally friendly FCEV vehicles is not going to consider uptake of hydrogen if its source is from SMR; this is ambiguously labelled as "brown", regardless of whether there is CCS strategies in place or even if the company producing the hydrogen has net-zero, or net-negative, carbon emissions. However if given the distinct bracketing of the Certify project, growth of infrastructure will be made more feasible as the economic and technical maturity of existing technology will be supported by a guarantee of environmental impact.

On Page 55, there are potential recommendations given to incentivise uptake of hydrogen transport infrastructure. While I support most of these recommendations, I cannot endorse "feebates" on high-emissions vehicles; this principle is no different to scrapping ACC subsidies for vehicles with higher safety ratings – the difficulty in affording a safer car is no different to the difficulty in affording a CO2-free car. I worry that the impact of such a recommendation will seriously disenfranchise low-income families, rural communities, and anyone not within a main centre or near a major highway.

Subsidies for purchasing an FCEV are a good idea, however this will require its own regulation. Taxing fuel will likely be the primary decider for whether FCEVs will be commonplace among Kiwis – things that will need to be considered are how roading infrastructure will be affected and how to supplement this cost without hydrogen fuel tax (and no feebates) and at what unit threshold road user charges will come into effect.

What are the challenges when using hydrogen for mobility and transport?

As highlighted in the response to Question 3a, the primary challenge for the uptake of hydrogen for mobility and transport should be focused around incentives for FCEV usage while not disenfranchising low-earning families and communities.

Consideration should also be given to the implementation of CNG vehicles in days past. When developing a direction for hydrogen, the failures of implementing CNG should be reviewed – if the model doesn't work without funding, consideration needs to be given to how it could, or if it will ever, work.

What are the opportunities for using hydrogen for mobility and transport?

This has been highlighted well on Page 51 of the Green Paper. However I would expect the level of detail to resemble Section 5.2 of the Australian National Hydrogen Roadmap (Bruce et al., 2018).

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Bruce, S., Temminghoff, M., Hayward, J., Schmidt, E., Munnings, C., Palfreyman, D. & Hartley, P. (2018). National hydrogen roadmap. Australia: CSIRO.

What is the role of Government in encouraging the use of hydrogen for industrial processes including process heat supply?

The primary role of the Government to encourage uptake of hydrogen is to implement a clear, long-term strategy and policy direction for enrichment and subsequent displacement of natural gas. This will need to include the quantification of big-picture economic implications of fuel subsidies and commercial incentives to drive growth.

Strong emphasis should be made on commercial and academic research, development and demonstration projects. There are opportunities for cross-government-department collaboration for funding and incentivising research in the hydrogen space in conjunction with industrial users. For example, creating research fellowships and scholarships for graduate and postgraduate students who are working with, or for, industry partners to achieve real-impact solutions for uptake of hydrogen.

Incentives should also be provided for technical qualifications and training for, as an example, hydrogen-specific gas fitters. There is an opportunity here for technical pathways straight from secondary school, rather than an academic route through graduate study.

Consideration should also be given to legislating the manufacture of easily-convertible gas appliances. Especially for commercial appliances which are not necessarily major industrial equipment, such as in commercial kitchens, boilers, or crematoria.

What are the challenges for using hydrogen in industrial processes?

Not all natural gas is currently used for heating purposes, so simple substitution is not necessarily as easy as it sounds. According to MBIE (2018), 53 PJ of the 195 PJ of natural gas consumed in 2017 was for non-energy use. In some cases this has been used as a chemical feedstock where it is converted into hydrogen, so substitution with “reticulated hydrogen” is not a core problem; however the biggest single user in NZ requires both the hydrogen and carbon monoxide produced from steam methane reforming to produce its added-value product methanol.

Other industrial process units, such as furnaces and kilns, have been optimised with natural gas. In many cases, waste gases from other processes will be used as energy source feedstock in such appliances. Consideration will need to be given here to chemical compatibility of such integrated process gases with pure hydrogen rather than components of natural gas. Some potential applications have been mentioned on Page 60, however potential issues have not even been identified; for example, a particular issue with hot hydrogen is a phenomena known as High Temperature Hydrogen Attack – this requires specialised metal alloys such as Incoloy to resist long-term and short-term exposure damage to equipment at gas temperatures above ~200°C.

Another consideration required for use of hydrogen in industrial processes is the composition of combustion products. Unlike a hydrogen fuel cell (where water, hydrogen and oxygen are the chemical species involved), a hydrogen burner has the potential to produce NOx emissions. A hydrogen flame burns much hotter than a typical methane flame – with combustion in a stoichiometric balance of air initially at 20°C, a hydrogen flame will reach ~2210°C compared to methane which will reach ~1950°C (Engineering Toolbox, 2003). The increased temperature increases the potential for oxygen and nitrogen in the air to react to form NOx compounds.

New Zealand has a skilled workforce and access to expertise in fields such as Oil & Gas and Chemical Industry. There is likely a concentrated workforce in Taranaki, however experts such as gas fitters and process technicians are found throughout the country. What we do not have, is a specialised hydrogen-capable workforce.

With appropriate accreditation and training, this hurdle can be overcome. The onus for such training will be dependent on industry and commercial outlets, however incentives, guidance, and regulation is in the realm of government.

Ultimately, economics will dictate the uptake of hydrogen as a fuel in different industries. As it currently stands, the price of hydrogen production is too high by comparison to natural gas. A gradual replacement of one gas with the other will be required if the production maturity of current and future technologies is to reach viable levels.

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Engineering Toolbox. (2003). Flame temperatures gases. https://tinyurl.com/y3nyqbab
MBIE. (2018). Energy in New Zealand 18. Wellington, NZ: Author.

What are the opportunities for the use of hydrogen in industrial processes?

As mentioned in the responses to Questions 4a and 4b, there is a lack of both technical and academic expertise specifically for hydrogen in New Zealand. Therefore there is a major opportunity for wide-reaching collaboration between universities, technical institutes, secondary schools, crown research institutes, industry partners, government departments and iwi to address these skill shortages. Such collaboration could also provide the catalyst needed for explosive growth in production and utilisation of hydrogen technologies, as well as drive RD&D which will make New Zealand competitive on a global hydrogen stage.

I support the suggested development of a National New Energy Development Centre mentioned on Page 64. This is an excellent step towards encouraging collaboration from a central contact.

What is the role of Government in encouraging hydrogen uptake for decarbonisation of our natural gas uses?

As a core starting point, the Government needs to commission a national roadmap for the country-wide implementation of hydrogen infrastructure and technologies. A few examples have been prepared for regional development such as that for Taranaki, however for New Zealand Inc. to be competitive on a global market, a national strategy needs to be in place. The technical, commercial, political and social outlooks need to be presented with the same level of detail as the Australian National Hydrogen Roadmap (Bruce et al, 2018) or similar documents produced by other interested nations.

The Government needs to implement incentive schemes for the major natural gas users to, at least partially, decarbonise their fossil energy use and encourage uptake of synthetic fuels, not necessarily just replacement with hydrogen. This should be extended to other industries and eventually to commercial and residential applications if economically feasible. This should coincide with mandated low emissions fuel supply targets.

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Bruce, S., Temminghoff, M., Hayward, J., Schmidt, E., Munnings, C., Palfreyman, D. & Hartley, P. (2018). National hydrogen roadmap. Australia: CSIRO.

What are the challenges for hydrogen to decarbonise the applications using natural gas?

In addition to those addressed in the response to Question 4b, another major challenge which may appear is public perception of hydrogen. The general public need to be familiarised with hydrogen and its day-to-day applications, as mentioned in the response to Question 2a.

What are the opportunities for hydrogen to decarbonise our gas demand?

Research and development into power-to-fuel technologies, as well as optimisation of existing technologies for waste reuse.

What is the role of Government in producing hydrogen in sufficient volume for export?

The Government needs to engage with international authorities to ensure the appropriateness of regulatory frameworks for shipping hydrogen.

Intergovernmental agreements for exports and negotiation of tariffs will be required to instil industry confidence for production. This should be coupled with appraisals for renewables dedicated for hydrogen production specifically for feeding export markets.

What are the challenges for hydrogen if produced for export?

The requirement of dedicated renewables to maintain a constant, sustainable feed of exportable product. This will require land appraisals as well as assessments for yield potential and suitability – suitable areas for such investment might not be within the vicinity of shipping ports, so further infrastructure may also be required.

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.

There is a potential to create a hydrogen-capable workforce by investing in trade qualification and higher education focused around the requirements of an overhaul of the country's infrastructure.

Engagement plans should be developed for the use of hydrogen systems in remote communities – particularly regarding the potential for remote area power stations operating with hydrogen.

What are the opportunities for hydrogen if produced for export?

Considering the global trend toward hydrogen applications with limited production capacity, most notably in Japan and Korea, there is obvious potential for a large export market – particularly in the Pacific region.

If provided adequate incentives, there is also opportunity for entering other markets, such as the US, China and Europe, by development of competitive technologies for hydrogen production. I expect the ability to produce hydrogen effectively from a greater variety of sources, rather than just electricity, will be integral to the competitive successfulness of New Zealand Inc.

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