2 November 2023

Ministry of Business Innovation and Employment

Wellington, New Zealand

Attention: Advancing New Zealand's Energy Transition

To whom it may concern,

Response to public consultation on Advancing New Zealand Energy Transition

The Institute of Geological and Nuclear Sciences Te Pū Ao ("GNS") welcomes the opportunity to provide feedback on "Advancing New Zealand Energy Transition".

GNS Science, Te Pū Ao, is New Zealand's national institute of geological and nuclear sciences. As a Crown Research Institute, GNS Science is strongly mission led. Through world-class science, we are focused on delivering economic, environmental and social benefits for Aotearoa New Zealand.

GNS Science has led the energy exploration and research needs for the nation through-out its history. Traditionally this has been in the oil and gas sector. Through our Science Roadmap, we have now transitioned that effort to support the nation's zero carbon needs and focus our effort on the development and support of renewable energy resources.

Science-based decisions are essential

We would like to acknowledge that MBIE's public consultation document is based on evidence which adequately frames the critical crossroads we are at internationally, and we congratulate MBIE for using challenging facts as the foundation on which to negotiate.

The message we would like the New Zealand representation delegation to hear is that <u>the global community must insist on continually making decisions based on sound scientific evidence.</u>

There is little doubt that urgent action for both increasing renewable electricity share and alternate fuel to mitigate and adapt to climate change is required, but we must temper enthusiasm for low cost novel solutions by insisting that adequate scientific validation of the effectiveness of these actions is evident and provides insight that helps ensure we avoid unintended consequences.

Science and research underpin our current understanding of natural resources and future energy solutions and continue to be used to guide our decisions to advance and support the transition of New Zealand energy system to a cleaner renewable feet for purpose solution.

GNS Science collaborates with a wide range of international and local research and industries partners and we are committed to continuing work to enhance technologies uptake.

Implementing a ban on new fossil-fuel baseload electricity generation

GNS Science does not support any new fossil-fuel baseload plant. We recommend that no exception should be granted for fossil-fuel baseload should be granted however we acknowledge that a fair transition supporting the energy access security will likely require the use of gas and the development of potential storage for electricity peak needs. Gas or CCUS requires further geological and technological assessments to ensure environmental safety. We recommend throughout investigations on energy storage for peak performance.

The ban for new fossil-fuel baseload electricity generation will support investment in other baseload electricity generation such as geothermal. Recent technological development by the sector is transforming the industry into a carbon zero renewable source, and the potential growth of geothermal for New Zealand has been underestimated. GNS Science recommends to continued investigation to access low footprint supercritical geothermal solution, and to develop supporting regulations. GNS Science demonstrated that deep geothermal resource could potentially generate 30,000GWh of energy annually (Castalia, 2023), supressing the need for fossil-fuel baseload plant.

Interim Hydrogen Road Map

GNS Science supports the Interim Hydrogen Roadmap's positioning of green hydrogen's role in addressing the climate crisis, in enhancing energy security and resilience, and creating economic value for local communities and New Zealand industry. GNS Science agrees that research and development will play a key role in improving efficiencies in hydrogen production, compression, storage and conversion. These advances will ultimately provide cheaper hydrogen. Ensuring a research and development presence in the governance structure of the proposed coordination body will ensure better identification of research gaps for investment.

GNS Science recommends that an overt identification of principal risk factors to the viability of the Interim Hydrogen Roadmap, alongside an indicative approach to address these factors, should form part of the setting out of a strategic landscape for hydrogen in New Zealand. The government's assessment of the strategic landscape for hydrogen in New Zealand does not include an overt consideration of risk, particularly risk associated with climate change impacts. Water is a key input for green hydrogen production, and fresh water availability over the long term is vulnerable to climate change impacts. Given water's cultural importance for Iwi and Māori as well as the rights and interests in freshwater assets across the country, this would be an important to consider in assessing the overall strategic landscape for hydrogen in New Zealand. Given climate change's likely impacts on freshwater availability as noted earlier in this submission, it is important to support investigations that progress green hydrogen production from a range of other water sources.

Another key risk to the viability of the Interim Hydrogen Roadmap is the significant renewable electricity generation build-out required. The development of an hydrogen industry sector will need to be supported by electricity generation and we recommend investigation to support cascade use of electricity to limit energy depletion.

The government views the largest potential advantages for hydrogen in New Zealand to lie with its use in existing industrial processes to decarbonize large and hard-to-abate sources of emissions such as fertiliser, steel and chemical production, as well as in use across a range of transport applications. GNS Science agrees that green hydrogen use in the heavy transport sector as well as to decarbonise industrial process heat particularly for some high temperature options are areas of immediate viability.

Regulatory Framework for Offshore Renewable Energy

The marine regulatory space is already very complex and to help achieve offshore renewable energy development GNS Science recommends adoption of Marine Spatial Planning as a management framework for the marine environment. The proposed Spatial Planning Act already signals this tool. Spatial planning is a way to recognise that the demand for use of our seas and the resulting pressures on them will continue to increase, manage competing demands on the marine area, enable the co-existence of compatible activities wherever possible; and integrate with terrestrial planning.

GNS Science has identified gaps and recommend inclusion of natural hazard information products in an Marine Spatial Planning. Some of this information is already available in the public space, while in other cases, specific hazards are understudied. GNS Science suggest that such that natural hazard information should be linked to a Marine Spatial Planning data repository and portal to provide an explicit picture of potential risk to future installations, to support risk mitigation. GNS Science recommends mandatory lodging of feasibility information and data by offshore renewable energy developers and public availability through a Marine Spatial Planning data repository and web based portal.

A Marine Spatial Planning commits government to make decisions on the best available scientific evidence. GNS Science recommends a panel or group be established to regularly review Marine Spatial Planning's for offshore renewable energy and determine where evidence gaps and uncertainties exist.

Measures for Transition to an Expanded and Highly Renewable Electricity System

GNS Science has conducted analysis exploring the social issues in relation to subsurface energy storage in New Zealand. There are several overarching policy drivers supporting action around large-scale energy storage options in the country (for example the New Zealand Battery Project) and policy action around addressing intermittency issues in relation to renewable energy sources that are intended to replace fossil fuel reliance. However, subsurface energy storage options are not clearly demarcated (or focused upon) within these policy drivers at the moment.

New Zealand should advocate for enhanced collaboration to develop new geothermal technologies for the identification and characterisation of resources, and for energy extraction and conversion. This would accelerate the viability for geothermal energy to become a key component of the energy systems. Many countries are looking to use geothermal energy in the transition from fossil fuels as it is an established technology and abundant renewable resource. For example, GNS Science has an established partnership with Japan and the US Department of Energy to share our expertise in geothermal exploration and energy generation.

GNS Science recommends facilitating the development of distributed decentralised energy solution via thermal network systems and utilisation of ground source geothermal heat pump. In response to global demands towards electrification, high-temperature heat pump technology, tailored for industrial applications, is progressing at an accelerated pace. Although the initial capital outlay remains relatively high, ongoing technological innovations indicate a trajectory towards greater cost competitiveness, alongside advancements that are poised to enable even higher industrial process temperatures in the near future. The feasibility assessment showed a lot of promise for this type of technology, and GNS Science recommends that conducting feasibility assessments in the future would be useful, especially with anticipated technological advancements. The potential for lower temperature technologies extends nationwide. Therefore, it is recommended that national guidance on the opportunity and potential consenting process that include best practices for subsurface and groundwater management be established to facilitate and standardize the development of these technologies.

Future of the Gas Industry

A full transition to zero carbon energy sources may require time to be completed, due to the need for maturation of new technologies. During this time, the gas sector may fail to remain operational due to the lack of economic feasibility and investment.

An unmanaged transition poses challenges for the sector and could contribute to unintended adverse consequences: The potential loss of industries which mostly rely on gas in their manufacturing process, a decrease in the energy sector resilience due the loss of gas operated power plants (in emergency scenarios), the risk of a loss of gas pipelines and infrastructure, leaving various small users without mature solutions to replace gas (earlier than planned).

Summary of recommendations

1. *The global community must insist on continually making decisions based on sound scientific evidence.*
2. *New Zealand should advocate for improved scientific understanding of hydrogen future environmental impact.*
3. *New Zealand should advocate for the development of guidelines and methodologies for evaluating and verifying to improve efficiencies in hydrogen production, compression, storage and conversion.*
4. *New Zealand should advocate for the establishment of a hydrogen government and sector coordination body that has oversight over actions under a range of policy objectives, and that will be responsible for monitoring outcomes.*
5. *New Zealand should advocate for reconsidering the role of geothermal as baseload electricity generation and district energy solution.*
6. *New Zealand should advocate internationally for indigenous-led/co-designed approaches to local energy needs.*
7. *New Zealand should advocate for enhanced collaboration to develop new geothermal technologies for the identification and characterisation of resources, and for energy extraction and conversion.*

8. *New Zealand should advocate for a panel be established to regularly review Marine Spatial Planning's for offshore renewable energy and determine where evidence gaps and uncertainties exist.*
9. *New Zealand should advocate for clear assessment of environmental guideline for offshore wind developments supported by scientific evidences.*
10. *New Zealand should advocate for the development of technologies that are affordable and have clear international standards to ensure interoperability.*

Concluding remarks

Reducing the growing impact of climate change requires the fast tracking development of renewable, baseload, regional and national mixed energetic solutions. Our comments are intended to support an the development of a New Zealand Energy Strategy, we have brought together knowledge and expertise from many areas across our organisation and hope that our feedback is carefully considered and useful. GNS Science would welcome the opportunity to engage to further develop any of these ideas.

#19

COMPLETE

Collector: Hydrogen (Web Link)
Started: Thursday, November 02, 2023 3:35:02 PM
Last Modified: Thursday, November 02, 2023 3:46:31 PM
Time Spent: 00:11:29
IP Address: 203.211.111.54

Page 4: Privacy Information

Q1

Privacy information

Respondent skipped this question

Page 5: Submitter information

Q2

Name

Q3

Organisation and role (if submitting on behalf of a company or organisation)

Strategic Advisor, GNS Science

Q4

Email Address

Q5

Are you happy for MBIE to contact you, if we have questions about your submission?

Yes

Q6

Please clearly indicate if you are making this submission as an individual, or on behalf of a company or organisation.

Company/Organisation

Page 6: Strategic context

Q7

If there are other issues we should be considering in our assessment of the strategic landscape for hydrogen in New Zealand?

GNS Science supports the Interim Hydrogen Roadmap's positioning of green hydrogen's role in addressing the climate crisis, in enhancing energy security and resilience, and creating economic value for local communities and New Zealand industry.

The government's assessment of the strategic landscape for hydrogen in New Zealand does not include an overt consideration of risk, particularly risk associated with climate change impacts. GNS Science recommends that an overt identification of principal risk factors to the viability of the Interim Hydrogen Roadmap, alongside an indicative approach to address these factors, should form part of the setting out of a strategic landscape for hydrogen in New Zealand.

Water is a key input for green hydrogen production, and freshwater availability over the long term is vulnerable to climate change impacts. The Ministry for the Environment analysed projected impacts of climate change on freshwater flows and noted that extreme rainfall, more frequent and intense droughts, and sea-level rise are likely to increase the demand for water to irrigate land and increase competition for this resource. Social challenges in relation to water access were expressly left out of scope of the modelling that underpins the Interim Hydrogen Roadmap. Given water's cultural importance for iwi and Māori as well as the rights and interests in freshwater assets across the country, this would be an important to consider in assessing the overall strategic landscape for hydrogen in New Zealand.

Another key risk to the viability of the Interim Hydrogen Roadmap is the significant renewable electricity generation build-out required, with an estimated added capacity of 12.5 GW by 2050 for domestic use alone. While the modelling suggests that a value-add export scenario for hydrogen production would itself act to incentivise investments in renewable electricity generation, risks associated with global supply chain challenges relating to the critical minerals needed for the new builds are not factored in (IEA 2023, IEA 2021), nor are they addressed in the electricity system measures proposed by the government.

International Energy Agency [IEA] (2023). Energy Technology Perspectives 2023. Energy Technology Perspectives 2023 (windows.net)

International Energy Agency [IEA] (2021). The Role of Critical Minerals in Clean Energy Transitions. The Role of Critical Minerals in Clean Energy Transitions (windows.net)

Page 7: Use cases for hydrogen

Q8

Do you agree with our assessment of the most viable use cases of hydrogen in New Zealand's energy transition?

Yes,

Please provide further explanation to your response:
GNS Science agrees that green hydrogen use in the transport sector (Qi et al 2023) as well as to decarbonise industrial process heat particularly for some high temperature options (Reid 2019) are areas of immediate viability. Given the ban on new fossil-fuel baseload electricity generation, hydrogen production concurrent with (or sequential to) offshore and onshore renewable energy generation (including wind, solar and geothermal) would be a helpful enabler of the energy transition, as it would act as an energy storage system to smooth power variability (Maestre et al 2021). Maestre VM, Ortiz A & Ortiz I. (2021). Challenges and prospects of renewable hydrogen-based strategies for full decarbonization of stationary power applications. Renewable and Sustainable Energy Reviews, Vol 152, Dec 2021, 111628. https://doi.org/10.1016/j.rser.2021.111628 Qi L, Sharp B, Sheng S, Talwar S, Kennedy J & Wen Le. (2023). New Zealand's Energy Transition: evaluating potential technology trajectories and costs of CO2 emissions in transportation using the NZIES model. Forthcoming publication in the Journal of the Royal Society of New Zealand's special issue on "Renewable Energy: Enabling a just transition in Aotearoa New Zealand". Reid G. (2021). Hydrogen as a fuel for industrial process heat in New Zealand. Research submitted in partial fulfilment of the requirements for the degree of Master of Energy, The University of Auckland. UoA # 303105493. 15 December 2021.

Q9

What other factors should we be considering?

Respondent skipped this question

Page 8: The pathway to 2050

Q10

Do you agree with this assessment of the potential for hydrogen supply and demand in New Zealand?

Respondent skipped this question

Q11

Do you agree with the key factors we have set out that are likely to determine how hydrogen deployment could play out?

Respondent skipped this question

Page 9: How hydrogen could contribute to our objectives

Q12

Do you agree with our findings on the potential for hydrogen to contribute to New Zealand’s emissions reduction, energy security and resilience and economic outcomes?

Yes,

Please provide further explanation to your response. You may comment on any or all of these objectives.:

GNS Science agrees that green hydrogen use in the transport sector (Qi et al 2023) as well as to decarbonise industrial process heat particularly for some high temperature options (Reid 2019) are areas of immediate viability. Given the ban on new fossil-fuel baseload electricity generation, hydrogen production concurrent with (or sequential to) offshore and onshore renewable energy generation (including wind, solar and geothermal) would be a helpful enabler of the energy transition, as it would act as an energy storage system to smooth power variability (Maestre et al 2021). Maestre VM, Ortiz A & Ortiz I. (2021). Challenges and prospects of renewable hydrogen-based strategies for full decarbonization of stationary power applications. Renewable and Sustainable Energy Reviews, Vol 152, Dec 2021, 111628. https://doi.org/10.1016/j.rser.2021.111628 Qi L, Sharp B, Sheng S, Talwar S, Kennedy J & Wen Le. (2023). New Zealand’s Energy Transition: evaluating potential technology trajectories and costs of CO2 emissions in transportation using the NZIES model. Forthcoming publication in the Journal of the Royal Society of New Zealand’s special issue on “Renewable Energy: Enabling a just transition in Aotearoa New Zealand”. Reid G. (2021). Hydrogen as a fuel for industrial process heat in New Zealand. Research submitted in partial fulfilment of the requirements for the degree of Master of Energy, The University of Auckland. UoA # 303105493. 15 December 2021.

Q13

Do you have any insights we should consider on what is needed to make hydrogen commercially viable?

Yes,

Please provide further explanation to your response:

GNS Science supports a greater focus on hydrogen's role in distributed energy generation and storage (see Kotowicz et al 2023). This would complement the proposed measures taken to advance flexibility in distributed generation in the government's electricity system measures report. The MBIE Endeavour research 'Pūhiko Nukutū: a green hydrogen geostorage battery in Taranaki' investigates green hydrogen storage at scale in underground reservoirs in Taranaki, which is a key contributor to a successful energy transition. GNS Science notes that there is likely to be a sequencing to some of the use cases. Blended hydrogen in the reticulated gas network may incentivise investments into maintenance of the gas infrastructure, which is a priority objective under the Gas Transition Plan to ensure a stable energy transition. While there are specific infrastructure requirements to transporting hydrogen in existing gas pipelines (see Topolski et al 2022's analysis for the US Department of Energy), Firstgas has confirmed the technical feasibility of using the existing gas pipeline network to transport hydrogen in New Zealand, initially as a blend and then to 100% if required and can start blending hydrogen into their existing pipelines by 2030 (Firstgas 2021, p 7). Firstgas (2021) Brining zero carbon gas to Aotearoa. Hydrogen Feasibility Study. Firstgas-Group_Hydrogen-Feasibility-Study_web_pages.pdf Kotowicz J, Uchman W, Jurczyk M & Kekret R. (2023). Evaluation of the potential for distributed generation of green hydrogen using metal-hydride storage methods. Applied Energy. Vol 344. https://doi.org/10.1016/j.apenergy.2023.121269 Topolski K, Reznicek E.P., Erdner B.C., San Marchi C.W., Ronevich J.A., Fring L., Simmons K., Fernandez O.J.G., Hodge B-M & Chung M. (2022). Hydrogen blending into natural gas pipeline infrastructure: review of the state of technology. National Renewable Energy Laboratory, US Department of Energy. Hydrogen Blending into Natural Gas Pipeline Infrastructure: Review of the State of Technology (nrel.gov)

Page 10: Government position and actions

Q14

Do you agree with our policy objectives?

Yes,

Please provide further explanation to your response.:
GNS Science agrees with the overarching policy objectives set out in the Interim Roadmap but is of the view that the governance structure to oversee the implementation of these policy objectives is as important as the objectives themselves. A key action under the Interim Hydrogen Roadmap is the establishment of a government and sector coordination body that has oversight over actions under a range of policy objectives, and that will be responsible for monitoring outcomes. GNS Science is of the view that to govern a fledgling sector like hydrogen it is important to have a strong Research & Development presence in this governance structure, to reflect key science and technology advances in decision making. Having this presence in this governance structure of the new coordination body will also enable the government to align hydrogen more effectively with New Zealand's national research priorities as it wishes to do, as well as enable a more effective investigation of gaps in funding support across research, development and deployment (p 55-56 Interim Hydrogen Roadmap).

Q15

Do you agree with our positioning on hydrogen's renewable electricity impacts and export sector?

No,

Please provide further explanation to your response.:
The value-add export scenario in the Interim Roadmaps economic modelling requires the largest renewable electricity build-out compared to the other scenarios (27GW by 2050 if industrial feedstock is included). It is currently unclear if this increased demand will divert electricity from the country's larger electrification goals, or if it will act to incentivise electricity generation in the country, thereby helping to achieve those broader electrification objectives. While the government sees no immediate role in supporting an export industry for hydrogen, GNS Science recommends that the government revisit this decision once there is increased clarity on renewable electricity generation impact, in view of the economic development and potential energy security benefits of an export led hydrogen industry.

Q16

Do you agree with the proposed actions and considerations we have made under each focus area?

Yes,

Please provide further explanation to your response.:
GNS Science agrees with the proposed plan to establish a government and sector coordination body. GNS Science agrees that the proposed regulatory work to enable safe basic operation of hydrogen projects is important. Transparent and fit-for-purpose standards give facilitate investor confidence and addresses public concerns over safety of hydrogen deployment. GNS Science agrees that the Regional Hydrogen Transition consumption rebate scheme incentivises early industry adopters and therefore helps establish a market for hydrogen. GNS Science agrees that research and development will play a key role in improving efficiencies in hydrogen production, compression, storage and conversion. These advances will ultimately provide cheaper hydrogen. GNS Science agrees with the action to continue to raise the public profile of Hydrogen.

Page 11: Other Feedback

Q17

If there is anything else you'd like to tell us, please comment below.

As New Zealand moves towards a low-emissions, climate-resilient and more sustainable economy, identifying the right roles for hydrogen in the energy transition also requires a consideration of how this meets the objectives of a 'just' transition (Just Transition Center 2017, Pueyo and Leining 2023, Morgan et al 2022, Wang & Lo 2021). Energy transitions have traditionally disadvantaged some groups more than others (Bartiaux et al 2019, Axon & Morrissey 2020). A Just Transition process explicitly acknowledges this imbalance, and plans for a transition that is more fair, equitable and inclusive.

GNS Science commends initiatives such as the Regional Hydrogen Transition that closely aligns to local partner and stakeholder interests in the larger Just Transitions for Southland program.
GNS Science recommends supporting research that progresses green hydrogen production from a range of other water sources given the potential future pressures on freshwater.

An example of this is GNS' research on new nanostructured electrocatalysts and electrodes that allow green hydrogen production from non-pure water sources such as wastewater and sea water (Aotearoa: Green Hydrogen Technology Platform funded under the government's Strategic Science Investment Fund Advanced Energy Technology Platform). Khan et al 2021 argue that the additional cost of purifying seawater for use in hydrogen generation leads to 'insignificant increase' in the levelized cost of hydrogen as well as in carbon dioxide emissions.

Further evidence the government could be considering pertains to decarbonisation. The Ernst & Young modelling calculates decarbonisation benefits enabled by hydrogen use through fossil fuel displacement. It does not factor in the impact of leaked hydrogen on atmospheric composition, which may have an indirect warming effect on climate partially offsetting some of the climate benefits of carbon dioxide reduction (CSIRO 2021, Warwick et al 2022, Ocko & Hamburg 2022, Bertgani et al 2022). Researchers at GNS Science are currently progressing our understanding of the scope of this issue.

Axon S & Morrissey J. (2020). Just energy transitions? Social inequities, vulnerabilities and unintended consequences. Buildings & Cities. Vol 1, Issue 1, pp 393- 411. https://doi.org/10.5334/bc.14

Bartiaux F, Maretti M, Cartone A, Biermann P, Krasteva V. (2019). Sustainable energy transitions and social inequalities in energy access: a relational comparison of capabilities in three European countries. Global Transitions. Volume 1, 2019. Pp 226-240. https://doi.org/10.1016/j.glt.2019.11.002
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Commonwealth of Australia [COAG] (2019) Australia's National Hydrogen Strategy. https://www.dcceew.gov.au/sites/default/files/documents/australias-national-hydrogen-strategy.pdf

CSIRO (2021). Modelling the impacts of future hydrogen emissions. Modelling the impacts of future hydrogen emissions – HyResearch: Australian Hydrogen R&D Portal (csiro.au)

HyResearch: Australian Hydrogen R&D Portal (csiro.au)
Department of Energy [DOE] (2023), U.S National Clean Hydrogen Strategy and Roadmap. https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/us-national-clean-hydrogen-strategy-roadmap.pdf

Ocko I.B. & Hamburg S.P (2022). Climate consequences of hydrogen emissions. Volume 22, Issue 14. https://doi.org/10.5194/acp-22-9349-2022.

Khan MA, Al-Attas T, Roy S, Rahman MM, Ghaffour N, Thangadurai V, Larter S, Hu J, Ajayan PM & Kibria MG. (2021). Seawater electrolysis for hydrogen production: a solution looking for a problem? Energy & Environmental Science. Vol 14, 4831. DOI:10.1039/D1EE00870F