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Dear Ministers,

I am writing to draw to your attention some issues and questions that need to be addressed before any decisions are made that would commit significant renewable energy resources to the production of green hydrogen for export from New Zealand.

Green hydrogen could help to decarbonise some hard-to-abate sectors in New Zealand, such as long-haul flight, heavy freight, shipping and steel manufacturing. However, producing green hydrogen in New Zealand would have an opportunity cost since there are potentially more economically efficient and environmentally beneficial uses for that renewable electricity. The trade-offs need to be explicit and transparently balanced.

Green hydrogen technology has received a great deal of publicity over the last decade or more, both in the scientific literature and in the general media. A number of recent statements suggest that the Government is considering giving its support to the development of a green hydrogen production industry in New Zealand. In her Opening Statement on 8th February, the Prime Minister said:

"New Zealand is uniquely placed to become a world-leader in hydrogen production using renewable energy, creating new export opportunities, high-wage jobs and regional industries."[1]

[1] Ardern, J., 2022. Jacinda Ardern: Opening Statement 2022. www.labour.org.nz/news-jacinda-ardern-priorities-2022.

While some domestic demand for green hydrogen could plausibly materialise in some sectors, it is unlikely – at least in the near term – that this would be on a scale that would make its production in New Zealand economic. A green hydrogen production industry would therefore rely predominantly on an export market to provide the scale that investors would require. This is where the government appears to suggest the opportunity for New Zealand presently lies.

Green hydrogen may provide a potential long-term global solution for a small number of hard-to-abate sectors such as long-haul flight, heavy freight, international shipping and steel manufacturing.[2] But it is by no means a climate panacea and its production may not be the best use of scarce renewable energy resources in New Zealand. In fact, over the short term, the development of a green hydrogen production industry for export markets will do little to help New Zealand achieve its climate commitments and may even make achieving them more difficult.

In September 2019, the Ministry of Business, Innovation and Employment (MBIE) released a green paper entitled *A vision for green hydrogen in New Zealand* produced by the consultancy Arup. The green paper's stated vision was to "harness the hydrogen opportunity for a sustainable and resilient energy future for New Zealand".[3] Building on this vision, MBIE then engaged Castalia to develop an economic assessment of the production of green hydrogen under different conditions. The further development of a roadmap for green hydrogen is expected within the next year.

All this work starts from the premise that green hydrogen is a good idea for New Zealand. It is unfortunate that MBIE had not first asked *whether* there *was* a hydrogen opportunity to be harnessed in New Zealand.

In its final advice to the Government, the Climate Change Commission noted that:

"The costs, benefits, trade-offs and risks of a hydrogen economy will need to be carefully assessed. This includes assessing the cost of production and storage, the costs to maintain, upgrade and repurpose existing infrastructure, and the practicality and affordability for all consumers."[4]

Determining whether hydrogen should be part of the energy system requires a **whole energy system analysis** so the opportunity cost of green hydrogen can be estimated and compared with alternative options. Any such analysis should start

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[2] IRENA, 2022. Geopolitics of the energy transition: The hydrogen factor. www.irena.org/publications/2022/Jan/Geopolitics-of-the-Energy-Transformation-Hydrogen.
[3] MBIE, 2019. A vision for hydrogen in New Zealand. www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/a-vision-for-hydrogen-in-new-zealand/.
[4] Climate Change Commission, 2021.Ināia tonu nei: a low emissions future for Aotearoa. www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/.

from agnostic premises about the desirability of hydrogen and consider a range of energy technologies and pathways for achieving deep reductions in carbon dioxide emissions together with the social, economic and environmental implications of those pathways. Economic analysis should include all costs associated with the development of a hydrogen industry in New Zealand. This includes the development of import and export terminals, export production facilities (e.g. ammonia), transport infrastructure and the development of new renewable energy capacity to replace renewable energy that would otherwise feed into the wholesale electricity market.

I would commend such an approach before providing any further support to the development of a domestic green hydrogen production industry. Critically, this needs to compare the opportunity costs of committing renewable energy to green hydrogen production with those of other energy pathways designed to eliminate fossil fuel emissions from the economy.

There are some significant challenges that must be investigated and discussed before making a decision that would commit significant blocks of renewable energy and government finances to green hydrogen production.

First, the production of green hydrogen remains commercially unproven in New Zealand. While several governments across the world are actively investigating hydrogen as a potential energy carrier for the future, there is not yet a competitive global energy market for green hydrogen.[5] Globally, almost USD 30 billion of subsidies have been announced as part of stimulus packages for green hydrogen projects.

However, the International Energy Agency notes that a lack of demand for the product remains a key uncertainty for an expansion of green hydrogen production and whether these projects will end up being commissioned on time and on budget.[6] Several global studies have shown that hydrogen has the potential to be cost-competitive with other low-carbon technologies somewhere between 2030 and 2040,[7] but this requires economies of scale to drive down the costs of electrolysers and substantial reductions in the price of renewable electricity.[8]

Second, if green hydrogen for export is the end goal, there appear to be better placed countries with a stronger comparative advantage than New Zealand. The

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[5] IRENA, 2022.
[6] IEA, 2021. Could the green hydrogen boom lead to additional renewable energy capacity by 2026? www.iea.org/articles/could-the-green-hydrogen-boom-lead-to-additional-renewable-capacity-by-2026.
[7] Hydrogen Council, 2020. Path to hydrogen competitiveness: A cost perspective. https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/.
[8] MBIE, 2019. A vision for hydrogen in New Zealand. www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-strategies-for-new-zealand/a-vision-for-hydrogen-in-new-zealand/.

economic case for producing green hydrogen is strongest in places with plentiful renewable energy resources and low power prices. Countries such as Brazil, Norway, Canada, Sweden, Peru and Finland have high shares of renewables in their electricity generation mixes, [9] combined with lower electricity prices than New Zealand,[10] and are therefore likely to be more competitive locations for green hydrogen production.

Of the green hydrogen production plants that have been commissioned to date, most have been powered by dedicated sources of offshore wind or solar photovoltaics (PV). In New Zealand, most green hydrogen in the near term would likely be produced from a dedicated source of hydropower such as the Manapouri power station in Southland. It is not evident that hydrogen produced in this way would be cost-competitive with green hydrogen produced overseas at larger scales using cheap offshore wind, solar PV or other renewables.[11]

Third, producing green hydrogen for export is likely to make it more difficult and costly for New Zealand to meet its climate change commitments. The Climate Change Commission has already demonstrated how difficult it will be to achieve our domestic emissions budgets. Even so, green hydrogen production is not incorporated in any of the Climate Change Commission's scenarios for meeting the next three carbon budgets out to 2035. Looking out to 2050 is more uncertain and the opportunity for novel technologies such as green hydrogen may emerge with time.

Embarking on the creation of a new green hydrogen production industry focused on the hydrogen export market will add new demand for scarce renewable energy resources, making it more difficult to meet our domestic emissions budgets. A green hydrogen production industry will divert renewable electricity from the wholesale electricity market and potentially increase the price of electricity for end-consumers above what might otherwise have prevailed. The international commitment that New Zealand has made in its first Nationally Determined Contribution (NDC) is even more demanding than its domestic emissions budgets and may end up causing the Government to spend even more on purchasing carbon offsets overseas. Building an export industry for green hydrogen would be likely to increase the total amount spent purchasing carbon offsets overseas.

The renewed interest in producing green hydrogen coincides with the possible

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[9] Our World in Data. Renewable Energy. https://ourworldindata.org/renewable-energy [accessed 9 March 2022].
[10] GlobalPetrolPrices.com. Electricity prices, June 2021. www.globalpetrolprices.com/electricity_prices/ [accessed 9 March 2022].
[11] The costs of green hydrogen production are highly site-specific. While some types of electrolysers work best when operated more or less continuously, others are optimised for use with variable renewable energy sources such as wind energy. Hydrogen production from wind energy can provide demand side flexibility and support the integration of high levels of variable wind energy into electricity grids.

cessation of aluminium production at the Tiwai Point smelter. The possibility that renewable electricity from Manapouri could become available on wholesale electricity markets instead of being exported as aluminium raises important national interest questions about how that energy might be used. It could provide an opportunity to accelerate the decarbonisation of New Zealand's economy by releasing additional renewable electricity supply onto wholesale electricity markets. This could enable a more ambitious decarbonisation pathway based on electrification of fossil-dependent technologies like coal and fossil gas fired boilers, fossil gas space heaters and internal combustion engine light vehicles.

The electricity currently consumed at Tiwai Point is equivalent to around 13 per cent of national electricity consumption or the demand of around 680,000 homes.[12] Modelling from the Climate Change Commission shows that releasing this electricity could lower wholesale electricity prices below what they would otherwise be by as much as $20 per MWh for up to a decade.[13] Diverting this supply of renewable electricity from consumers to produce green hydrogen would maintain upward pressure on consumer electricity prices over the foreseeable future at the very time the Government will be asking consumers to make the shift to using low-carbon electricity in households and in transport. The Government's commendable insistence on a just transition would be made much more difficult and I fear the outcome would be less ambitious emissions budgets.

Recent events have also once again revealed New Zealand's exposure to volatile liquid fossil fuel prices and potential exposure to supply disruption. Locking up onshore energy production for export for decades to come denies New Zealand an opportunity to de-risk domestic energy supply.

A whole energy system analysis needs to take account of the energy costs of producing green hydrogen. The process of electrolysing water (splitting water into hydrogen and oxygen) is energy intensive – between 20 and 30 per cent of the energy is lost when renewable electricity is converted into hydrogen. There are also losses associated with the transport of the fuel to dispensing stations and again associated with engine and transport losses once used in vehicles. Once all these losses are added up, hydrogen has an end-to-end efficiency of only 30–40 per cent. By comparison, battery electric vehicles have an end-to-end efficiency of around 60–70 per cent.[14] Given the thermodynamic inefficiencies of hydrogen it is hard to

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[12] Devlin, C. and McCarthy, P., 2015. Tiwai Smelter deal signed between Meridian Energy and NZAS. *Stuff.co.nz*, 3 August 2015. www.stuff.co.nz/business/industries/70763839/tiwai-smelter-deal-signed-between-meridian-energy-and-nzas [accessed 22 February 2022].
[13] Climate Change Commission, 2021.Ināia tonu nei: a low emissions future for Aotearoa. [Page 281] www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/.
[14] Yoo, E., Kim, M. and Song, H. H., 2018. Well-to-wheel analysis of hydrogen fuel-cell electric vehicle in Korea. International Journal of Hydrogen Energy 43 (41): 19267–78. https://doi.org/10.1016/j.ijhydene.2018.08.088.

see green hydrogen competing with electric battery technology at scale for light vehicles, which account for nearly a quarter of our emissions.

Green hydrogen may make sense for long-haul flight, heavy freight (which accounts for around 3 per cent of New Zealand's total emissions) and a small number of other hard-to-abate sectors such as international shipping and steel manufacturing (0.2 per cent of total emissions), all of which are important to New Zealand. But abating emissions from these sectors will be costly. In the immediate future we should be focused on decarbonising the light vehicle fleet (23 per cent of total emissions), electricity and heat production (8 per cent of total emissions) and industry (14 per cent of total emissions). In each case, electrification already offers a practical and competitive pathway.

Supporting the development of a green hydrogen industry too early could result in path-dependencies that may prevent other, more cost-effective solutions from materialising. That said, a strategy for dealing with longer-term, hard-to-abate sectors should be developed so that decarbonisation of these sectors can be undertaken when viable technological pathways are closer to hand.

Careful, transparent examination of the alternative energy and emissions pathways available to New Zealand is required. Recontracting the supply of electricity to the Tiwai Point smelter or its closure in the context of New Zealand's climate change obligations raises matters of national interest that cannot be determined solely by the commercial interests of electricity generators.

I am appending to this letter a number of questions that, if answered, could contribute to a well-informed public debate about whether and how to pursue green hydrogen production. Responding to climate change has become a challenge that goes to the heart of the economy. My concerns, as you will appreciate, are driven by the environmental effectiveness of this challenge. Hydrogen made from wind, solar, hydropower and other renewables likely has a role to play in the forthcoming global energy transition. But reducing domestic emissions in a cost-efficient manner whilst maintaining security of supply should be the primary focus of the Government's low carbon energy strategy.

The Government should be particularly cautious about subsidising the creation of a green hydrogen production industry. While subsidy will sometimes be a sensible way of bringing forward technological change, the potential environmental consequences need to be fully understood in advance – in this case, the likely emissions trajectory caused by any new path dependencies that might be created.

While it could be argued that exporting green hydrogen would reduce emissions elsewhere in the world, it is reasonable to ask whether New Zealand should be facilitating other countries' transitions when it is still unclear if New Zealand will even meet its own emissions budgets. There is a finite amount of renewable generation capacity that can be deployed over the coming decade. In my view it

would be best used to decarbonise the domestic economy of New Zealand. It would also improve energy security – something that current events have highlighted.

Yours sincerely,

Simon Upton
Parliamentary Commissioner for the Environment

CC:
Hon David Parker, Minister for the Environment
Dr Rod Carr, Chairperson, Climate Change Commission

Appendix: Questions related to green hydrogen

1. What are the ***opportunity costs*** of green hydrogen production within a whole energy system context?
2. What is the effect on ***domestic emissions budgets*** of diverting renewable electricity from wholesale electricity markets to green hydrogen production (e.g. in the event that Tiwai Point aluminium smelter closes) and what will this mean for ***wholesale electricity prices?***
3. When the ***costs and benefits*** of a new green hydrogen production industry are assessed, will the costs of developing the import and export terminals, ammonia production facilities, additional renewable energy capacity and hydrogen transport infrastructure be factored into the analysis?
4. What is the government's ***definition*** of 'green hydrogen'?
5. How will a global market for 'green hydrogen' be regulated and what ***assurance*** and ***certification processes*** will be in place to verify the sale of 'green hydrogen' on international markets?
6. What effect does the government expect the development of new green hydrogen production facilities to have on investment in ***new renewable energy capacity***?