ARUP

Submission on the *Interim Hydrogen Roadmap*

Name	
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Responses to questions

Section 1: Hydrogen is emerging as an important part of the future global energy system	
1	**Are there other issues we should be considering in our assessment of the strategic landscape for hydrogen in New Zealand?**

It is important to show in more detail how the Hydrogen Roadmap fits into and integrates with the wider policy and energy context in NZ. It is also important to be clear about the role of green hydrogen versus other types of hydrogen as a lot of the emissions benefits diminish when other forms of hydrogen are used.

It is important to direct funding and resources that can most effectively contribute to the decarbonisation of New Zealand economy by 2050 (with due consideration for Just Transition, care for local environment and culture, etc). We need to learn lessons from what has happened globally with hydrogen. Over-allocation to certain inefficient uses of hydrogen, to the detriment of more low-hanging fruit in other areas, could hinder New Zealand's decarbonisation overall especially if renewable generation buildout is struggling to keep pace (and the reverse is also true of hydrogen under-investment). It is also critical that supply of hydrogen is balanced by demand and that there are sufficient offtake agreements provided to sustain the supply of green hydrogen in NZ. The upcoming Energy Strategy will provide critical guidance to decision-makers who will need to allocate resources across multiple competing decarbonisation efforts.

The role of hydrogen to provide electricity system support services and emergency backup power generation is more nuanced than the Interim Roadmap describes. Please refer to Question 3 for our detailed position on these issues.

Section 1 of the Interim Roadmap is notably silent on two issues: renewable generation & transmission buildout and consenting; and workforce, skills and education/training considerations. These are discussed in some detail elsewhere in the document, but seem to be overlooked in this section.

The role of hydrogen in specialist off-road transport applications requiring 24x7 operation has been understated. Examples include port and aviation landside transport operations, as well as mining.

Lastly, the cost barriers that hydrogen needs to overcome in order to be commercially viable for most applications cannot be overstated. Particular caution should be taken with future cost forecasts for green hydrogen production and benchmarking against alternatives. Top-down forecasts (e.g. those based on the premise of meeting emissions reduction targets) may not be realised if they are based on optimistic assumptions regarding economies of scale, unproven / non-existent technological advancements, etc. We note Boston Consulting Group's October 2023 report which forecasts a 2030 green hydrogen production cost in Europe of €5-8 per kg, in contrast to the 2021 consensus view of €3 per kg.[1] The exact figures will certainly not translate directly to New Zealand conditions (and indeed if Europe's production cost is much higher than New Zealand's, this could strengthen the case for an

	export market). Nevertheless, the report clearly underscores the huge uncertainties in forecasting medium- and far-future costs of a rapidly-developing technology which is sensitive to much broader market conditions such as renewable electricity cost. [1] https://media-publications.bcg.com/Turning-the-European-Green-H2-Dream-into-Reality.pdf
Section 2: The role for hydrogen in New Zealand's energy transition	
2	**Do you agree with our assessment of the most viable use cases of hydrogen in New Zealand's energy transition?**
	Broadly yes. Please refer to our response to Question 3 for further detail.
3	**Do you support some of these uses more than others?**
	Yes – in descending order based on a balance of viability, urgency, competitiveness and presence/absence of alternative options: 1. **Industrial feedstocks** (including ammonia, fertiliser/urea, and methanol), **steel production**, and **high-temperature process heat**: all seem to be obvious low-hanging fruit where green hydrogen can displace existing inputs with relatively high technological application maturity to achieve major emissions reductions. 2. Electricity system support: we strongly support hydrogen's candidacy for certain valuable grid support services, most notably demand-response and as one component of a portfolio of long-duration storage/generation firming services. This will require the market to provide appropriate and sufficient signals/incentives for hydrogen producers to ramp/up down their electrolyser utilisation in response to grid operating parameters, without compromising the economic operation of the hydrogen plant and investment return to owner/operators. Ensuring these signals are present and working effectively will require ongoing review of the market design and operation. We note however that demand-response is unlikely to be a primary business driver for any particular hydrogen production facility; rather it will be a valuable secondary outcome of hydrogen production for other purposes. 3. **Aviation** (especially long-haul) and **biofuels**: the aviation sector is starved of options for decarbonisation pathways, and requires sustained long-term investment to foster development and ultimately meet emissions reduction targets. New Zealand is already well-positioned in this space through existing efforts such as Sustainable Aviation Aotearoa, Hydrogen Aviation Consortium, Marsden Point eSAF project, etc. These will provide valuable insights and test beds into likely scenarios for technological development pathways (e.g. batteries vs hydrogen fuel cells vs hydrogen engines vs eSAFs vs biofuels for short, medium and long-haul applications). NZ could be a good global test bed for hydrogen in these applications. 4. **Heavy road vehicles (trucks, buses, etc)**: are a relatively mature hydrogen application, with pilot projects already underway and good prospects for ongoing development. Hydrogen is a good application for freight over 3.5 tonnes, long-distance bus services and 24x7 transport operations and services. These also provide valuable and immediate avenues for "advertising" to increase public awareness and alleviate perceived safety concerns.

5. **Export**: we support government's "wait and see" position on hydrogen exporting. We would note the possibility (however unlikely) that an export market could create undesirable outcomes such as:
    - Hydrogen producers favouring export over the domestic market, thus impacting energy security or contributing to Aotearoa New Zealand failing to meet emissions reduction targets and/or needing to purchase additional emissions offset credits (in the most perverse case, back from the countries where the hydrogen was exported in the first place).
    - Contributing to an unsustainable reduction in local electricity prices (i.e. cost pressure that threatens the commercial viability of generators, Transpower and distributors), in response to indirect pressure from international electricity markets via global hydrogen trade (the Interim Roadmap alludes to this on page 44).
6. **Rail, specialty vehicles and vessels** (forklifts, mining, ports, construction, farming etc): these areas show promise, including the Toyota Hydrogen Chase Boat and the hydrogen farm bikes but are likely to follow behind heavy road transport since the vehicle fleet sizes are smaller, with more diverse operational needs and smaller cumulative emissions footprints.
7. **Marine bunkering fuel**: shows promise, but should be approached with a cautious outlook since the technological direction of travel and timescales remain unclear (and will be dictated by much larger global players).
8. **Reticulated gas networks**: hydrogen is unlikely to ever completely replace natural gas in existing distribution networks, since the scale of investment required to address embrittlement and leakage challenges would be difficult to justify. Hydrogen blending in low ratios could provide valuable reduction in emissions from natural gas use, however there is a good chance that this will be more effectively mitigated by direct electrification first.
9. **Emergency backup power generation**: in the near- and medium-term, biofuels are likely to be preferable over hydrogen for emergency backup power generation applications as a much more direct drop-in substitution. This may change over longer timescales as hydrogen costs reduce and if biofuels come under cost / credibility pressure due to feedstock scarcity. This transition is unlikely to require or benefit from significant government intervention, except in the form of developing and upholding certification schemes for low- and zero-emissions hydrogen and biofuels. We would highlight that emergency backup generators by their nature operate very infrequently. As such, in the short to medium term, capital investment in hydrogen-fuelled generators is unlikely to provide particularly good value for money in terms of emissions reductions, compared to investment in other hydrogen use-cases or other decarbonisation efforts.
10. **Electricity system peaking**: we do not see a convincing case for hydrogen to provide short-duration i.e. "peaking" generation firming services. There are other technologies that are (and will remain or become) much better technologically and commercially suited to this application: most obviously lithium-ion batteries; but other dispatchable technologies exist with varying levels of potential suitability

	including other secondary battery chemistries, flow batteries, various forms of hydropower, compressed air storage, geothermal overbuild, etc.
4	**What other factors should we be considering when assessing the right roles for hydrogen in New Zealand's energy transition?**
	The details of if/how the NZ Battery Project progresses will inform the potential for hydrogen to play a role in providing electricity system support services, especially long-duration generation firming. Closely connected with this are the impacts of climate change on Aotearoa New Zealand's water cycle, particularly exacerbation (or less likely, alleviation) of the dry year problem and local water availability as an input to hydrogen production. International developments in hydrogen market parameters (such as the US cost target and BCG report, both already mentioned in the context of export prospects), regulatory frameworks and technology will also be a powerful determinant of hydrogen's future in key areas of New Zealand's energy ecosystem, such as: 1. Local production vs import; 2. Export; 3. Transport (aviation, marine bunkering fuels, heavy road and rail).
5	**Do you agree with this assessment of the potential for hydrogen supply and demand in New Zealand?**
	Broadly yes. However (as noted in the Interim Roadmap), realising this potential will be highly sensitive to whether certain assumptions are met, such as reductions in renewable electricity prices and capital costs. To date, we are not aware of any modelling that has been undertaken to understand what price point various potential consumer sectors in New Zealand would be willing to pay for green hydrogen at various future dates. We recommend this be initiated as a priority, to firm up government's understanding of how future demand would adjust in response to evolving production costs as well as the scale of incentives that might be required to stimulate uptake. We note that the EY modelling did not cover a "value-add but no export of raw hydrogen" scenario, which is a possibility.
6	**Do you agree with the key factors we have set out that are likely to determine how hydrogen deployment could play out?**
	Yes, although we have outlined various additional factors to consider in our responses to other questions.
7	**What do you think needs to happen to address these factors?**
	Generally as outlined in Section 3 of the Interim Roadmap (and our responses to the discussion questions from that section).
8	**Do you have any evidence to help us build a clearer picture?**

	Hydrogen-powered trains may not be as far behind hydrogen-powered trucks as page 33 of the Interim Roadmap suggests – see https://www.arup.com/projects/hydrogen-train-scotland.
9	**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. Outcomes for domestic employment will need to be carefully managed and monitored – there is a risk that a significant proportion of workforce demand will be met by imported labour due to the "peaky" nature of this demand for capital construction, specialised skills required, and relatively small available total workforce in New Zealand.
10	**Do you have any insights we should consider on what is needed to make hydrogen commercially viable?**
	Please refer to brief commentary in our response to Question 1. The capital cost of hydrogen production technology is likely to be driven by global developments. New Zealand Government should focus primarily on ensuring local electricity costs are managed appropriately, and supporting R&D efforts that are specifically targeted to a New Zealand context. In addition, the NZ government should focus on creating a local Australasian supply chain to help create more certainty in pipeline and reduce risk. There is also a role for the NZ government to partner with other countries and sign Memorandums of Understanding (MoUs) for the supply and delivery of hydrogen whilst supporting a domestic marketing and pushing the price of hydrogen down.
11	**Is there any further evidence you think we should be considering?**
	We have no specific comments on this.
Section 3: Government position and actions	
12	**Do you agree with our policy objectives?**
	Yes.
13	**Do you agree with our positioning on hydrogen's renewable electricity impacts and export sector?**
	Broadly yes. Please refer to Question 3 for our position on the merits of hydrogen to provide various specific grid support services, and on the prospect of an export market. We note one particular line [emphasis added]: "**The** key challenge for hydrogen is the significant renewable electricity generation build-out it would require." We would suggest that there are other equally (if not more) important challenges, most notably cost.

	We note that some sections of the Interim Roadmap are worded in a way that suggests government is assuming each hydrogen production facility will be co-located with dedicated (and most likely overbuilt) renewable electricity generation. While this is likely to be the case for at least some facilities (see e.g. Kōwhai Park at Christchurch Airport), some hydrogen production facilities may prefer to source electricity from the wider grid (either through completely traditional avenues, or through Power Purchase Agreements linking them with remote renewable generation resource).
14	**Do you agree with the proposed actions and considerations we have made under each focus area?** Regarding the Regional Hydrogen Transition consumption rebate, has MBIE considered whether existing (non-green) hydrogen consumers would be eligible? It is not obvious whether supporting such users to transition to green hydrogen would serve to catalyse a larger demand market, or if it would detract from ultimate goals such as increasing overall hydrogen market demand and reducing emissions. On a related note, ideally prospective green hydrogen consumers should not be discouraged from using other (i.e. non-green) forms of hydrogen in the short term, as a stepping-stone in their decarbonisation journey. This offers the potential to bolster the overall hydrogen offtake market, while also reducing the barrier for consumers to make the final transition to green hydrogen use in the future. Regarding the Clean Heavy Vehicle Grant scheme, we understand this is intended to be technology-agnostic, however we note several direct references to fuel cell and battery vehicles which give a suggestion of these being preferred (or the only viable) technologies. We suggest clarity is necessary to ensure prospective applicants pursuing hydrogen combustion engines are not deterred simply due to misunderstanding their eligibility. (We note that hydrogen combustion engine vehicles may need to be diesel-blended at least initially – would this render them completely ineligible for the scheme? This may not be desirable if it inhibits deployment of blended engine vehicles as an interim step towards 100% hydrogen-fuelled engines.) The Interim Roadmap also highlights prior government support for capital investment in hydrogen ecosystem-enabling projects (e.g. Kapuni production facility and Hiringa refuelling network), however there is a lack of clarity about the level and direction of capital funding available in the coming years outside of the Clean Heavy Vehicle Grant scheme. A structured funding programme for capital infrastructure enabling hydrogen production and consumption would help provide certainty to the private sector about what opportunities exist. This could also help participants in the Regional Hydrogen Transition consumption rebate to commit the necessary capital investment to enable them to start consuming hydrogen in the first place. This would also send a signal to the global hydrogen market that NZ is worth investing in and it's a priority for the NZ government.

It is not really clear how Māori partnership will be implemented in practice, except as an outcome of the Regional Hydrogen Transition rebate scheme. One concrete recommendation would be to ensure Māori representation in the various working groups and in governance under the headings of "Regulatory settings and standards", "Workforce, skills and training", and "Planning system". Interested iwi and hapū will doubtless have useful input on how partnership can best be realised. Māori and iwi partners will also have a role to play in outreach to raise public awareness, understanding and acceptance of hydrogen's role within New Zealand's energy systems and also growing the hydrogen Māori economy.

On the topic of consenting processes, there may be merit in adopting a national consent framework for major infrastructure projects of potential national significance. This would see a national government body as the ultimate approval authority and relevant local/regional councils (among others) as stakeholder parties to the consultation process. Such a framework could potentially encompass major hydrogen projects directly, as well as enabling projects in enabling areas (such as e.g. electricity generation and transmission). This would reduce the approvals burden for local/regional councils to have specialist expertise in assessing these projects, while also allowing benefits of broader national importance to be appropriately weighted against local considerations such environmental impacts, amenity, cultural heritage, safety, employment etc.

The heading of "government as a purchaser of goods and services" is quite under-developed. We would highlight several considerations under this category:

1. Decarbonisation of the public vehicle fleet – we support hydrogen for this purpose in relation to heavy vehicles (e.g. public buses, ferries and rail, but subject to detailed assessment as these show signs of potentially pursuing alternative technology pathways to decarbonisation. Clearer signalling on this will be important as investment priorities become known). Light vehicle fleets will be better served by BEVs than hydrogen.
2. Purchasing certified 100% green electricity (i.e. Renewable Energy Credits, potentially via Power Purchase Agreements) for government-owned or -tenanted buildings would foster broader renewables investment – a highly valuable outcome in its own right – including limited indirect benefits to the hydrogen ecosystem.

Participation in international efforts to standardise green hydrogen certification is a critical enabler for any prospect of international trade, and will help ensure New Zealand's green hydrogen credibility even as a domestic market. As such, we note that New Zealand is already leading the APEC Technical Working Group considering an international standard for low-carbon hydrogen, and we agree with the recommendation of that report to align APEC members to an existing/emerging international standard ("Development Option 3") with minimal if any localisation.

We support efforts to enable iwi and local skills and workforce development, and suggest these should be increased to enable a hydrogen ecosystem to flourish without becoming “stranded” due to skills shortages. Further work will be needed to ensure the right policy settings are chosen for specific areas e.g. education & training, immigration etc. In particular, government will need to find ways to mitigate the risk of education and training investments being lost via emigration to overseas job markets (human capital flight / "brain drain"). Partnering with other countries to help grow and retain our workforce would also help.

We would like to clarify the statement that “currently, there may be limited options for support to demonstrate and scale hydrogen technologies outside of transport applications.” Is this in reference to a lack of projects to support, or a lack of funding available to support them? If the former, we do not agree (and this is evidenced by many of projects shown in Diagram 3 of the Interim Roadmap). Government support for capital investment in hydrogen projects could, alongside the consumer rebate scheme, help to decarbonise major point sources in the steel production, fertiliser and high-temperature process heat sectors.

15	**Is there any evidence we should be considering to better target actions in the final Hydrogen Roadmap?**
	We have no specific comments on this.

General comments

The language of the Interim Roadmap signals a significant degree of uncertainty (e.g. "the scale of hydrogen deployment within our overall mix of energy sources remains uncertain"). This is very understandable given the level of maturity in global (green) hydrogen markets, technologies etc, however it will be important for government to be an early leader in establishing definitive positions as early as possible. This will foster confidence in the intended, if not definitive, direction of travel. In the words of the Interim Roadmap itself: "getting this right will require a clear vision of where we are collectively heading".