National Energy Research Institute

20 October 2023

Comments from NERI[1] on:

Interim Hydrogen Roadmap

Summary

The Interim Roadmap develops a pathway for the Government to achieve its overall objective of optimising "the potential for hydrogen to contribute to New Zealand's emissions reductions, economic development, and energy sector to the extent compatible with broader electrification goals" (p 42).

We work within this overall aim, but any such optimisation cannot proceed in isolation from the wider energy sector, including the potential of other clean fuels in the various applications.

The Interim Roadmap is seriously deficient on this account because it:

- Is weak in assessing and testing demand assumptions.
- Lacks systematic analysis of alternative fuels to meet possible demand[2].
- Lacks analysis of the key uncertainties and risks in and around the alternatives, demand, supply, and how these should be managed.

Addressing these will naturally lead to the need to invest in research into the various assumptions, alternatives, uncertainties, and risks. However, the discussion of research in the Interim Roadmap is limited to outlining existing research investments focused on hydrogen in isolation i.e., addressing the supply of hydrogen and to enhancing its potential uses.

[1] The National Energy Research Institute (NERI) is a Charitable Trust incorporated in New Zealand (NZ). Its primary purpose is to enhance NZ's sustainability and to benefit the NZ community by stimulating, promoting, co-ordinating and supporting high-quality energy research and education within NZ. Its research members are GNS Science, Scion, University of Canterbury, University of Otago and the Western Institute of Technology at Taranaki, and its industry association members are the Bioenergy Association of NZ, BusinessNZ Energy Council, the Carbon and Energy Professionals New Zealand, the New Zealand Geothermal Association, the New Zealand Wind Energy Association, Ia Ara Aotearoa Transporting New Zealand, and Tourism Industry Aotearoa.

[2] Only hydrogen interests appear to have been consulted in its production including in the key E&Y background document.

This lack of robust comparative analysis and supporting research calls into question the conclusions of the Interim Roadmap, underlining the importance of the Section 4: Next Steps.

We recommend that **this Interim Roadmap be put aside, and the role of hydrogen first be evaluated in the wider context of NZ's future energy system**.

Initial Observations: Likely demand

The Interim Roadmap sits within an overall Energy Strategy being developed by MBIE. The Energy Strategy's objective is to ensure clean energy is available to meet the 2050 target of net zero emissions, while ensuring reliable affordable energy is available, and the needs of the economy are supported[3]. It is intended to provide guidance to New Zealand and identify the key actions required by the Government.

Therefore, any Hydrogen Roadmap has to anticipate where the Energy Strategy will identify strategic roles for clean hydrogen[4], either as the only solution or as one of a number of potential options.

It will also need to take account of hydrogen's role as an industrial chemical and as an intermediate in the production of other fuels. While the industrial applications are not strictly part of the energy sector they need to be included in any Roadmap because they will likely require significant clean hydrogen production. This could impact positively or negatively on its supply for the energy sector.

With the Energy Strategy framework not yet available, there is a risk that the work on hydrogen becomes dominated by technology push, and *this is what has happened in the Interim Roadmap*.

To begin to address this risk there are many reports that cover the future of the NZ energy sector, the various fuels likely to be required, and where the uncertainties lie. There is also published work on the NZ energy sector and emissions reductions, including consideration of clean hydrogen within that[5].

In this submission we have relied on a limited number of representative references, but there is a significant body of work on this subject. This shows up the lack of a reasonable literature review sitting behind the Interim Roadmap.

Based on these references and relevant international work we can form a broad high-level view on the potential role of clean hydrogen in NZ's future energy sector, along with where there are gaps in our understanding.

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[3] Summary of para 3 https://www.mbie.govt.nz/dmsdocument/25373-terms-of-reference-new-zealand-energy-strategy

[4] Not just limited to electrolytic hydrogen e.g. from fossil fuels with CCUS, Natural/White, and bio-hydrogen.

[5] E.g. NERI (2023) *From Fossil Fuels to Local Renewables: A Research Framework to address Aotearoa NZ's energy GHGs* https://www.neri.org.nz/resource/Files/NERI%20Energy%20Research%20Framework%202023.pdf

First, clean hydrogen will be needed for existing applications as a chemical, either in its own right (e.g., as a reductant) or as an intermediate in the production of more complex chemicals.

Many of these applications do not require high purity electrolytic hydrogen, and the hydrogen may be able to be supplied by other chemicals that carry it. These alternative approaches will need to be canvassed, along with the long-term viability of the businesses creating the demand if NZ becomes a relatively unattractive place to source clean hydrogen as a feedstock[6].

New opportunities will also emerge as the global economy changes.

Second, there will be the emerging demand for clean hydrogen as an intermediate to other synfuels, e.g., ammonia, methanol, DME, syn-gases, syn-diesel and syn-SAF etc. They are being variously investigated for long-haul marine[7] and aviation[8,9] and possibly for NG and LPG replacements. Ammonia and methanol are already being produced in NZ for non-fuel uses but their eventual role in the energy sector, along with other synfuels, remains uncertain[10].

The role of wood and other organic waste as an alternative in producing some of these fuels needs to be considered. This is a potential NZ feedstock likely to be available in the quantities required, particularly for marine bio-fuels, SAF, bio-NG and possibly bio-LPG[11].

Third, clean hydrogen can also play a role in the gas industry to exploit existing infrastructure, and this is one of a number of options discussed in the Gas Transformation Plan. But this notes "[i]nitial analysis indicates blended hydrogen would be less cost effective at reducing emissions compared to other options"[12].

Fourth, long-haul land transport has FCEVs along with BEVs and biofuels (including bioCNG) as options, and the same options apply for short-haul sea and perhaps short-haul air. Short-haul land in NZ is adopting BEVs given our internationally high proportion of clean electricity, the relatively low cost of adding renewable capacity[13], its relatively much greater energy efficiency compared with FCEVs, the relatively low duty cycles of our heavy transport compared with Europe and North America, and continuing improvements in battery and charging technologies. For these reasons the

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[6] E.g. these businesses often established in NZ because of our then resource endowments like NG, if the replacement feedstocks become relatively expensive these business may move and others take their place.

[7] Global Martine Forum (2023) *The shipping industry's fuel choices on the path to net zero*

[8] https://www.iata.org/en/programs/environment/roadmaps/

[9] CSIRO (2023) *Sustainable Aviation Fuel Roadmap.* CSIRO

[10] Although their significance in terms of hydrogen use has been questioned, e.g. Liebreich, M (2022) *The Unbearable Lightness of Hydrogen.* BloombergNEF

[11] Hall, P (2022) *Residual biomass fuel projections for New Zealand; 2021* Scion.

[12] An example would be the use of CCUS with NG for the large point source emitters.

[13] Concept Consulting (2022) *Which way is forward? Analysis of key choices for New Zealand's energy sector*

Interim Roadmap notes “it is uncertain how much of New Zealand’s future heavy road freight fleet will use hydrogen”.

Fifth, as both the Interim Roadmap and Concept Consulting[14] have noted electrolytic hydrogen has no significant role to play in electricity services, at least on current technoeconomic forecasts. The round-trip efficiency and cost of holding means it won’t compete with other forms of battery[15], apart from relatively limited amounts in nickel hydrogen batteries for intraday smoothing[16].

Finally, as again the Interim Roadmap and Concept note, using electrolytic hydrogen to export clean energy is not of strategic importance to NZ: there will be a shortage of clean energy in NZ as EVs replace fossil fuels; exporting as hydrogen will be very wasteful of the electricity; we can better add value to it by local efforts[17,18;] and our electricity system won’t need it for stabilising the grid (see discussion about electricity services above).

It is however quite possible that we will indirectly import clean hydrogen in fuels such as syn-SAF and marine fuels.

So, at a high level the key strategic issues for clean hydrogen demand arise from its use:

- As an **industrial chemical** (definite, but issue of specific applications and the type of hydrogen required).
- As an **intermediate in the production of synfuels** (possible, driven by synfuel development/demand in e.g., long haul transport fuels, and gas replacements).
- By the **gas industry in pipelines**, (unlikely but depends on other clean gas developments).
- In **long-haul land, short-haul sea, and possibly short-haul air**, (uncertain, the alternatives are better batteries and storage, biofuels (e.g., SAF), and possibly synfuels).

It should have been the primary role of the Interim Roadmap to flesh out these issues and set up processes to address them. This will need to be addressed as part of the Next Steps.

There are various technological breakthroughs that might alter this analysis and they should be monitored, particularly step changes in the cost-efficiency of the various conversion processes; storage technologies; and emergence of new lower cost feedstocks. This relates not just to hydrogen but also to alternative fuels.

Most of this will come from international efforts, just as opportunities for supply and demand will often be shaped overseas, but most of the issues have a local context

[14] E.g., Concept Consulting (2022) *ibid*.

[15] E.g. DNV (2023) *Energy Industry Insights 2023: Closing The Energy Storage Gap*

[16] Ara Ake (2023) *Stationary Battery Energy Storage Systems Analysis*

[17] NERI (2023) *ibid*

[18] Finkel, A (2023) *The Fish That Got Away or the Fish in the Bucket?* Presentation to Australian Hydrogen Research Conference 2023

that create their own uncertainties and need for research. Particular examples are the impact of NZ's relatively positive renewable resource endowments (electricity, biomass, and some geological resources) and our geographical isolation.

With these initial observations in mind, we turn to specific comments on the discussion questions.

Section 1: Context

The section of the Interim Roadmap dealing with the Global Context is of limited use because the various comments lack focus on where hydrogen might be needed in the NZ energy system, why, and how to develop the necessary supply chains.

First, this can be seen in the statement of **advantages**.

Zero (net) emissions is an essential feature of any potential fuel in a net zero energy system, and all clean fuels are *versatile* at the level of detail considered in the Interim Roadmap.

Further, contrary to the claim otherwise, hydrogen along with most gaseous fuels, have a very poor *energy density* at atmospheric pressure and ambient temperature, and hydrogen has the lowest condensation temperature (20K) of potential fuels. Overcoming this poor energy density requires additional work (cryocooling, pressurising) and balance of plant (containment etc). LOHCs and conversion to synfuels are chemical routes to partially overcome these weaknesses.

Hydrogen's very high specific energy partially rescues it from this limitation and also makes it suited to applications requiring very high thermal energy, e.g., rocket fuels.

To be useful the **challenges** need the context of the intended use and comparisons with alternatives. The 'missing market' problem is spurious, it is market uncertainty that is the issue.

Transportable fuels require a combination of good specific energy (not too heavy) and energy density (not too much space). Looking at the relative pros and cons of hydrogen on this basis would be more useful[19].

Finally, the discussion of **international interest** in hydrogen lacks the underlying characteristics of the countries' energy systems in comparison with ours. Most countries are pursuing hydrogen for reasons that do not apply in NZ.

To elaborate, NZ has an isolated electricity system but comparatively speaking it does have: high levels of renewables; a useful mix of dispatchable hydro and base load geothermal; a good grid; a world class wind resource[20]; and the ability to expand our electricity system at relatively low marginal cost provided we are not seeking 100%

[19] As Global Martine Forum (2023) *ibid* does in considering marine fuels.

[20] https://www.windenergy.org.nz/generation

renewable[21]. We have a temperate climate with available land giving high potential levels of biofuels feedstocks from renewable sources[22].

On the other hand, most of NZ's transport fuels are imported as refined fossil fuel.

On the demand side NZ has a relatively low population density and limited demand for very long-haul heavy land transport. Our history of a good electricity system means we are less dependent on fossil fuel for heating, particularly for homes[23].

We are however dependent on international sea and air links.

This creates a relatively unique environment internationally on both the energy supply and the demand sides. International interest in hydrogen cannot be directly transferred to NZ.

In particular:

- We have an existing high level of renewable electricity to electrify transport with adequate head room to grow. Japan and other countries with constraints on clean electricity supplies are dependent upon importing clean fuels for short haul transport[24]. Hence, they are importing hydrogen and looking to adopt FCEVs[25]. Other countries face greater difficulty in moving electricity around than NZ, and so for them hydrogen likewise offers a potential alternative.
- We don't have the long trips for heavy trucking that occur internationally, however often local analysis does not adjust for this[26]. Recent analysis suggests BEVs are both lower cost and give a lower abatement cost than FCEVs (or biofuels) for the types of trips being serviced by NZ's heavy-duty trucking[27]. The Interim Roadmap bases its case for FCEVs on longer trips than experienced here.
- NZ is relatively exposed to international sea and air transport and the need is to find clean fuels for that purpose, particularly as consumer preferences move away from fossil fuels. Thus, clean fuels for international mobility (both goods and services) have a higher priority for NZ than for many other countries.

The discussion on the **Domestic Context** is by-and-large a summary of issues that impact on electricity and the general need for clean fuels. However, hydrogen's contribution to addressing these is moot. At a general level hydrogen might appear attractive, but in a more detailed analysis (lacking) other solutions are much more attractive. A specific example is the suggested role for hydrogen in electricity systems

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[21] E.g., Concept Consulting (2022) *ibid*.

[22] E.g,. Hall, P (2022) *ibid.*

[23] Concept Consulting (2022) *ibid*

[24] In Japan's case curtailed nuclear generation and an islanded electricity system.

[25] As an aside their industry will want markets and Japan will be keen to encourage other countries like NZ to adopt FCEVs too, particularly if they are RH drive.

[26] E.g. Castalia (2022) *New Zealand Hydrogen Scenarios* ref. 21. With BEV heavy trucks having a projected maximum range of 800kms by 2030 there would be few trips in NZ requiring a recharge, e.g., Auckland to Wellington 640kms.

[27] https://www.araake.co.nz/projects/tco/

services that has been discussed above with the general conclusion hydrogen won't have a role.

The **Ecosystem** section gives a useful outline of the various project being undertaken in NZ. But it lacks an evaluation of these including particularly: how they stack up against alternative approaches, learnings, and the extent to which they are likely to be viable without Government funding.

Question

- *Are there other issues we should be considering in our assessment of the strategic landscape for hydrogen in New Zealand?*

Response

- *The assessment of the strategic landscape for hydrogen in NZ should not be relied upon and it should be redone once the better understandings foreshadowed in Section 4 have been reached. It is unlikely that that work will confirm the analysis in the Interim Roadmap for the reasons outlined in this submission.*

Section 2: Role of Hydrogen

In our Initial Observations we have identified the likely areas where hydrogen might contribute. To repeat:

- As an **industrial chemical** (definite, but issue of specific applications and the type of hydrogen required).
- As an **intermediate in the production of synfuels** (possible, driven by synfuel development/demand in e.g., long haul transport fuels, and gas replacements).
- By the **gas industry in pipelines**, (unlikely but depends on other clean gas developments).
- In **long-haul land, short-haul sea, and possibly short-haul air**, (uncertain, the alternatives are better batteries and storage, biofuels (e.g., SAF), and possibly synfuels).

At one level the Interim Roadmap accepts this assessment, but is much more bullish on:

- **Heavy land transport** where it sees a potential for hydrogen blending kits as a possible transitional measure[28]. But the extent to which this approach will make a material difference or is relatively economic is not addressed.
- **Specialty land transport** (e.g., buses, public sector transport) where it suggests there might be a market for FCEVs despite general reservations about this. At best this will make a small contribution and isn't material in the context of a wider energy strategy focused on significant GHG reductions in an uncertain future.

[28] These already exist for other gas fuels. DieselGas was a NZ company doing these conversions until recently.

- **Long haul aviation** either FCEV or direct combustion, rather than as a role in SAF production. But hydrogen alone is not seen as likely prior to 2050 by e.g., key US government agencies[29], or Air NZ[30].
- **Electricity system services** particularly demand response and peaking, and power backup[31]. But no comparative analysis is undertaken, and various application will need different characteristics, but the relative round trip electricity efficiency of electrolyser/storage/FC systems limits all these.
- **Export**, but repeats the caveats from earlier in the Roadmap.

The one certain source of hydrogen demand is as an industrial gas and addressing this is important. However, by-and-large the users are significant businesses, and they will need to lead.

We need to be evaluating the fuel options for long-haul land transport: hydrogen, better batteries and charging, and biofuels. At present it is looking increasingly certain BEV are likely to be the most cost-effective for by far the bulk of NZ's market, and work on introducing the shorter haul BEV land transport will help de-risk this. So, we should be reticent about significant investment in hydrogen fuelling infrastructure, but we need to avoid closing off options. Reducing uncertainties should be our prime focus at this stage.

Short-haul aviation may use clean hydrogen either directly or as a FCEV, or these flights may electrify (potentially in a hybrid configuration), or use SAF. The demand for these fuels will be closely linked to purchase decisions for new aircraft with SAF requiring the least adjustment. In the NZ context this might build to a significant source of demand for hydrogen but again the prime focus should be on maintaining options while the various technologies mature.

The demand for SAF for long-haul aviation is clear, and renewable hydrogen may have a role in its production. There are significant work streams internationally addressing this topic[32] and, including NZ, through the role of bio-feedstocks[33]. Hydrogen and CO2 capture for a synfuels pathway is possible alongside biomass gasification etc., but electric planes using hydrogen and FCs is not in scope for existing work.

The most important point in considering the role of hydrogen in NZ is that any assessment needs to be in the context of the source of demand, the alternatives, and the availability of feedstocks. Investment in research is needed to better understand these options and reduce the uncertainty.

Without those the Roadmap becomes technology push.

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[29] SAF Grand Challenge (2022) *Flight Plan for Sustainable Aviation Fuel* P.1.

[30] https://www.airnewzealand.co.nz/press-release-2023-air-new-zealand-and-new-zealand-government-to-invest-more-than-2-million-in-sustainable-aviation-fuel-studies

[31] See earlier references. The ability to curtail electricity use at various levels is a feature of any electricity intensive industry, and a future electricity system in NZ is expected to be more flexible.

[32] E.g., SAF Grand Challenge *ibid*.; ATAG Waypoint 2050 (2021) *Fueling Net Zero*

[33] https://www.airnewzealand.co.nz/press-release-2023-air-new-zealand-and-new-zealand-government-to-invest-more-than-2-million-in-sustainable-aviation-fuel-studies

Question

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

Response

- *No, it is much too bullish because it ignores potential lower-cost and/or more convenient alternatives.*

Question

- *Do you support some of these uses more than others?*

Response

- *The need for industrial hydrogen is inevitable, but whether it needs to be derived from electrolysis is unclear. The other proposed uses are at best unclear.*

Question

- *What other factors should we be considering when assessing the right roles for hydrogen in New Zealand's energy transition?*

Response

- *Again, the alternatives, options and uncertainties need to be taken into account. Section 4 needs to be addressed, and this will require applied directed research into the uniquely NZ unknowns.*

Pathway to 2050

The scenarios[34] are unrealistic because the assumptions are. A discipline would be to assess what would have to happen for each scenario to occur and hence its consequent likelihood. To do this at least three factors would need to be assessed that are currently not looked at – the likelihood demand for that service would emerge, the competition, and the cost of the inputs and the competition for them.

Our assessment is that the base case would be the most realistic as things stand, but we still need better information to be definitive.

Specific issues include:

- Other modelling work[35] has come to quite a different set of conclusions from the Interim Roadmap on the economics of large-scale expansion of electrolytic hydrogen production in NZ and this should be discussed.
- Use as an electricity service seems very unlikely for the reasons cited/discussed.
- The economic value of using the electricity directly in much higher value-added applications than producing commodity chemicals has not been addressed.

[34] Ernst & Young (2023) *Hydrogen Economic Modelling Results Final Report*

[35] Again e.g., Concept Consulting (2022) *ibid*

- Most of the cost in the relevant supply chains will be determined by international efforts, and we should monitor these (contributing where we can).
- The price of electricity is a product of local settings, but it isn't clear why its preferential use for hydrogen production warrants special consideration.
- These markets are by and large serviced by significant industrial companies and if the economics do start to stack up they will have considered the whole supply chain and most of issues listed as key factors will be addressed.
- The scenarios are silent on the possible role in the production of syn-fuels. This warrants consideration including comparison with the alternatives (biofuels). For example, we should extend CSIRO's research on sustainable aviation fuels[36] to consider NZ's circumstances more directly including the alternative of bio-SAF from woody waste.

Question

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

Answer

- *In the absence of evidence that hydrogen will be competitive in the other uses, the base case is the only likely scenario, with the accelerated scenario giving an upper bound.*

Question

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

Answer

- *These factors are largely irrelevant if electricity has higher return opportunities elsewhere. Otherwise, most are outside NZ's control; electricity pricing is a wider issue and the case for hydrogen getting special consideration isn't addressed; and demand and value stacking are issues that will largely resolve themselves in the unlikely event that there is significant interest.*

Question

- *What do you think needs to happen to address these factors?*

Answer

- *These factors will only be addressed if there are sound business cases supporting any potential hydrogen opportunities. This will not be clear until the Next Steps have been properly addressed, and/or investors come forward. Better targeted research to support the public interest, including understanding the options, will help.*

Question

- *Do you have any evidence to help us build a clearer picture?*

[36] CSIRO (2023) *ibid*

Answer

- *As of today, the prima facia evidence is that hydrogen will not be a competitive use of electricity in the markets assumed beyond the base case, e.g., there is increasing evidence that electricity will be better used to support electricity intensive services, say, based on ICT[37].*

Contribution to objectives

The outcomes suggested in the Interim Roadmap[38] are derived from an analysis that ignores what else is happening in the energy sector and the economy.

For example:

- Other clean fuels might contribute to emissions reductions in transport and process heat better and/or at lower cost. It might be better to use the clean electricity to cut more emissions elsewhere in the economy. On the evidence both seem likely.
- Export of clean hydrogen might lower emissions in other countries, but export of clean services based on clean electricity might well do it better, particularly if the relative emissions from shipping are included.
- The value of demand response using electrolysers will be more expensive than other approaches, and the need will likely diminish as the electricity system develops[39].
- If the clean electricity used to produce hydrogen was instead used directly to replace transport and industrial heat loads the impact on NZ's energy independence would be at least double that if it is used to produce hydrogen[40].
- The net welfare contribution of the extra value-add and the extra jobs is unknown.

From a public policy perspective there is no need "to make hydrogen commercially viable" in its own right. If it isn't, it is telling us something.

Question

- *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?*

Answer

- *No. On the evidence presented it is quite possible that other fuels etc would make the contribution at lower economic, social, and environmental cost. Investing in hydrogen as a solution under those circumstances will be wasteful of NZ's resources.*

Question

[37] E.g., https://www.digital.govt.nz/dmsdocument/193~towards-a-digital-strategy-for-aotearoa/html

[38] Note the language in the Interim Roadmap is appropriately condition.

[39] Concept Consulting (2022) *ibid*

[40] This reflects the relative inefficiency of producing hydrogen by electrolysis and its distribution. More so if FCs are used to produce electricity.

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

Answer

- *The prior question is what is the public policy rationale for wanting to make hydrogen commercially viable? Answering this will help lead to a better set of outcomes, a better understanding of the potential interventions, and then what might need to be done and how. None of this analysis is undertaken in the Interim Roadmap, so doing this would be a good starting point. Note the "do nothing" option can be the best option in the face of uncertainty, and it should be included in any such analysis.*

Question

- *Is there any further evidence you think we should be considering?*

Answer

- *The underlying analysis of the issue needs to be undertaken before considering what evidence should be considered.*

Government's role

The Policy Objectives contained in this section are reasonable apart from the lack of attention to managing the uncertainties. The uncertainties include the assumed emphasis on electrolytic hydrogen. We assume that the objectives for hydrogen will be derived from the needs of the energy sector, but this hasn't been the practice in the balance of the Interim Roadmap.

To address the uncertainties, they need to be explicitly acknowledged and analysed, and with that the various options and how to manage those. For example, the options for hydrogen production will not just be limited to the electrolytic hydrogen as the Policy Objectives tacitly imply.

But the main issue is that hydrogen does not sit alone in our energy futures. In all cases there will be alternative fuels and their relative importance will be uncertain. If energy sector outcomes require attention to fuel supplies, it isn't clear that fuel-specific interventions (e.g., hydrogen) in isolation are required or even desirable.

Among other things this means any actions will need to be even handed, assessing hydrogen against the alternatives.

Two key themes are identified in the Interim Roadmap as particularly requiring Government intervention: addressing the potential constraint of renewable energy availability; and enabling exports.

In both cases the evidence in support of addressing hydrogen as a special case is very limited, if not negative:

- Industrial hydrogen is likely to be the mainstay for demand and the extent to which electrolytic hydrogen is required or is the cheapest or priority option given other demands for electricity has not been analysed. Even if it is, there is no evidence offered that hydrogen production has priority over other uses for

electricity, rather the evidence appears to suggest servicing BEVs and industrial loads will be more important[41].

- In the case of an export market for electrolytic hydrogen it is very uncertain that this low value-add to a valuable resource warrants special encouragement by the Government. This calls for a better analysis of our resource endowments in the face of the need to reduce GHGs[42].

Actions

The Interim Roadmap identifies seven areas for government intervention:

1. **Governance.** An industry/government body is proposed based on Sustainable Aviation Aotearoa (SAA). The difference is that hydrogen is an input, not a sector in its own right. It would be more appropriate for organisations like SAA and others to have special interest groups looking at fuel options that include hydrogen.
2. **Regulatory.** To the extent that hydrogen starts being used in new applications regulations should be being addressed.
3. **Market creation.** This existing programme is designed to target hard-to-abate areas, particularly commercial users of fossil fuels. Given the outcomes sought are GHGs abatement and the relative position of hydrogen against other clean fuels is moot, this kind of programme should apply at the energy emissions level, not for a specific fuel.
4. **Capital investment support.** This programme has assisted specific hydrogen projects. In the future the Clean Heavy Vehicle Grant is fuel neutral and this is appropriate.
5. **Government procurement.** Government purchasing for clean products and services needs to achieve the best outcomes, and not select particular fuels.
6. **Support trade in hydrogen**. As with *2. Regulation* developments in trade related certification and mutual recognition is important, although this is often achieved by user bodies and regulators rather than producers (e.g., IMO).
7. **Work force**. Better understanding of workforce and skills needs will be required but based upon realistic assessments of the needs.

All these actions and the subsequent discussion about planning are built on assumptions that have not considered the alternatives to hydrogen. They are therefore not secure foundations. Some of the regulatory proposals, including proposals around trade and international recognition, make general sense, but government intervention needs to be better evidence based than these actions are or even have been up until now.

This is where the role of applied directed research comes in. In the absence of any Government funded programmes addressing the comparative issues, the Roadmap outlines the research being funded through existing mechanisms, Endeavour, Catalyst and Strategic Science. These focus on supply chain issues.

[41] Remembering long-haul land in NZ looks likely to be using direct electricity.

[42] Again Finkel, A (2023) *ibid* is worth a read, making suitable adjustments for the NZ environment.

As the Roadmap notes this portfolio of research investments hasn't arisen from a systematic top-down consideration of NZ's energy sector priorities, instead each of the programmes in question has won selection through competition with other research proposals. They are addressing reasonably fundamental internationally relevant questions in the hydrogen supply chain.

There is a need for additional research into the role of hydrogen in our future energy and industrial sectors relative to other alternatives[43]. This should emerge from any wider work by the government into energy research priorities.

The Government is also funding various development projects with hydrogen; is developing international partnerships; and is raising the public's awareness in conjunction with the NZ Hydrogen Council. These activities will all be required but like the research priorities there is the need for a more systematic top-down context for these activities. In its current form the Interim Roadmap will not give this.

Question

- *Do you agree with our policy objectives?*

Answer

- *These are reasonable apart from (a) the lack of attention to managing the uncertainties, and, (b) them dealing with hydrogen in isolation, and not being set in the context of the energy sector.*

Question

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

Answer

- *No. There is no basis offered for hydrogen's demand for electricity to be given priority or that it is likely to be significant compared with other demands. The case for electrolytic hydrogen being a significant export is not made. Its export as an intermediate in other chemicals/fuels needs better consideration.*

Question

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

Answer

- *The work on the regulatory regime both domestic and international is prudent. Otherwise, the actions taken so far and proposed need much better justification against their likely relative contribution to a clean energy sector. This requires better comparative applied research than is currently being undertaken.*

[43] NERI (2023) *ibid.*

Question

- *Is there any evidence we should be considering to better target actions in the final Hydrogen Roadmap?*

Answer

- *Yes, there is a considerable body of research available on the needs of the energy sector for clean fuels. This should be used to provide context for any proposals to invest in hydrogen for NZ, and further work should be commissioned where indicated.*

Recommendation

We recommend that **this Interim Roadmap be put aside, and the role of hydrogen first be evaluated in the wider context of NZ's future energy system**.

Simon Arnold

Chief Executive