Submission on the *Gas Transitions Plan Issues Paper*

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Responses to questions

Chapter 2: Transitioning our gas sector	
1	**How can New Zealand transition to a smaller gas market over time?**
2	**What is needed to ensure fossil gas availability over the transition period?**
3	**What factors do you see driving decisions to invest or wind down fossil gas production?**
4	**Does the Government have a role in enabling continued investment in the gas sector to meet energy security needs? If yes, what do you see this role being?**
5	**Does the Government have a role in supporting vulnerable residential consumers as network fossil gas use declines? If yes, what do you see this role being?** 1.1. The roadmap correctly captures the decline of gas demand in the residential sector and the need to transition to an alternative energy source. Hydrogen is sometimes debated in the press as a potential substitute, but research indicates it will not play a role in the residential sector. There are currently no scientific studies that support hydrogen use in residential applications, and a large number that refute its use[1]. This is based on physics: the main applications of residential natural gas use (heating, hot water, cooking) are simply more efficient and cleaner when using electricity instead. In other words, current residential gas use will be electrified, motivated not only by emissions reductions but also economics. This electrification, while showing attractive payback times, does require non-prohibitive but significant upfront costs. To support this switch, other countries are offering subsidies to the general public (e.g., heat pumps in Germany, U.K.), and similarly supporting vulnerable consumers in NZ seems obvious.
	Fossil gas and electricity
6	**What role do you see for gas in the electricity generation market going forward?**
7	**What would need to be in place to allow gas to play this role in the electricity market?**

[1] Rosenow (2022). Is heating homes with hydrogen all but a pipe dream? An evidence review. Joule 6:10, 2225-2228. https://doi.org/10.1016/j.joule.2022.08.015

8	**Do you think gas can play a role in providing security of supply and/or price stability in the electricity market? Why / Why not?**
9	**Do you see alternative technology options offering credible options to replace gas in electricity generation over time? Why / Why not?**
10	**If you believe additional investment in fossil gas infrastructure is needed, how do you think this should be funded?**

Chapter 3: Key issues and opportunities

Renewable gases and emissions reduction technologies

1	**On a scale of one to five, how important do you think biogas is for reducing emissions from fossil gas? Why did you give it this rating?**
1	**Do you see biogas being used as a substitute for fossil gas? If so, how?**
1	**On a scale of one to five, how important do you think hydrogen is for reducing emissions from fossil gas use? Why do you think this?**

New Zealand's Energy Balance 2022[2] shows that the main uses of fossil gas are industry (47.9 PJ), followed by the commercial (7.5 PJ) and residential sectors (6.8 PJ). The latter two are relatively small and straightforward to electrify, e.g., with heat pumps. So, the question becomes "how important is hydrogen to substitute fossil gas *in industry*?".

2.1. Within the industrial sector, the main uses of fossil gas are chemicals (23.8 PJ) and food processing (17.2 PJ).

2.2. Chemicals: most of the energy goes to ammonia (which is then used for fertilizers) and methanol production. Ammonia is today one of the largest hydrogen demands in the world[3], but we currently use hydrogen atoms from fossil gas (called grey hydrogen). Using green hydrogen instead is internationally seen as an obvious use case. Numerous green

[2] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/energy-balances/

[3] https://www.iea.org/reports/the-future-of-hydrogen

ammonia projects have been announced and are being deployed just this year. Most notably, Liebreich's "Clean Hydrogen Ladder" (Figure 1) classifies this application as "unavoidable" because we do not have real, non-fossil alternatives. The same goes for methanol. The internationally renowned energy system analyst, Prof. Tom Brown from TU Berlin, also has recently underlined the growing role of methanol[4].

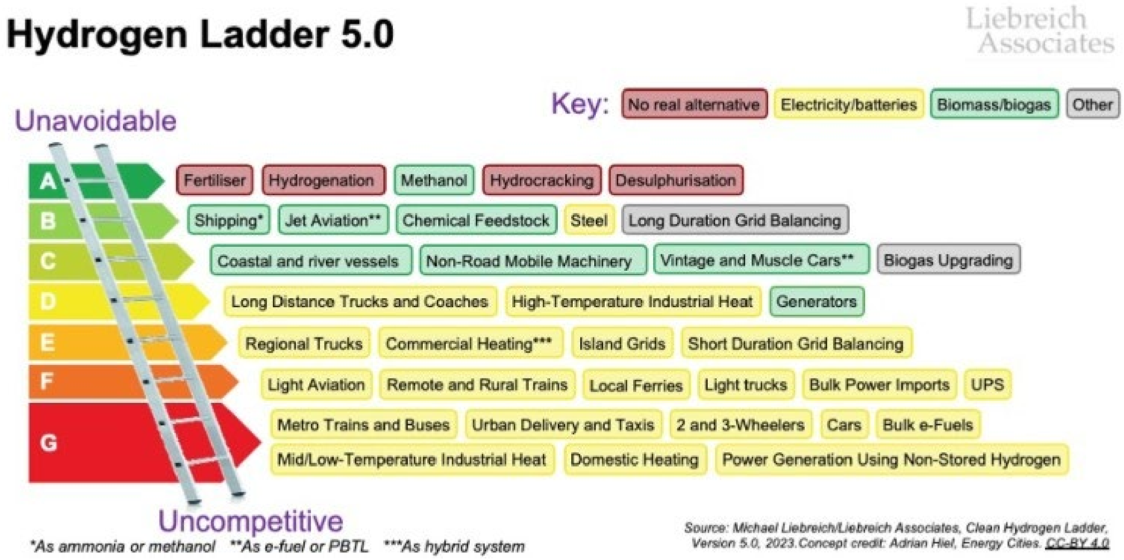

Figure 1: The Clean Hydrogen Ladder (version 5) [5]

2.3. Food processing: this mainly refers to burning fossil gas to produce heat for drying[6] (30 PJ in 2016), with milk powder being the largest application. Most of these processes use low (below 100°C) to medium temperature (200°C) heat (Figure 2). For these applications, we do have alternatives. Out of these many alternatives, heat pumps and biomass look particularly promising for New Zealand (cheap and available). Experts on industrial heat transitions would comment that the switch is nontrivial nonetheless because of the numerous systems and status quo bias. As a side note, hydrogen might play a role for high temperature heat applications (steel, cement, glass) but here again it stands in direct competition with electrical heat, which is more efficient.

2.4. In short, in our understanding, hydrogen will be important to reduce emissions and substitute fossil gas, but only for specific applications, particularly ammonia and methanol. Other applications that currently use fossil gas will very likely be electrified, at least that is what the physics and economics suggest. Based on all the above, on the suggested scale from 1 to 5, **we see hydrogen as a 4** to reduce emissions and substitute fossil gas use.

[4] Innovation Outlook: Renewable Methanol, IRENA Report (2021), ISBN: 978-92-9260-320-5, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jan/IRENA_Innovation_Renewable_Methanol_2021.pdf

[5] https://www.liebreich.com/the-clean-hydrogen-ladder-now-updated-to-v4-1/ (accessed 25 Oct, 2023)

[6] Process Heat in New Zealand – Overview, MBIE https://www.mbie.govt.nz/dmsdocument/152-process-heat-current-state-fact-sheet-pdf

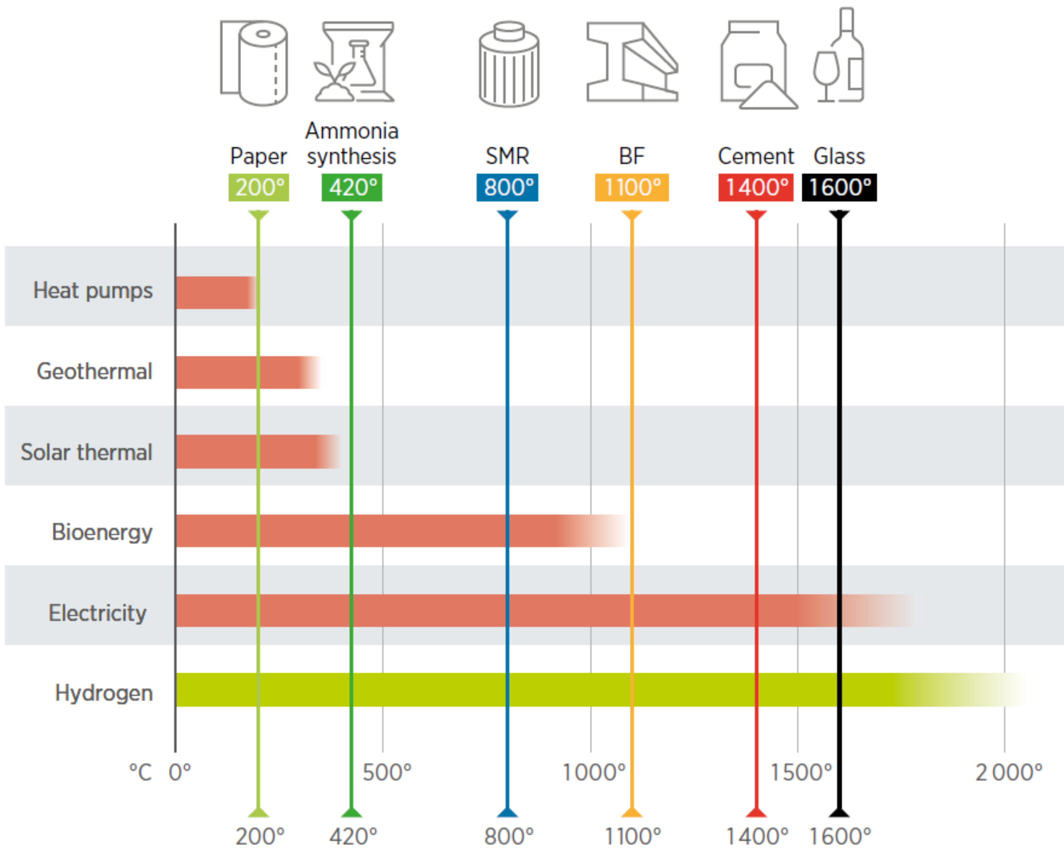

Figure 2: Working temperatures for selected renewable heat technologies and for selected industries[7]

1 **Do you see hydrogen being used as a substitute for fossil gas? If so, how and when?**

1 **What else can be done to accelerate the replacement of fossil gas with low-emissions alternative gases?**

1 **On a scale of one to five how important is a renewable gas trading to supporting the uptake of renewable gases? Why have you given it this rating?**

1 **What role do you see for the government in supporting such a scheme?**

Carbon Capture, Utilisation and Storage

[7] Green hydrogen for industry – a guide to policy making, IRENA report (2022). https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Mar/IRENA_Green_Hydrogen_Industry_2022_.pdf

2

On a scale of one to five how important do you think CCUS is for reducing emissions from fossil gas use? Why did you give it this rating?

Four, reflecting a high rating, but not the highest possible. The justification of this ranking follows:

3.1. Suitability for Near-term Implementation: CCUS component technologies have medium to high technology readiness levels (capture, transport, storage; see Fig. 3)[8]. From a technical perspective, CCUS is relatively well-placed for implementation in the near term. This means it is a credible option for accelerating the pace of decarbonization in NZ, being less dependent on future technological development, or growth of new markets (e.g., green H_2).

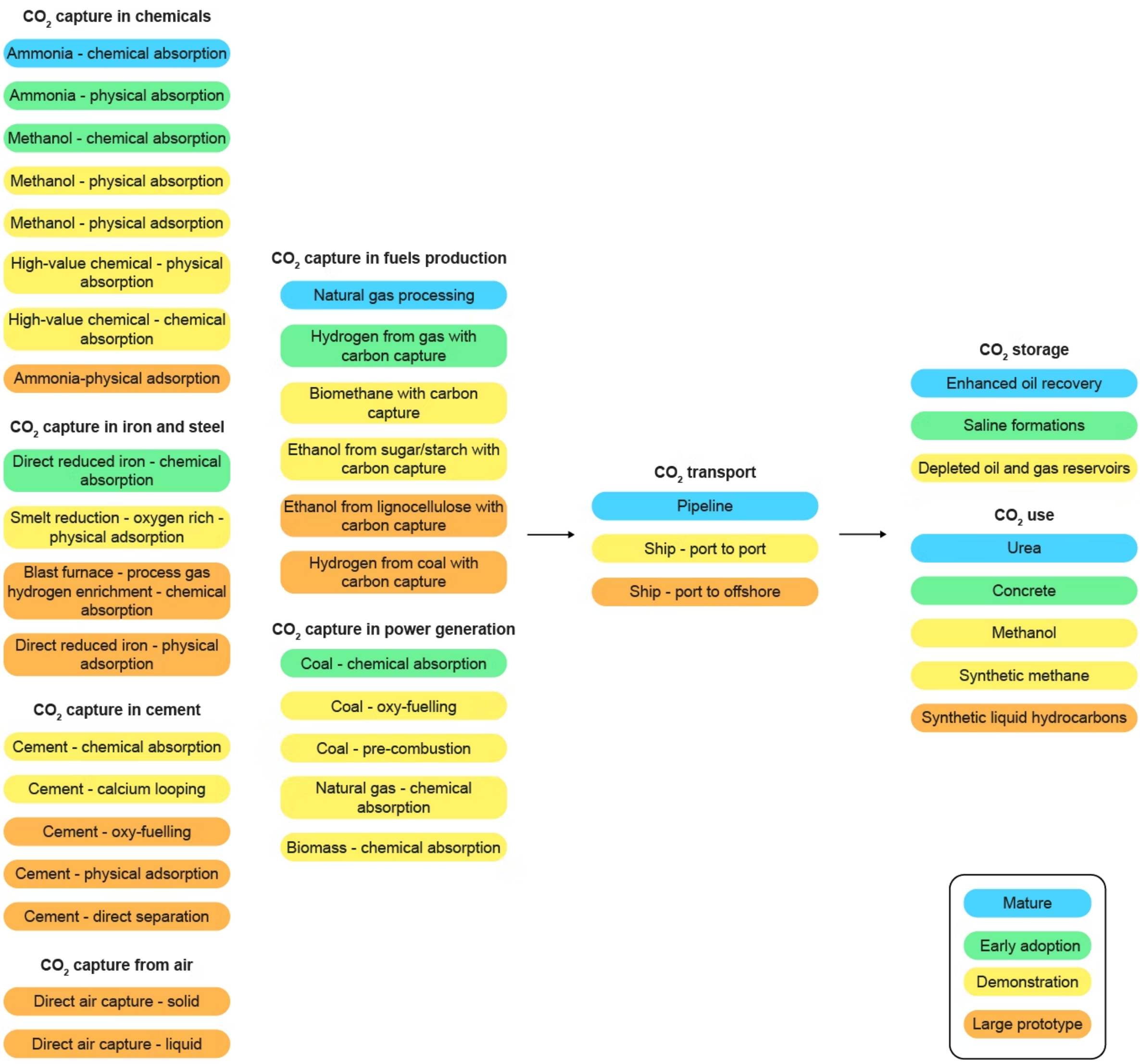

Figure 3: Estimated Technology Readiness Levels of CCUS component technologies, from IEA Special Report on Carbon Capture Utilisation and Storage CCUS in Clean Energy Transitions.

[8] Ausfelder, F., & Baltac, S. (2020). Special Report on Carbon Capture Utilisation and Storage CCUS in Clean Energy Transitions. In *IEA*. https://iea.blob.core.windows.net/assets/181b48b4-323f-454d-96fb-0bb1889d96a9/CCUS_in_clean_energy_transitions.pdf

3.2. Potential Economic Feasibility: A 2010 study by Transfield Worley Ltd[9] considered two CCUS case studies: (1) retrofit of a North Island gas-fired power station, and (2) a new lignite processing facility in the South Island. The second case study was deemed feasible at an abatement of about $25/tonne of CO_2. The first case study was regarded as infeasible, requiring EETS prices of $63/tonne of CO_2 for cost recovery. Financial analysis would need to be redone in today's prices and tailored to a specific project, however, it is notable that recent ETS prices now exceed historic thresholds of economic viability.

3.3. International Context and Global Alignment: CCUS constituent technologies are researched and developed widely overseas. CCUS has been identified as a major contributor in China's decarbonisation policies[10] and is incentivized under Section 45Q tax credit of the US Code[11]. Thus, as major overseas economies move towards CCUS technologies, New Zealand's access to lower cost and more efficient technologies is likely to improve. Effectively, this is an argument that New Zealand should consider the relevance of technological and market trends of our major trading partners, particularly where these can be expected to lead to lower overall decarbonization costs.

3.4. Spillover benefits for non-fossil gas applications of CCUS: Investment in CCUS may later have decarbonisation benefits beyond fossil gas. For example, Glenbrook Steel Mill & Golden Bay Cement are large, hard-to-abate point source emitters and are therefore good opportunities for emissions capture. Genesis Energy is investigating conversion of the Huntly Power Station to run on torrefied wood pellets[12]. The latter would create a large point source of biogenic CO_2 that, when captured and stored, would present a negative emissions source (carbon dioxide removal).

3.5. **Recommendation:** CCUS coupled with fossil gas should not be viewed in isolation but rather as one part of a wider CCUS strategy for the country. Particularly, the potential benefits to later enable negative-emissions carbon removal technologies, e.g., Direct Air Capture and Bioenergy Capture, may eventually be substantial. Taking a whole of system view to CCUS is encouraged as it may reveal synergies and opportunity-costs that are not visible at the sector level.

3.6. Retrofit of Hydrocarbon Assets: New Zealand has a large natural gas transport and distribution network, comprising a large backbone (high-pressure Maui pipeline from Taranaki to Huntly) and a wider distribution network across much of the North Island. In future, a suitably retrofit pipeline network could transport CO_2 in the opposite direction of historic gas flows, from large point source emitters to repurposed hydrocarbon reservoirs in Taranaki. A retrofit gas pipeline for CO_2 transport would preclude its future use for fossil gas transmission and would incur retrofits costs.

What are the most significant barriers to the use of CCUS in New Zealand?

Despite the advantages described above, CCUS is not without its own barriers and was therefore
2 not given the highest rating.

4.1. Public Perception: CCUS is poorly understood by the wider public. Public views are often focused on potential technical risks, e.g., seismicity or leakage, that can be managed and mitigated, and less on the potential for emissions reductions. However, these risks can likely

[9] CCS in New Zealand – Case Studies for Commercial Scale Plant Final Report, Transfield Worley (2010), https://www.mbie.govt.nz/dmsdocument/2868-ccs-case-studies-commercial-scale-plant-report-2010-pdf (accessed 25 Oct, 2023)

[10] Ma, Q., Wang, S., Fu, Y. *et al.* China's policy framework for carbon capture, utilization and storage: Review, analysis, and outlook. *Front. Energy* **17**, 400–411 (2023). https://doi.org/10.1007/s11708-023-0862-z

[11] Section 45Q Tax Credit for Carbon Sequestration: https://sgp.fas.org/crs/misc/IF11455.pdf

[12] https://www.genesisenergy.co.nz/about/news/genesis-biomass-trial-successful (accessed 25 Oct, 2023)

be mitigated with standard management practices deployed in existing natural gas and CO_2 storage projects, including robust geological characterisation, appropriate pressure management to avoid induced seismicity, and monitoring within and above the storage reservoir to detect leakage.

4.2. CCUS is a mechanism for reducing net emissions. Some groups have argued that the country should adopt a focus on reducing gross emissions. From an atmospheric warming perspective, there is no difference between net and gross emissions – all that matters is that there are fewer CO_2 molecules in the atmosphere. From a whole-of-system decarbonisation perspective, technologies that effect net emission reductions will tend to remove incentives to replace that emissions source with low- or zero-emissions alternatives.

4.3. CCUS technology may not be trusted as it is seen as an enabler to industries with historically high emissions, i.e., providing a "license to pollute". This argument is valid where the possibility of future deployment of CCUS is used to defer present-day emissions reductions. However, after CCUS is implemented and further emissions are avoided, the "license to pollute" argument falls over. In such cases, CCUS operates like the liner of a landfill, that is, an engineered component of the activity whose purpose is to contain pollutants within a controlled environment.

4.4. Retrofit Cost of Existing Assets: The Maui pipeline connects the Oaonui Production Station (south of New Plymouth) to the Huntly Power Station, with a Methanex offtake along the way. The main pipeline has a maximum operating pressure of 7 MPa and the lateral to Huntly Power Station has a maximum of 5 MPa. CO_2 should ideally be compressed and transported as a supercritical liquid which requires a minimum of 8 MPa, therefore some upgrade to the compression, and possibly pipe rating, would be required. Compression would also be required for injection into a storage site, which will incur additional costs.

4.5. If storage is to make use of depleted hydrocarbon fields, then infrastructure will need to be upgraded. CO_2 is known to attack the cement used in some gas wells, which may require them to undergo costly retrofit before they can be used to inject. Alternatively, new injection wells can be drilled, although these too will incur significant cost. Monitoring systems will be needed to image and confirm containment of the injected plume, which adds further cost.

4.6. Operational Complexity: CCUS requires three separate technologies to, individually, work properly and, as a system, interface smoothly. Emissions capture, CO_2 transport, and subsurface storage are all technical activities that need to be designed to the parameters of their specific engineering context. Each activity need to be properly operated and maintained in a way that ensures minimum down time.

4.7. The ownership structure of capture, transport and storage may be complex, likely owned and operated by separate commercial entities. An outage of any one component may result in costs for other operating entities, e.g., a pipeline shutdown could require an emitter to release captured CO_2 and hence incur emissions charges. These challenges are in part mirrored in the fossil gas sector, where production, transmission and end-use are the owned and operated by separate commercial entities.

4.8. Policy and market setting: Significant investment is required to bring a CCUS project online, particularly with respect to the storage reservoir, but also to underwrite the CAPEX for capture and transmission infrastructure. Owners of these assets will want to be convinced of their long-term commercial viability and this will be supported where government policy sets clear expectations of the future eligibility and pricing of CCUS. This, in turn, would allow commercial operators to write long term contracts for CCUS procurement, similar to how such agreements were used to underwrite investment and development in NZ's fossil gas sector.

2 **Do you see any risks in the use of CCUS?**

2 **In what ways do you think CCUS can be used to reduce emissions from the use of fossil gas?**

Options to increase capacity and flexibility of gas supply

2 **What role do you see for gas storage as we transition to a low-emissions economy?**

2 **On a scale of one to five, how important do you think increasing gas storage capacity is for supporting the transition? Why did you give it this rating?**

2 **What should the role for government be in the gas storage market?**

2 **Our position is that LNG importation is not a viable option for New Zealand. Do you agree or disagree with this position? If so, why?**

2 **What risks do you anticipate if New Zealand gas markets were tethered to the international price of gas?**

General comments

Disclosures:

5. The authors of this submission are University of Canterbury academics and scientists whose research interests include climate change impacts, renewable energy, decarbonisation and carbon dioxide removal.
6. We receive funding from the Ministry of Business, Innovation and Employment to undertake public-good research in some of these areas.
7. In our research, we develop relationships with parties within or adjacent to the hydrocarbon industry and energy industry. These relationships can provide us with access to proprietary data that enable our research and they are channels through which we disseminate research findings to relevant stakeholders. However, we do not purport to speak on behalf of, nor is this submission influenced by, those parties.