A Vision for Hydrogen in New Zealand

1. Challenges and Opportunities for using Hydrogen for Storage and Distribution

Hydrogen at ambient temperatures needs to be stored at pressures above 450 atmospheres for vehicles and typically more than 650 atmospheres for large scale storage. For reference, LPG is stored at around 15 atmospheres pressure.

This elevated pressure presents significant public safety risks given that in addition to the stored energy of combustion, there is the stored energy of pressure which translates into a release profile that is somewhat instantaneous versus straight combustion-release from stored hydrocarbon liquids. The instantaneous release would result in an atmospheric over-pressure shock wave and as such, will require significant separation distances from buildings and structures housing people. This would need to be independently hazard-assessed at the time of resource consenting.

Further, such facilities would require classification as a major facility for the purposes of managing hazardous materials with appropriate controls for initial and ongoing management. In addition, the nature of managing such hazardous material large facility high pressure cycles may be globally unique and as such may require a highly conservative design and operating regime to protect the public from unanticipated failure mechanisms that are only proven with many years of operating and design experience. New Zealand does not currently have an economy geared for managing this type of concentration of public risk.

These costs will be significant relative to the current regime for managing liquid hydrocarbons as an entire support infrastructure, both people and materials, would need to be established.

Clearly, if this route proves to be competitive in time with other options, then the experience gained in NZ could be leveraged to other jurisdictions.

2. What is the role of Government in developing the complementary role of **electricity and hydrogen**? What are the challenges and opportunities for this complementary role?

The idea here is that surplus renewable electricity can be routed into making renewable hydrogen through electrolysis. This concept has been around for decades. The only problem is that the electrolysis process itself is incredibly inefficient and consumes vast amounts of electricity.

Hence, the real economics are driven by the investment in renewables which other than geothermal are intermittent. Therefore, the cost of conversion of generated power into hydrogen should be incorporated into the investment economics of renewables, assuming no grid capacity to deal with

intermittent supply. This basis then truly values the cost of the electricity supply available for producing hydrogen. If this is indeed done, NZ will see geothermal as the only renewable option with no surplus power available for anything else.

Therefore, the government should allow for the hydrogen economy to develop via the market but require all renewable power to incorporate the economics of alternative power supply when the renewable power is not flowing. Up until now, this has been absorbed via the built-in hydro capacity and coal and gas based firming and peaking power.

3. What is the role of the Government in supporting hydrogen use for the transport sector? What are the challenges and opportunities for using hydrogen in the transport sector?

The government should stay neutral on policies that drive the uptake towards decarbonizing the transport sector. The rationale for this is that it is impossible to predict what the winners of tomorrow's technologies will be given that I believe the technologies of tomorrow have not yet been identified. The triangle of public policy/technology/market should be used to guide the government to stay focused on generating robust, transparent and a non-regretted public policy mix that meets NZ's needs. Given that NZ is not a technology leader in this field, it is somewhat arrogant to assume public policy should be leading edge. NZ should be watching what other countries are doing and have independent assessments carried out to see what their efficacies are and how they would suit the NZ environment. This in itself is highly complex and will test the current capabilities of the public bodies.

The greatest challenge today is that hydrogen is highly uncompetitive based on fundamental thermodynamics and today there are other options that will lower NZ's carbon intensity at far lower cost. There are many examples playing out in China today.

4. What is the role of the Government in encouraging the use of hydrogen for industrial processes, including process heat supply? What are the challenges and opportunities for using hydrogen for industrial processes?

The same process as item 3 above. Leave the market to find the least cost commercial pathway, leveraging technology and risk and leave the government to focus on good public policy.

Industrial processes are ultimately part of a global supply chain where NZ competes with other locations. Therefore, alternative heat sources for industrial processes must compete with other options across the globe. If public policy mandates arbitrary change to utilizing hydrogen, industrial processes will largely relocate offshore.

Methanex, NZ Refining and Ballance utilize hydrogen at industrial scale within their facilities, Methanex being by far the largest consumer of hydrogen in NZ. This hydrogen has high purity and at above 80 atmospheres pressure and available at more than 90,000 Nm3/h so is ideally suited to be purified and further compressed by third parties for transport in NZ. This stream is currently burnt

and would require natural gas substitution but could be a first step in a hydrogen economy for transportation. Yet, this is not done anywhere in the world today.

5. What is the role of Government in encouraging hydrogen uptake for the decarbonisation of our natural gas uses? What are the challenges or opportunities to decarbonisation?

The same process as item 3 above. Leave the market to find the least cost commercial pathway, leveraging technology and risk and leave the government to focus on good public policy. Eliminating natural gas uses makes little commercial sense given other countries are choosing natural gas processes to assist in decarbonizing their economies. NZ is taking the approach that full decarbonization is the aim. This is just not going to happen unless global civilisation as we know it today ends. We simply have insufficient capital to achieve this and if we attempt to force it, we will create mass demand destruction with consequences that are far-reaching for NZ.

6. What is the role of the Government in producing hydrogen in sufficient volume for export? What are the challenges or opportunities to producing sufficient hydrogen volume for export?

The same process as item 3 above. Leave the market to find the least cost commercial pathway, leveraging technology and risk and leave the government to focus on good public policy.

Why would it make sense for NZ to produce hydrogen for other economies? Why would NZ subsidize the energy requirements of other nations? It would be akin to NZ accepting the waste materials of other nations. NZ does not offer a natural competitive advantage to produce renewable hydrogen. There are better wind (eg Chile) and solar (eg Australia) resources elsewhere and while NZ has world-class geothermal resources, geothermal power generation is highly capital intensive and will be driven to operate continuously at full operating capacity 24/7.

This very process for submissions implies that hydrogen somehow has a unique and compelling benefit to NZ. I suggest no such thing and it would be folly for the government to set public policy that somehow advantages hydrogen as a fuel over other cheaper options such as methanol.

Power generation and storage of the future is highly likely to be driven by technologies that are yet to be developed so in this context NZ needs to be a fast follower, not a bleeding edge driver. The very high cost and safety considerations of using hydrogen will ultimately mean it will not scale well relative to other options, some of which are yet to be created. Hydrogen electrolysis has been around for many, many decades and is therefore quite mature with breakthroughs limited by the fundamentals of thermodynamics even as new materials are developed.

Methanex has experience with producing green methanol using electrolysis to first produce hydrogen then this is reacted with CO2 recovered from a geothermal power plant in Iceland. The only reason this operates today is due to EU carbon credits with the resulting methanol blended into the EU gasoline pool. This is far lower cost than using the hydrogen directly as methanol is simple to transport and store and utilizes existing liquid fuels infrastructure.