ROAD TRANSPORT FORUM NEW ZEALAND INC

The Green Freight Project, background paper on reducing greenhouse gas emissions from road freight in New Zealand through the use of alternative fuels

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THE GREEN FREIGHT PROJECT, BACKGROUND PAPER ON REDUCING GREENHOUSE GAS EMISSIONS FROM ROAD FREIGHT IN NEW ZEALAND THROUGH THE USE OF ALTERNATIVE FUELS, COMMENTS BY ROAD TRANSPORT FORUM NEW ZEALAND INC

Introduction

1.1 Road Transport Forum New Zealand (RTF) is a national organisation representing the road transport industry. RTF provides services to, and public policy advocacy for, its affiliated members who comprise owner-drivers, fleet operators and international corporates engaged in freight and logistics.

1.2 RTF's constituent associations include:

- National Road Carriers (Inc)
- Road Transport Associations NZ (Inc)
- NZ Trucking Association

1.3 RTF's member associations have in excess of 3,000 members and associate members who operate 16-18,000 trucks over 3,500 kg.

1.4 RTF is the authoritative voice of New Zealand's road transport industry which employs 28,600 people (3.0% of the workforce), has a gross annual turnover of $6 billion and carts over 70% of New Zealand's land-based freight on tonnes/kilometre basis.

1.5 Forum members are predominately involved in the operation of commercial freight transport services both urban and inter-regional. These services are based entirely on the deployment of trucks both as single units for urban delivery and as multi-unit combinations that may have one or more trailers supporting rural or inter-regional transport.

1.6 One of the imperatives of today's truck transport is the necessity to demonstrate to customers and clients the best in environmentally sustainable logistic solutions. Managing vehicle related emissions is only one aspect of a menu of mitigation processes. The trend in most industrialised countries (after fully exploiting payload and trip performance efficiencies, as has occurred in New Zealand with 50 MAX and HPMV) is toward exploring tangible but reliable alternatives to fossil fuels. The RTF fully recognises the need to support this position if we are going to make any sort of impact on reducing the road freight's carbon footprint.

1.7 Our comments focus on the heavy vehicles, whose operators we represent. It is worth noting that this is not all trucks, just those over 3,500 kg.

1.0 General comments

2.1 The RTF welcomes the opportunity to comment on *The Green Freight Project, Background paper on reducing greenhouse gas emissions from road freight in New Zealand through the use of alternative fuel as* (the paper). These comments are supplemented by the RTF's *Submission on NZ Government/MBIE Consultation document: A vision for hydrogen in New Zealand: Green paper*, which is attached as an appendice which better explains in some detail the future direction for vehicle technology and fuel source developments. We thank MoT for engaging with the RTF in person, as well as via the opportunity to comment in writing.

2.2 Road freight is essential to New Zealand. No other method of freight transport is as flexible and cost effective as trucks. Road freight shifted around 74% of the total freight task in 2018 on a tonne/kilometre basis (*Commercial Road Transport Industry Environmental Scan,* Infometrics & MITO, Nov 2018). New Zealand's freight task is projected to grow by 58% by 2042 (MoT, *Future Freight Scenarios Study*, 2014), and over 90 percent of this increase is expected to be transported by truck.

2.3 New Zealand's transition to a low or zero carbon emissions economy will occur over the next 30 years. Reducing fossil fuel use by the transport industry is essential for a low carbon economy. Currently, transport contributes 20% (MoT) of New Zealand greenhouse gas (GHG) emissions. Heavy vehicles contribute 24.2% of that total and cars some 67% overall.

2.4 For trucks, particularly heavy trucks, New Zealand is dependent on the new power system development by international truck manufacturers, because we are too small a market to support independent development.

2.5 New Zealand's trucking industry will adopt the new fuel technologies when those technologies are widely and dependably available; reliable in terms of performance and servicing; and cost competitive.

2.6 Modern trucks have been built to match environmental considerations including fuel efficiency and reduced GHG emissions.

2.7 Early adoption of new technology is risky and expensive. Those higher costs would be passed onto the freight industry's customers and eventually, all consumers, increasing the cost of living.

2.9 The choice of fuel (hydrogen/methanol/electricity) will be dependent on the availability and cost of those fuels in New Zealand. Each of the possible fuel types depend on New Zealand having an adequate electricity (or gas) supply for its manufacture, or direct use to recharge batteries. Therefore, policies for de-carbonising the road freight industry must also consider the renewable electricity sector's ability to supply the electricity required, as well as the investment impact of purchasing new equipment and the availability of technicians and resources to service the new equipment.

2.10 To hasten uptake of the new fuel technology in the road freight industry, or "de-risk" it, RTF would likely aim for some kind of financial incentivising from the government, as has been done with electric light vehicles.

2.0 Specific questions

3.1 The paper poses a number of questions, some of which are not applicable to heavy transport and others which are covered off in the supporting submission on hydrogen in New Zealand, referred to in 2.1.

3.2 RTF believes the heavy truck industry in New Zealand has already made significant strides to reduce GHG emissions through the uptake of heavy-duty diesel engine technology advances provided by truck manufacturers and suppliers. These vehicles meet accepted international emission standards and coupled with the use of internationally recognised fuel specification standards necessary for these engines to perform optimally reduced emissions have occurred. Based on NZTA data Euro 5 and its US, Australian, and Japanese equivalents are well bedded in the NZ truck fleet with some estimated 23,892 trucks across all GSL mass classes meeting this standard. The government's 2010 HPMV initiative and the subsequent 50 MAX derivative combination vehicles has also seen the emissions per tonne of payload and gross weight tonne fall by something in the order of 10% for those vehicles operating at the higher weights. An increase in fuel consumption is not lineal with each tonne increase in payload. This particular group of vehicles is typically involved in transporting consumer freight and taking produce off NZs hinterland for export or processing prior to export and make up the bulk of NZs heavy duty high payload capacity fleet.

3.3 While freight vehicle technology continues to advance toward Government's low carbon aspirations there will always be a lag. The dedicated freight sector dominated by the HPMV and 50MAX combinations will be the most likely adopters of new technology given the demanding duty cycle these vehicles operate at. However, investment costs in upgrading obviously has some influence on the actual pace of change. The tension in the freight market obviously results in lower transport costs and low margins and the ability to invest in the newest equipment is therefore somewhat inhibited especially for small freight enterprises that make up the bulk of the sector. While RTF would like to see greater investment in advanced existing technology options, the present situation suggests various options incentivising fleet upgrades to Euro Standard 6, and future Euro Standard advances should be explored. An obvious example is allowing accelerated depreciation, a model used in the USA when there was market resistance to EPA 2007 engine standards. Incentivisation would be expected to have an immediate impact on vehicle purchase strategies and consequential impact on GHG emissions. As a back drop to support this initiative, the Land Transport Emissions Rule would need to urgently be amended, to cite the Euro 6 Emissions standard and other internationally accepted equivalents. Consideration should also be given to including explicit and enforceable anti tampering provisions in the same rule. MOT has in the past sought information from RTF regarding emissions tampering in NZ and we have provided details of this occurring to some significant level in overseas jurisdictions.

3.4 By taking immediate action and using existing energy sources, this may alter the future landscape and consequently, the imperatives around decision making on alternative fuel sources.

3.5 RTF is concerned the Government's desire to rid the country of fossil fuels will result in premature decision-making that will create expensive or unworkable outcomes.

3.6 The reality is, fuel cell enabling technologies (FCETs) for heavy-duty trucks are still a work in progress, with mixed results. Commercialisation at scale is still a long way off.

3.7 Government climate change policies will have an impact on the cost competitiveness of new fuels through excise taxes, licensing costs, and the Emission Trading Scheme (ETS). Our view is that the government should not pick a technology for its support prematurely, but instead allow technological developments and industry response to find the best solutions.

3.8 Competition between both road freight companies and other modes of transport (rail and coastal shipping) has served New Zealand and its economy better than Governments 'picking winners' and favouring one transport mode over another.

3.9 A Government giving an advantage to one transport mode over another inevitably creates unnecessary additional costs and lower overall economic prosperity, because it removes the choice to use the most cost-efficient freight solution.

3.10 To the specific questions - *How could we reduce GHG emissions by changing the composition of the heavy truck fleet (e.g. size and weight of trucks entering NZ)? What influence does the end consumer have in driving changes to the way freight is delivered?* And, *What freight tasks could be achieved in New Zealand using commercially available electric battery trucks?* – these can be answered together.

3.10.1 Ultimately, delivery of freight is a service industry and the customer sets the terms and conditions. The most significant reason road freight is increasing is the improvement of truck payload efficiency – that means bigger trucks that carry more load, reducing the number of truck trips. Over the past six years, efficiency gains through the uptake of HPMV and 50 MAX have been realised in dairy, logs, livestock, aggregates, and petroleum distribution. To meet customer demand for speed and efficiency in delivery of their goods, bigger and heavier trucks are required.

3.10.2 Commercially available electric battery trucks have a much smaller payload therefore, more truck journeys would be required, at greater cost, if they were used to replay the more efficient heavy trucks.

3.10.3 Heavy trucks have a lot of inbuilt emissions control attributes that support the Government's imperative to reduce GHG emissions, so arguably Euro 6 should not be dismissed or ignored in the medium term. The problem with a focus on pure battery or hydrogen fuel cells in the heavy-duty truck space is the former has a number of unresolved issues and the latter is still at the exploratory stage and neither has been tested on a roading environment as tortuous as NZs. The *Wrightspeed* system adopted for NZ bus failed in its application due to the Wellington bus route gradients, but conversely works acceptably with short range stop/start rubbish compactor applications in USA.

3.11 To the question: *What other mechanisms might support GHG emissions reduction from road freight?* There are a range of initiatives that will support a reduction in GHGs and these include the use of scheduling and fleet management tools. They are not ideal for NZ as most of the NZ network is lineal but, in the UK, where truck routes are more circuitous, they can help reduce unnecessary travel. Various European countries have encouraged green auditing as a support mechanism for GHG reduction because focusing solely on vehicles is a particularly very narrow perspective for mitigating environmental consequences.

6.0 Evidence

The difficulty NZ has is trying to develop a unique NZ solution to displace fossil fuels in NZ when the international suppliers of vehicles are the ones determining the power train developments. This is evidenced by the information covered in RTF's *Submission on NZ Government/MBIE Consultation document: A vision for hydrogen in New Zealand: Green paper*, which is as mentioned attached as an appendix.

7.0 Summary

7.1 RTF does not believe the Government is in a position, at this stage, to "pick a favourite" to replace fossil fuels for the heavy road freight task.

7.2 RTF believes the Government should acknowledge that for the heavy vehicle fleet, which delivers the greatest efficiency for the increasing demand for road freight, New Zealand is dependent on the new power system development by international truck manufacturers.

7.3 RTF believes the Government should acknowledge that heavy trucks meet some environmental imperatives – less journeys equals less emissions – and that immediate investment should be in incentivizing greater use of the trucks and fuel technologies that offer the lowest GHG emissions.

7.4 The choice of fuel (hydrogen/methanol/electricity) will be dependent on the availability and cost of those fuels in New Zealand. Each of the possible fuel types depend on New Zealand having an adequate electricity (or gas) supply for its manufacture, or direct use to recharge batteries. Therefore, policies for de-carbonising the road freight industry must also consider the renewable electricity sector's ability to supply the electricity required, as well as the investment impact of purchasing new equipment and the availability of technicians and resources to service the new equipment.

7.5 To hasten uptake of the new fuel technology in the road freight industry, or "de-risk" it, we would likely aim for some kind of financial incentivising from the government, as has been done with electric light vehicles, once this technology is commercially available at scale.

7.6 Government climate change policies will have an impact on the cost competitiveness of new fuels through excise taxes, licensing costs, and the Emission Trading Scheme (ETS). Our view is that the government should not pick a technology for its support prematurely, but instead allow technological developments and industry response to find the best solutions.

7.7 Competition between both road freight companies and other modes of transport (rail and coastal shipping) has served New Zealand and its economy better than Governments 'picking winners' and favouring one transport mode over another. RTF wants to see continued investment by the Government in the infrastructure that supports road freight, given its dominance of the freight task that keeps the economy moving.

7.8 Government giving an advantage to one transport mode over another inevitably creates unnecessary additional costs and lower overall economic prosperity, because it removes the choice to use the most cost-efficient freight solution.

7.9 RTF welcomes ongoing discussion on the Green Freight Project and remains committed to the uptake of technology and energy sources that reduce New Zealand's GHG emissions.

APPENDIX 1

RTF's *Submission on NZ Government/MBIE Consultation document: A vision for hydrogen in New Zealand: Green paper*

ROAD TRANSPORT FORUM NEW ZEALAND INC SUBMISSION ON NZ GOVERNMENT/ MBIE CONSULTATION DOCUMENT: *A VISION FOR HYDROGEN IN NEW ZEALAND*

REPRESENTATION

Road Transport Forum New Zealand (RTFNZ) is made up of several regional trucking associations for which the Forum provides unified national representation. The Forum members include Road Transport Assns. NZ, National Road Carriers, and NZ Trucking Assn. The affiliated representation of the Forum is some 3,000 individual road transport companies which in turn operate 16-18,000 trucks involved in road freight transport as well as companies that provide services allied to road freight transport.

The Forum is the peak body and authoritative voice of New Zealand's road freight transport industry which employs 28,600 people (3.0% of the workforce) and has a gross annual turnover in the order of $6 billion. Road transport in its totality transports about 70% of New Zealand's land-based freight measured on a tonne/kilometre basis.

Forum members are predominately involved in the operation of commercial freight transport services both urban and inter-regional. These services are based entirely on the deployment of trucks both as single units for urban delivery and as multi-unit combinations that may have one or more trailers supporting rural or interregional transport.

One of the imperatives of today's truck transport is the necessity to demonstrate to customers and clients the best in environmentally sustainable logistic solutions. Managing vehicle related emissions is only one aspect of a menu of mitigation processes. The trend in most industrialised countries (after fully exploiting payload and trip performance efficiencies, as has occurred in New Zealand with 50 MAX and HPMV) is toward exploring tangible but reliable alternatives to fossil fuels. The RTF fully recognises the need to support his position if we are going to make any sort of impact on reducing the road freight's carbon footprint.

Our comments focus on the viability of investing in hydrogen production in New Zealand and its applicability to commercial truck transport.

Summary of the RTF response to the discussion paper

- Hydrogen is not a one-stop solution for the energy demand market. It's a complementary option with specific applications.
- The government strategy should focus on setting standards, regulations and protocols for managing the manufacture, storage and distribution applicable to hydrogen as an energy source. RTF is not convinced government should

invest in hydrogen processing, given the expertise already in the international market. A joint venture (JV) approach may help mitigate any financial risk involving government/tax payer support, or seed funding.

- It is essential government considers the need to up skill the work force working with hydrogen from the manufacture to end-user situations, and a technician registration scheme might be worth considering to meet the fuel cell vehicle market demand.
- Fuel cell enabling technologies (FCETs) for heavy-duty trucks are still a work in progress with JVs or collaboration being the norm for fuel cell bus initiatives overseas. It is premature to rule out diesel, and oil demand will continue even if there is significant transition to alternative energy sources in the freight transport sector. It's entirely possible the road transport market will be split due to the duty cycles of vehicles. Urban delivery may elect to go battery electric vehicles (BEV) and the heavy-duty market, FCETs.
- Hydrogen FCETs currently carry significant costs over existing fuel source vehicles in both capital and running costs. Advances in diesel engine technology are occurring all the time and until the costs of the two types of vehicle are somewhat parallel, and vehicle longevity and reliability is on a par, FCETs will struggle to get traction in a market as diverse as New Zealand. The possibility of purchase incentives should not be ruled out.

Setting the context for heavy-duty hydrogen powered trucks

Without the availability of reliable and cost-effective energy sources to power surface vehicles, particularly trucks, food supply, industry and commerce in New Zealand would cease to be possible in today's form. Product distribution by commercial road vehicles has, over the past 100 years, resulted in a cost effective and almost unchallengeable service for household consumers and value adding producers alike. The reliability, flexibility and efficiency of road transport has, since the 1950s, largely displaced much of the rail terminal-to-terminal distribution service. Rail cannot deliver point-to-point and its full capability has been entirely dependent on road transport support.

Over this same time period, internal combustion (IC) engines utilising petrol have been replaced by sophisticated diesel compression ignition power units. The new generation diesel engine and power train developments have been driven by jurisdictional demands requiring reduced emissions from IC fossil fuelled engines. These changes have not come cheaply, and truck capital and maintenance costs have risen dramatically, while the need for highly skilled technicians has fallen behind resulting in a maintenance capability deficit. This is not unique to New Zealand. It is a feature of both the European and North American markets where the focus, like in New Zealand, has been on not only attracting driver trainees but technician trainees as well. We suspect this situation will escalate with the introduction and availability of hydrogen fuelled trucks if appropriate steps are not undertaken early within the hydrogen fuel policy framework to develop the means and processes for attracting technician trainees.

No matter what energy source trucks use, trucks and their heavy trailers are large pieces of industrial equipment and like all complex systems have a high demand for both routine maintenance and reactive maintenance.

Prioritising future energy options for heavy-duty trucks

Developments in truck power train technology are spawning new opportunities in alternative energy applications for heavy-duty trucks, but with mixed results. Many of the new approaches, particularly those utilising hydrogen fuel cell technology, EVs, or hydrogen fuel cell battery EVs (FECVs), are in the early stages of reliability testing only, in back-to-base truck fleets in both Europe and USA. The light vehicle hydrogen FCEVs present a different picture, and a growing number of mainstream vehicle manufacturers are investing heavily in FCEVs, having created promising markets and a customer expectation in terms of range performance for their products. However, penetration in the market is relatively modest and even California data shows only some 8800 light FCEVs in what one would expect to be a significant market.

Battery technology is now recognised as not an entirely viable option for heavy-duty truck applications even though it has some acceptability for light vehicles and for urban delivery trucks on fixed duty cycles which have modest payload applications.

There are some BEV applications for heavy-duty trucks but they tend to be limited by range. Battery-only drivetrains in whatever guise and form they come, are not nearly as environmentally clean as the advocates would have everyone believe. Battery technology has a legacy of labour exploitation for the constituent minerals and potential recycling limitations, both of which have been well documented in various sources of international literature and more recently, in New Zealand’s print media. In fact, pure battery technology could be as exploitative for vulnerable population groups as the biofuel initiative proved to be for certain equatorial populations. Even if a new generation of high-performance batteries were to be developed, consumer sensitive governments may elect to consider the exploitative reach and true environmental impact before endorsing their availability in a market becoming common place. To tackle the recycling issue responsibly, it may require vehicle drivetrain batteries to include a prescribed ‘return to country of origin’ or ‘return to supplier base’ requirement, to avoid any domestic accumulation of end of life batteries.

While the focus of the discussion document is on hydrogen as a fuel source and implying unlimited potential to displace fossil fuels, it also gives the impression that in itself will totally decarbonise the transport system. Unfortunately, that’s a very narrow perspective and the demand for oil and oil derivatives will continue unabated. Trucks, and nearly all types of industrial equipment, have an enormous appetite for lubricating oils for their transmissions and hydraulic ancillaries. The manufacture and fabrication of the many of the recyclable components of trucks, including the high-end metals used in the driveline, chassis and cabs, require highly refined lubricants to sustain the manufacturing processes. The term decarbonisation is often read in an extremely broad context that oil exploration and oil production will become redundant, being displaced by entirely by new fuels and vehicle propulsion systems, but because of the variety of applications for oil across industry and commerce, oil will continue to have to be sourced from somewhere.

The discussion document

The human cost and environmental negatives of the current battery technology, or alternatives to hydrogen, could result in hydrogen and its associated fuel cell and hybrid technology becoming the energy option of choice for many applications. In our view, the advances in heavy high-duty trucks power train development taking place in the USA would seem to offer a promising opportunity for New Zealand-based truck and tractor units for combination vehicles, utilising the full benefits of original equipment manufacturer (OEM) designs, to be marketed with this fuel as their primary source of drivetrain power.

In terms of selecting the energy source model, we can't help but reference the power shut down around 10 October, 2019, across California. This impacted 800,000 customers and over one million people in more than 22 counties. It was expected to take some days to resolve due to major equipment failures. This type of energy source failure presents significant challenges to those solely reliant on BEVs for transport, including emergency services. This event illustrates the vulnerability of building a mobility system based on one single fuel source. That's not to say fossil or hydrogen fuelled vehicles will fare any better in such a crisis situation, but they might have more flexibility to fuel up elsewhere.

The question the California experience raises is, given New Zealand's vulnerability to natural disasters, including earthquakes, could an event of some magnitude threaten our primary energy infrastructure, and where does it leave the country's transportation system if it is entirely reliant on renewables or green energy solutions? Arguably the country might not be in that position for some years, but it does raise an important consideration as far as having an appropriate risk analysis undertaken before all the eggs are put in one basket.

We appreciate the discussion document it is not to debate the merits of hydrogen and its associated fuel cell technology versus any other energy options. Instead, it is seeking opinion on the merits or otherwise of New Zealand Inc committing to a hydrogen fuel strategy and to developing a supporting hydrogen production business and infrastructure to deliver that strategy.

Before answering those questions, we have to be confident a market opportunity actually exists. The purpose of the green paper is to generate and provoke discussion in that vein. Being a vision-driven document, the context is very much a tentative one.
In our response to the document we attempt to provide some outline to the questions presented, but we are not entirely clear how involved in an emerging market the government should be.

Question 1a: What is the role of Government in developing hydrogen for storage and distribution?

The role of government is an important one, as far as facilitating the production processes around hydrogen generation and introducing the administrative and compliance framework to cover off the manufacturing and distribution legal framework. Government should be guided by established international conventions that cover safety and 'fit for purpose' around any sort of hydrogen distribution systems.

However, any risks associated with market investment should be left to private industry as is the norm with other energy products and their respective distribution and user delivery systems. The hydrogen strategy shouldn't be built on creating a unique New Zealand technology, but instead should rely on the technological solutions already developed by countries that have been supplying the technology to end-users for some years.

Nel ASA, trading as Nel Hydrogen, based in the Norwegian city of Oslo, is a well-established provider of solutions for the production, storage and distribution of hydrogen from renewable energy sources. The company is internationally recognised as leaders in this field and has been around since 1927.

This approach minimises risk for the investors and given the portability of the electrolysers and the scalability of the technology, it is hard to stack up a case for investment in New Zealand technology.

While the government's goal may be energy independence, there is no evidence that New Zealand has a surfeit of current, or unrealised clean or green energy sources, from which to power the electrolyser technology systems. The role of government should be to facilitate the planning and approval processes and see the adoption of the appropriate regulatory norms to assists the market being a viable option.

According to a recent *Financial Times* article (Jan 2019), China produces an estimated 150 gigawatts through renewable energy generating capacity that is excess to demand every year. This is the result of intensive investment in renewable energy sources and has the capability to make China more than self-sufficient in hydrogen from electrolysis processing. The cost to China to embark on a hydrogen generating approach is almost negligible. Given the scale of its resource availability, the general view is that China is going to build its hydrogen vehicle manufacturing programme and hydrogen fuel programme on largely subsidised incentives.

In terms of resource adequacy, China is interested in moving away from its reliance on lithium iron component batteries that require cobalt, nickel, and high-grade lithium. The hydrogen fuel cell approach requires only platinum, an abundant mineral in northern South Africa. It is against this background that New Zealand is going to enter the hydrogen supply and export market.

New Zealand’s renewable energy generating capacity is limited and not always reliable. There are frequent and well documented situations where the weather patterns force New Zealand to implement fossil fuelled power generation.

The vulnerability of the New Zealand energy production environment is openly explained in the discussion document on pages 44/45.

A micro economy such as New Zealand, would struggle to achieve a fully sustainable hydrogen production capability using green energy to the meet domestic needs even though this is alluded to as possibility on page 46. Given the opposition to any new investment in significant hydro power generation, or other models of carbon neutral power generation, a fully developed hydrogen generation initiative looks less than promising.

The discussion document (page 45) touches on variety of approaches such as micro grids and remote area power stations, as well as stationary facilities, but without having any definitive design criteria it’s hard to gauge the performance, efficiency, or public acceptance of these approaches. From our perspective these concepts have merit and should be explored in more depth

Questions 1b & 1c: What are the challenges and opportunities for using hydrogen for storage and distribution?

Both these questions can be discussed in the same paragraph as they simply opposite sides of the same coin.

Pages 40 and 42, outline the different options for transporting and storing hydrogen. The transport industry will adapt to transporting hydrogen to meet the needs of the market. The alternatives are the once again utilizing small-size, on-site electrolysers, such as the ones produced by Nel Hydrogen. The role of government in this part of the process is to adopt the correct standards and protocols to ensure adequate public safety. This is already highlighted as one of the steps in the hydrogen policy road map. SAE already has standards available for adoption and application by regulatory agencies, so the issue is giving visibility of these to potential hydrogen producers and end-users. This would reduce upskilling lags occurring in the labour market. Ideally, this aspect should occur early in the policy framework development phase, as set out in the road map.

With growing interest in hydrogen use around the world, it would be worth examining whether there has been any resistance to the use of hydrogen energy by the public. Commercial users of fuel resources are always looking to find the least cost option. If the hydrogen market was sufficiently developed and the end line market price was comparable and appropriately specified vehicles were available in the market, users would gravitate to the hydrogen option. Price point differences for the vehicles is an important consideration, something we touch on in one of our extracts.

Questions 2a,2b &2c: What is the role of Government in developing the complementary role of electricity and hydrogen and what are the opportunities and challenges?

We have already covered some aspects these questions. Government's role is to facilitate the opportunities in a regulatory framework and coordinate the development process, leaving private and public investors to take the market risk. Government also has a role to protect the wider public good, which might be necessary in a market that would be attempting to move with some urgency. Private investors are more sensitive to the market and end-user and are better at gauging where the low hanging fruit in an emerging market might be, whereas government is often compromised by trying to be all things to all people, which usually stifles innovative solutions.

Meeting the complementary challenges alluded to in the discussion document might only be able to be resolved by government involvement, and direct government participation in the balancing competing aspects with the policy framework and within the planning process. We believe government's role is to develop policy and guidance and appropriate standards to allow the market to flourish, but the actual technology applications and end-user aspirations are for the market and end-users of the hydrogen products to determine. We don't want to see government over-invest in end-user applications or marketable technology when the FCEV hydrogen heavy-duty truck developments are at such an immature state.

The FCEV bus market is more developed with numerous joint ventures already in place around the world. China is one of the leaders in this area with its BYD electric bus initiative. Hawaii has a hydrogen FCEV programme that has advanced significantly over the past year, and several Californian transit agencies have invested in FCEV buses. As an aside, the BEV bus programme stalled in Hawaii due to the fact the buses weren't capable of negotiating the gradients in some parts of the transit routes. This was in part caused by the saturated power demand on these vehicles and the high tare weight of the batteries. The new FCEVs operate on a route that is some 400km and are essentially back-to-base operations, which must be recognised as completely different to the way trucks operate servicing their client base.

Questions 3a,3b & 3c: What is the role of Government in supporting hydrogen use for the transport sector and what are the challenges and opportunities?

Due to these three aspects of the discussion paper being so interrelated it's easier to address our comments to the three questions together.

We have already indicated that we see the market maturing and developing through end-user demand. It's worth noting nearly all the FCEV bus options have been based on joint ventures between vehicle suppliers and transit companies, with government support through technology initiatives. In other words, there has been some form of subsidy from government sources to test and evaluate the viability of FCEV propositions.

With commercial trucks the market might be more difficult to establish. Hyundai Motor Company has entered into a cooperative arrangement with H2 Energy to introduce 1600 trucks into the Swiss heavy vehicle market over the next six years. The objective is to establish a beachhead market for the rest of Europe, before embarking on the US market. These vehicles are essentially what New Zealand would term medium-duty trucks, with a range of 400 km. They are not heavy-duty trucks capable of taking products from New Zealand's pastoral and hinterland production, to market or processing for export. The Hyundai model would most likely be deployed in urban delivery in a New Zealand context.

A recent article, by John Kingston, in the US *Freight Waves* magazine states with some authority, "Alternatives to diesel in long-haul trucks still face big challenges", citing a report by S&P Global Platts Analytics. We have taken the following extract from the full article because it frames the present state around heavy-duty truck alternative power technologies particularly well.

A problem for alternative technologies – the diesel truck is simply too efficient. "Our analysis of contemporary long-haul semis shows that across battery electric vehicles, fuel cell electric vehicles and compressed natural gas [CNG] drivetrains, none were economically competitive on average with the status quo diesel truck," the report said in its conclusion.

And it's not as if diesel engines are standing still. As noted by the report's authors, Zane McDonald and Roman Kramarchuk, diesel engines have a 30 percent efficiency improvement capability using existing technologies. That potential move away from the status quo – which for the most part has never truly been static but is always evolving – "further complicate(s) any prospects of unseating diesel as the primary energy source for long-haul semis in the near- to medium-term."

That doesn't mean that there aren't strengths in other technologies. The report focuses heavily on the advantages and disadvantages for battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEV) in the long-haul market. But as the onion is peeled away, the report finds that significant penetration by these technologies is going to need enormous technological gains alongside the improvements in diesel engines, or will need a government boost through programs like the California Low Carbon Fuel Standard, which gives low-carbon technologies like BEVs an advantage.

What the Platts report does find is that there are more immediate opportunities for alternative fuels in the regional haul market, which it defines as less than 200 miles per day with a truck averaging 29,000 miles per year. The lower range of these vehicles means that regional haul trucks can use smaller battery packs, a major cost source in long-haul tractors because of their weight.

Platts lays out a mathematical case that the smaller battery in a regional vehicle reduces the "purchase premium" – another term for higher price – of a regional truck to $22,500 from $63,000 for a long-haul tractor. Throw in the savings on diesel and maintenance and "during typical regional haul operation, a 2030 BEV semi will break even with a high-efficiency diesel in less than two years," the Platts report said. "Past this point, there is an economic advantage to be had in reduced fuel and maintenance expenditure."

But for long-haul trucking, that $63,000 price premium on the cost of a BEV is too large for the fuel and maintenance cost savings to compensate. "Reduced operational costs to improve the competitiveness of the drivetrain with increasing cumulative mileage, it is not enough for the average BEV to be cost-competitive with an anticipated high-efficiency diesel semi," the report said.

The numbers on the weight of batteries in BEVs are stark. The unit needed to service the average long-haul truck can weigh more than five tons. The report says existing diesel trucks can approach a gross vehicle weight of 33,000 pounds, so a five-ton battery would be 10,000 pounds (though offset in part by the loss of the weight of the internal combustion engine).

Such a battery pack would "reduce the overall freight that a truck can carry, reducing revenue per mile," the report says. "Furthermore, batteries are relatively expensive, increasing the cost of a long-haul semi by over 80 percent at current technologies."

For other technologies being utilized in the long-haul segments, the figures are stark on how much two key costs would need to decline to make them competitive with diesel. Fuel cell costs would need to decline to a level near $90/kW from nearly $250/kW today, and the cost of hydrogen would need to be down toward $4.40/kg. The price today is $16/kg.

This summary outline of the Platts report puts into context the real opportunity for FCEV heavy-duty trucks, and also identifies the practical limitations of the BEV technology for the same vehicles.

The USA has more conservative tare weights than we have in New Zealand, but because we have road user charges as our road tax system for heavy vehicles, tare weight considerations become even more imperative in as much they impact on the payload capability of the vehicle.

If we take pragmatic view of the opportunity to displace diesel as the dominant fuel source for heavy vehicle applications, the market is a split model with potentially two-thirds of the fleet involved in intra-regional distribution and intercity deliveries being candidates for either FCEV/FVET technology, or BEV technology, where the vehicles are predominantly back-to-base operations within typical 400 km range limits.

The other one-third are the multi-unit heavy-duty combinations where the payload demands are such that FCEV will most likely dominate due to the fact that operating ranges are likely to be in the order of 1000km, and load demands are at the upper levels commonly utilised by 50MAX and HPMV vehicles. There are number of vendors in this latter space developing vehicles, but the Nikola Motors trucks seem to offer the most promise. Nikola has had vehicles in experimental fleet applications, but has yet to offer its models to US domestic end-users. Nikola has three FCETs in sleeper cab and day cabs in various configurations to meet the needs of both European and US end-users. Nikola doesn't sell its trucks and proposes a marketing model based on fixed-term leasing, which means it can control maintenance issues and gain knowledge directly from end-user experiences with their chassis and vehicle systems. Nikola is also developing its own hydrogen refuelling network, both domestically and internationally, through associations with Air-liquide, Hyundai, Nel, Shell and Toyota. TUV SUD is also working to expand hydrogen stations across Europe to meet the growing demand for hydrogen.

In 2019, Kenworth announced a heavy-duty fuel cell electric truck (FCET) produced jointly with Toyota. However, we need to be careful an intermediate application for heavy-duty trucks doesn't emerge somewhere between diesel only, and full FCET. Wright Speed, a US company, had some success with its rubbish collection truck applications using a hybrid technology. A number of major manufacturers (predominantly Japanese) already have reliable mainstream diesel hybrids. Nikola motors, started out with a fuel agnostic hybrid drive system before fully committing to fuel cell technology. So, there are a number of technological steps that can be employed before committing to the full hydrogen fuel cell model.

In a heavy-duty vehicle market as small as New Zealand's, there is total reliance on the importation of built-up vehicles, as there is with diesel vehicles. Before New Zealand truck operators make the decision to invest, they will be looking to their overseas counterparts' experience with hydrogen powered vehicles. The well documented price differential between a diesel-powered truck and a FCET would need to be resolved, because operators are very sensitive not only to capital costs, but to whole-of-life vehicle operating costs, as well as vehicle costs per kilometre. The price/cost differentials in our comments are stated in US dollars and although they relate to BEVs, similar price differentials apply to FCETs, which our extract of the Platts commentary touches on.

One thing truck operators need as an imperative, is low operating and maintenance costs, and modest capital costs. Vehicle power system longevity and in-service reliability are other cornerstones applicable to commercial truck operations. The New Zealand trucking industry is beset by low margins, and fleet replacements result in a long legacy of finance costs that must be recovered before the vehicle's first life comes to an end. Large fleets have more scope for purchasing new technology than smaller fleets. Unfortunately, New Zealand's transport industry like every other jurisdiction, is made of small businesses with single unit operators making up the bulk of players. In light of the limited capacity to purchase new technology, we suggest Government might like to consider a transitional subsidy or suspensory loan approach to help encourage the uptake of FCETs. Once the reliability and pricing profiles of the FCETs come closer to the diesel option the government support might be able to withdrawn. The difficulty here is future state of the heavy-duty vehicle market is somewhat unknown.

Concluding comments

The discussion document provides a snapshot into the future, a future that has some uncertainties as far as the commercial trucking industry is concerned. However, the document is timely and presents factors such as hydrogen supply and delivery options that must be considered by Government for a future state energy market. While there has been some success with hydrogen powered vehicles in some specific markets, it is difficult to gauge with any certainty whether a market in New Zealand could be developed with enough sophistication to result in the significant reliance on diesel being displaced in favour of FCEVs or FCETs. At present, no one has clear picture of where things are likely to go. The international market for heavy-duty FCETs is erratic, with commentators offering divergent perspectives. This situation doesn't help Government bed down its strategy and certainly doesn't help the trucking sector plan where it wants to go. There seems to be two likely approaches; wait another five years to see where the FCET market sits, or continue to explore making hydrogen available in New Zealand for future consumer demand, such as when the fuel cell technology for light vehicles and trucks is well bedded down

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