Zero Emission Vehicles

"Yes We Can" Symposium
Hotel Intercontinental
Wellington
31st May 2016

Reducing Emissions in the New Zealand Heavy Vehicle Fleet

Introduction

At the 2015 United Nations Climate Change Conference held in Paris in 2015 (COP 21), New Zealand committed to achieving a 30% reduction on 2005 greenhouse gas emissions by 2030. This requires a reduction of 25 million tonnes in 14 years.

Converting the entire New Zealand vehicle fleet to electric achieves 50% of New Zealand's greenhouse gas emission reduction requirement.

- The energy sector represents 40% of gross emissions
- Transport represents 45% of the gross emissions from the energy sector
- The heavy vehicle sector represents only 4% of the national fleet – but 21% of the transport emissions

Converting the heavy vehicle fleet to battery electric provides a cost effective technological solution for the reduction of greenhouse gas emissions. The technology is already available and proven and is able to be deployed in the 14 years available to New Zealand given appropriate policy support.

The heavy vehicle fleet is unique within the transportation sector as economies of scale are easily achieved when compared to the light vehicle fleet. As few as 10 heavy vehicles being manufactured at a time achieves the necessary economy of scale required to realise a commercially acceptable market cost.

The shortage of proven battery electric solutions and the perception of risk are the primary barriers to the adoption of heavy battery electric vehicles in New Zealand. Risk includes factors such as maintenance cost and timeliness, operational costs, performance in the New Zealand environment, resale value and initial capital purchase cost.

Within the transport fleet, the heavy vehicle sector offers the greatest potential for emissions gains for the smallest investment. Despite only comprising 4% of the total national vehicle fleet, heavy commercial vehicles account for 21% of the total greenhouse gas emissions from transport. Each heavy battery electric vehicle is the equivalent of from 6 to 20 electric passenger cars in terms of emissions savings.

This document outlines the importance of the heavy commercial fleet and proposes policies that maximise the deployment of battery electric commercial vehicles in the shortest time possible.

Zero Emission Vehicles

Current Application Examples

Nine Tonne Compacting Rubbish Truck on the Kapiti Coast

The ZEV 9000 battery electric compacting rubbish truck is a 9 tonne vehicle with 160 kW of motive power, 104 kWh battery pack and which has an average daily energy consumption of 0.48 kWh per km. Using off-peak electricity at 10 cents per km, the energy costs are 4.8 cents per km. The ZEV 9000 is already cost of ownership comparable to its internal combustion equivalent at a unit price of $240,000. This price is achievable in production quantities of just 10 such vehicles.
The ZEV 9000 operated by Kapiti Coast District Council (KCDC) has already accumulated in excess of 60,000km of zero emission use.

Possible Application Examples Utilising Existing Technology

High Productivity (H) Milk Tanker in the Waikato

A battery electric tanker truck and trailer combination carrying 26,000 litres of milk on an average route distance of 125km six times per day would have 550 kW of motive power, be fitted with a 507 kWh battery pack and consume around 3.5 kWh per km. The total cost of ownership is already cost comparable to its internal combustion equivalent at a unit price of $1,000,000. This price is achievable in product quantities of just five such vehicles.

Urban Bus Battery Electric Refurbishment and Conversion for Christchurch

A New Zealand built Euro VI diesel powered urban bus costs in excess of $400,000. Refurbishing and converting existing Euro I, Euro II, Euro III or Euro IV diesel buses to battery electric may cost as little as $250,000. The refurbished and converted bus would have a range of 150 km on a single charge with range extension of another 200 km per day when utilising fast charging. The total cost of ownership of a refurbished and converted bus would be around 50% of the cost of its equivalent internal combustion vehicle.

Multi Modal Logging Rail Vehicle in the North Island

A logging operator hauling logs from the volcanic plateau to the port at Wellington currently transports all the logs via road. The use of an electrically powered rail dolly attaching to conventional road truck logging trailers towed by a ‘light’ battery electric rail tractor achieves long haul energy efficient transportation of consolidated loads of up to 500 tonnes. This has benefits of reducing road traffic, while creating major cost savings for the logging operator.

Zero Emission Vehicles

Effective Policy Initiatives

Six policy areas have been identified as having the greatest impact in order to achieve the transition of New Zealand's commercial heavy vehicle fleet to zero emissions renewable energy power.

1 Regulations on Fine Particulate Emissions

Diesel emissions have been classified as carcinogenic by the World Health Organisation to the same extent as cigarette smoke and asbestos. New Zealand has neither emissions standards that take into consideration fine particulates nor any public health policy initiatives relating to exposure to the fine particulates from diesel combustion. By actively monitoring and seeking reductions in the volume of harmful particulates from fuel combustion in the atmosphere, especially in urban environments, both public bodies and fleet operators will be encouraged to seek clean alternatives for their heavy vehicles.

2 Industry Sector Solution Funding

Commercial heavy vehicles are designed or modified for specific industry sectors and applications (see examples). To cut emissions across industries, solutions must be provided and proven for each segment. Funding assistance to organisations providing, proving and promoting solutions is required to accelerate the transition of the commercial heavy fleet to battery electric.

3 Consolidated Orders

Larger orders of heavy electric vehicles create economies of scale and accelerates the development of expertise and infrastructure around such vehicles. A policy providing appropriate financial support to organisations that consolidate existing and forecast orders into one supply commitment would encourage this.

4 Multi-modal Rail Network

Rail represents an important opportunity to provide existing road transport operators with additional options for long haul, heavy freight where factors such as battery weight and range remain problematic. Rail in New Zealand has four characteristics that make it a part of the transportation mix of existing road transport operators.

1. The long haul rail network is not suffering congestion problems
2. Rail has significantly lower rolling resistance, significantly increasing electric vehicle range
3. The North Island main trunk line is already electrified and is able to be used to recharge batteries
4. Rail accommodates much greater weights which is able to be used for larger payloads and battery packs.

Opening up the rail network to multi-modal use by existing road transport operators reduces the amount of very heavy loads required to be transported long distances by road.

5 Electric Vehicle Depreciation

As no market currently exists for second hand battery electric commercial vehicles, the risk associated with the resale value of the vehicle needs to be adequately mitigated. One means of achieving this is the provision of more aggressive depreciation rates than is currently used for internal combustion vehicles.

Higher depreciation rates mean the second-hand sell price of heavy electric vehicles may be lower, which in turn stimulates the second-hand market for such vehicles.

6 National Emissions Accounting

Introducing a policy of emissions accounting for public and private bodies creates the ability to set goals and restrictions at finer levels than just the national accounting can achieve. This provides a measure for councils, corporates, industry sectors and geographical regions to quantify emissions reductions progress and performance and hold such groups accountable.

Scenarios

With the heavy commercial vehicle transport sector representing a clear and direct path to emissions reductions, there are three scenarios where the level of action directly impacts the level of reductions achieved.

Scenario 1: Business as Usual

- Heavy vehicle operators continue to be frustrated by the lack of practical, proven and affordable options for electrification.
- Engineers and service personnel have no qualification framework to train in the maintenance and construction of electric heavy vehicles.
- Heavy vehicle operators struggle to understand the true value of any battery electric vehicles they may operate
- There is only minimal investment in the design and manufacture of heavy electric vehicles.
- There is only minimal investment in alternative low carbon logistics scenarios.
- A policy of facilitating consolidated orders is insufficient to encourage significant take-up of heavy electric vehicles.
- A policy of RUCs exemptions remains only while the fleet of electric commercial vehicles is less than 2% of the heavy vehicle fleet
- The number of heavy electric vehicles does not increase in any substantial numbers relative to the overall diesel heavy vehicle fleet, resulting in no measurable reduction in emissions.

Urban buses start to be converted to battery electric from 2020 with 5% (250) battery electric by 2030, 30% of the fleet (1,800) battery electric by 2040 and 50% (3,000) battery electric by 2050. A much smaller number of specialist urban vehicles such as compacting rubbish trucks are battery electric with 10 by 2020, 100 by 2030, 500 by 2040 and 1,000 by 2050. By 2050, the heavy vehicle fleet is saving 210,000 tonnes of CO2, but total heavy vehicle emissions have still increased.

Scenario 2: Encouraged Growth

- A public policy position from Central Government acknowledging the carcinogenic nature of the fine particulates in diesel emissions shifts responsibility for the emissions related health and safety of employees and the public to the fleet operators. This leads to a change in safety policies for organisations nationwide and further stimulates demand for zero emission solutions.
- Co-funding of industry-specific solution projects sees viable options for heavy electric vehicles become available to select industries. This leads to greater private sector investment into design, manufacturing, marketing and support.
- A more aggressive consolidated orders policy leads to take up from numerous commercial fleets nationwide as heavy electric vehicles become near-comparable from a cost perspective when compared with their internal combustion counterparts.
- A policy of RUCs exemptions on electric commercial vehicles is extended to at least 5% of the heavy vehicle fleet
- More aggressive depreciation rates for battery electric commercial vehicles reduce the resale value risk to the vehicle owner.
- Emissions accounting is brought in to report on the emissions for individual bodies to empower them to make measureable changes.
- The increased market sees domestic and international vehicle manufacturers develop heavy electric vehicle solutions for New Zealand industry sectors.
- Expertise and experience in the maintenance of electric vehicles is slowly built to support the growing vehicle base.
- Around 10% of the national heavy vehicle fleet is fully battery electric by 2050, but emissions from the New Zealand heavy transport sector have still increased.

Urban buses start to be converted to battery electric from 2018 with 10% (500) battery electric by 2030, 40% of the fleet (2,400) battery electric by 2040 and 60% (3,600) battery electric by 2050. Specialist urban vehicles such as compacting rubbish trucks are battery electric with 20 by 2020, 500 by 2030, 2,000 by 2040 and 5,000 by 2050. A small number of large niche market vehicles are battery electric, with 5 by 2030, 10 x 2040 and 20 by 2050. Light duty battery electric trucks and buses are imported with 5 by 2020, 100 x 2030, 1,000 by 2040 and 5,000 by 2050. By 2050, the heavy vehicle fleet is saving over 460,000 tonnes of CO2, but total heavy vehicle emissions have still increased.

Scenario 3: Accelerated Growth

- A more aggressive policy of regulating particulates sees a nationwide staged changeover of heavy internal combustion vehicles to electric, most notable in public and urban transport fleets. This policy sees the steady phasing out of older diesel vehicles for electric, creating a secondary industry for electric conversion of existing vehicles.
- Fully-funding and targeted funding of industry-specific solution projects sees compelling options become available for all targeted industries. Private sector investment into the industry becomes significant.
- Attractive consolidated orders with financing means the cost of ownership of an electric heavy vehicle solution is clearly less than that of diesel. Under this scheme, all new heavy vehicles purchased are electric.
- A policy of RUCs exemptions on electric commercial vehicles is extended to all heavy electric vehicles.
- Aggressive depreciation rates for battery electric commercial vehicles provides an added incentive to heavy commercial vehicle operators to use battery electric solutions.
- Public and private bodies are set quantified emissions reduction targets to achieve within set Governmental timeframes.
- A rapid ramp-up of capability in expertise and infrastructure for heavy electric vehicles would occur nationwide, including the advent of specific qualifications for maintenance personnel.
- Opening up the rail network to existing road operators allows them to actively minimise their cost of transportation for very heavy or long haul goods in industries such as forestry. This solves any current technical issues such as battery weight impacting on range, so long-haul without any need for charging becomes immediately viable with current commercially-available technology.
- Over 60% of the national heavy vehicle fleet is fully battery electric by 2030, with around 13% of the total emissions from the New Zealand transport sector eliminated.

With the average vehicle life in New Zealand being around 15 years, this conversion could be completed by 2040 if every new vehicle purchased from now on was electric. To accelerate growth to these levels requires more aggressive policies.

Urban buses start to be converted to battery electric from 2018 with all urban buses battery electric by 2040. All medium duty trucks (less than 25,000 kg GVM) start to convert from 2018 with 90% of all medium duty trucks battery electric by 2050. By 2050, 60% of heavy trucks will be capable of battery electric operation. By 2040, the heavy vehicle fleet has started reducing its total emissions and by 2050 total heavy vehicle emissions have been reduced to around 500,000 tonnes, a saving of over 400% on the business as usual scenario.

Emission Changes to 2050 by Scenario

The chart *Figure 1 - Heavy Vehicle Emissions by Scenario* extrapolates the heavy vehicle emissions between 2009 and 2014 through to 2050 under the three different scenarios. Results indicated here are likely to be conservative as the newer heavy vehicles in the national fleet are more heavily utilised than the older vehicles in the fleet.

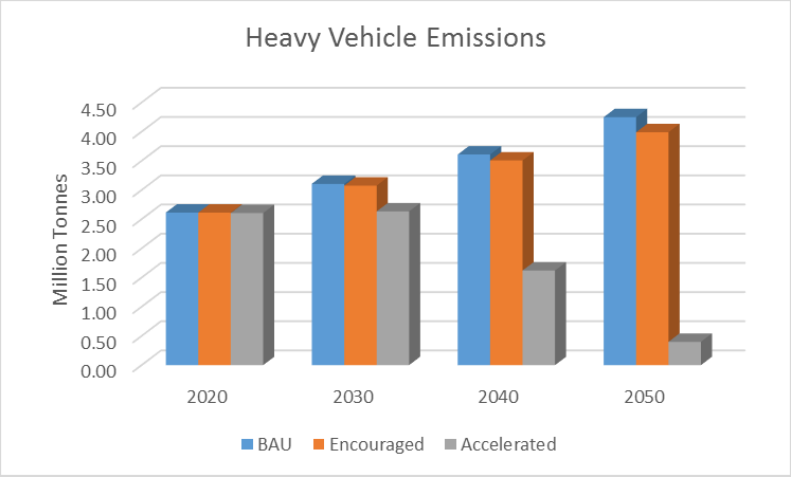

Figure 1 - Heavy Vehicle Emissions by Scenario

Zero Emission Vehicles

Answers to Commonly Asked Questions

Do batteries have enough energy to drive a heavy commercial vehicle?

The energy density of diesel is around 35.8 Mj/L, while lithium batteries are only 0.9-2.63 Mj/L. Surely this means that a battery electric commercial vehicle would require 40 times the volume of batteries as the diesel fuel in an internal combustion vehicle?

Modern lithium battery electric drive is much more efficient than traditional diesel fuel combustion. So this ratio has already reduced to less than 15:1 when the actual energy consumption of heavy battery electric and internal combustion vehicles is compared. Ongoing improvements in lithium battery technology and how they are engineered into commercial heavy vehicles will further reduce this ratio to less than 5:1. But even this does not take into account the extra space and weight required by modern internal combustion vehicle engines, transmissions, exhaust treatment systems, and air intake and filtration systems suggesting that the effective ratio may soon approach 2:1.

Will the number of batteries needed make the vehicles too heavy?

Battery electric vehicles are heavier than internal combustion vehicles. Surely this increase in the tare weight reduces the payload the vehicle can carry?

Because the energy density of electric heavy vehicles is less than an equivalent internal combustion vehicle, it does require more batteries than diesel fuel in order to achieve the same daily workload of an equivalent internal combustion vehicle. For example, a 14 tonne internal combustion vehicle may have as much as one tonne extra payload when compared to a first generation battery electric vehicle. Three initiatives recapture this lost payload:

1. RUCs exemption. The exemption for battery electric commercial vehicles from RUCs charges reduces the commercial significance of the payload reduction.

2. High Productivity. Battery electric commercial vehicle manufacturers are able to configure the vehicle design to take advantage of the High Productivity classification available in New Zealand, and so recover the lost payload.

3. Better vehicle design. New battery electric commercial vehicle designs incorporate the battery pack as an integral part of the chassis design, and so recover much of the lost payload.

Will battery electric vehicles have enough range for commercial applications?

Battery electric vehicles cannot go as far on one battery charge as an equivalent internal combustion vehicle can go on one tank of diesel. Surely this decreased range reduces the usefulness of the battery electric vehicle?

The battery capacity is the key determinant of the vehicle range. The battery capacity is determined by the range requirement, the payload requirement and the capital cost requirement. Consideration of all three factors is required in order to achieve the optimum utility of the battery electric commercial vehicle. Battery electric commercial vehicles already have a range in excess of 150km on a single charge with 200km to 250km range with nominal opportunity charging – sufficient for all urban applications. The challenge of range for battery electric commercial vehicles is further mitigated by:

- Battery electric commercial vehicles are capable of in-service recharging during loading, unloading and normal driver rest periods which significantly increases the “refuelling” frequency, and so extends the effective range. Fast charge opportunity charging can increase the battery electric vehicle daily range to more than 400km.

- Battery electric vehicles recharge while parked – so are always “ready to go”. The equivalent internal combustion vehicle must be driven to a gas station and manually refuelled every few days

Andrew Rushworth
Managing Director
Zero Emission Vehicles Limited
www.zevnz.com
andrew.rushworth@zevnz.com