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SPECIAL CONFERENCE ISSUE: NEW THINKING ON SUSTAINABILITY

THIS ISSUE INCLUDES CONTRIBUTIONS BY

Joshua Aird	Sir Geoffrey Palmer
Klaus Bosselmann	Nicole Rogers
Peter D Burdon	Nathan Ross
Joel Colón-Ríos	Greg Severinsen
Benjamin F Gussen	Linda Sheehan
Catherine J Iorns Magallanes	Gerald Torres
Gay Morgan	

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI



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The Student Editor
New Zealand Journal of Public and International Law
Faculty of Law
Victoria University of Wellington
PO Box 600
Wellington, New Zealand
e-mail nzjpil-editor@vuw.ac.nz
fax +64 4 463 6365

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STUDENT ESSAY: CARBON EMISSIONS AND ELECTRIC CARS – INTRODUCING THE POTENTIAL OF ELECTRIC VEHICLES IN NEW ZEALAND'S CLIMATE CHANGE RESPONSE

*Nathan Jon Ross**

Regardless of the efficacy of New Zealand's emissions trading scheme, a suite of complementary measures will remain necessary if New Zealand is to avoid free-riding on other States' efforts to mitigate climate change. A key growth sector in our emissions profile has been transport. Demand-side measures, such as cycling and public transport, are one side of the coin, and supply-side measures are the other. In particular, New Zealand is extremely well-placed to extract the maximum mitigation potential from electric vehicles (EVs) because of our high and growing use of renewable electricity. This essay assesses the potential role of light EVs in our climate change response, surveying functionality, environmental performance, economics, and market and regulatory barriers. It concludes that targeted government intervention to hasten the uptake of EVs is justifiable. A number of general policy options are then identified for further investigation.

I INTRODUCTION

Debates on mitigating climate change often focus on central pillar policies aimed at economy-wide changes, such as carbon taxes and emissions trading schemes (ETS), which are intended to

* LLB, BEnvSc, Barrister and Solicitor of the High Court of New Zealand. The author would like to thank Elizabeth Yeaman and David Rohan from the Energy Efficiency and Conservation Authority for their invaluable input into the development of this essay.

An earlier version of this essay was written for the Environmental Law course at Victoria University of Wellington taught by Catherine Iorns and was awarded the Environmental Defence Society Short Essay Award for 2014. The author would like to thank Catherine and the Environmental Defence Society for the opportunity and the award.

internalise a cost for greenhouse gas (GHG) pollution. However, a portfolio of complementary measures will remain necessary to hasten the transition to a low-carbon future.

In most developed nations, mitigation efforts focus largely on electricity generation. However, as is well known, New Zealand's emissions profile is relatively unusual. Because 75 per cent of our electricity is generated from renewable energy¹ and because renewables are widely expected to be preferred over fossil fuels for meeting any new electricity demand,² the four priority areas for mitigation are instead agriculture, transport, stationary energy (process heat and electricity) and industrial processes.³

Transport generates two-and-a-half times as much GHG as stationary energy and is a growing component of New Zealand's emissions profile.⁴ Between 1990 (the baseline for the Kyoto Protocol)⁵ and 2013, transport emissions rose by 69.4 per cent (from 7.4 million to 12.7 million tonnes of carbon dioxide equivalents (CO₂e)) and, as a proportion of New Zealand's total emissions, rose from 12.2 to 15.67 per cent.⁶

Measures to reduce GHGs from transport tend to focus on the demand-side, namely public transport, cycling, walking and urban design. However, despite discrete success stories, behavioural and structural barriers make demand-side mitigation notoriously difficult and sometimes impossible. Promisingly, ongoing technical developments in supply-side measures, fuel-switching from petroleum to renewable biofuels or electricity, have already created real opportunities to simply get around those behavioural barriers.

This essay assesses the potential role of light electric vehicles (EVs) in New Zealand's climate change response. It covers battery EVs (BEVs) and plug-in hybrid EVs (PHEVs) as the two classes of ultra-low carbon vehicle. It does not include hybrid vehicles that are predominantly powered by petroleum (petrol or diesel) nor other vehicle classes such as motorbikes. This essay also surveys

1 Ministry of Business, Innovation and Employment *Energy in New Zealand* (2014) at 50 and 55.

2 Geothermal and wind generation is generally cheaper for electricity than fossil fuel generation, as evidenced by the ongoing increase in geothermal supply. See Ministry of Business, Innovation and Employment, above n 1, at 55.

3 Ministry for the Environment *New Zealand's Greenhouse Gas Inventory 1990–2013: Fulfilling reporting requirements under the United Nations Framework Convention on Climate Change and the Kyoto Protocol* (April 2015) at viii.

4 At ix.

5 Kyoto Protocol to the United Nations Framework Convention on Climate Change 2303 UNTS 162 (opened for signature 11 December 1997, entered into force 16 February 2005).

6 Ministry for the Environment, above n 3, at viii–x.

potential market barriers that may need to be overcome to improve the uptake of EVs and capitalise on the potential they offer. It concludes that EVs need to and can play an important role in New Zealand's climate change mitigation response, but that government intervention will be required.

II HISTORY

Between 1828 and 1835, EVs were invented independently in Hungary, Scotland, Holland and America. Battery technology improved and by 1897, a fleet of New York taxis was entirely EVs.⁷ In 1900, EVs outsold petrol and steam-powered cars. However, the EV market was undermined by the combined effects of longer roads demanding longer range, the discovery of cheap oil in Texas and the development of mass production by Henry Ford. Niche markets began to re-emerge in the 1960s and 1970s and, since the 1990s, growing concerns and regulation regarding air pollution and climate change have gradually seen the re-development of EVs and EV markets.

III CURRENT EV TECHNOLOGY AND ENVIRONMENTAL PERFORMANCE

Most car manufacturers now have one or two BEV or HPEV models in their range, but it still pales in comparison to the vast range of petroleum vehicles currently satisfying the market's diverse preferences. That said, the contemporary EV market is relatively new and is expanding at a promising rate, in part due to government policies to incentivise the uptake of EVs elsewhere around the globe.

The driving range for internal combustion engine vehicles (ICEVs) on one tank of petroleum is generally 350 to 700 km and PHEVs have comparable ranges.⁸ The range for BEVs is generally smaller, with most at around 160 to 320 km.⁹

Regarding the environmental performance of EVs, there is a myth in the public arena that EVs have a greater environmental footprint than ICEVs because of batteries.¹⁰ Life-cycle analysis has found that manufacturing EVs does create more GHGs than the manufacturing of ICEVs and that the total lifecycle impact of EVs is in fact higher than ICEVs *if* they are charged with *only* coal fired electricity.¹¹ Critically, however, that same analysis found that, once renewable energy is in the electricity generation mix, EVs' life-cycle GHGs are lower than ICEVs'. In other words, the additional GHG created during manufacturing of EVs is more than offset over the lifetime of the vehicles. It also

7 See generally Mary Bellis "History of Electric Vehicles" About <www.about.com>.

8 United States of America Department of Energy "Compare Plug-in Hybrids Side-by-Side" <www.fueleconomy.gov>.

9 United States of America Department of Energy "All-Electric Vehicles" <www.fueleconomy.gov>.

10 Catherine Harris "Electric cars 'simply transfer pollution to power station'" (29 March 2010) Stuff <www.stuff.co.nz>.

11 Troy R Howkins and others "Comparative Environmental Life Cycle Analysis of Conventional and Electric Vehicles" (2013) 17 *Journal of Industrial Ecology* 53 at 56.

seems probable that the carbon footprint of manufacturing EVs will decline with economies of scale, as the energy and carbon intensity of production reduces with each unit. Furthermore, some manufacturing could be increasingly powered by renewable energy, as is expected with Tesla's new battery production facility.¹²

In New Zealand, with our predominance of renewable electricity, GHGs per vehicle kilometre travelled (VKT) are, on average, 86 per cent lower for EVs than for ICEVs. EVs generate 21 grams of CO₂e per VKT, compared to 152 grams of CO₂e for petrol.¹³ New Zealand has a goal of 90 per cent renewable electricity by 2025 and, when renewable energy replaces aging thermal plant, GHG emissions for EVs will be cut even further.¹⁴ Therefore, the life-cycle CO₂e benefits of EVs in New Zealand could be significant and improving further.¹⁵

IV HOW DO THE ECONOMICS STACK UP?

The potential GHG savings are significant, so how much might it cost to achieve those savings? There are numerous variables that affect any calculation of the net present value (NPV) of EVs compared to ICEVs. The analysis in this essay therefore relies on a number of assumptions, which are described below. It is noted that those used here are mostly conservative and tend to favour ICEVs. Therefore, if less conservative assumptions were used, EVs would be cast in a more positive light.

The first assumption is that the marginal cost of a new EV is \$6,500 (comparing a Nissan Leaf to a Toyota Corolla, a superficially comparable ICEV).¹⁶ Note that this difference will continue to decrease as economies of scale develop in manufacturing cars and key components, such as batteries. Furthermore, the marginal cost is already slightly lower in the second-hand market because of the lower resale value of EVs: the imported 2012 and 2013 model Nissan Leaf cars on Trade Me cost \$22,000 to \$32,000, having done just 4,500 to 19,000 km, whilst the 2012 and 2013 model Toyota

12 Domenick Yoney "Sun and wind power could power Tesla Gigafactory for EV batteries in Nevada" (21 February 2014) Autoblog <www.autoblog.com>.

13 Mike Underhill, CEO of the Energy Efficiency and Conservation Authority "New Zealand: An ideal market for electric vehicles" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014) at 6.

14 Ministry of Economic Development *New Zealand Energy Strategy 2011–2021 and the New Zealand Energy Efficiency and Conservation Strategy 2011–2016* at 25.

15 This analysis is highly sensitive to assumptions used, such as the energy used in manufacturing, the kilometres travelled and the energy used for charging. See Howkins, above n 11.

16 Indicative prices were taken from various websites, including, inter alia, Donovan Edwards "Powered Up: How practical are electric cars in real world conditions" (Autumn 2014) AA <www.aa.co.nz>.

Corollas cost around \$16,000 to \$28,000 but having done 20,000 to 80,000 km.¹⁷ Further, it is arguable that cheaper alternatives to the Toyota Corolla could have been used for this comparison, plus it is noteworthy that the Leaf has higher specifications than the Corolla.

Secondly, the life of the EV is assumed to be 20 years. Thirdly, there is only one owner. On average, New Zealanders replace their car every 18 years, but this assumption avoids accounting for potential differences in re-sale value, which are highly variable.¹⁸ Fourthly, electricity costs 17 cents per kilowatt-hour (kWh) and an EV therefore costs 3.4 cents per km, and petrol costs \$2.10 per litre and an ICEV therefore costs 13.9 cents per km.

Fifthly, the battery is replaced every five to eight years, depending on mileage and other factors. Note that there is data that suggests certain batteries will last for as long as ten years.¹⁹ Sixthly, battery replacement costs \$9,000.²⁰ Note that this cost is 35 per cent lower than it was in 2008 and should continually decrease with economies of scale and innovation. Indeed, it may be that batteries already cost as little as \$5,000.²¹ Note, too, that EV batteries still have around 80 per cent capacity and can be re-used for other applications, (as is already happening overseas). An on-sale value of \$1,000 is accounted for in this analysis.²²

Seventhly, there are no differences in maintenance and repair costs. Note that the Association for the Promotion of Electric Vehicles (APEV) asserts that such costs "can be 30% lower than an ICE", but no evidence of this has been found.²³ Finally, a discount rate of 8 per cent has been applied.²⁴

Using all of these mostly-conservative assumptions, the NPV of an EV is equal to or less than an ICEV if the owner travels 20,000 km per annum or more, which is around 70 km per day and easily within the battery range of EVs, six days per week, 48 weeks per year.

17 Survey of Trade Me by author of vehicles for sale on 22 June 2015 <www.trademe.co.nz>.

18 Ministry of Transport "Driver Travel" (April 2013) <www.transport.govt.nz>.

19 See Jesse Jenkins "Cost of Batteries for Electric Vehicles Falling More Rapidly than Projected" (13 April 2015) The Energy Collective <www.theenergycollective.com>.

20 United States of America Office of Energy Efficiency and Renewable Energy "Vehicles" <www.energy.gov>; and Peter Kelly-Detwiler "The Afterlife for Electric Vehicle Batteries: A Future Source of Energy Storage?" (18 March 2014) Forbes <www.forbes.com>.

21 See Zachary Shahan "Are EV Battery Prices Much Lower Than We Think? Under \$200/kWh?" (7 January 2014) Clean Technica <www.cleantechnica.com>, in which batteries are estimated to cost US\$3,600.

22 See Kelly-Detwiler, above n 20.

23 Rob McEwen, Executive Director of the Association for the Promotion of Electric Vehicles "Electric Vehicles: Setting the Stage" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014) at 8.

24 The Treasury "Current Discount rates" (17 March 2015) <www.treasury.govt.nz>.

The average distances driven each year by New Zealanders is 12,000 km for men and 8,000 km for women.²⁵ When driving 8,000 km per annum, an EV costs \$400 extra per annum (\$8,022 over 20 years), and at 12,000 km per annum, an EV costs \$264 extra per annum (\$5,280 over 20 years).

An important measure for deciding and prioritising climate change measures is the cost per unit of GHG offset. On the economic analysis above:

- At 8,000 km, an EV saves 1.05 T-CO₂e per annum at \$317 per tonne.
- At 12,000 km, an EV saves 1.57 T-CO₂e per annum at \$168 per tonne.
- At 20,000 km, an EV saves 2.62 T-CO₂e per annum at \$12 per tonne.
- Greater than 20,000 km, the cost per tonne is negative.

It is important to remember that the purchase prices of two to three year old second-hand Nissan Leaf cars are in a comparable range as two- to three-year old Toyota Corollas. So, if the marginal cost was zero, then, even after accounting for the battery replacement cost, the NPV of the EV is equal to the ICEV if the owner travels 11,000 km per annum, which is below the average distance men drive and means that the owner saves \$37 per annum and saves CO₂e at a cost of –\$23.50 per tonne. At 8,000 km per year, the EV owner will pay \$100 extra per annum and save CO₂e at a cost of \$30 per tonne, a 90 per cent saving compared to the price with new EVs.

V MARKET ENVIRONMENT

New Zealand has 3,100,000 light passenger vehicles, which are used for 77 per cent of travel and account for 65 per cent of vehicle GHG emissions.²⁶ Over half of New Zealand households have two or more vehicles, with the average number of vehicles per household being 1.8; both of those statistics are increasing.²⁷ On average, New Zealanders drive less than 40 km per day, with our working day commute averaging 28 km. With those statistics, it is estimated that the battery range for EVs could cover 95 per cent of daily travel needs.²⁸ This is particularly pertinent for those people who have two or more cars, since their daily commute, which is the bulk of their driving requirements, could be powered by renewable electricity, and they can hold on to an ICEV for the rarer times when they need to drive longer distances.

The global market for EVs is growing, with a 43 per cent increase in 2014 alone, bringing the worldwide number of EVs to a total of 740,000.²⁹ The largest selling EV is the Nissan Leaf, with

25 Underhill, above n 13.

26 Ministry of Transport *The New Zealand Vehicle Fleet: Annual Fleet Statistics 2014* (August 2014) at 6 and 10.

27 Ministry for the Environment *Environment New Zealand 2007* at 92 and 97.

28 Energy Efficiency and Conservation Authority *Deploying electric vehicles in New Zealand: A guide to the regulatory and market environment* (February 2012) at 3; and Underhill, above n 13, at 7.

29 James Ayre "Electric Car Demand Growing, Global Market hits 740,000 Units" (28 March 2015) Clean Technica <www.cleantechnica.com>.

150,000 sold worldwide.³⁰ In New Zealand in December 2013 there were 108 new EVs (as well as 277 electric motorbikes and 62 electric buses), though unfortunately there is no more recently released data.³¹

The last remaining aspect of the market environment relates to charging infrastructure. Over 85 per cent of homes have garages with a power outlet suitable for overnight EV charging.³² Charging a car for 160 km takes 12 hours in a regular power point (2.3 kW) or six hours using a charger connected to the main switchboard (5 kW).³³ Most electricity retailers offer lower tariffs during off-peak times or at night, which will help to minimise charging costs.³⁴ There are also 74 rapid charging stations in public places around New Zealand.³⁵ At a national level, Transpower, which owns the main electricity transmission system, has confirmed that the electricity grid is able to accommodate substantial EV capacity.³⁶

VI LEGAL ENVIRONMENT: VEHICLE REGULATIONS, TAXES AND THE ETS

Like any vehicle, EVs must comply with various regulations. First, the New Zealand Transport Agency (NZTA) maintains rules that aim to ensure safety.³⁷ The NZTA also administers rules which regulate exhaust emissions, but only for air quality (emissions harmful to human health), not for GHGs.³⁸ EVs must also comply with electrical safety regulations. These regulations apply to any supply and use of electricity, so by default they apply to both EVs and charging equipment (if any).³⁹ Another simple compliance issue is that the sellers of ICEVs are required to display energy efficiency

30 Ayre, above n 29.

31 Ministry of Transport, above n 26, at 2 and 45.

32 At 4; and Rob McEwen, above n 23, at 12.

33 Kieran Devine, Trustee of the Centre for Advanced Engineering and System Operator Transpower "Is the New Zealand Grid Ready for Electric Vehicles?" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014) at 7.

34 Energy Efficiency and Conservation Authority, above n 28, at 4.

35 See Drive Electric "Chargers in New Zealand" <www.driveelectric.co.nz>.

36 Devine, above n 33, at 8.

37 Land Transport Act 1998, s 152; and see New Zealand Transport Agency "Approved standards" (9 February 2015) <www.nzta.govt.nz>.

38 Land Transport Rule: Vehicle Exhaust Emissions Amendment 2012, r 33001/6.

39 Ministry of Transport, above n 26, at 5; and Electrical (Safety) Regulations 2010.

ratings at the time of sale.⁴⁰ The energy rating labels for EVs are voluntary and they differ to those for ICEVs, showing kilowatts per 100 km instead of litres per 100 km, and also showing the vehicle's range in kilometres, which is not on the label for ICEVs.⁴¹

Vehicle users contribute to the costs of the land transport system through fuel excise (for petrol vehicles) or Road User Charges (RUCs). RUCs are payable for light vehicles "with motive power that is not wholly derived from petrol".⁴² This regulation reflects the now-outdated paradigm that vehicles are only petrol or diesel, as this regulation is targeted at diesel vehicles. RUCs would normally apply to EVs but there is an exemption from August 2012 until June 2020.⁴³ The revenue raised by these levies is significant, with the RUC raising \$420 million (and the fuel excise raising \$1.86 billion) in the 2012–2013 financial year.⁴⁴

Like RUCs, vehicle users also contribute to the cost of the ACC scheme.⁴⁵ ACC levies are paid differently on petrol and diesel vehicles.⁴⁶ On diesel vehicles (and vehicles with a non-excisable fuel source such as EVs and PHEVs), the ACC levy is paid at registration only. But for petrol vehicles, it is part-paid on registration and part on petrol at time of purchase at the pump. ACC has confirmed that a PHEV is currently considered non-petrol powered, thus it pays a higher rate on registration, like a diesel vehicle. But when petrol is used in the vehicle, the owner of a PHEV also pays the petrol ACC levy, so that the total combined average ACC levy rate will be higher than a petrol or diesel vehicle presuming it is driven the same average amount. This is the current situation, with no exemption like for RUC to 2020.

The last main piece of the regulatory jigsaw is the ETS, which, theoretically, should incentivise low or non-carbon polluting alternatives by internalising the cost of pollution. Petroleum suppliers must participate in the ETS, and so the additional costs of petroleum products ought to push consumers towards alternatives such as EVs (and biofuels).⁴⁷ However, the current design of New Zealand's ETS

40 Energy Efficiency (Vehicle Fuel Economy Labelling) Regulations 2007, ss 5–8 and 11.

41 Energy Efficiency and Conservation Authority, above n 28, at 6.

42 Road User Charges Act 2012, ss 7 and 5, definitions of "RUC vehicle" and "light RUC vehicle".

43 Road User Charges (Exemption Period for Light Electric RUC Vehicles) Order 2012, reg 4.

44 McEwan, above n 23, at 5.

45 Accident Compensation Act 2001, s 214.

46 Email from Elizabeth Yeaman (General Manager, Transport, Energy Efficiency and Conservation Authority) to the author regarding ACC levies (28 July 2014).

47 Climate Change Response Act 2002, ss 198–203 and sch 3, pt 2.

has meant that it has failed to alter behaviour and curb emissions.⁴⁸ Indeed, of the world's 26 ETSs, the World Bank rates New Zealand's as the least effective.⁴⁹ Unsurprisingly, the government tool that should be most effective at enticing consumers towards EVs is ineffectual.

VII COUNTERFACTUAL

What if there was no government intervention to increase EV uptake?

The number of new passenger vehicles registered annually has increased in every year since 2009: from 54,404 in 2009 to 90,635 in 2014.⁵⁰ However, sales of new cars represent a mere 2.65 per cent of the total national fleet, so the rate of renewal is extremely slow. Thus, the turnover of the national fleet is very slow and with only 108 registered EVs; this is a miniscule fraction of that slow turnover.⁵¹

That said, the market will see some natural increase in the number of EVs in the New Zealand market because of, *inter alia*, manufacturers' sales targets and the arrival of lower-cost second hand imports. Roughly half of the cars that New Zealand imports are second-hand,⁵² so our market will gradually see more EVs. This is because the countries of origin of these cars, especially Japan and Europe, implement regulations and incentives to mitigate climate change.⁵³ As a result of those countries' climate change policies, New Zealand will "accidentally" reduce emissions, but only to an extremely limited extent given the other market trends described above. Second-hand EVs are already for sale in New Zealand for around \$17,000 to \$33,000.⁵⁴

Despite the immediate (and limited) availability of the cheaper, second-hand EVs, there is a general inertia against replacing our cars that stands in the way of broad uptake. As noted earlier, New Zealanders only replace their car every 18 years. For EVs, this inertia may be exacerbated due to perception-related problems. The perception remains that EVs are expensive despite declining prices and despite the growing second-hand import market. There are also general misperceptions about

48 See Euan Mason "Why NZ's Emissions Trading Scheme is Failing and How We Could Fix It" (19 December 2013) Hot Topic <www.hot-topic.co.nz>.

49 Rod Oram "Perpetuating the ETS scam" (8 June 2014) Stuff <www.stuff.co.nz>.

50 Motor Industry Association "Registration data – 1975 onwards" (July 2015) <www.mia.org.nz>, excluding data for second-hand import vehicles.

51 Ministry of Transport, above n 26, at 45.

52 Mark Gilbert, Chair of the Association for the Promotion of Electric Vehicles "Opening Presentation" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014), at 2.

53 At 2.

54 See generally Trade Me <www.trademe.co.nz>.

performance capabilities, particularly in relation to battery range and replacement (frequency, cost and inconvenience). Moreover, consumers are not aware of the potential environmental and economic benefits.⁵⁵

The industry has also recorded its own barriers to wider uptake, including concerns about the international variability of safety standards, along with the lack of standardisation of charging regimes and equipment, which could be an impediment to the second-hand market and re-sale value, thereby also hindering the new car market.⁵⁶ The industry may be less concerned about overcoming these barriers than suits the public good outcome, since any lost EV sale is perhaps just a gain to an ICEV sale.

Incentives for consumers are much stronger, given the reduced carbon footprint and running costs and, in fact, the more they drive, the more they save. For government, however, the exact opposite is true. Whilst the RUC exemption is in place, government is losing revenue that goes into transport development and maintenance.⁵⁷ If New Zealand had, say, 10,000 EVs each travelling 20,000 km per year, that would be \$11,600,000 in lost revenue.⁵⁸ This issue is currently negligible because of the very small number of EVs, but the current eight-year exemption could create an expectation amongst sellers and buyers that EVs remain exempt, which might affect transport networks funding and be opposed by levy-paying road users.

That said, the exemption will continue to be important for two reasons. First, fleet owners have already indicated that the uncertainty about the longevity of the RUC exemption is a barrier to uptake of EVs now.⁵⁹ Secondly, the RUCs are payable on kilometres travelled and it has been noted that, where it should be more economical to operate a small diesel vehicle, the RUCs negate that incentive altogether.⁶⁰ The exact same problem will face EV drivers, particularly those who would otherwise get a greater benefit because of their greater annual VKT.

In summary, the overall pattern is that the rate of turnover of New Zealand's light fleet is very slow and that EVs comprise a tiny fraction of that slow renewal. Even if EV sales increased to 100 or 200 per month, the impact on total transport emissions would remain negligible. Given the aforementioned market trends and barriers, any GHGs avoided by EVs will be lost to the rising GHG

55 Gilbert, above n 52, at 3.

56 Energy Efficiency and Conservation Authority, above n 28, at 2.

57 Ministry of Transport "Road user charges" (29 May 2014) <www.transport.govt.nz>.

58 The RUC for 2014 is \$58 per 1,000 km. See Ministry of Transport "Road user charges (RUC) calculator" <www.transport.govt.nz>.

59 Yeaman, above n 46.

60 Robert Barry "RUC makes small diesel cars unviable says Hyundai GM" (23 July 2014) AutoTalk <www.autotalk.co.nz>.

emissions from the increased demand for ICEVs, and therefore transport emissions will continue to rise. This will be even more so with the government's agenda for investing significantly in roads, which could be expected to increase usage. So, for EVs to have a meaningful role in reversing the upward trend of transport emissions, government intervention will be essential.

VIII OPTIONS FOR GOVERNMENT INTERVENTION

This assessment has demonstrated that EVs have significant GHG mitigation potential; they can service the functional requirements of many New Zealanders and the economics of EVs can match comparable vehicles. However, there are clearly significant market barriers, largely relating to consumers' inertia with vehicle replacement, and these barriers persist even if less conservative assumptions are used when comparing the economics of EVs and ICEVs. These factors combined with the urgency to abate GHGs mean that EVs are a valid target for government intervention aimed at increasing their uptake to replace or avoid ICEVs and their GHG emissions.

What types of intervention might overcome the aforementioned barriers? Below is an outline of measures that could be explored, but it is outside the scope for this essay to fully analyse potential efficacy and risks of these and other options.

The central piece of any reputable climate change policy is a price on carbon that effectively adjusts incentives away from fossil fuels, whether it comes in the form of a carbon tax or an ETS. A transport-specific alternative (or in addition to a carbon price) is to apply a pollution tax directly to ICEVs pro rata according to their GHG emissions. Whichever form of levy is imposed, the revenue raised can be recycled to promote EVs (and perhaps biofuels). Japan, France, the United Kingdom and the United States of America all have variations of such schemes.⁶¹ The key is that any pollution pricing tool must actually work as a disincentive for consumers to purchase ICEVs, rather than work merely as a tool for governments to give the appearance of being good global citizens without actually reducing GHGs. Ideally, any levy-subsidy scheme would be cost-neutral or close to it, but a cost-benefit analysis that is governed by a national, scientific carbon budget should identify whether and how much government input should support the policy's objective of reducing GHGs.

There are, of course, other means of incentivising uptake of a desirable technology. Examples applied to EVs include: (a) direct subsidies; (b) a buy-back scheme for consumers with ICEVs older than (say) ten years that are being replaced by an EV; (c) extending the RUCs exemption; (d) an exemption from import duties for EVs;⁶² and (e) preferential treatment for EV owners, such as the

61 KPMG International *The KPMG Green Tax Index: An exploration of green tax incentives and penalties* (2013).

62 See New Zealand Customs Service "Duties & charges" <www.customs.govt.nz>.

ability to use bus lanes and prioritised central city parking. All incentive schemes have risks and complexities and they, of course, need to be identified and evaluated so that preferred options can be determined. This is merely a basic outline of some options.

A basic requirement for a government programme aiming to increase consumer uptake of something is the provision of objective information and marketing to support and encourage consumers to make decisions that support the desired policy outcome. The first step regarding EVs is for government to have objective data. Then government can work with the new and second-hand markets to correct consumer misperceptions with objective information, which should move consumer preference towards EVs.⁶³ Industries' commercial incentives to promote their goods will see some investment in market development, and industries will understand their markets better than government. However, government will have useful data and, by working together, industries and government can share information and work strategically together to increase EV sales.

Along with incentives and consumer information, a coordinated programme for dealing with technical issues is required. Government should lead the development of national standards for certain technical topics such as charging infrastructure, based on consumer needs as well as industry requirements. In other technical aspects, there may be opportunities in niche areas for government to stimulate industry developments. For example, as noted above, EV batteries still have around 80 per cent capacity after their life in vehicles and can be re-used for other applications.⁶⁴ Government might support the development of a recycling industry, for example, in storage for solar photovoltaic systems installed elsewhere in the Pacific.⁶⁵

The final area in which government might support the EV market is in relation to infrastructure. As already noted, the national grid can accommodate substantial EV capacity, so no work is required there. The requirements for in-home charging is readily available for most households since a standard power point can do the job, but it can be enhanced by installing the 5kW chargers that reduce charging time by more than half.⁶⁶

Regarding public charging stations, there are at least three considerations. First, they risk exacerbating the myth of poor capacity, but an information programme as described above should help to avoid that risk. Secondly, there are claims that battery life is reduced by "fast charge" (50–60kW) technologies that are used for public charging so government could support research into this

63 See Drive Electric <www.driveelectric.org.nz>.

64 Kelly-Detwiler, above n 20.

65 Government ought not support solar photovoltaic systems in New Zealand due to the consequential increase in GHG, see the internal document Energy Efficiency and Conservation Authority "Counter-intuitive electricity CO₂ paper: What's the impact of electricity efficiency on national CO₂ emissions? (i.e. with a renewable build schedule)" (May 2014).

66 Devine, above n 33, at 7.

issue and provide objective data to local authorities and consumers.⁶⁷ Thirdly, it has been contended that fast charging is unnecessary because of the viability of home charging.⁶⁸ On the other hand, if technical concerns prove incorrect and perception risks are managed, public charging can offer flexibility, thereby enhancing consumer experiences. Also, the public nature of charging stations offers a signage platform for social marketing regarding climate change mitigation and enables prioritised central parking. These benefits combined could justify support for installing public charging infrastructure.

On the final question of funding, any support for EVs could be funded either by pollution taxes on ICEVs or reprioritising funding from policy programmes that increase emissions such as the Roads of National Significance, the Irrigation Acceleration Fund or the subsidies that go towards fossil fuels.⁶⁹

IX CONCLUSION

New Zealand is exceptionally well-placed for realising the potential GHG savings that EVs offer because of its high use of renewable energy for electricity generation and the commercial viability for more renewables when thermal plant retires. Only two other OECD countries could capitalise on this opportunity more because of their higher use of renewables: Iceland and Norway.⁷⁰

The potential is impeded significantly by New Zealanders' reluctance to replace their cars and their low mileage, thus reducing financial savings potential. Therefore, any government support will need to be very active to overcome those barriers. A carefully selected and designed package of specific EV measures from those described above is needed to enable EVs to play an effective role in New Zealand achieving scientifically-based GHG reduction targets. Those measures can be paid for from revenue raised from a price on GHGs and from reprioritising funding from emissions-intensive projects.

Overall, in an increasingly carbon-constrained world, EVs will have an important role in New Zealand's transport future; but active government support is essential.

67 See Liane Yvkoff "Will DC fast charging harm electric car batteries?" (29 July 2010) CNet <www.cnet.com>; Sebastian Blanco "DC fast charging not as damaging to EV batteries as expected" (17 March 2014) Autoblog <www.autoblog.com>; and Kevin Bullis "Will Fast Charging Make Electric Vehicles Practical?" (24 September 2012) MIT Technology Review <www.technologyreview.com>.

68 Bullis, above n 67.

69 On subsidies for fossil fuel industries see World Wide Fund for Nature New Zealand *Fossil Fuel Finance in New Zealand* (2013).

70 "How Much Electricity Comes From Renewable Sources" *The New York Times* (online ed, New York, 23 March 2013).

