Laws 325 – Advanced Environmental Law Essay

Carbon Emissions and Electric Cars

Word Count: 3,000.

I Introduction

It is well-established that anthropogenic greenhouse gases (GHG) are causing climate change.[1] Debates on solving the crisis have focused on central pillar policies aimed at economy-wide changes, such as carbon taxes and emissions trading schemes (ETS). However, a portfolio of complementary measures will remain necessary to hasten the transition to a low-carbon future.

In many nations, mitigation efforts focus largely on electricity generation. In New Zealand, since 77 per cent of our electricity is from renewable forms of generation,[2] the four priority areas for mitigation are agriculture, transport, stationary energy (mostly process heat but also electricity) and industrial processes.[3]

Transport generates twice as much GHG than stationary energy and is a growing component of New Zealand's emissions profile.[4] Between 1990 (the baseline for the Kyoto Protocol)[5] and 2012, transport emissions rose by 68 per cent (from 7.41 to 12.44 million tonnes of carbon dioxide equivalents (CO_2e)) and, as a proportion of New Zealand's total emissions, rose from 12.2 to 16.4 per cent.[6]

To-date, transport measures have focused mainly on the demand-side, namely public transport, cycling, walking, urban design and enhanced logistics. However, despite discrete success stories, behavioural barriers make demand-side mitigation notoriously difficult. Promisingly, ongoing technical developments in supply-side measures – fuel-switching from petroleum to renewable biofuels or electricity – create real potential to simply get around those behavioural barriers.

This research focuses singularly on the potential role of light electric vehicles (EVs) in New Zealand's climate change response, covering battery EVs (BEVs) and plug-in hybrid EVs

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1 See Svante Arrhenius "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground" (1896) 5(41) Philosophical Magazine and Journal of Science 237; Intergovernmental Panel on Climate Change Working Group 1 Climate Change 2014: The Physical Science Basis: Summary for Policy Makers (2014); and S Lovejoy "Scaling fluctuation analysis and statistic hypothesis testing of anthropogenic warming" Climate Dynamics 6 April 2014.

2 Ministry for Economic Development "New Zealand Energy Data File: 2011 Calendar Year Edition" (2012) at 7.

3 Ministry for the Environment "New Zealand's Greenhouse Gas Inventory, 1990–2012" (2014), at ix.

4 Above n 3, at xi.

5 Kyoto Protocol to the United Nations Framework Convention on Climate Change (1998).

6 Above n 3, at vi and xi.

(PHEVs) as the two classes of ultra-low carbon vehicle (therefore, not including hybrid vehicles for which motive power remains predominantly petroleum, or other vehicle classes such as motorbikes).

II History[7]

Between 1828 and 1835, EVs were invented independently in Hungry, Scotland, Holland and America. Battery technology improved and by 1897, a fleet of New York Taxis were EVs. 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 gradually saw the re-development of EVs.

III Current EV Technology

A Vehicles

Most car manufacturers now have one or two BEV and/or HPEV models in their range, but whilst this range is expanding, it still pales in comparison to the vast range of petroleum vehicles currently satisfying the market's diverse preferences.

The range for internal combustion engine vehicles (ICEVs) on one tank of petroleum is generally 350 to 700 kilometres (km), and PHEVs have comparable ranges.[8] BEV ranges are smaller, from 60 to 426 km, with most at around 130 km.[9]

B Environmental Performance

Research has shown that EVs can have greater life-cycle impacts than ICEVs.[10] Life-cycle analysis has shown that EVs create more GHGs during manufacturing than ICEVs and, where only coal-fired electricity is used to charge EVs, whole-of-life emissions are 17 to 27

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[7] Mary Bellis "History of Electric Vehicles" About.com <www.about.com>.
[8] US Department of Energy "Compare Plug-in Hybrids Side-by-Side" <www.fueleconomy.govt>.
[9] US Department of Energy "All-Electric Vehicles: Compare Side-by-Side" <www.fueleconomy.govt>.
[10] Catherine Harris "Electric cars 'simply transfer pollution to power station'" (29 March 2010) *Stuff.co.nz* <www.stuff.co.nz>.

per cent higher than ICEVs'.[11] However, once renewable energy is in the electricity generation mix, EVs' life-cycle GHGs are lower than ICEVs'.

With New Zealand's predominantly renewable electricity, GHGs per vehicle kilometre travelled (VKT) are, on average, 86 per cent lower for EVs. EVs generate 21 grams of CO_2e per VKT, compared to 152 grams of CO_2e for petrol.[12] New Zealand has a goal of 90 per cent renewable electricity by 2025 and, as renewable energy replaces aging thermal plant, EV emissions will be cut even further.[13] Therefore, the life-cycle CO_2e benefits of EVs in New Zealand could be significant on a net global basis.[14]

C Operating Costs

Calculating the total cost of EVs compared to ICEVs is impossible because of the large number of variables, meaning assumptions need to be made. Therefore, I have roughly calculated one estimated net present value (NPV) of EVs compared to ICEVs on the following (disputable) assumptions:[15]

1. The marginal cost of a new EV is $6,500 (comparing a Nissan Leaf to a Toyota Corolla).[16]

   Note: This difference will decrease as the industry develops economies of scale.

2. The life of the EV is 20 years.

3. There is only one owner.

   Note: On average, New Zealanders replace their car every 18 years, but this assumption avoids accounting for potential differences in re-sale value.[17]

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[11] Troy R Howkins and others "Comparative Environmental Life Cycle Analysis of Conventional and Electric Vehicles" (2012) 17(1) Journal of Industrial Ecology 53 at 56.
[12] Mike Underhill, CEO Energy Efficiency and Conservation Authority "New Zealand: An ideal market for electric vehicles" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014) at 6.
[13] Ministry of Economic Development "New Zealand Energy Strategy 2011–2021 and the New Zealand Energy Efficiency and Conservation Strategy 2011–2016" at 25.
[14] 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 17.
[15] Net present value represents the whole of life costs in a present sum of money.
[16] Indicative prices were taken from various websites, including, *inter alia*, Donavan Edwards "Powered Up: How practical are electric cars in real world conditions" (Autumn 2014) AA <www.aa.co.nz>.
[17] Ministry of Transport "Driver Travel" (April 2013) <www.transport.govt.nz>.

4. Electricity costs 17 cents per kilowatt hour (kWh) and an EV costs 3.4 cents per km, and petrol costs $2.10 per litre and an ICEV costs 13.9 cents per km.

5. The battery is replaced every five to eight years, depending on mileage.

6. Battery replacement costs $9,000 (net after sale for re-use)[18].

   Note: This cost is 35 per cent lower than it was in 2008 and should continually decrease with economies of scale and innovation.

7. There are no differences maintenance and repair costs.

   Note: the Association for the Promotion of Electric Vehicles asserts that such costs "can be 30% lower than an ICE", but no evidence of this has been found.[19]

8. A discount rate of eight per cent.

On those 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, six days per week, 48 weeks per year. The average distances driven each year is 12,000 km for men and 8,000 km for women.[20] 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).

D GHG Mitigation Costs

An important measure for deciding and prioritising climate change measures is the cost per unit of CO_2e offset. On the economic analysis above:

- At 8,000 km, an EV saves 1.05 tonnes of CO_2e per annum, at $317 per tonne.
- At 12,000 km, an EV saves 1.57 tonnes of CO_2e per annum, at $168 per tonne.
- At 20,000 km, at EV saves 2.62 tonnes of CO2 per annum, at $12 per tonne.
- Greater than 20,000 km, the cost per tonne is negative.

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[18] US Office of Energy Efficiency and Renewable Energy "Vehicles" Energy.gov <www.energy.gov>; and Peter Kelly-Detwiler "The Afterlife For Electric Vehicle Batteries: A Future Source Of Energy Storage?" Forbes (18 March 2014) <www.forbes.com>.

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

[20] Above n 12.

IV Current Environment

A Vehicle market attributes

New Zealand has 2.7 million light passenger vehicles,[21] which are used for 77 per cent of travel and account for 65 per cent of vehicle GHG emissions.[22] Over half of New Zealand households have two or more vehicles and the average number of vehicles per household is 1.8. Both of these statistics are increasing.[23] On average, New Zealanders drive less than 40 km per day, with working day commute averaging 28 kilometres per day, so it is estimated that EVs' battery range could cover 95 per cent of daily travel needs.[24]

The global market for EVs is growing, with the number of EVs sold doubling the last two years to a total of 400,000.[25] The largest selling EV is the Nissan Leaf, with 115,000 sold worldwide.[26]

In New Zealand in December 2012, there were 73 EVs (as well as 291 electric motorbikes and 59 electric buses), though unfortunately there is no more recently released data.[27] However, Mitsubishi reported 41 sales of its new Outlander HPEV in the month of April 2014 (after the vehicle's launch in March) and is aiming for 50 sales per month.[28]

B Regulatory Environment

1 The ETS

Petroleum suppliers must participate in the ETS.[29] However, the scheme's design has meant that it has failed to alter behaviour and curb emissions.[30] Indeed, of the world's 26

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[21] Above n 14, at 5.
[22] Ministry of Transport "The New Zealand Vehicle Fleet: Annual Fleet Statistics 2012" (February 2013) at 5, 6, 11 and 54.
[23] Ministry for the Environment "Environment New Zealand 2007", at 92 and 97.
[24] Energy Efficiency and Conservation Authority "Deploying electric vehicles in New Zealand: A guide to the regulatory and market environment" (February 2012), at 3; and Above n 18, at 7.
[25] Above n 14, at 4.
[26] Ken Green Burridge "Nissan LEAF Leaps Ahead Again" (23 May 2014) EV.com <www.ev.com>.
[27] Above n 22, at 54.
[28] Tony Johnston, Mitsubishi "Plug-in Hybrid EV" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014), at 5.
[29] Climate Change Response Act 2002, ss 198–203 and sch 3, part 2.
[30] 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>.

ETSs, the World Bank rates New Zealand's as the least effective.[31] Unsurprisingly, the legal tool that should entice consumers towards EVs is ineffectual.

2 Vehicle standards

Like any vehicle, EVs must comply with New Zealand Transport Agency (NZTA) rules that aim to ensure safety.[32] NZTA rules also regulate exhaust emissions, but only for air quality (emissions harmful to human health), not for GHGs.[33]

Sellers of any car are required to display energy efficiency ratings at the time of sale.[34] The labels for EVs 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.[35]

EVs must also comply with the Electrical (Safety) Regulations 2010. These regulations apply to any supply and use of electricity, so apply by default to both EVs and charging equipment.[36]

3 Levies

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".[37] 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.[38]

The revenue raised by these levies is significant, with the fuel excise raising $1.86 billion and RUC raising $0.42 billion in 2012/13.[39]

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[31] Rod Oram "Perpetuating the ETS scam" (8 June 2014) Stuff.co.nz <www.stuff.co.nz>.
[32] Land Transport Act 1998, s 152; and see New Zealand Transport Agency "Approved standards" (30 August 2012) <www.nzta.govt.nz>.
[33] Land Transport Rule 33001/6: Vehicle Exhaust Emissions Amendment 2012.
[34] Energy Efficiency (Vehicle Fuel Economy Labelling) Regulations 2007, ss 5–8 and 11.
[35] Above n 24, at 7.
[36] Above n 24, at 5; and Electrical (Safety) Regulations 2010.
[37] Road User Charges Act 2012, ss 7 and 5, definitions of "RUC vehicle" and "light RUC vehicle".
[38] Road User Charges (Exemption Period for Light Electric RUC Vehicles) Order 2012, reg 4.
[39] Above n 14, at 5.

C Infrastructure

Over 85 per cent of homes have garages with a power outlet suitable for overnight EV charging.[40] Charging a car for 160 km takes 12 hours in a regular power point (2.3kW) or six hours using a charger connected to the main switchboard (5kW).[41] Most electricity retailers offer lower tariffs during off-peak times or at night, which will help to minimise charging costs.[42]

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.[43]

V Counterfactual

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

A Market Trends

The number of new passenger vehicles registered annually has increased in each of the last three years: 64,009 in 2011; 76,871 in 2012; and 82,433 in 2013.[44] However, even 2013 sales represented a mere three per cent of the national fleet, so the rate of renewal is extremely slow.

As noted above, total sales figures for EVs are unavailable, except Mitsubishi's reported 41 sales for April 2014. Total passenger vehicle sales in April 2014 was 6,151.[45] Thus, the Outlander comprised 0.67 per cent of the month's sales, though it must be remembered that it was only its first month on the market.

The number of EVs in the market will almost certainly increase because of, *inter alia*, manufacturers' sales targets and the arrival of lower-cost second hand imports. Roughly

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[40] Above n 24, at 4; and Above n 14, at 12.
[41] Kieran Devine, Trustee, 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.
[42] Above n 24, at 4.
[43] Above n 39, at 8.
[44] Motor Industry Association "Monthly Sales Data" <www.mia.org.nz>.
[45] Motor Industry Association "New vehicle market remains buoyant during April" (6 May 2014) <www.mia.org.nz>.

half of the cars that New Zealand imports are second-hand,[46] so our market will gradually see more EVs because of the regulations and incentives of their countries of origin, especially Japan and Europe.[47]

B Market Barriers

1 For consumers

New Zealanders replace their cars only 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 the growing second-hand import market. There are also general misperceptions about performance capabilities, especially regarding battery range and replacement (frequency, cost and inconvenience). Moreover, consumers are not aware of the potential environmental and economic benefits.[48]

2 For industry

The industry reports concerns about international variability of safety standards. Additionally, the lack of standardisation of charging regimes and equipment could be an impediment to the second-hand market and re-sale value, thereby hindering the new car market.[49]

3 For government

Whilst there is potential for consumers to save money and, in fact, the more they drive, the more they save, the exact opposite is true for government. Whilst the RUC exemption is in place, government is losing revenue that all goes into transport development and maintenance.[50] If New Zealand had, say, 10,000 EVs each travelling 20,000 km per year, that would be $11.6 million in lost revenue.[51] This issue is currently negligible because of the very small number of EVs, but the current eight year exemption could create an expectation that EVs remain exempt, which might affect transport networks funding and be opposed by levy-paying road users.

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[46] Mark Gilbert, Chair, Association for the Promotion of Electric Vehicles "Opening Presentation" (APEV Ministerial Round Table Meeting, Wellington, 8 May 2014), at 2.
[47] Above n 44, at 2.
[48] Above n 44, at 3.
[49] Above n 24, at 2.
[50] Ministry of Transport "Road user charges" (29 May 2014) <www.transport.govt.nz>.
[51] The RUC for 2014 is $58 per 1,000 km. See Ministry of Transport "Road user charges (RUC) calculator" <www.transport.govt.nz>.

C Summary

The overall pattern is that the rate of turnover of the 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, the impact of EVs on New Zealand's carbon footprint will be negligible without government intervention.

VI Options

The potential GHG savings with EVs is very high, but the cost per tonne of CO_2e can also be high, presenting a potential barrier for national policy support. Furthermore, EVs rely on importation and may negatively affect New Zealand's balance of trade. Biofuels, by comparison, could be manufactured domestically and may reduce imports of petroleum. Such economic matters are material considerations, so analyses of other CO_2e mitigation options is needed. That said, the need for GHG mitigation can barely be understated, so economics should not be determinative; it should only be a tool for designing and prioritising mitigation measures that so that benefits and co-benefits are maximised and negative outcomes are avoided. Moreover, costs could be met by reprioritising funding from projects that increase emissions, such as the $11 billion "Roads of National Significance".[52]

Assuming that EVs will be supported, it is recommended that the following government measures be explored, though it is outside scope for this project to fully analyse potential efficacy and risks of these options.

A Supporting Legal Framework

There may be options for mandating EVs, such as obligations on fleet owners or minimum sales for manufacturers, but such blunt instruments are open to criticism as "nanny state" interference and risk undermining support for the overall policy.

Instead of mandating, legislative instruments can be used to reduce the appeal of ICEVs and so enhance the appeal of EVs. The principal options are a carbon tax or an effective

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[52] New Zealand Transport Agency "Roads of national significance" (10 September 2013) <www.nzta.govt.nz>.

ETS that works as a disincentive for consumers to purchase ICEVs.[53] Alternatively, pollution taxes can be applied to directly to ICEVs pro rata according to their emissions. Whichever form of levy is imposed, the revenue raised can be recycled to subsidise EVs. Japan, France, the UK and the US all have variations of such schemes.[54]

B Incentives

There is a wide range of public policy tools that could be deployed to incentivise EV uptake, including:

- Direct subsidies for EVs and/or the conversion to 5kW in-home charging;
- A buy-back scheme for consumers with vehicles older than (say) ten years that are being replaced by an EV;
- Extending the RUCs exemption;
- An exemption from import duties for EVs;[55] and
- Preferential treatment for EV owners, such as the ability to use bus lanes and prioritised central city parking.

Incentives could initially preference drivers travelling 20,000 km or more per annum, since that is the economic 'sweet spot' for vehicle owners and GHG mitigation.

C Leadership

Government could demonstrate leadership on transport emissions by purchasing EVs for fleets, such as the ministerial cars.[56]

D Working with Industry[57]

Industries' commercial incentives to promote their goods will see investment in market development, and industries will understand their markets better than government.

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[53] Above n 31.
[54] KPMG "KPMG Green Tax Index: An exploration of green tax incentives and penalties" (2013) <www.kpmg.com>.
[55] See New Zealand Customs Service "Duties & charges" <www.customs.govt.nz>.
[56] See Radio New Zealand "Govt orders new fleet of luxury ministerial cars" (16 February 2011) Radio New Zealand News <www.radionz.co.nz>.
[57] "Industry" refers to the new car market, the second-hand import market and the vehicle charging market.

However, government will have useful data and, by working together, industries and government can share information and work strategically together to increase EV sales.

E Information

Industry and government can work to correct consumer misperceptions with objective information that encourages consumer preference towards EVs.[58]

Consumers' perceptions reportedly change markedly after test-driving EVs so creating such opportunities could be a role for government.[59] For example, government-owned EVs could be made available at public events for public trial.[60]

F Technical

Government should lead the development of national standards for certain technical topics such as charging infrastructure, based and industry and consumer needs.

It is unlikely that New Zealand could materially contribute to technology research and development compared to private investment overseas. However, there may be opportunities in niche areas. For example, after their life in vehicles, EV batteries still have around 80 per cent capacity and can be re-used for other applications.[61] Government could support the identification of markets and a recycling industry.

G Infrastructure

As already noted, the national grid can accommodate substantial EV capacity.

Infrastructure for in-home charging is readily available for most households, although it can be enhanced by installing the 5kW chargers that reduce charging time by more than half.[62]

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 may overcome that. Secondly, there are claims that battery life is reduced by "fast charge"

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[58] See Association for the Promotion of Electric Vehicles, Plug-In.org.nz <www.plugin.org.nz>.
[59] Above n 14, at 9.
[60] See Wellington City Council "Electric Vehicle Day" (press release, 19 June 2012).
[61] Peter Kelly-Detwiler "The Afterlife For Electric Vehicle Batteries: A Future Source Of Energy Storage?" Forbes (18 March 2014) <www.forbes.com>.
[62] Above n 39, at 7.

(50–60kW) technologies that are used for public charging.[63] Government could support research into this issue and provide objective data to local authorities and consumers. Thirdly, it has been contended that fast charging is unnecessary because of the viability of home charging.[64]

If technical concerns prove incorrect and perception risks are managed, public charging can offer flexibility, thereby enhancing consumers' EV experiences. Also, the public nature of charging stations offers a signage platform for social marketing regarding climate change and enables prioritised central parking. These benefits combined could justify support for installing public charging infrastructure.

VII Conclusions

New Zealand is 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 user of renewables: Iceland and Norway.[65]

The potential is impeded significantly by New Zealanders' reluctance to replace their cars, and their low mileage and thus reduced financial savings potential. Therefore, government support will need to be very active to overcome those barriers. A suitable price on carbon plus a carefully selected and designed package of specific EV measures from those described above is needed to achieve scientifically-based GHG reduction targets. Those measures can be paid for from revenue raised from a carbon price and from reprioritising funding from emissions-intensive projects.

Overall, in an increasingly carbon-constrained world, EVs will have a significant place in New Zealand's transport future.

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[63] 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 Green <www.green.autoblog.com>; and Kevin Bullis "Will Fast Charging Make Electric Vehicles Practical?" (24 September 2012) MIT Technology Review <www.technologyreview.com>.
[64] Bullis, above n 56.
[65] The New York Times "How Much Electricity Comes From Renewable Sources" (23 March 2013) <www.nytimes.com>.