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Submission to the Senate Inquiry into electric vehicles

Submission

David Richardson

July 2018

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ISSN: 1836-9014

Electric vehicles do let you breathe easier!

The Australia Institute is pleased to make a submission to the Senate inquiry into electric vehicles (EVs).

The Australia Institute has published papers on EVs; Tasmania in pole position for electric car industry: The potential of electric vehicles in Tasmania in September 2017 and If you build it, they will charge: Sparking Australia's electric vehicle boom in October 2017. These papers should be read as part of this submission.

Tasmania in pole position… argues that thanks to its compact geography, Tasmania would encourage people to purchase electric vehicles by providing even just a handful of public vehicle charging stations. The paper explores two options for providing coverage to a large part or most of the state, with three or six charging stations. These options cover the most travelled routes and the most popular tourism areas and could be built very cheaply for approximately $1 million or $2 million respectively. Tasmania has a reputation for a very clean environment and a high reliance on renewable sources of electricity. It makes sense that Tasmania should look to showcasing policies that support EVs.

If you build it… proposes four incentives to overcome structural barriers and help boost electric vehicle uptake:

1. A Luxury Car Tax exemption for electric vehicles, to better target the scheme's two tiered threshold structure towards environmental outcomes;
2. Charging station rebates, which would boost rollout of electric vehicle infrastructure and minimise duplication of sites and technological standards;
3. A scheme to reduce the upfront cost of electric vehicles without cost to the budget;
4. An offer to allow electric vehicles to utilise bus lanes in congested urban centres, supported by a rollout of EV-only license plates.

Public interest in electric vehicles continues to rise and policies to support electric vehicles are popular. This paper reports polling for The Australia Institute shows that nearly two thirds of voters support incentives for electric vehicles

Only as clean as the electricity it uses?

The appendix to this submission is an article that has been submitted to an international economics journal on the topic of the emissions intensity of EVs and how this has been misunderstood. We hope this article will assist in completely rethinking

arguments about the relative emissions intensities of EVs vis a vis internal combustion vehicles.

Here we briefly outline the argument.

Most people have probably seen claims that in fact EVs are as polluting as, or maybe worse than, their petrol/diesel equivalents. The reasoning is that EVs rely on an electricity supply that is heavily polluting. So you seem to be stuck with a choice to pollute directly with a petrol/diesel vehicle or indirectly with smokestack electricity. But appearances can be deceptive and we have to think that through.

Consider the case of a consumer making the switch to an EV. The new car will no longer be emitting green-house gases and other noxious pollutants from its tail pipe. The EV increases the demand for electricity. People claim that EVs pollute indirectly because the electricity comes from dirty coal-fired power stations. Hence people can suggest that a Tesla can be more polluting than a very fuel efficient small car.

But averages tell us nothing about the consequences of a change. What we do know is that almost universally around the world new generation capacity is mainly renewable and old coal-fired power plants are being junked. So to the extent that new generation capacity is required to meet increases in demand (and to replace coal-fired generation) then the marginal response to an increase in demand has a very low emissions intensity and may well be zero.

If I had installed a solar panel to charge my EV there are no emissions and it is exactly the same if I let the electricity utility add the solar panel for me.

Looking at averages before and after the change cannot show the impact of switching to EVs. Indeed, looking at the averages can be positively misleading in a case where there is a legacy of heavily polluting electricity generation plant.

We also note that the above analysis is not confined to EVs. Any new demand for electricity that is met from new renewable sources will have zero impact on Australia's emissions.

This submission recommends that:

Tasmania offers the perfect opportunity for encouraging electric vehicles with just a few strategically placed charging points.

For Australia as a whole:

1. The Commonwealth Government should introduce a Luxury Car Tax exemption for electric vehicles, to better target the scheme's two tiered threshold structure towards environmental outcomes;

2. The Commonwealth Government introduce a charging station rebate scheme, which would boost rollout of electric vehicle infrastructure and minimise duplication of sites and technological standards;

3. The Commonwealth Government should introduce a scheme to reduce the upfront cost of electric vehicles without cost to the budget;

4. The Commonwealth Government should recommend to the COAG that the states and territories allow electric vehicles to utilise bus lanes in congested urban centres, supported by a rollout of EV-only license plates.

The Senate take note of the fact that any new demand for electricity in Australia is being met by new generation capacity comprising mainly solar and wind.

Accordingly the Senate should reject any analysis that uses average electricity emissions estimates to impute emissions to EVs.

Appendix

THE ENVIRONMENTAL BENEFITS OF ELECTRIC VEHICLES: CONFUSING THE AVERAGE AND THE MARGIN.

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Abstract

While electric vehicles are associated with zero emissions it is often said that they are no “cleaner” than the electricity source. It is suggested that electric vehicles using high emissions-intense sources of electricity offer little improvement and may even be worse than internal combustion engine vehicles. This argument is widespread but we argue it is fallacious. This argument compares the average emissions intensity of electricity generation with the marginal increase in demand for electricity associated with a switch to electric vehicles. It is instead argued that the proper perspective should be to compare the switch to electric vehicles with the marginal supply of electricity and it is argued that the additional supply of electricity is associated with zero or near zero emissions in most markets.

Introduction

There has been a good deal of discussion about the role of electric vehicles in personal transport and their role in reducing emissions. Electric vehicles are associated with zero emissions while internal combustion engine vehicles are a major source of emissions in most countries. The response has been that electric vehicles use electricity from 'dirty' sources so that their credentials may not be so clean after all. Hence switching from internal combustion to electric vehicles may well increase the overall level of emissions. This short paper takes issue with that suggestion.

It is well-known that pollution of various forms can be a joint product along with electricity supply. There have been many suggestions in popular magazines and newspapers suggesting that the operation of electric vehicles is heavily polluting because when they are plugged in they often access electricity from very dirty sources. It is always possible to find examples of a heavy electric vehicle apparently responsible for more emissions than a very frugal internal combustion vehicle. Examples are often taken from American states that have a high proportion of coal in their electricity generation mix. Generally what is being referred to is some concept of the average intensity in the electricity supply in the region concerned. Here is argued that the average emissions intensity of electricity generation is a poor guide to the marginal emissions intensity which should be the focus when we look at changes to electricity usage involving electric vehicles. As Marshall put it; 'go to [the] margin to study the action of those forces which govern the value of the whole' (Marshall 1890 p 340). The rest of this paper explains how the marginal analysis works and how it happens to be critical in this context. In short we argue that emissions are a joint product with electricity depending on the technology used in generation. However, at the margin the types of new generating technology being installed implies zero emissions.

The argument that electric vehicles pollute

Even among apparently 'green' sources the argument that the operation of electric vehicles causes some pollution seems pervasive. It is not their operation but the charging up that is associated with emissions according to this argument. There are a number of references we could provide but the ones here seem representative of the more serious magazine-style treatment. Hence in *Livescience* an academic mechanical engineer is quoted as saying

> electric vehicles aren't necessarily more environmentally friendly than conventional combustion vehicles. If the electricity used to charge the electric vehicle comes from a coal power plant, for example, it can be dirtier than even the worst internal-combustion vehicle (Lewis 2015).

One apparently sympathetic source says the:

> carbon emissions of grid powered electric cars in countries with coal based generation are no different to average petrol vehicles… It is quite well understood that electric cars have the potential to reduce carbon emissions, but important to realize this potential is dependent on the type of electricity that charges the battery (Shrink That Footprint nd).

A University of Michigan study examined the average imputed emissions intensity of electric vehicles and, as expected, found they vary widely throughout the world. They also calculated the fuel efficiencies internal combustion vehicles would need to achieve to outperform electric vehicles and in some countries that was not very high (DeGroat B 2017). *Scientific American* published an article that said "your battery-powered vehicle is only as green as your electricity supplier' (Biello 2016). It made the point that "Low emissions, much less zero emissions, are only true in certain places where most of the electricity comes from a mix of low-carbon sources such as the sun, wind or nuclear reactors… and it all depends on where the electricity comes from".

The Union of Concerned Scientists accepts the use of traditional measurement of the emissions of electric vehicles and has said that

> Two-thirds of all Americans now live in areas where driving an EV produces fewer climate emissions than almost all comparable gasoline and gasoline

> hybrid cars—a fact attributable to more efficient EVs and an increasingly clean electricity grid.*(Union of Concerned Scientists nd)*

This is good news but still misses the point as we argue below.

In relation to China there have been reports that Scott Kennedy from the Washington Center for Strategic and International Studies said "since the electricity that powers them [electric vehicles] could come from fossil fuels, which in China means coal…EVs may just be moving air pollution from one part of the country to another" (Anderson 2018). This is backed up by an article in the *Financial Times* with the headline 'Pollution studies cast doubt on China's electric-car policies' (Clover 2018). The headline says it all. The remarkable thing about this report is that it presents a graph of the electricity output from 1990 to a projected 2040 figure and breaks it into sources. The figures show fossil fuels constant from around 2016 to 2040. All the growth in output is accounted for by renewables and (unfortunately) nuclear. That means the response to *additional* electricity demand is not associated with additional emissions. So if the emissions are not rising when electricity usage is increasing it must mean that the incremental demand is not bringing forward any increase in emissions.

Hanley accuses those with a vested interest in oil and internal combustion vehicles of being responsible for spreading falsehoods (Hanley 2018). Some may well exaggerate but we have to say that the standard used to compare electric vehicles is the average emissions intensity of their fuel source and this is wide-spread practice.

When we dig further we find the failure to look at the margin is not confined to the newspapers and magazines. A paper in the *American Economic Review* (Holland et al 2016) measured emissions from charging electric vehicles and examined the implications for any subsidy that might be justified. Holland et al use emissions intensities for electric vehicles by relying on the average emissions intensities of the relevant power utilities awhen they are charged and found that electric vehicles in some locations are more emissions intensive than internal combustion vehicles. However, given past trends and projections (see below) additional electricity supply is likely to be less emissions intensive suggesting that additional demand due to electric vehicles will elicit a much less emissions intensive supply response than suggested by the average.

Instead of thinking like that, Holland et al use the average emissions intensity approach but make very sophisticated modifications to take account of variations due to the time of day vehicles are charged, inter-utility trade and other complexities. They find that on average emissions are higher in relation to electric vehicles and that is especially so in many particular locations with particularly 'dirty' electricity. This result

is then taken to support the suggestion that a shift towards electric vehicles could be associated with a worsening in emissions.

Despite the claims in Holland et al and others who make similar arguments, in our view the argument does not correctly address the nature of the change in emissions associated with a substitution away from internal combustion towards electric vehicles.

Back to the margin

We might expect that the average emissions intensity of internal combustion vehicles is similar to the marginal emissions intensity of the additional vehicle. However, it is certainly not necessarily the case with electric vehicles that the average and marginal emissions intensity are the same. To know whether a substitution from internal combustion to electric vehicles increases or reduces emissions we need to investigate the emissions intensity of the additional electricity supply consequent on the marginal increase in electricity demand.

There is in fact every reason to believe that the emissions intensity at the margin of the electricity supply will be very different from the average. It is well-known that the electricity supply mix is moving away from fossils and new capacity is predominantly renewable. Across the US as a whole EIA data (EIA 2018) suggest total electricity generation from all sources has remained fairly flat over the past decade. Within that there has been a substantial decline in coal and a growth in natural gas and renewables. Overall the share of fossil fuels (coal, gas and petroleum) has fallen and that of renewables increased. On present EIA projections there will be a modest increase in demand overall and the additional generation capacity will be met with mainly solar and gas with wind important in the short to medium term. Those projections suggest new capacity is likely to have a zero or near zero emissions intensity. A survey of electricity utilities showed that 76 percent of respondents expected 'significant or moderate growth of wind power in their generation mixes over the next 10 years. Wind, solar and natural gas rank as the top three energy sources among utilities for projected growth' (Brown 2018).

On this reasoning and to the extent that overall fossil fuel generation continues to decline in absolute terms we suggest that analyses of issues like electric vehicles should be framed against a background in which the marginal supply response in electricity is either emissions-free or associated with very low emissions and certainly much lower than the average emissions intensity. In other words, the emissions that appear as joint products with electricity are not evident in the increases in supply. If some of the additional electricity demand is met with gas generation then the marginal emissions will be greater than zero but well below the averages that drive the Holland et al results. It is even possible that the marginal impact of electric vehicles on emissions is negative. That may occur if for example the additional demand for electricity results in additional renewable supply and that additional experience with low-cost renewables encourages some early retirement of coal generation facilities in

favour of further renewable capacity. That may be associated with leaning-by-doing on the part of electricity utilities as they get used to renewables in the electricity generation mix. Of course, at the other extreme there is the possibility that in some locations the marginal response may be to increase coal power capacity.

It is worth pointing out that in the regions covered by the EIA International Outlook the electricity generated from coal is not expected to increase in the future and should decline in Japan and OECD Europe (EIA 2017). India is the only exception among the countries and regions mentioned by the EIA.

The Australian argument

Alan Finkel, Australia's Chief Scientist, was Chair of the panel that conducted the *Independent Review into the Future Security of the National Electricity Market*. While this report did not give much attention to electric vehicles Finkel has made his views clear elsewhere. He is reported as saying:

> [A] Tesla [electric vehicle], charged at the national average greenhouse intensity of the grid (910 kg CO_2/MWh), is responsible for 168 grams of CO_2 per km (emitted at the power station), and a Toyota Corolla for 178 grams per km (at the tailpipe). He also mentions one of the smallest EVs in the Australian Green Vehicle Guide, the Renault Zoe, at 121 grams per km...'The lowest-emission car in Australia is still the Toyota Prius hybrid. This is essentially a petrol car – you can't plug it in – which recovers the energy lost in braking and stores it in batteries. This may not sound like much, but at 84 grams per km it has half the emissions of the Tesla (Wilkenfeld 2018).

Clearly Finkel cannot escape thinking in terms of averages. He has elsewhere expressed the view that the emissions intensity of the electricity grid is high enough to mean that there are no emissions savings associated with electric car use. He has said that 'the threshold for being a better environmental citizen in an electric car is to use electricity where the associated carbon dioxide emissions are 700 grams per kilowatt hour or fewer. That's the crossover point at which a Nissan Leaf produces fewer emissions per kilometre than a similarly sized, best of breed fossil-fuel car such as the Mazda3 diesel' (Finkel 2015). Finkel says that it might be decades before that point is crossed in the state of Victoria which is dependent on brown coal.

Finkel himself apparently pays the premium some retailers charge for electricity which is guaranteed 100 per cent renewable (Wilkenfeld 2018). That should have prompted Finkel to think a bit harder. By making the choice to pay a premium to buy renewable energy Finkel has ensured that if there is a need to increase electricity supply to meet his needs then the increased generation will come from renewable sources.

To appreciate what is going on imagine that instead Finkel installed solar panels to power his car. In that case it would be clear that there is a net reduction in emissions using an electric rather than internal combustion vehicle. However, if instead Finkel's electricity supplier added solar panels to supply additional electricity for his vehicle then there would also be a net reduction in emissions. This is the critical point. The fallacy in Finkel's reasoning is that he is using the average relationship between

electricity and emissions but should be using the marginal relationship when he is considering an increase in electricity supply associated with an increase in electric vehicle usage. As it happens Australian suppliers are indeed adding solar (and other renewables) to meet the increase in demand.

Over the last ten years on average electricity generation increased by 0.6 per cent per annum in Australia. However, on average electricity generated by fossil fuels fell by 0.1 per cent while generation of electricity from renewable sources increased by 6.8 per cent with a 12.1 per cent in 2015-16 alone (Department of the Environment and Energy 2017). Within the small reduction in fossil fuels overall there was also a switch from black and brown coal towards gas. Gas-fired electricity is less emissions intensive than coal. Black and brown coal decreased by an average 1.6 and 1.2 per cent per annum respectively while gas increased at 5.3 per cent per annum from a much smaller base.

The Australian Energy Regulator (AER) figures show that since 2012–13, capacity additions to the NEM have largely been in wind and solar plant. All plant retirements over this period have been in coal fired plant, but some gas powered plant has also been mothballed (2017). AER's data shows clearly that the reductions in capacity have been in coal-fired plant while the increases have been in solar, wind and gas. Moreover the reductions in coal-fired plant are clearly larger than the additions in gas. The latter is also likely to include peaking plant that will idle much of the time and may ultimately be replaced by storage. So among fossil fuels there is a substitution to gas but an overall decline in fossil fuels with renewables accounting for the difference.

These trends are projected to continue. Australian Energy Market Operator (AEMO) data suggest that at January 2018 total proposed new capacity was 40,007 Mw of which 3,450 Mw is gas (CCGT or OCGT) and the rest renewables. However, announced withdrawals are 2,272 Mw of which 2,000 Mw was coal the rest gas. Hence as far as we can be certain about the future it looks as if future new capacity will be dominated by renewables and that any new gas plant will be roughly matched by the retirement of mainly coal-fired plant, at least in terms of the emissions involved. Finkel can drive his electric vehicle without worrying about paying any premium. Again, to the extent that electric vehicles in Australia create new electricity demand and supply increases to match it the response will be almost completely supplied by renewables.

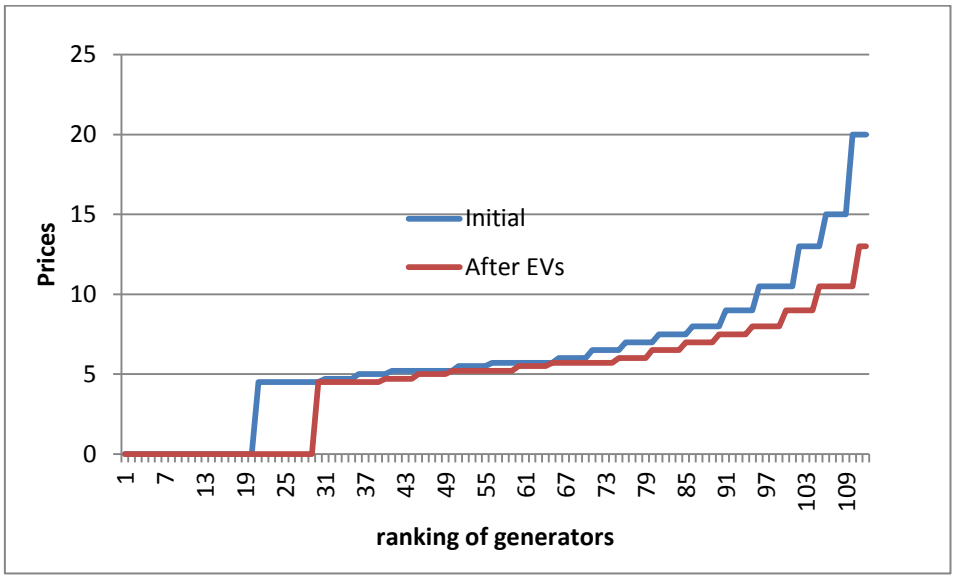
Sources of confusion?

It is possible that when economists have turned their attention to the electricity supply they have been distracted by the very short-term issue facing the supplier. There are all sorts of electricity sources and generally the supplier first dispatches the cheapest and certainly those with zero marginal cost and/or those that cannot be switched off easily. The latter of course includes any renewables in the system. Then the next cheapest are dispatched in order until demand is met and the last source to be dispatched sets the marginal cost. At peak times particular gas and some coal generators tend to be among the last units to be dispatched.

What we have described is the minute by minute administration facing the supply management. At the moment renewables are very competitive relative to fossil fuels, especially for new plant. But existing fossil fuel plant need only cover marginal costs. That has resulted in new capacity being comprised of wind and solar with coal generally being replaced when plant has reached the end of its useful life, or as in the US, when it is not junked but converted to gas. While renewables are being added gas and storage seem to be taking over as the preferred peak supply. The result is that coal is being squeezed between renewables and gas/storage (see Fell and Kaffine 2018).

We can illustrate the argument in the figure below which also allows us to examine the increase in electric vehicles which elicits the increase in supply. The figure shows the effect of increasing the electric vehicle usage which increases the demand for electricity and so induces the supply response. Suppose the new electric vehicles increase electricity demand by 10 units. As seems to be usual practice, the industry will respond to increase supply using renewables and that response is illustrated by shifting the despatch schedule out by 10 units. The initial position is indicated by the blue dispatch schedule and the red indicates the one after the increase in renewables.

Figure 1: Impact of electric vehicles on the electricity dispatch schedule



In the figure 20 units of renewables and 80 units of fossil fuel was supplied before the increase in demand. Following the increase in demand and after supply side adjustments the figures are 30 and 80 respectively. While normally we would look at the right-hand side of the graph in the region of equilibrium to examine the marginal condition, in this case the marginal change acts like a horizontal shift factor in the dispatch curve. Nevertheless, emissions from electricity generation are unchanged and have certainly not increased following the additional generation from renewables.

If it were found that people disproportionately plug in their electric vehicles at peak times then of course the argument here would have to be modified. There would also be a policy challenge to try to shift that demand to off-peak times. However, the evidence above seems to suggest that in the medium term the increase in demand is going to involve a response by non-peaking plant and to date that has been renewables and in the future is increasingly likely to be renewable energies.

Conclusion

Economists are used to examining marginal costs and benefits of particular items but they like to assume homogenous units. In the present case while the item itself remains the same the conditions of supply are vastly different at the margin than they are for infra-marginal supply. On average pollution is a joint product with electricity but under current trends in electricity technologies this is not true at the margin. The average cannot be used as a proxy for the margin. The comments here suggest that electric vehicles have had a 'bum rap' in some circles.

Given the world-wide movement toward renewables the arguments here seem generally applicable. So in most of the regions of the world a switch to electric vehicles would be associated with a significant net reduction in emissions. We save the emissions associated with the replaced internal combustion vehicles and power the electric vehicles with additional "green" power which adds no additional emissions.

There remains an important agenda in eliminating *all* coal-fired generation. But the existence of legacy fossil fuel generation should not blind us to the positive impact of electric vehicles. The positive contribution of electric vehicles is more apparent when we appreciate that new electricity sources tend to be very clean and it is new sources that are relevant when discussing new demands for electricity.

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