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Select Committee on Electric Vehicles - General Submission

Dan Cass
July 2018

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Summary

Electric vehicles are a very small segment of the Australian automobile market currently, with sales of just over 2000 vehicles last year, in a market with over 1 million annual sales.

Technological and policy progress internationally is likely to see the global market grow significantly, with Bloomberg New Energy Finance predicting annual sales of 30 million electric vehicles in 2030. This could be expected to drive our market significantly.

The Australian Energy Market Operator's Integrated System Plan offers a wide range in predicted fleet growth for Australia, ranging from around 526,000 (weak scenario) to around 3.9 million (strong scenario) in the NEM in 2030.

Electric vehicles are powered by lithium-ion batteries and the pace of price reductions and range improvements are major factors in the growth of the electric vehicle market. Lithium battery prices dropped 93% between 1995 and 2014, and are predicted to be less than half their current level, several years from now. This would see prices fall from US\$ 3,185 / kWh in 1995 to around the symbolically significant threshold of US\$ 100 / kWh, over a thirty-year period.

Electric vehicles will increase overall demand in the NEM by perhaps 1-5% by 2030 in different states. However electric vehicles can have a very significant and positive impact on grid stability, offering storage but also grid stability services. This will require sensible strategies to encourage charging to take place 'off peak'.

The major environmental benefit of electric vehicles is they could help arrest rising emissions from our transport sector. A rise in petroleum emissions have almost offset the decline in Australia's electricity emissions over the past several years. Electric vehicles can also help us manage the grid during our transition from coal to responsible energy sources.

If the growth of electric vehicle sales is significant then it will substantially reduce petroleum imports.

Whilst there may be relatively limited potential for Australia to manufacture electric vehicles, there are major mining and refining opportunities for Australia and potentially in the manufacture of lithium batteries and other and electric vehicle components. In the case of lithium mining, we capture only around 0.53% of the total value in the battery supply chain in Australia.

Mining of battery minerals should, like all mining, involve genuine negotiations with Aboriginal communities and native title representative bodies who have rights over the deposits and areas impacted by mining. Miners should also be subject to proper environmental regulation, including rehabilitation. This is an area that is badly regulated, with no comprehensive national database of mining rehabilitation sites, despite there being between 460 and 2,994 mines in operation, between 206 and 972 mines in care and maintenance and perhaps 60,000 abandoned mining sites.

The two key policy measures likely to have a big impact on sales are public charging infrastructure and financial incentives. We propose the French Bonus-Malus scheme, which is revenue neutral to government and uses fees on highly polluting vehicles to cross subsidise less polluting vehicles and electric vehicles would benefit the most in such a transfer scheme, as they have no tailpipe emissions.

Note

This submission should be read in conjunction with another submission from The Australia Institute by David R Richardson (submission 1) which is focused on the marginal emissions impact of electric vehicles.

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Introduction

With US President Donald Trump posturing for war against Iran, there is new attention on the strategic risks posed by global reliance on oil. Passenger vehicles account for about 26% of global oil consumption, so in theory a complete transition to electric vehicles would cause a very significant reduction in demand for the oil exported from the Persian Gulf.¹ The International Energy Agency counters this with its own scenario modelling which shows that electric vehicles will only reduce oil demand by 2% by 2040,² although this scenario has been criticised on the basis that it would see the global carbon budget for 1.5C exhausted by 2022.³

The point is that electric vehicles are a technology with global consequences, yet Australia still lacks a national policy in this area. Despite no national policy, Australia's electric vehicle journey has already begun and that makes the Senate's inquiry very apposite.

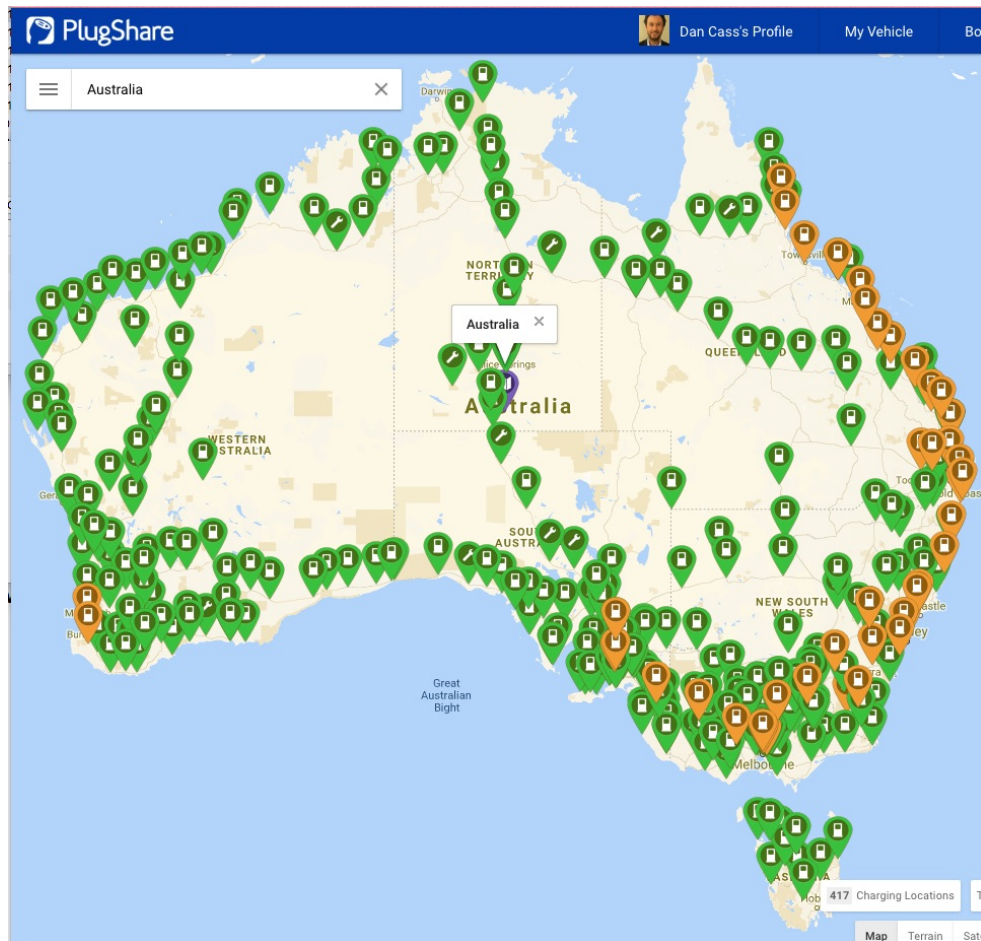
Figure 1 tells an important story about electric vehicles in Australia. It shows the location of 417 electric vehicle charging stations, across every state and territory, according to a crowd-sourced database called PlugShare (at 17 July 2018). As the map illustrates, there are charging stations spaced around most of the coastline and inland from Adelaide in the South to Darwin in the North and in the island state of Tasmania. Australia does not have a national policy on electric vehicles, but charging stations are being built and drivers are crowd-sourcing their own map of where they are.

¹ Jaffe, AM, & L Fulton, 'How electric vehicles could take a bite out of the oil market', *The Conversation*, 2017, <<http://theconversation.com/how-electric-vehicles-could-take-a-bite-out-of-the-oil-market-81081>> [accessed 26 July 2018].

² 'Global oil demand to withstand rise of electric vehicles: IEA', Reuters, 2017, <<https://www.reuters.com/article/us-oil-outlook-iea/global-oil-demand-to-withstand-rise-of-electric-vehicles-iea-idUSKBN1DE007>> [accessed 26 July 2018].

³ J Watts, 'IEA accused of undermining global shift from fossil fuels', *The Guardian*, 2018, <<http://www.theguardian.com/environment/2018/apr/05/iea-accused-of-undermining-global-shift-from-fossil-fuels>> [accessed 26 July 2018].

Figure 1: Crowd-sourced map of electric vehicle chargers in Australia



Source: PlugShare⁴

Everyt, an Australian start-up, is planning to take this enthusiastic crowd-sourcing and apply it to ownership and use of charging stations. It uses a mobile app to enable sharing of private chargers, to promote electric vehicle use and ownership. As the *Australian Financial Review* explains, the founders envisage

an Airbnb-style network of privately-owned electric vehicle chargers that could also solve the problem of "range anxiety" that experts say is a brake on electric vehicle penetration⁵

⁴ 'PlugShare - EV Charging Station Map - Find a place to charge your car!', <<https://www.plugshare.com/>> [accessed 17 July 2018].

⁵ B Potter, 'Airbnb of electric vehicles aims to plug charging problems', *Australian Financial Review*, 22 September 2017, <<https://www.afr.com/news/airbnb-of-electric-vehicles-aims-to-plug-charging-problems-20170921-gylr5w>> [accessed 17 July 2018].

Even without Federal Government leadership, Australians are embracing electric vehicles. Like the renewable energy sector, the electric vehicles market is likely to grow, whatever policies are in place to support it - or hinder it.

Whilst electric vehicles are projected to be a mainstream choice around the world within several years, currently they are an expensive choice in Australia. If we include plug-in hybrid vehicles, along with pure electric vehicles then in 2017 there were 23 models available but only one (Mitsubishi Outlander) was priced under \$60,000 and readily available for individual consumers. At the other end of the scale, there were twelve models priced over \$100,000.⁶

The latest projections from the Australian Energy Market Operator (AEMO) are that, under a 'neutral' scenario where there is no coordinated policy facilitation for electric vehicles, they will still comprise around 10% of the national vehicle fleet by 2030.⁷

CSIRO's Low Emissions Technology Roadmap demonstrated argued that there could be significant economic benefits from electric vehicles. The modelling predicts that within several years, consumers should benefit through reduced operating costs, producing a general lift in national energy productivity by around 2030. It could also see 'the displacement of 11,000 barrels of oil equivalent per day'.⁸

The question for the Select Committee is not whether or not Australia will have electric vehicles, but what policies will maximise the benefits for the environment, society and economy.

In each of the chapters below, we will address each of the terms of reference of the Select Committee on Electric Vehicles.

Note on terminology

In this submission, we will use the term 'electric vehicle' to refer to battery-powered electric vehicles, which are powered solely by the energy stored in their batteries and charged via a plug.

We use other terminology to make it clear when we are discussing the other two related vehicle types; 'hybrid vehicles' that combine an internal combustion engine with an electric engine and 'plug-in hybrid vehicles', which have both types of engine and also a plug which allows for charging from an external supply of electricity.

⁶ ClimateWorks Australia, *The state of electric vehicles in Australia second report: driving momentum in electric mobility*, Electric Vehicle Council, June 2018, p.11.

⁷ AEMO, *Integrated System Plan 2018*, Australian Energy Market Operator, July 2018, p.27.

⁸ T Campey et al., *Low Emissions Technology Roadmap*, CSIRO, p.43.

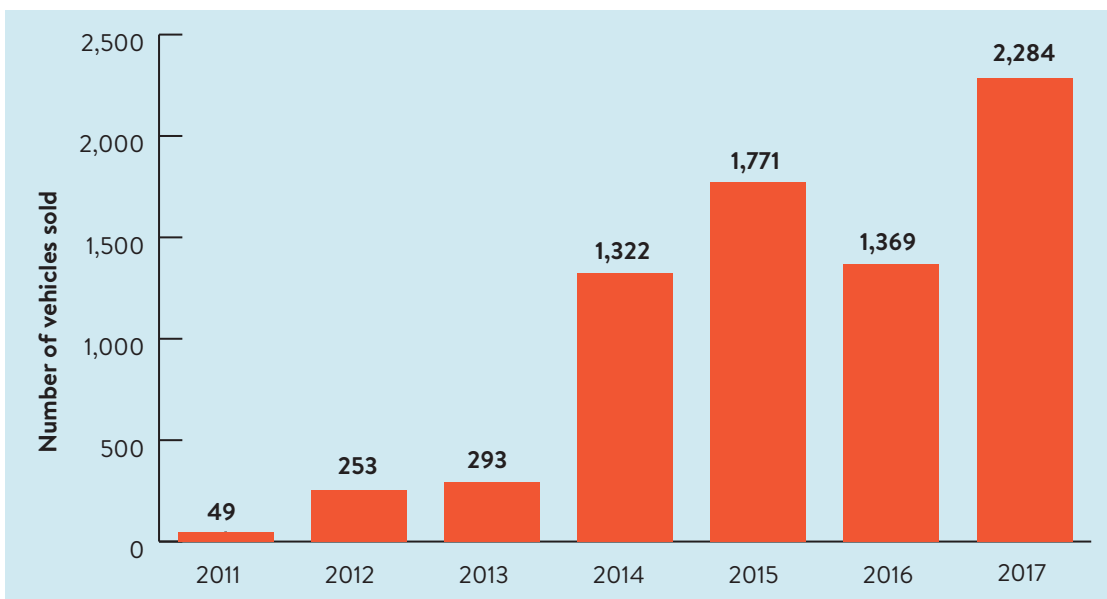
A. Benefits

Terms of Reference a) the potential economic, environmental and social benefits of widespread electric vehicle uptake in Australia

RAPID GROWTH, BATTERY IMPROVEMENTS

Before we evaluate the potential benefits of electric vehicles, it is necessary to understand the size and dynamics of the market globally and in Australia. We had essentially no public market for electric vehicles until recently. Figure 2 shows that despite coming off a very low base, there has been rapid growth in Australia in recent years, rising from 49 sales over the whole of 2011 to an average of 44 sales per week during 2017. These numbers are obviously very small compared with total sales of passenger vehicles of around 1.19 million in the year to December 2017.

Figure 2: Electric vehicle sales in Australia, 2011-2017



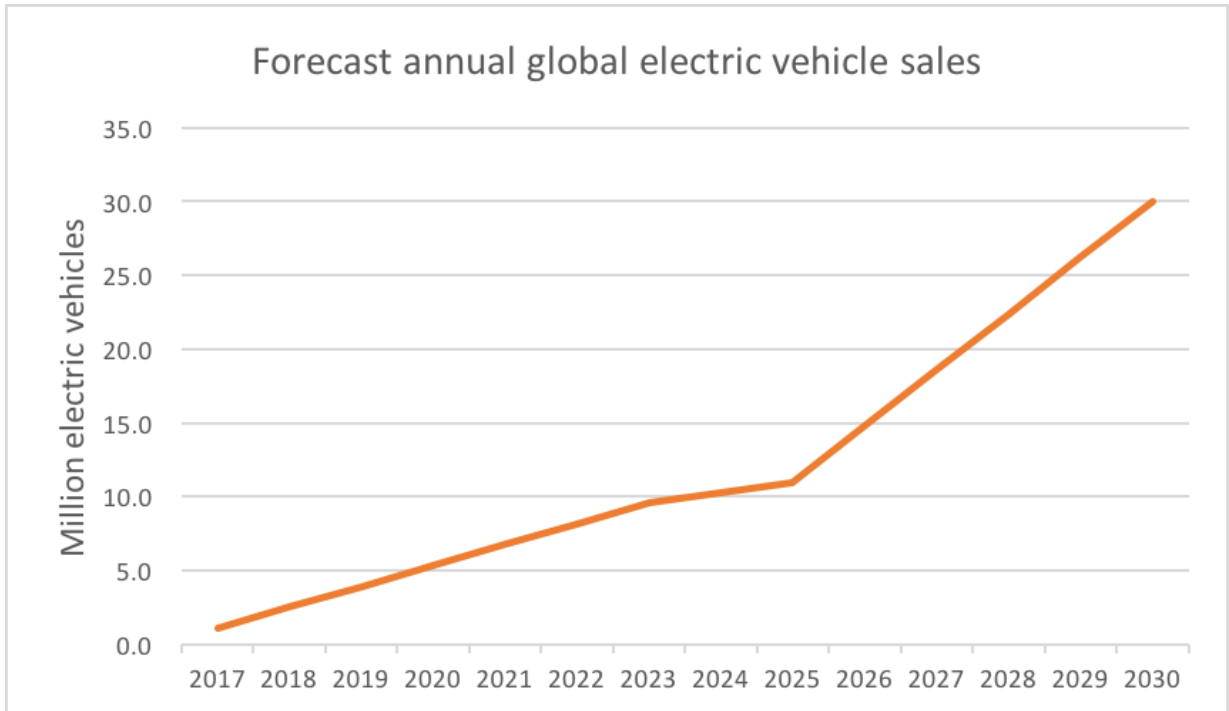
Source: Electric Vehicle Council⁹

Even if Australia has little political support for electric vehicles, global momentum will carry us forward, providing us with more models, at lower prices and a broader spread of prices, powered by batteries that have greater ranges. Figure 3 uses Bloomberg New Energy Finance's (BNEF) *Electric Vehicle Outlook 2018* data, which predicts that annual global sales of electric vehicles will grow around thirty-fold, to 30 million by 2030.

⁹ ClimateWorks Australia.

BNEF’s 2017 forecast for 2030 was for less than 25 million sales. Forecasts of the electric vehicle market are becoming more optimistic year on year, as they keep pace with actual sales growth, declining battery prices and policy action.¹⁰

Figure 3: Forecast global sales of electric vehicles, to 2030



Source: Bloomberg New Energy Finance¹¹



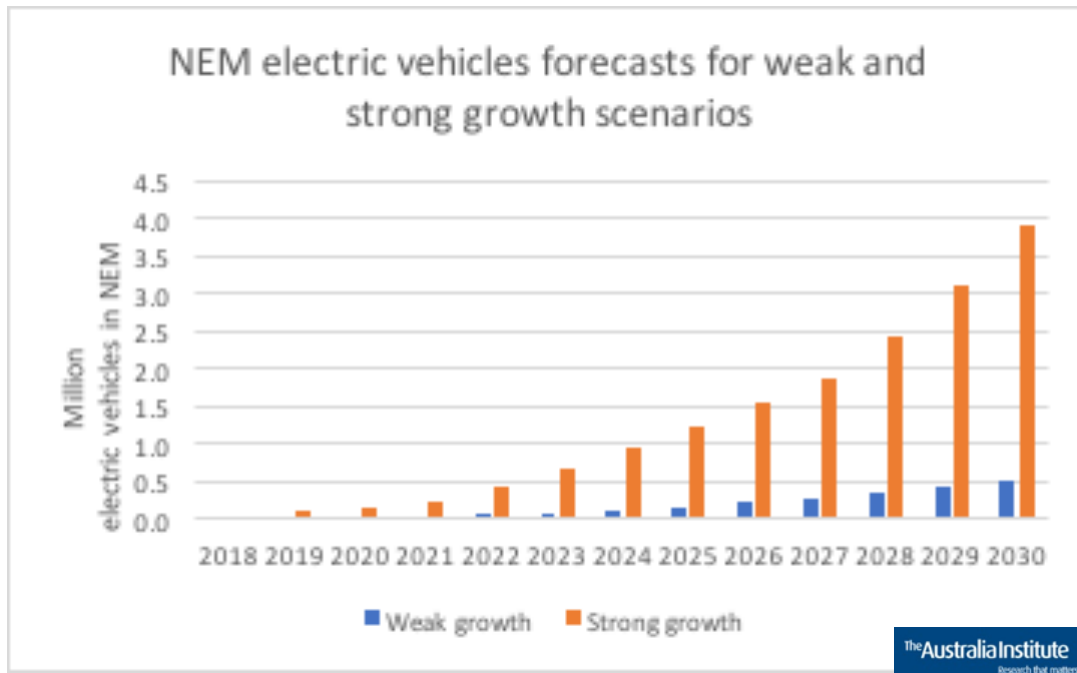
If global progress is as fast as BNEF and others predict, this will have a big impact on the market here. In July 2018 AEMO updated its projections for energy generation and demand in the NEM, for its first Integrated System Plan (ISP). Figure 4 shows the ISP scenarios span a wide range of projected totals for the electric vehicle fleet across the NEM in 2030: around 526,000 in the weak growth scenario and about 3.9 million in the strong growth scenario.¹² This broad range for the predicted size of the electric vehicle fleet is itself an important factor that the Select Committee will have to consider carefully.

¹⁰ Bloomberg New Energy Finance, *Electric Vehicle Outlook*, July 2017, <https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF_EVO_2017_ExecutiveSummary.pdf> [accessed 15 April 2018].

¹¹ BNEF, 'Electric Vehicle Outlook 2018', *Bloomberg NEF*, 2018, <<https://about.bnef.com/electric-vehicle-outlook/>> [accessed 17 July 2018].

¹² AEMO, '2018 Integrated System Plan Modelling Assumptions', Australian Energy Market Operator, 2018, sheet: 'Electric Vehicles'.

Figure 4: Forecast total electric vehicles in the NEM, 2018 to 2030



Source: AEMO¹³

Electric vehicles store their energy in lithium-ion batteries. The dramatic cost reductions and performance improvements of lithium batteries are key factors improving the affordability and range of electric vehicles and thus propelling market growth. In 2016 The Australia Institute published exclusive polling and other research on batteries, which showed that average lithium battery prices had fallen by 93% between 1995 and 2014.¹⁴ In 1995, lithium batteries cost US\$ 3,185/kWh. If petrol prices in Australia had dropped as fast as lithium batteries, the lowest average capital city price for petrol would have reached \$0.04 / litre by 2014 over the same period.

Figure 5 presents the predicted Australian prices for lithium batteries, which was prepared for AEMO. It predicts that prices will continue to decline very rapidly for about fifteen years and then level off. This accords with global market predictions, which are that the price will drop from current level of US\$ 209/kWh and crash through the symbolically powerful threshold of US\$ 100/kWh about seven years from

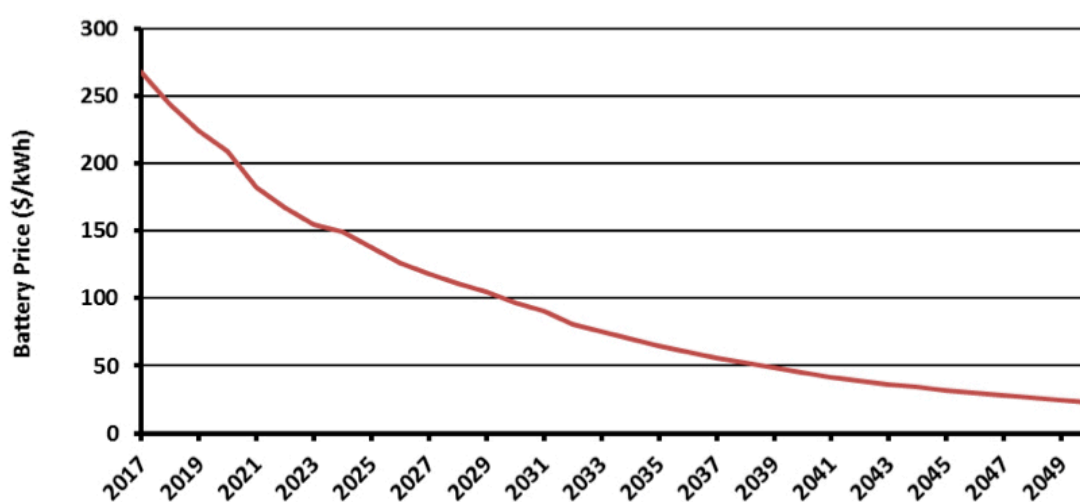
¹³ AEMO, '2018 Integrated System Plan Modelling Assumptions'.

¹⁴ D Cass, *Securing renewables: how batteries solve the problem of clean electricity*, Canberra, The Australia Institute, 31 May 2016, <<http://apo.org.au/node/64251>> [accessed 1 March 2017], p.5.

now (vehicle batteries are generally cheaper than stationary batteries used to store solar PV in households, simply because the market is larger for vehicle batteries).¹⁵

The economic benefits of electric vehicles could be very significant for Australia. According to detailed modelling done for CSIRO’s Low Emissions Technology Roadmap, high efficiency and electric vehicles could have around a \$14 billion value to 2040.¹⁶ PWC’s modelling for the Electric Vehicle Council states that if Australia emulated policies like Norway’s and our growth followed its trajectory, then by 2030 we could see an increase in GDP of \$2.9 billion, a net increase in employment of 13,400 jobs and reduction in oil imports of 16 million barrels per year.¹⁷

Figure 5: Projected prices for vehicle lithium-ion batteries in Australia, to 2050



Source: Energeia¹⁸

AUSTRALIA’S VEHICLE EMISSIONS RISING

The major environmental benefit of electric vehicles is that they would allow us to tackle the problem of rising transport sector emissions. This is particularly important in the current policy context, where there is not even bipartisan agreement about an

¹⁵ M Chediak, ‘The Latest Bull Case for Electric Cars: The Cheapest Batteries Ever’, *Bloomberg New Energy Finance*, 2017, <<https://about.bnef.com/blog/latest-bull-case-electric-cars-cheapest-batteries-ever/>> [accessed 15 April 2018].

¹⁶ *Low Emissions Technology Roadmap*, p.44.

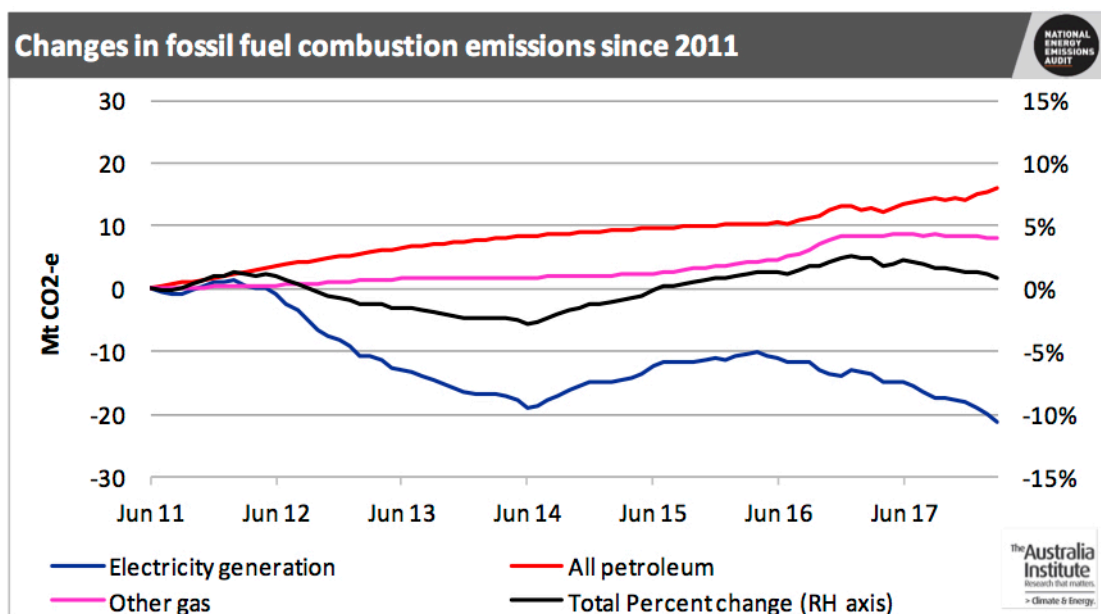
¹⁷ EVC, *New Policy Proposal: Recharging the economy*, Electric Vehicle Council, 2018, <<http://electricvehiclecouncil.com.au/wp-content/uploads/2018/03/New-Policy-Proposal-ELECTRONIC.pdf>> [accessed 17 July 2018], p.6.

¹⁸ Energeia, *Electric Vehicles Insights*, Energeia, September 2017, <https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/EFI/2018/FINAL---AEMO-EV-Insights---September-2017.pdf> [accessed 17 July 2018], p.39.

electricity sector emissions target for 2030. The Australia Institute’s National Energy Emissions Audit for June 2018 demonstrated that Australia’s petroleum emissions are rising, largely cancelling out the reduced emissions from fossil fuel combustion for electricity generation. This is a serious challenge for policymakers, if we are to meet out international climate obligations under the Paris Accord.

Figure 6 shows that between mid 2011 and the end of 2017, emissions from electricity generation dropped around 10% but this was more than nullified by a rise in gas emissions of around 4% and petroleum emissions of about 7%.

Figure 6: Emissions from petroleum, electricity and gas combustion in Australia, from 2011



Source: National Energy and Emissions Audit¹⁹

ENERGY DEMAND AND GRID ISSUES

The quantity and nature of electricity demand from electric vehicles gives rise to three important issues for the NEM:

1. Demand
2. Peak demand / grid stability
3. Emissions

¹⁹ H Sandler, *National Energy Emissions Audit June 2018*, Canberra, The Australia Institute, June 2018.

Devotees of coal have often told us that Australia has a baseload problem, when the most pressing problem issue is actually managing prices and ensuring security during peaks in demand. When the supply of energy in the grid has trouble keeping up with demand, that causes security issues and high prices.

In 2013 the Productivity Commission reported that

in New South Wales, capacity that caters for less than 40 hours a year of electricity consumption (or less than 1 per cent of time) accounts for around 25 per cent of retail electricity bills.²⁰

This section will focus on peak demand, grid stability and emissions impacts of electric vehicle demand for electricity.

Demand

The overall energy consumption impact on the NEM will be modest initially. According to AEMO's strong growth scenario, electric vehicles will consume between 1% (Tasmania) and 5% (Victoria) of average annual operational demand in 2030 and this will rise to 14% in two states (Victoria, NSW) by 2038.²¹

Peak demand / grid stability

If electric vehicles all charge at times of high demand, then they would add to peak demand problems. If electric vehicles charging is rational and regulated, then they can avoid adding to system stress and can even be used to help deliver security and lower prices.

Research commissioned by the Energy Supply Association of Australia in 2012 found that 'there were substantial potential peak demand reduction benefits available to both the NEM and SWIS [South West Interconnected System of Western Australia], of between \$60 and \$537 million.'²²

It is not yet clear how large numbers of batteries can be used to contribute to grid security more broadly. There is potential for electric vehicles to provide a range of vehicle-to-grid or V2G services including grid storage and frequency regulation.

A recent study published in the journal *Energy Policy* concluded that 'V2G can be an enabler for carbon reduction' in markets that are making a transition to renewable

²⁰ Productivity Commission, *Electricity network regulatory frameworks : volume 2*, Canberra, Productivity Commission, 2013, p.335.

²¹ AEMO, '2018 Integrated System Plan Modelling Assumptions', sheet: Electric Vehicles.

²² ESAA, *Sparking an Electric Vehicle Debate in Australia*, Energy Supply Association of Australia, November 2013, p.33.

energy and thus have a demand for storage and grid security services.²³ The authors make clear that this requires an open market for third party aggregators who would effectively buy the services from thousands of electric vehicle owners, manage their charging and discharging and offer this as services to networks or the system operator. This is the same market access issue as in demand response markets, where it is necessary for third party aggregators to recruit households and small businesses and then manage the fleet of devices.²⁴

In July 2018, the UK energy regulator Ofgem commenced public consultations on a change to the market rules that would penalise electric vehicle owners if they charge during peak times. They would be given an incentive to charge at midnight, on a lower tariff rate.²⁵

There are problems with Ofgem's approach of using price alone to manage electric vehicle charging peak issues. This is because if the price penalty of charging at peak times is low then many consumers may not make the decision to charge at night. And, if the price penalty is made very high, that may lead to a mass shift of consumption to a single point in time (midnight in the Ofgem proposal), which would then become a new peak, potentially causing new problems.

China is the leading market for electric vehicles and researchers there are working on the design of strategies for electric vehicle charging that can accommodate a high concentration of electric vehicles. For example, the journal *Applied Energy* published a strategy developed for Shenzhen by three local researchers Linni Jian, Yanchong Zheng and Ziyun Shao. Jian et al modelled scenarios with 1 million and 2 million electric vehicles, in Shenzhen in 2035.

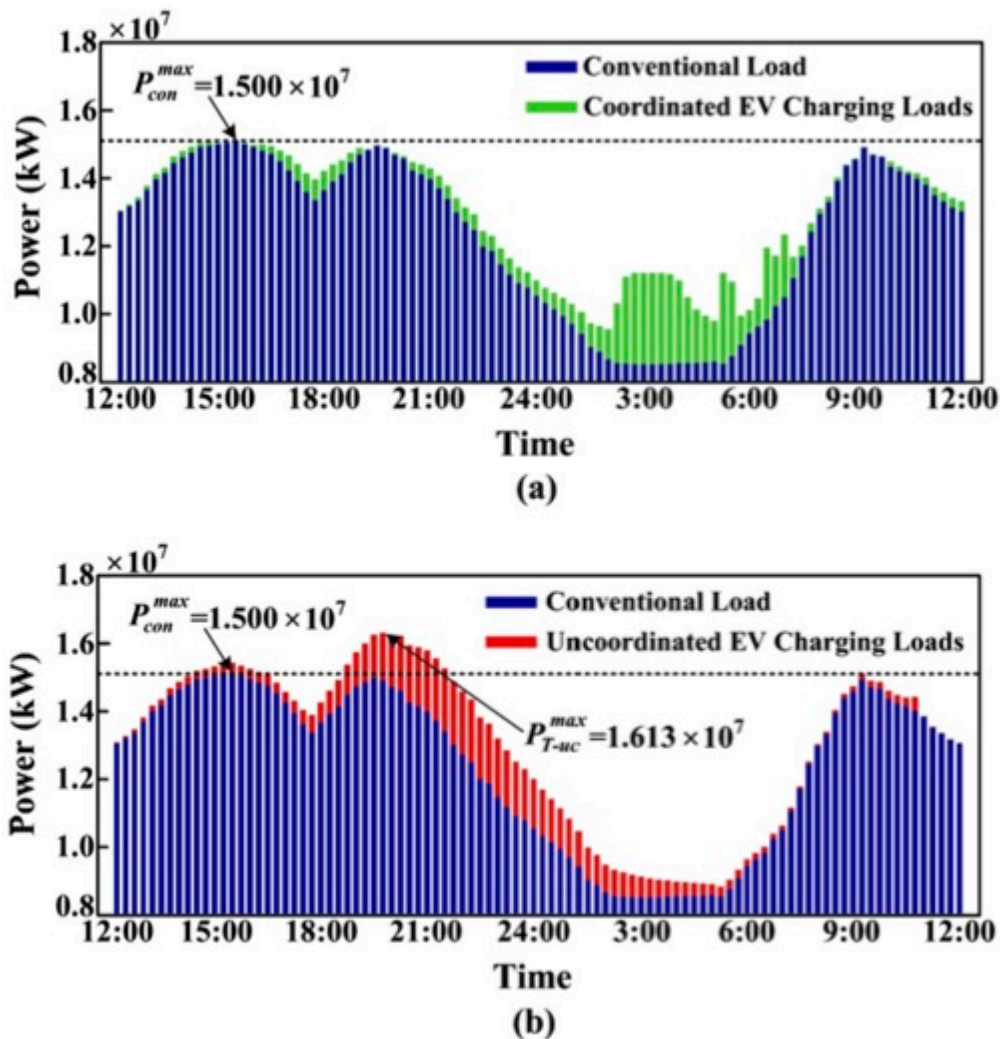
Figure 7 illustrates how a coordinated strategy would work and compares it to the uncoordinated approach. The bottom graph is the current, uncoordinated situation, in which private owners will charge whenever it is convenient to do so. The blue bars show the pre-existing demand at a given time in the day. The red bars are the additional demand caused by electric vehicles. The graph shows electric vehicles would raise demand peaks higher than usual, at around 3pm and then again around 8 pm.

²³ K Uddin, M Dubarry & MB Glick, 'The viability of vehicle-to-grid operations from a battery technology and policy perspective', *Energy Policy*, vol. 113, 2018, p. 346.

²⁴ D Cass, *Saving mega bucks with negawatts*, Canberra, The Australia Institute, July 2017.

²⁵ A Vaughan, 'UK electric car drivers face paying more to charge at peak times', *The Guardian*, 23 July 2018, <<http://www.theguardian.com/environment/2018/jul/23/uk-electric-car-drivers-charge-peak-times-ofgem-electricity>> [accessed 24 July 2018].

Figure 7: Coordinated, aggregated charging strategy for 1 million electric vehicles versus uncoordinated charging strategy, Shenzhen 2035



Source: Jian et al²⁶

The top graph depicts how a coordinated charging strategy would work. Firstly, it would prevent electric vehicle charging from increasing the size of afternoon and evening peaks. Secondly, it would shift the charging periods overnight, to 'fill' the demand 'valley', when electricity is cheaper.

They show that uncoordinated charging would add 1.1 GW to peak demand, bringing it to a total of 16 GW (Figure 7, b). By way of comparison, AEMO predicts that total peak demand across the NEM in 2035 will be just under 40 GW.²⁷ Once there are very large numbers of electric vehicles in a region (1 million plus) it becomes inefficient to rely on

²⁶ L Jian, Y Zheng & Z Shao, 'High efficient valley-filling strategy for centralized coordinated charging of large-scale electric vehicles', *Applied Energy*, vol. 186, 2017, p.53.

²⁷ AEMO, '2018 Integrated System Plan Modelling Assumptions', sheet: Maximum Demand.

price as the driver of charging decisions. The authors write, 'it could lead to new load peaks if a large number of EVs are lured to charge at the same time by a relatively low electricity price.'²⁸

The authors propose instead that third party aggregators could control the charging of the fleet of privately owned electric vehicles. Big data and modern control systems make this a sensible approach for creating efficient markets for the energy services provided by large numbers of distributed resources, whether they are rooftop solar and battery systems, electric vehicles or commercial demand loads. For example, the Australian Energy Market Commission (AEMC) has proposed a similar model of open markets for aggregation as a suitable design for wholesale demand response in the NEM.²⁹

Recommendations

Tariffs should be designed to encourage electric vehicle charging either off-peak, if drawing energy from the grid, or any time from behind the meter generation.³⁰

Third-party aggregation of electric vehicle charging should be specifically enabled in all electricity sub-markets (wholesale energy, frequency and ancillary services, emergency, NEG reliability mechanism).

Emissions

Critics of electric vehicles claim that they would perversely *increase* emissions when compared with business as usual, when the vehicle fleet is overwhelmingly dominated by internal combustion engines.³¹ For example, a very powerful electric vehicle charged in Victoria today will be responsible for relatively high emissions compared with the national fleet average for internal combustion engine vehicles, because

²⁸ L Jian et al., p.47.

²⁹ D Cass, *Implementing wholesale demand response*, Canberra, The Australia Institute, May 2018, pp.11-12.

³⁰ A simpler version of this policy is recommended by the Electric Vehicle Council (EVC, *New Policy Proposal: Recharging the economy*, Electric Vehicle Council, 2018, <<http://electricvehiclecouncil.com.au/wp-content/uploads/2018/03/New-Policy-Proposal-ELECTRONIC.pdf>> [accessed 17 July 2018], p.19).

³¹ G Parkinson, 'Why is Australia misleading consumers on electric vehicle emissions?' in *RenewEconomy*, 2018, <<https://reneweconomy.com.au/why-is-australia-misleading-consumers-on-electric-vehicle-emissions-13631/>> [accessed 18 July 2018].

brown coal burned in that state produces a lot of carbon dioxide per unit of energy generated.³²

The undesirably high emissions for a large electric vehicle charged in Victoria today is not a valid generalization for the future electric vehicle fleet across Australia. In a separate submission to this Committee, by David R Richardson, Senior Research Fellow at The Australia Institute, it is argued that the marginal emissions impact of electric vehicles will be very much less than their current average emissions impact.

As Richardson explains, if we are to understand

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.³³

Richardson is correct to point out that the emissions intensity of electricity generated in the NEM is declining. The June 2018 National Energy Emissions Audit shows that emissions intensity has been falling quite consistently since around 2009 and is now around 10% lower than it was in 1990.³⁴ Since 2011, annual brown coal emissions are down by around 25 MtCO₂ across the NEM.³⁵

As numerous government reports have indicated, it is unlikely that a new coal-fired power station will ever be built in the NEM, without government support. For example,

- According to the ACCC (June 2018) we can expect to see ‘the exit of further major coal generators from the market’³⁶
- The Australian Energy Regulator stated, ‘Coal generators are being retired and not being replaced’³⁷
- AEMO’s long term plan for the NEM, the Integrated System Plan states, ‘retiring coal plants can be most economically replaced with a portfolio of utility-scale

³² See for example, analysis on pp.14-15 of ClimateWorks Australia, *The state of electric vehicles in Australia second report: driving momentum in electric mobility*, Electric Vehicle Council, June 2018.

³³ D Richardson, *Submission to the Senate Inquiry into electric vehicles*, The Australia Institute, July 2018, p.9.

³⁴ H Saddler, *National Energy Emissions Audit June 2018*, Canberra, The Australia Institute, June 2018, p.8.

³⁵ Saddler, p.6.

³⁶ ACCC, *Retail Electricity Pricing Inquiry—Final Report June 2018*, Canberra, Australian Competition & Consumer Commission, June 2018, p. 53.

³⁷ AER, *State of the energy market 2017*, Melbourne, Australian Energy Regulator, May 2017, p.4.

renewable generation, storage, DER [Distributed Energy Resources], flexible thermal capacity, and transmission.’³⁸

If we accept the analysis of the regulators and Mr Richardson, then the impact of a growing electric vehicle fleet would be to slightly increase demand, which should see more generation built, which is likely to be much less emissions intensive than the current NEM average, consisting of a portfolio of mostly clean technologies and no black or brown coal.

³⁸ AEMO, *Integrated System Plan 2018*, p.5.

B. Manufacturing opportunities

Terms of Reference b) opportunities for electric vehicle manufacturing and electric vehicle supply and value chain services in Australia, and related economic benefits;

Lithium batteries provide us with the greatest current opportunities for electric vehicle and battery manufacturing and related industries. We are more likely to see economic activity in mining minerals required by electric vehicles than in manufacture of the vehicles themselves. Australia had a long history of automotive manufacturing, up until 2017, which had started as far back as 1901 (or 1896 if we date its commencement with steam cars, not internal combustion engines).³⁹ However there are no major car manufacturers looking to return and build electric vehicle models.

There is a degree of enthusiasm for an electric renaissance for our auto industry, but plans so far are either small, or at an early stage. For example, a start-up called ACE Electric Vehicles claims it will start trading in 2018, offering a ute (branded 'Yewt') and a cargo van, both assembled in Australia, from carbon fibre panels made in China.⁴⁰

British entrepreneur Sanjeev Gupta and his GFG Alliance have very substantial capital and a proven track record, so there is much greater attention paid to their plan to repurpose the former Holden factory in South Australia to manufacture electric vehicles.⁴¹ Reuters describes GFG Alliance as 'a \$10 billion industrials, energy, banking and real estate conglomerate, [which] also has a global property portfolio and a financing arm.'⁴²

Australia still has a motor vehicle component manufacturing sector which makes parts such as magnesium wheels and dashboard instrumentation. Some of those components are sold on the world market and it is possible that procurement,

³⁹ 'Automotive industry in Australia', in *Wikipedia*, 2018, <https://en.wikipedia.org/w/index.php?title=Automotive_industry_in_Australia&oldid=846355038> [accessed 20 July 2018].

⁴⁰ C Latimer, 'Start-up looking to build electric cars here', *Sydney Morning Herald*, 16 April 2018, p. 23.

⁴¹ A Davies, 'British billionaire eyes electric car plan for former Holden factory', *The Guardian Australia*, 2018, <<http://www.theguardian.com/australia-news/2018/jan/22/british-billionaire-eyes-electric-car-plan-for-former-holden-factory>> [accessed 16 April 2018].

⁴² 'Factbox: GFG Alliance to maintain rapid pace of expansion', *Reuters*, 21 February 2018, <<https://www.reuters.com/article/us-australia-gupta-strategy-factbox/factbox-gfg-alliance-to-maintain-rapid-pace-of-expansion-idUSKCN1G50GS>> [accessed 25 July 2018].

awareness campaigns and other policies could be used to help those manufacturers make and export parts used in electric vehicles.

Australia is soon to have its first lithium battery factory, located in South Australia. We already mine lithium (as spodumene) and other minerals used in lithium (and other batteries).

Our first lithium battery factory will be owned and operated by Sonnen, from Germany.⁴³ Sonnen is a vertically integrated energy storage innovator, which manufactures stationary batteries and control systems for home energy management and also offers a retail product which is like a power purchase agreement for households.⁴⁴ This means that it can be expected to have a local market ready for batteries it manufactures.

There is a more ambitious proposal by a new investment consortium called Imperium3 to build a factory in Townsville with an annual production capacity of 15 GWh of lithium batteries.⁴⁵ According to the company's calculations, this is enough for 1 million home battery units or 250,000 electric vehicles with 400km of range.⁴⁶ It has received \$3.1 million from the Queensland government.

The most significant move towards electric vehicle related industry in Australia was in May 2018, when the Government of Western Australia announced a taskforce 'to capitalise on the State's potential to produce and process lithium and other energy materials.'⁴⁷ In July 2018 the West Australian government endorsed an ambitious proposal to create a 'Lithium Valley' industrial hub in WA, hoping it would dominate the new energy materials economy as Silicon Valley dominated the computer sector.

Regional Development Australia, which is a Commonwealth agency, has funded a substantial report on the 'New Energy' marketplace, its demand for mineral, the potential for Western Australia to become a major player and a suite of policy recommendations.

The 'Lithium Valley' report draws on MIT research to propose that a mining and processing strategy should involve a set of minerals beyond lithium, which are

⁴³ C Latimer, 'Battery maker's big SA step', *The Canberra Times*, 23 February 2018, p. 39.

⁴⁴ 'sonnenFlat', *sonnen*, 2017, <<https://sonnen.com.au/en-au/sonnenflat>> [accessed 20 July 2018].

⁴⁵ C Turi, 'Lithium battery plant plugs into Siemens', *The Australian*, 23 April 2018, p. 19.

⁴⁶ S Vorrath, 'Townsville battery "gigafactory" plan gains momentum', *RenewEconomy*, 2018, <<https://reneweconomy.com.au/townsville-battery-gigafactory-plan-gains-momentum-49401/>> [accessed 24 July 2018].

⁴⁷ Government of Western Australia, 'Lithium and Energy Materials Industry Strategy', <<http://www.jtsi.wa.gov.au/economic-development/economy/lithium-and-energy-materials-industry-strategy>> [accessed 20 July 2018], p.56.

expected to be in demand from a range of emerging technological sectors: renewables, electric vehicles and also IT, robotics, as well as existing sectors such as oil and gas.

The minerals and materials discussed in the WA strategy work include:

- Rare Earth Metals (or Rare Earth Elements): 17 elements which are reasonably common but only rarely in a chemical form which can be readily processed. They are used for various niche technological applications such as lasers, microwave filters, oil cracking catalysts, advanced wind turbines magnets, fibre-optics, x-ray machines, positron emission tomography scanners, naval sonar and luminous paint.
- Battery minerals: lithium, cobalt, nickel, manganese, vanadium
- Other minerals such as tantalum

The Lithium Valley authors make the point that Australia has vast reserves, but earns relatively little because we mostly just mine our battery minerals without any value-adding. This has been an historical curse for our resource sector, compounded by our failure create a credible sovereign wealth fund. They write, 'WA currently supplies 44% of the world's lithium, 5% of the world's cobalt, 14% of manganese, 16% of alumina, 9% of nickel, and 5% of copper'⁴⁸ and explain that in the case of lithium, we capture 0.53% of its total value in batteries.⁴⁹

When the battery minerals are added to Rare Earth Metals, iron ore (or liminte), copper, bauxite, graphite and rutile (titanium), we are the holder of the world's largest reserves of what report author Professor Ray Wills groups together as 'key battery materials'. Figure 8 shows the relative size of reserves in twenty-one countries prominent in battery materials.

The significance of the data on reserves presented in Figure 8 is that Australia is the global superpower in these minerals. We do not only hold first place but our relative proportions of deposits are larger than China, in second place and the third-place getter, Brazil, put together.

This is increasingly being seen as having geopolitical significance. The authors point out that both the EU and America have identified a set of strategically important materials

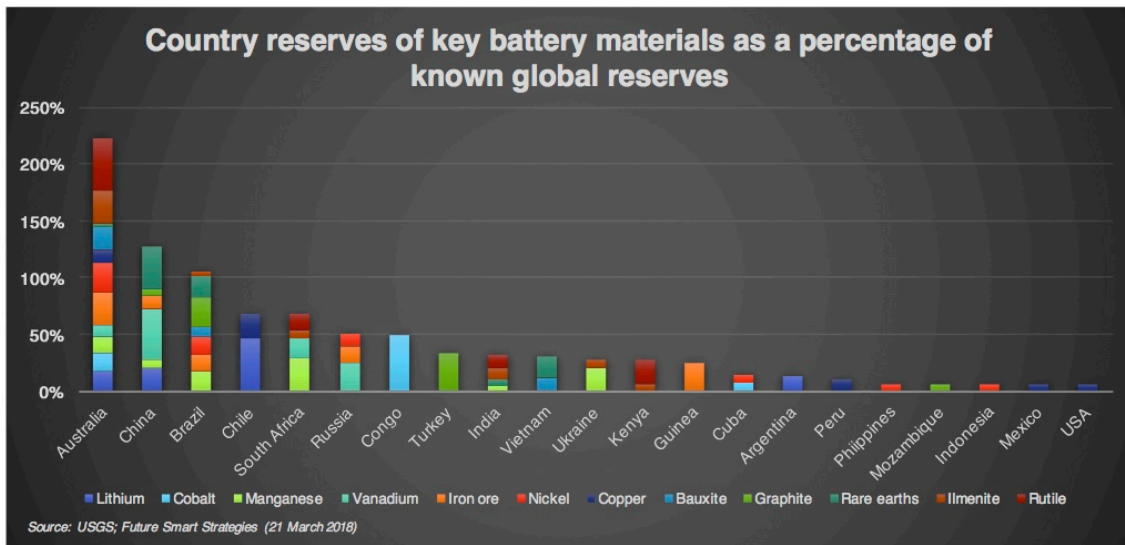
⁴⁸ RDA, *Lithium Valley Main Report 2018*, Perth, Regional Development Australia, 2018, <https://www.rdaperth.org/wp-content/uploads/2018/05/RDA4491-LITHIUM-REPORT-2018_LOWRES.pdf> [accessed 20 July 2018], p.35.

⁴⁹ RDA, p.35.

reserves for their economies and national security. These lists significantly overlap with each other and with the minerals found in Western Australia.⁵⁰

According to the Regional Development Australia report, the annual value of this minerals strategy could be in the order of \$50 billion, within a decade.⁵¹

Figure 8: Australia has the largest proven reserves of battery minerals in the world



Source: Regional Development Australia⁵²

⁵⁰ RDA, pp.50-55.

⁵¹ RDA, p.50.

⁵² RDA, p.13.

C. Market support

Terms of Reference c) measures to support the acceleration of electric vehicle uptake

The two most important measures for supporting the growth of electric vehicle markets are public charging infrastructure and financial incentives.⁵³ The Australia Institute has previously published reports on policy options for increasing the rate at which car owners in this country buy electric vehicles, with a focus on Tasmania⁵⁴ and nationally⁵⁵.

We recommended four key national policies should be considered:

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 CHARGING INFRASTRUCTURE

Australia is a vast country and so if we are to have a reliable electric vehicle charging infrastructure, the Federal government will have to lead, particularly with high speed chargers which add to the range of electric vehicles on long journeys.

Households and businesses already build 'destination' chargers, which provide a relatively low charge rate and can take hours to charge the batteries, for motorists to use overnight when they are home or during the day when they have arrived at work. These level 1 or 2 chargers cost as little as a few hundred dollars. They use residential voltages and amperages.

⁵³ Energeia, *Australian Electric Vehicle Market Study*, May 2018, pp.3-6.

⁵⁴ L Minshull, *Tasmania in pole position*, Canberra, The Australia Institute, September 2017, <<http://www.tai.org.au/sites/default/files/Tasmania%20in%20pole%20position%20FINAL.pdf>> [accessed 22 July 2018].

⁵⁵ D Cass & M Grudnoff, *If you build it, they will charge*, Canberra, The Australia Institute, October 2017.

However, when drivers go long distances, they require more powerful ‘journey’ chargers, which can top up the batteries in a shorter time. These level three chargers cost a few thousand dollars each and require higher voltages (400 – 500 V) and draw a larger current (around 60-300 A).

There is also a problem with multiple standards for chargers, which the electric vehicle industry is working to solve. The Federal Government should monitor this and ensure that Australia does not replicate the problem of multiple rail gauges. When the Australian colonies started to build rail networks in the nineteenth century they opted for different widths and despite a national gauge being set in 1901, at Federation, there was no standard network linking all mainland state capitals until 1994.⁵⁶

One of the key ways to increase the value of chargers is to maximize their access. Petrol stations were privately owned businesses that would serve any customer. If chargers are mostly privately owned, how can they be fully open to all drivers? Every is an Australian start-up which was built through the EnergyLab network, and it plans to allow households and businesses who chargers to sell their services, like the Airbnb model where residences can be leased as accommodation.⁵⁷

Recommendation

The Federal government should invest in a level 3 charging stations network for Australia.

INCENTIVES

Financial incentives for electric vehicle purchase generally involve a payment from government to consumers, or in the case of the luxury car tax exemption, a foregone tax revenue which amounts to the same thing. Since 2017 The Australia Institute has been advocating a different, ‘feebate’ model, which has no impact on federal revenue, but should lead to electric vehicle adoption and at the same time, a reduction in the average pollution of Australia’s fleet of internal combustion engine vehicles. The ‘feebate’ structure involves putting a fee on an activity we want less of and using that to give a rebate to an activity we want more of.

⁵⁶ ‘Rail gauge in Australia’, in *Wikipedia*, 2018, <https://en.wikipedia.org/w/index.php?title=Rail_gauge_in_Australia&oldid=846385576> [accessed 23 July 2018].

⁵⁷ Potter.

The vehicle policy was developed by France and is referred to as a Bonus–Malus (Latin for good–bad) scheme. The policy provides an incentive for low emissions vehicles at the same time as a disincentive for high emissions vehicles.

What this means for consumers is that they are free to purchase vehicles that are more polluting than a defined emissions ‘pivot’ point, but their decision means they pay a fee, which is effectively transferred to consumers who choose to buy vehicles that are less polluting than the pivot point. The fee and rebate levels and the emissions levels at which they are charged are regularly reviewed and optimised, to ensure that the scheme works well. Governments can choose to make the scheme revenue neutral. The original pivot point in France in 2008 was 131 to 160 CO₂ g/km.

France introduced the Bonus-Malus policy in 2008, so there is now a decade’s worth of data with which we can evaluate its effectiveness. According to the International Council on Clean Transportation, the policy design changes implemented in 2017 mean the French scheme is now ‘the absolute best way to do things’.⁵⁸ It should be seriously considered in Australia as it is in other countries. For example, Sweden implemented its Bonus-Malus policy on 1 July 2018. The full rebate for electric vehicles there is almost \$10,000.⁵⁹ In the Australian market this level of rebate would constitute a very significant financial incentive.

Figure 9 shows the financial and emissions architecture of the Bonus-Malus scheme, at its inception in 2008 and then again in 2016. The levels of fees and rebates are shown by the solid lines, where blue is 2008 and red is 2016 and can be read off the left axis. The intersection of these lines with the Y-axis correspond to the emissions pivot point. The steps in the lines show the gradations of fee charged (above the X-axis) and rebate paid (below the X-axis).

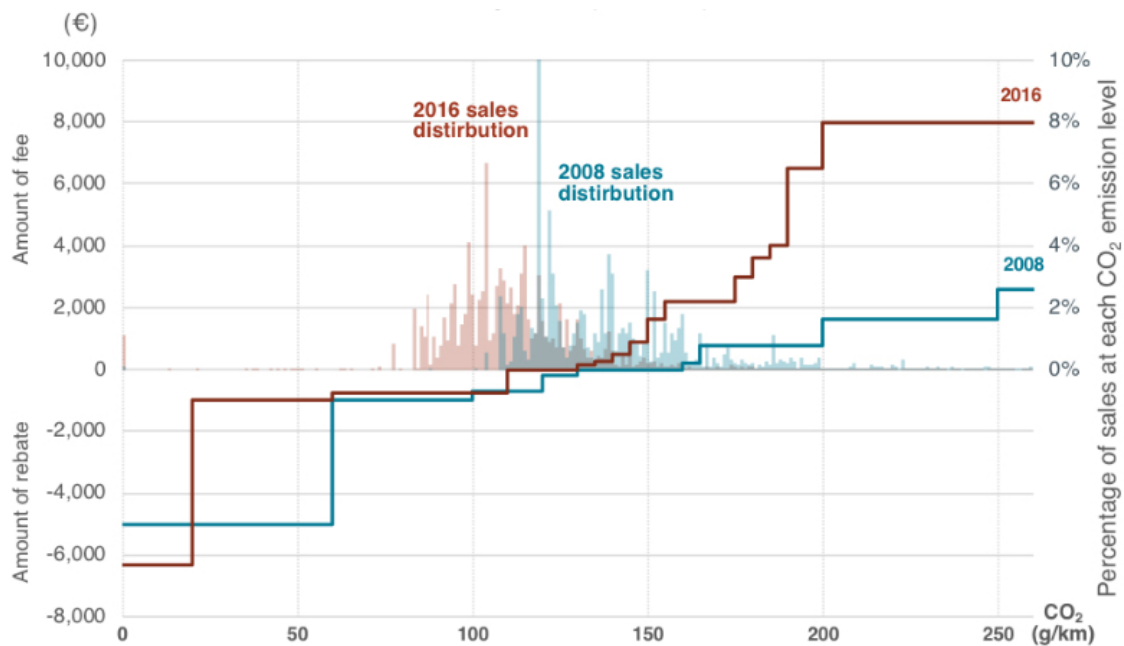
The bars are a histogram of sales at each emissions level and should be read off the right axis. The blue bars are clustered to the right of the red bars and that demonstrates the decline in the emissions intensity of electric vehicles in France between 2008 and 2016. It should be noted that the fee levels for the most polluting vehicles are much higher now than in 2008.

⁵⁸ Z Yang, ‘Practical lessons in vehicle efficiency policy: The 10-year evolution of France’s CO₂-based bonus-malus (feebate) system’, *International Council on Clean Transportation*, 2018, <<https://www.theicct.org/blog/staff/practical-lessons-vehicle-efficiency-policy-10-year-evolution-frances-co2-based-bonus>> [accessed 22 July 2018].

⁵⁹ ‘New Swedish Car Policies Expected To Boost Electric Car Market Share In Sweden’, *CleanTechnica*, 2018, <<https://cleantechnica.com/2018/05/02/new-swedish-car-policies-expected-to-spike-electric-vehicle-market-share-in-sweden/>> [accessed 23 July 2018].

The Select Committee could very readily commission an investigation of a Bonus-Malus scheme in Australia, as the International Council on Clean Transportation has made a model publicly available which could be populated with Australian vehicle fleet data and policy settings.⁶⁰

Figure 9: Emissions level of vehicles sold in France and feebate amounts under Bonus-Malus system, 2008-2016



Source: International Council on Clean Transportation⁶¹

Recommendation

The Federal government should design a Bonus-Malus system for vehicle emissions in Australia.

POPULARITY AND COMMERCIALISATION

Polling commissioned by the Australia Institute found that there is support in the community for electric vehicles and government playing a role in building the market. 64% of respondents support government incentives to encourage consumers to

⁶⁰ 'Feebate simulation tool', *International Council on Clean Transportation*, <<https://www.theicct.org/feebate-simulation-tool>> [accessed 23 July 2018].

⁶¹ Yang.

purchase electric cars, including a majority of National Party voters (53%) and Liberal Party voters (58%).⁶² Almost half of respondents think electric vehicles would pay less tax than regular vehicles, one third think they should pay about the same tax and less than one in twenty think they should pay more tax.

Electric vehicles enjoy high public support. They can play a major role in our transition to a low carbon economy. Whilst Australia does not have a vehicle manufacturing industry currently, we did until recently and there are many opportunities for manufacturing and perhaps also new business models such as the Everyty charger sharing platform.

In 2016 the Government proposed cutting \$1.26 billion from ARENA's future appropriations from 2017–18 to 2021–22. The Labor Opposition opposed this cut but agreed to a reduction of \$461 million over the same period.⁶³ This should be reinstated, to provide ARENA with its full intended budget so it has a greater capacity to invest in electric vehicle and other clean energy technologies.

Recommendations

The Federal government should reinstate \$461 million which was removed from the ARENA budget up to 2021-22.

The Federal government should work with the CEFC and ARENA and other research agencies to develop an electric vehicle and related technologies commercialization strategy.

⁶² Cass and Grudnoff, p.iii.

⁶³ A St John, 'What's happening with ARENA?', *Parliament of Australia*, 2016, <[https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Flag Post/2016/September/ARENA-changes](https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Flag_Post/2016/September/ARENA-changes)> [accessed 10 July 2018].

D. Manufacturing support

Terms of Reference d) measures to attract electric vehicle manufacturing and electric vehicle supply and value chain manufacturing to Australia

It is not yet clear what potential there is for electric vehicle manufacturing in Australia. An electric vehicle industry of the scale of our previous internal combustion engine auto sector would be a major contribution to the economy.

Recommendation

The Federal Government should commission a study into the potential for electric vehicle and supply chain manufacturing in Australia, in conjunction with industry and unions.

E. Intergovernmental cooperation

Terms of Reference e) how federal, state and territory Governments could work together to support electric vehicle uptake and manufacturing, supply, and value chain activities

The most important area for intergovernmental policy is that all three tiers of government work together on the funding and facilitation charging infrastructure. This is already being recognized by governments, such as the ACT, which has committed to;

Work with local and state governments to facilitate the installation of charging stations on major routes to and from Canberra including routes to Sydney and coastal areas.⁶⁴

Governments are starting to specify electric vehicles in procurement and leasing policies. This is an important measure especially in the early stages of growth of the electric vehicle market.

One idea which has not been floated is to use numberplates to identify electric vehicles, in order to build their profile and create value around the electric 'brand'.

Recommendation

The Federal Department of Transport should work with state and territory transport departments to investigate an electric number plate concept and if there is support then fund \$40,000 for design and its implementation as an option for electric vehicle buyers.

⁶⁴ ACT Government, *The ACT's transition to zero emissions vehicles: Action Plan 2018-21*, p. 12.

E. Other matters

Terms of Reference f) any other related matters.

NATIVE TITLE

It is vitally important that indigenous communities and their representative land councils are given fair rights to negotiate access, royalties and other issues with miners of lithium and other battery minerals. Already there is significant pressure on native title rights in Australia and leading organisations are concerned about specific projects and the integrity of the underlying legislation, the *Native Title Act*.⁶⁵

GEOPOLITICS

There is no clear vision of how electric vehicles and related renewable energy transformations will reshape global security. It will diminish demand for oil and increase demand for lithium and cobalt and other strategic minerals but there is debate about the overall impact of these changes. It has even been proposed that fuel displacement caused by electric vehicles will, paradoxically, destabilise the world, precisely because they will undermine the wealth of the major oil producing nations including Russia, Saudi Arabia, Iraq and Iran.⁶⁶

Last year the International Renewable Energy Agency (IRENA) announced a Global Commission on the Geopolitics of Energy Transformation, in order to explore these issues. The Commission is supported by the governments of Germany, Norway and the United Arab Emirates and is chaired by Olafur Grimsson, the former President of Iceland. It will report at the 9th Session of the IRENA Assembly in January 2019.

⁶⁵ 'Native title being watered down for big mining, say Traditional Owners', *NITV*, <<https://www.sbs.com.au/nitv/nitv-news/article/2017/03/02/native-title-being-watered-down-big-mining-say-traditional-owners>> [accessed 24 July 2018].

⁶⁶ D Koranyi, 'Will Electric Cars Destabilize the World?', *The National Interest*, 2016, <<https://nationalinterest.org/feature/will-electric-cars-destabilize-the-world-16387>> [accessed 23 July 2018].

The key factor that will change the geopolitical landscape is that electric vehicles can use electricity generated by any primary energy source – including renewable energy which is plentiful and not concentrated in one locality – whereas internal combustion engines can only burn petroleum or gas. As *The Economist* puts it, ‘Since oil and gas are exhaustible and not available everywhere, they have often been rationed, to the benefit of an oligopolistic group of producers.’⁶⁷

The stakes are high because oil has been a causal factor in at least one quarter and perhaps up to half of all international conflicts between 1973 and 2012.⁶⁸ It is the driver of Western policy in the Middle East. For example, if tensions between Iran and America lead to hostilities, that could threaten the passage of oil tankers out of the Persian Gulf through the Strait of Hormuz which would disrupt 30% of seaborne-traded crude oil.⁶⁹

The EU and USA are currently working on strategies to ensure access to a set of minerals which will be vital to the future technological economy, including lithium. The top three nations holding deposits of battery minerals are Australia, then China and Brazil in third place. According to a report in *The Financial Times*, ‘rather than tensions with the Middle East, the advent of the electric car will usher in greater friction with China.’⁷⁰ That would make Australia’s role particularly important, as China is our key trading partner and we are a key competitor in battery and other strategic ‘new economy’ minerals.

ETHICS OF BATTERIES

One of the important emerging problems for electric vehicles and other technologies that use lithium batteries is that they mostly rely on cobalt that comes from the Democratic Republic of Congo (DRC), where it is mined in conditions that are often unregulated, exploitative and dangerous. Most of the world’s cobalt comes from the

⁶⁷ ‘Clean power is shaking up the global geopolitics of energy’, *The Economist*, 2018, <<https://www.economist.com/special-report/2018/03/15/clean-power-is-shaking-up-the-global-geopolitics-of-energy>> [accessed 23 July 2018].

⁶⁸ H Sanderson, ‘The geopolitics of electric cars will be messy’, *Financial Times*, 23 May 2018, <<https://www.ft.com/content/eb23bec8-5ce6-11e8-9334-2218e7146b04>> [accessed 23 July 2018].

⁶⁹ ‘Trump’s War of Words With Iran Shines Spotlight on Vital Oil Route’, *Bloomberg.com*, 2018, <<https://www.bloomberg.com/news/articles/2018-07-23/trump-war-of-words-with-iran-shines-spotlight-on-vital-oil-route>> [accessed 26 July 2018].

⁷⁰ Sanderson.

DRC and it has 50% of known global reserves; Australia has the second largest deposit, at 17%⁷¹.

Amnesty International has documented the problem of human rights abuses in cobalt mining in the DRC in detail.⁷² The issue is that at least one fifth of cobalt exports originate in 'artisanal' mines. Amnesty International explains;

Artisanal miners operating outside of authorized mining zones typically lack basic protective or safety equipment, such as respirators, gloves or face protection, and do not enjoy legal protections nominally provided by the state. Those involved with artisanal mining frequently suffer from chronic illnesses, as well as from serious and potentially fatal respiratory diseases due to prolonged exposure to dust containing cobalt and other metals. Researchers found children as young as seven who scavenged for rocks containing cobalt.⁷³

There are two solutions to this problem; improve mining conditions in the DRC and eliminate the use of cobalt in lithium batteries. The mining conditions issue is being dealt with directly in the DRC through work with the government and miners and also indirectly through public pressure and engagement with companies that purchase lithium, especially the large consumer brands such as Microsoft.

The technological solution is to use another kind of lithium battery chemistry. Cobalt is used in the cathode (the positive terminal) of batteries and this currently makes up around 42% of global demand.⁷⁴ There are already several demonstrated alternatives to cobalt-based cathodes for lithium batteries and we may see more manufacturers including global brands moving to these new chemistries in the future.⁷⁵ Even if this happens, cobalt would still be in demand for other applications such as alloys, catalysts and pigments so the human rights issues in DRC will remain important.

MINE REHABILITATION

The recent 'Lithium Valley' report from Regional Development Australia contains extensive recommendations for the Federal and West Australian governments. There is one major area omitted from the recommendations in that report, which is mine rehabilitation.

⁷¹ RDA, p.53.

⁷² AI, *Time to Recharge*, London, Amnesty International, 2017.

⁷³ AI, p.4.

⁷⁴ 'BU-310: How does Cobalt Work in Li-ion?' *Battery University*, 2018, <http://batteryuniversity.com/learn/article/bu_310_cobalt> [accessed 23 July 2018].

⁷⁵ RDA, p.101.

It is important that any boom in electric vehicle and related minerals and materials does not leave a negative environmental legacy for future generations. This should be dealt with properly in any national mining policy.

The Australia Institute has found that there is scant reliable data on the full extent of the mine rehabilitation in Australia, so it is very hard to determine the scale of the challenge.⁷⁶ The report found;

- There is no comprehensive database of the environmental rehabilitation of mining sites in Australia
- There are between 460 and 2,944 mines in operation currently
- Governments hold around \$10 billion in environmental bonds
- There are between 206 and 972 mines in care and maintenance
- There are perhaps 60,000 abandoned mining sites⁷⁷

Recommendation

Any development of mining for batteries and all other minerals should include proper provision for mine rehabilitation.

⁷⁶ R Campbell et al., *Dark side of the boom*, Canberra, The Australia Institute, April 2017.

⁷⁷ Campbell et al, pp.4-13.

Conclusion

The Select Committee into Electric Vehicles is very timely.

Political conflict in July 2018, between America and Iran is highlighting yet again that the world's addiction to oil makes it a source of economic and military risk. A transition to electric vehicles would reduce our reliance on oil imports and have other economic, social and environmental benefits. It should help reverse the rise in emissions resulting from petroleum consumption for transport.

The batteries in our fleet of electric vehicles could potentially become a major resource for the NEM, helping us make the transition away from coal to renewable energy. Vehicle-to-grid services can include grid storage also deliver for frequency regulation and related reliability markets.

Australia had a vehicle manufacturing sector for over a century. It may very well be possible to rejuvenate the industry to make electric vehicles and this should be investigated as a matter of priority by the Federal Government.

There is considerable economic value in the mining and processing of Australia's considerable reserves of lithium and other minerals used in batteries. If the global rise of electric vehicles causes a local mining boom, it should be managed properly so it benefits the economy over the long run, respects Native Title and provides adequately for mine rehabilitation.

With smart policies to encourage public charging infrastructure and well-designed incentives for electric vehicle purchase, such as the French Bonus-Malus scheme, we should be able to increase the purchase of electric vehicles in Australia considerably.