Chapter 3

Increased EV uptake and use—benefits and challenges

Introduction

3.1 This chapter outlines the benefits and challenges associated with increased uptake in electric vehicles (EVs) and manufacturing opportunities in Australia.

Benefits

3.2 There are a range of economic, environment and social benefits that would result from an increased uptake in EVs that are widely known and have been canvassed in a number of recent reports.[1] These impacts are briefly summarised below.

Economic

3.3 A number of submissions highlighted the broad economic benefits of an increased uptake in EVs for both owner-operators of EVs, and the mining and manufacturing sectors.[2] A report titled *Recharging the economy: the economic impact of accelerating electric vehicle adoption* (PwC Analysis) was recently completed by PwC on behalf of the Electric Vehicle Council, NRMA and the St Baker Innovation Fund. This report found that if EVs made up 57 per cent of new car sales by 2030 there could be an increase in real GDP of $2.9 billion and an increase in net employment of 13 400 jobs, and an additional investment of $3.2 billion in charging infrastructure. These projections were based primarily on consumer savings and the rollout of charging infrastructure; however, the report did not consider the economic benefits to local manufacturing or investment in Australian electricity generation and transmission assets.[3]

3.4 The Australian Electric Vehicle Association (AEVA) of Victoria also claimed that significant savings would be made available to the economy as a reduction in liquid fuel costs:

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1 See, for example: International Energy Agency, *Global EV Outlook 2018*, May 2018, https://webstore.iea.org/global-ev-outlook-2018; PwC, *Recharging the economy: The economic impact of accelerating electric vehicle adoption*, March 2018, (PwC, 'Recharging the economy', March 2018), http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/Recharging-the-economy.pdf ; Victorian Legislative Council Economy and Infrastructure Committee, *Inquiry into electric vehicles*, (May 2018), https://www.parliament.vic.gov.au/eic/inquiries/article/3507; NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, https://www.parliament.nsw.gov.au/researchpapers/Documents/electric%20vehicles%20in%20NSW.pdf (accessed 15 August 2018).

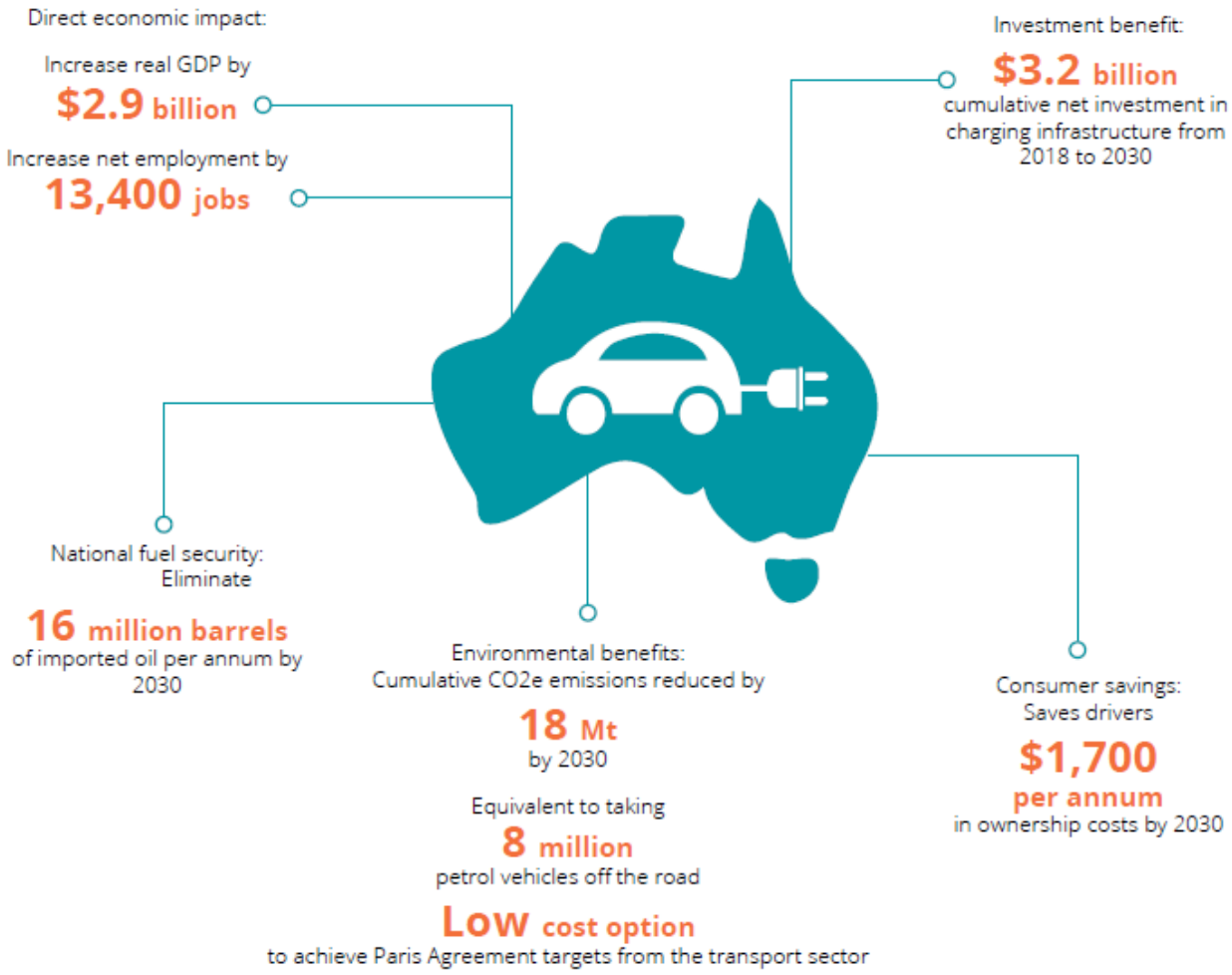
2 For example: Associate Professor Tim Nelson, Chief Economist, AGL Energy Ltd, *Committee Hansard*, 31 August 2018, p. 79; Ms Sarah Fumei, Project Manager, ClimateWorks Australia, *Committee Hansard*, 17 August 2018, pp. 60–61.

3 PwC, 'Recharging the economy', March 2018, p. 6. See also: AGL Energy, *Submission 55*, p. 3.

Direct fuel cost savings of $500M per year and $100M in maintenance costs for every 1 million electric cars in the national fleet. A potential $7.8 billion per year saving for 80% penetration. Up to $15 billion per year in fuel import replacement and benefit to the balance of payments, with $8 billion transferred to the local economy, and a subsequent improvement to fuel security against disruption.[4]

3.5 The economic impacts associated with an increased uptake of EVs, as projected by the PwC Analysis, are summarised in Figure 3.1.

Figure 3.1: Projected economic benefits of high EV uptake in Australia between 2018 and 2030[5]



3.6 The Queensland Government cited the opportunities for 'new green jobs' such as those created at local Queensland EV charging infrastructure manufacturer, Tritium.[6]

4 PwC, 'Recharging the economy', March 2018. See also: AEVA (Victoria), *Submission 9*, p. 2.

5 PwC, 'Recharging the economy', March 2018, p. 4.

The EV owner-operator

3.7 There are also a number of economic impacts at the EV owner-operator level. Currently, the upfront cost of an electric car exceeds the cost of an internal combustion engine (ICE) equivalent. The Victorian Department of Environment, Land, Water and Planning (DELWP) acknowledged the comparatively high upfront cost as a significant barrier to EV sales.[7] Mr Daniel Hilson, Founder and Managing Director at Evenergi, explained his company's research on the cost of owning and operating an EV:

> Our research has shown that there's about a $5,000 gap in terms of the total cost of ownership of electric vehicles over five years, and that's based on quite an extensive model that we've built.[8]

3.8 Notwithstanding this, the purchase price of EVs is expected to fall in line with expected decreases in the costs of lithium-ion batteries.[9] The Victorian Automobile Chamber of Commerce (VACC) reasoned that on current trends in battery pricing, consumers could expect price parity by 2025 and could be 'up to 15 per cent cheaper than equivalent' ICE vehicles by 2030[10] based on EVs 'having a lower cost to produce based on raw materials and a less complex drivetrain'.[11] Bloomberg New Energy Finance projected that EVs would reach price parity with ICE by 2024.[12]

3.9 In their recent report, the Electric Vehicle Council made the following observation in relation to projected purchase prices of EVs:

> Over the coming year, Nissan, Renault and Hyundai will join Tesla in introducing new electric vehicle models in Australia priced between $35 000 and $50 000. While a new car is not affordable for many Australians, the increased availability of vehicles at these prices will broaden the market, with fleet vehicles then entering the secondary market.[13]

3.10 The Committee also heard evidence that EVs are subject to greater depreciation of value than their ICE counterparts because of concerns about rapid

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6 Queensland Department of Transport and Main Roads, *Submission 43*, p. [2].

7 Victorian Government Department of Environment, Land, Water and Planning, *Submission 129*, p. 7. See also: Queensland Department of Transport and Main Roads, *Submission 43*, p. [2].

8 Mr Daniel Hilson, Founder and Managing Director, Evenergi, *Committee Hansard*, 31 August 2018, p. 57.

9 Dr Jacek Jasieniak and Prof. Mainak Majumder, Monash Energy Materials and Systems Institute, Monash University, *Submission 128*, p. 2.

10 VACC, *Submission 26*, p. 9.

11 Victorian Government Department of Environment, Land, Water and Planning, *Submission 129*, p. 7.

12 Bloomberg New Energy Finance, *Submission 127*, p. 5.

13 PwC, 'Recharging the economy', March 2018, p. 10.

technological development rendering older models obsolete and concerns about the longevity of battery life.[14] Mr Behyad Jafari, Chief Executive Officer of the Electric Vehicle Council stated that the global experience is that these issues are resolved with increased EV uptake:

> Depreciation is an issue because there's not a lot of data available, and people are asking questions like: what is the risk associated with reselling an electric vehicle? These are things that are being overcome globally that haven't been overcome in Australia.[15]

3.11 However, once a motorist has purchased a vehicle, the on-going operation and maintenance costs of an EV are significantly less than that of an ICE vehicle. The Tesla Owners Club of Australia noted that an EV has 'around 20 moving parts' as opposed to closer to 2000 in an ICE vehicle.[16]

3.12 The Electric Vehicle Council found that drivers could save $2 326 per annum in ownership costs as 'EVs are less costly to maintain and run'.[17] Associate Professor Tim Nelson, Chief Economist at AGL Energy remarked:

> Over a 10-year ownership period, UBS estimate the total cost of ownership to be $5,000 less for EVs relative to internal combustion engine vehicles by 2021, and $11,000 less by 2025 as battery prices fall. This translates to projected savings of $1,700 per annum by 2030. Total consumer savings over the entire period are estimated to reach $14 billion.[18]

3.13 Fuel costs are a significant driver of the savings—an EV will cost around 3 cents per kilometre compared to around 10 cents per kilometre for an ICE equivalent (see Figure 3.2 below for more costs). Depending on the electricity price sensitivity (low to high pricing) and based on current petrol prices, the savings can range from $4.72/100km (high electricity price) to $11.04/100km (low electricity price) or the equivalent of $0.50 per litre.[19]

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14 See, for example: Bus Industry Confederation, *Submission 68*, p. 3. Professor Mainak Majumder, Department of Mechanical and Aerospace Engineering, Monash University, *Committee Hansard*, 31 August 2018, p. 41.

15 Mr Behyad Jafari, Chief Executive Officer, Electric Vehicle Council, *Committee Hansard*, 17 August 2018, p. 21.

16 Tesla Owners Club of Australia, *Submission 28*, p. 4. See also: Department of the Environment and Energy, *Submission 72*, p. 3.

17 Associate Professor Tim Nelson, Chief Economist, AGL Energy Ltd, *Committee Hansard*, 31 August 2018, p. 79.

18 Associate Professor Tim Nelson, Chief Economist, AGL Energy Ltd, *Committee Hansard*, 31 August 2018, p. 79.

19 Queensland Department of Transport and Main Roads, *Submission 43*, p. 2. See also: NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, p. 5, https://www.parliament.nsw.gov.au/researchpapers/Documents/electric%20vehicles%20in%20NSW.pdf (accessed 15 August 2018).

3.14 Regenerative braking also brings about operating and cost efficiencies for EV owners as the car is able to recover battery charge through braking.[20] Mr Karl Gehling, Head of Corporate Communications and Government Relations at Mitsubishi Motors Australia explained:

> Basically what happens is, if the car is ever on a downhill descent or in a coastal situation, then it collects the kinetic energy from the electric motors and puts that back into the batteries. That increases the EV driving range, which is amazing technology.[21]

3.15 Although these vehicle operating savings flow to the consumer, it does result in less business for automotive service and fuel retailers, which is discussed later in the chapter.

3.16 The Committee also heard that EV owners and drivers were being penalised through the application of additional demand charges on the use of public charging infrastructure. Mr Rodger Whitby, Chief Executive Officer of St Baker Energy Innovation Fund argued that if an EV 'plugs in at home versus down the street, it should aggregate to only one payment and not be two separate payments'.[22] Furthermore, Fast Cities Australia reasoned that a demand charge exemption for public chargers would assist in encouraging EV uptake.[23]

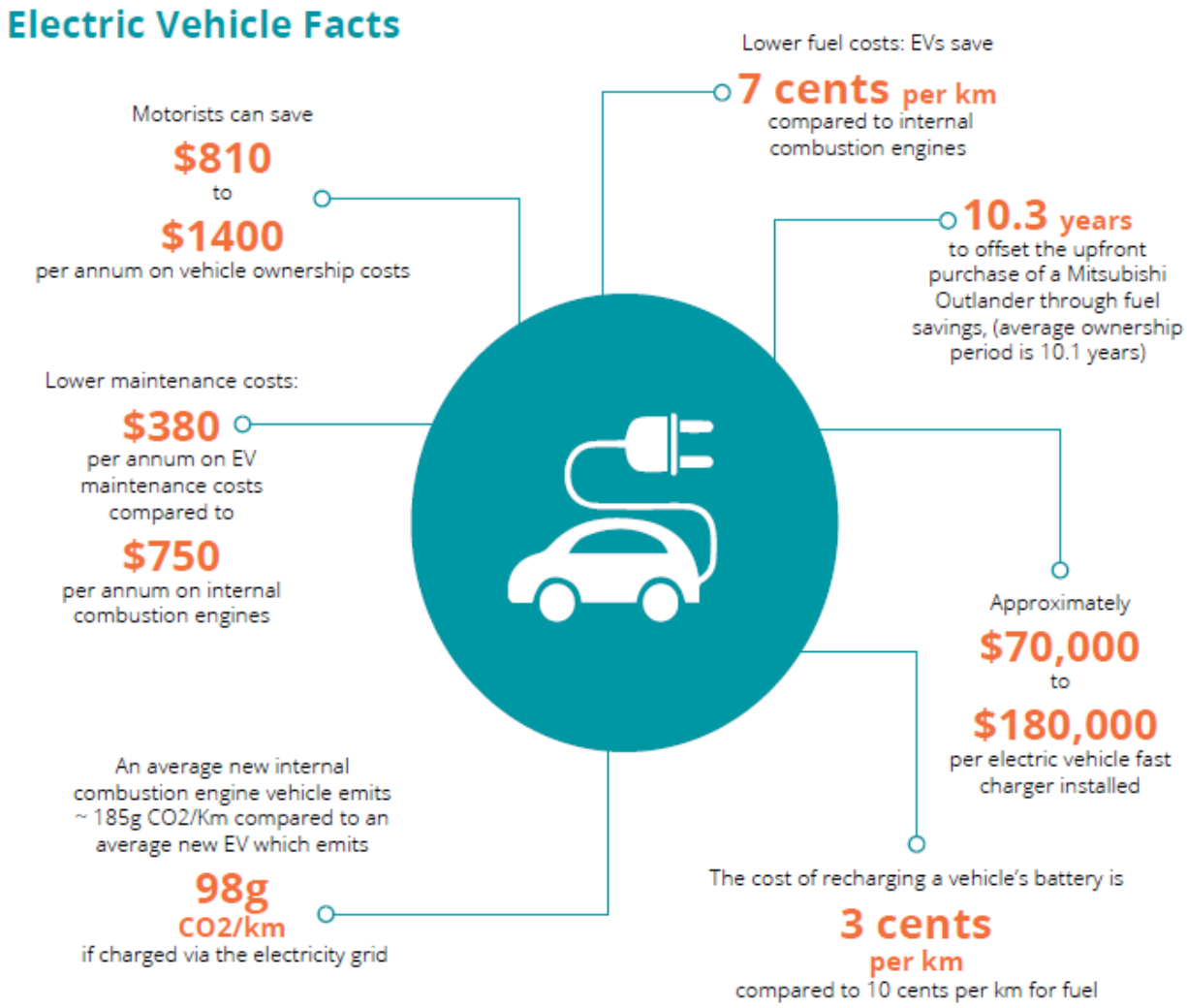
20 Resonant Solutions, *Submission 61*, p. 4.

21 Mr Karl Gehling, Head of Corporate Communications and Government Relations, Mitsubishi Motors Australia, *Committee Hansard,* 10 August 2018, p. 3.

22 Mr Rodger Whitby, Chief Executive Officer, St Baker Energy Innovation Fund, *Committee Hansard*, 27 September 2018, p. 28.

23 Fast Cities - answers to questions taken on notice from public hearing in Brisbane on 27 September 2018 (received 19 October 2018).

Figure 3.2: Projected electric vehicle operation costs and savings for Australian motorists[24]



Mining and manufacturing

3.17 The Committee has heard that Australia has a number of natural advantages that could support mining and manufacturing opportunities in relation to EV lithium-ion batteries. In its submission, the Association of Mining and Exploration Companies highlighted that Australia has large reserves of the minerals required to make lithium-ion batteries and outlined the advantages that Australia has in this area:

- Australia currently mines over 60 per cent of the world's lithium by value;
- Australia has all of the other minerals necessary to progress further down the lithium ion battery value chain;

24 PwC, 'Recharging the economy', March 2018, p. 5.

- Lithium spodumene, which is mined in Australia, is over 10% cheaper to process to lithium hydroxide than brine, which is more common internationally;
- The economics of developing further lithium hydroxide processing facilities in Western Australia is sufficient for four companies, including two of the world's largest lithium companies (Tianqi and Albermarle), to have invested;
- Currently, independent research suggests 89% of the battery precursor material processing occurs in China, thus Australia may stand to benefit from any international interest in geopolitical diversification; and
- The processing and manufacturing of battery precursors, components and final products is dependent on quality, precision and robotics rather than cheap labour and assembly line processing.[25]

3.18 Professor Peter Newman affirmed this view, and expanded on the value-adding opportunities beyond commodity mineral extraction and export activities, referring to a 2018 report titled *Lithium Valley: Establishing the Case for Energy Metals and Battery Manufacturing in Western Australia*:

> The need for quality battery metals means that processing of minerals is now happening in WA close to the mining so that shipping is minimised and high quality product can be made through highly automated production systems. Three new plants are being built.
>
> The next phase of this remarkable opportunity for Australia is to continue to develop the full value chain of battery metals from mining and processing to battery manufacture, battery use and battery recycling as set out in the report.[26]

3.19 The Committee also heard about the development of lithium-ion battery manufacturing facilities in the Northern Territory and Queensland (Townsville).[27] Mr Brian Craighead, Director of Renaissance Energy, spoke optimistically about the advantages that Australia has and the future of manufacturing in this country:

> I have personally been in several different electronic vehicle start-up manufacturing facilities around the world. They're small, they're lean, they're clean and they are more about smarts [than] design beauty. Scale isn't the advantage it once was. It's intelligence and design and customisation for market. For me, that works perfectly with the advantage

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25 AMEC, *Submission 20*, p. [1].

26 Professor Peter Newman AO, *Submission 23*, p. 1. See also: Regional Development Australia Perth, *Lithium Valley: Establishing the Case for Energy Metals and Battery Manufacturing in Western Australia*, 2018, https://www.rdaperth.org/rda-projects/lithium-valley/ (accessed 15 October 2018).

27 Mr Brian Craighead, Director, Energy Renaissance, *Committee Hansard*, 27 September 2018, pp. 11 & 13.

> here in Australia, We have very smart folks. We have the raw materials we need all within our walled garden. Pretty much every single raw material required to construct an electronic vehicle is within our walled garden of Australia, and that's quite unique. We've got the smarts, certainly. So, for me, it was really about: if the opportunity is there, the demand is there.[28]

3.20 Several witnesses and submitters expressed a view that Australia should look at its advantages and strategically manufacture in areas of competitive advantage in the supply chain.[29] Professor Mainak Majumder, Department of Mechanical and Aerospace Engineering at Monash University argued:

> The next question is: should we manufacture EVs in Australia? My opinion would be no, because there are already companies rolling out products, but we can be selective about this opportunity. We can identify and support areas of strength instead of joining the mass manufacturing bandwagon. In summary, I believe opportunities may lie in leveraging the strengths we have in our innovation and intellectual capability by finding and developing niches which can play well in this upcoming world.[30]

3.21 Throughout this inquiry, the Committee has visited and heard from a number of successful Australian manufacturers associated with the EV industry. The Victorian Branch of the AEVA highlighted that electric trucks and buses were currently being assembled in Australia by companies such as Victorian-based AVAAS and SEA.[31] The issues in relation to developing mining and manufacturing industries associated with EVs are explored further in chapter 4.

Environment—reducing greenhouse gas emissions

3.22 The Department of the Environment and Energy stated that 'transport, predominantly light vehicles, is the second largest source of greenhouse gas emissions (GHG) in Australia behind electricity', contributing about 19 per cent of Australia's total emissions.[32] The department further noted that:

> Under current policies, transport sector emissions are projected to steadily increase to 112 million tonnes CO_2-e by 2030 (a 15 per cent increase from present levels)…due to population and economic growth, with cars and light commercial vehicles projected to remain the sector's largest source of emissions.[33]

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28 Mr Brian Craighead, Director, Energy Renaissance, *Committee Hansard*, 27 September 2018, pp. 11.

29 See, for example: Mr Tony Wood, Director, Energy Program, Grattan Institute, *Committee Hansard*, 31 August 2018, p. 13; Australian Productivity Council, *Submission 7*.

30 Professor Mainak Majumder, Department of Mechanical and Aerospace Engineering, Monash University, *Committee Hansard*, 31 August 2018, p. 39.

31 Australian Electric Vehicle Association—Victoria, *Submission 9*, p. 2.

32 Department of the Environment and Energy, *Submission 72*, p. 5. See also: Australian Government Department of the Environment and Energy, *Quarterly update of Australia's National Greenhouse Gas Inventory: September 2017* p. 14.

33 Department of the Environment and Energy, *Submission 72*, p. 5.

3.23 Primarily these emissions reflect the combustion of petroleum-based fuels with 58.4 per cent of fuels being used by light passenger vehicles; and the balance, 41.6 per cent, being used by commercial and heavy vehicles.[34]

3.24 The PwC Analysis observed that Australia's transport sector would have to reduce its emissions profile in order for Australia to meet its commitments under the United Nations Framework Convention on Climate Change as agreed in Paris on 12 December 2015:

> Assuming the electricity sector meets its target emissions reductions, further contributions from transport and other sectors would be required to meet the overall national Paris commitment, as emissions from the electricity sector make up one third of total emissions.[35]

3.25 The PwC Analysis found if 57 per cent of new cars were EVs by 2030, there would be a cumulative reduction in CO_2 emissions of 18 million tonnes—the equivalent of removing 8 million petrol vehicles off the road.[36] Analysis from the International Energy Agency noted that in Europe, electric cars 'emitted about 50 per cent less than gasoline cars and 40 per cent less than diesel cars' when their fuel use (electricity or gasoline) was taken into account. Importantly, when the entire life-cycle of the car (including manufacturing, use and disposal) was considered, there was a reduction in GHG emissions of 30 per cent for EVs.[37]

3.26 The Queensland Government submitted that 'EVs charged on Queensland's current electricity grid, emit around 25 per cent less than a fossil fuel vehicle' noting that this will improve as Queensland 'works towards its target of 50 per cent renewable energy by 2030'.[38]

3.27 Although increased uptake of EVs leads to a reduction in GHG emissions from direct fossil fuel combustion as alluded to above, an important consideration becomes the source of electricity used to recharge the EVs. A NSW Parliamentary Research Paper highlighted that currently 'electricity generation in Australia is highly reliant on coal and other fossil fuels'.[39] Furthermore, 'charging EVs from high fossil fuel electricity networks generates more GHG emissions than charging EVs from low

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34 ABS 9208.0, *Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016*, http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/9208.0Main+Features112%20months%20ended%2030%20June%202016?OpenDocument (accessed 16 July 2018).

35 PwC, 'Recharging the economy', March 2018, p. 7. See also: United Nations Framework Convention on Climate Change, *The Paris Agreement*, https://unfccc.int/process#:a0659cbd-3b30-4c05-a4f9-268f16e5dd6b (accessed 6 November 2018).

36 PwC, 'Recharging the economy', March 2018, p. 6, http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/Recharging-the-economy.pdf (accessed 26 November 2018). See also: St Baker Energy Innovation Fund, *Submission 59*, p. 2.

37 International Energy Agency, 'Global EV Outlook 2018', May 2018, p. 58.

38 Queensland Department of Transport and Main Roads, *Submission 43*, p. [2].

39 NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, pp. 7–8.

fossil fuel electricity networks'.[40] In the Australian context, Tasmania emits the lowest GHG emissions due to its high reliance on hydroelectricity and other renewable sources for its electricity generation.[41] Whilst Victoria is the only jurisdiction where an EV's GHG emissions slightly exceed that of an average ICE due to the state's high reliance on brown coal generation.[42]

3.28 The Australia Institute (TAI) acknowledged the impact of electricity generated from brown coal on EV 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. For example, a very powerful electric vehicle [Teslas] charged in Victoria today will be responsible for relatively high emissions compared with the national fleet average for internal combustion engine vehicles, because brown coal burned in that state produces a lot of carbon dioxide per unit of energy generated.[43]

3.29 TAI has put forward the counter-argument noting that an increased demand for electricity stemming from increased EV uptake would lead to a requirement for additional or marginal electricity production. TAI observed:

> 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.[44]

Air pollutants and public health

3.30 The Committee has heard that increased use of EVs can also lead to a reduction in local air pollutants. Hobsons Bay Council noted that 'electric vehicles due to their electric motors emit less air pollutants than' ICE vehicles.[45] The Centre for Air pollution, energy and health Research expanded:

> Conventional vehicles with internal combustion engines are a major source of ground level air pollutants such as carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter (PM). Air pollution has severe adverse effects on health that can lead to premature mortality. The replacement of conventional vehicles with electric vehicles may result in a range of

40 NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, pp. 7–8.

41 NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, pp. 7–8. See also: Australian Productivity Council, *Submission 7*, p. 3.

42 ClimateWorks, *Submission 46.1*, p. 26.

43 TAI, *Supplementary Submission 1*, pp. 15–16.

44 TAI, *Submission 1*, p. 2.

45 Hobsons Bay Council, *Submission 52*, p. 3.

> environmental, health, and climate benefits due to possible reductions in ground level pollutants as well as greenhouse gas emissions.[46]

3.31 Dr Liz Hanna set out the impact of air pollution on health at a global scale:

> The World Health Organisation (WHO) reports that over 4.2 million deaths a year are linked to exposure to outdoor air pollution, and children are particularly susceptible. The WHO 2018 Fact Sheet on Air Pollution finds 9 out of 10 people worldwide breathe polluted air, almost all urban residents on the planet. Air pollution causes 24% of all stroke deaths (1.4 million deaths annually), 25% of global heart disease deaths (2.4 million deaths), and 43% of all lung disease and lung cancer deaths (1.8 million deaths every year).[47]

3.32 Dr Ingrid Johnson stated that 'air pollution from vehicle emissions results in thousands of deaths and yet the technology exists to massively reduce this pollution through the use of no-emissions [EVs]'.[48] ClimateWorks referred to research demonstrating the impact reduced vehicle emissions could have:

> Through reducing air pollution, the transition to electric vehicles will also have benefits for health. In their submission to the Australian Government's discussion paper on fuel quality standards, the Clean Air and Urban Landscape Hub and the Melbourne Energy Institute estimate that air pollution due to vehicle emissions caused 1 715 deaths in Australia in 2015, a number larger than the national road toll for the same year. Given that electric vehicle adoption is likely to be concentrated in metropolitan areas of Australia, where population densities are at their highest, there is strong potential for reductions in urban air pollution and meaningful benefits to community health.[49]

3.33 Dr Hanna estimated that the economic cost of air pollution from the transport sector to be as high as $17.4 billion in 2018. This cost takes into account:

> the economic burden on families for days, weeks and years and from premature deaths. It means (a) they lose their earning capacity (b) the society misses all the effort and cost that was put into their training and expertise, and (c) the society misses the additional contribution that people make to society not only as productive workers but in mentoring, parenting and caring et cetera.[50]

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46 Centre for Air pollution, energy and health Research, *Submission 63*, pp. 2–3. See also: Tesla, *Submission 92*, p. [6].

47 Dr Liz Hanna, *Submission 3*, p. 3.

48 Dr Ingrid Johnston, Senior Policy Officer, Public Health Association of Australia, *Committee Hansard*, 17 August 2018, p. 39.

49 ClimateWorks, *Submission 46*, p. 2. See also: Queensland Government Department of Transport and Main Roads, *Submission 43*, p. 2; Doctors for the Environment, *Submission 50*, p. 4; Department of the Environment and Energy, *Submission 72*, pp. 4–5.

50 Dr Liz Hanna, Senior Fellow, Fenner School of Environment and Society, and Climate Change Institute, Australian National University, *Committee Hansard*, 17 August 2018, p. 39.

3.34 Dr Hanna noted that some of the long term negative effects of air pollution on humans still remain unknown:

> You can draw the corollary to lead and lead petrol. Initially, we thought blood lead levels were okay and kiddies wouldn't have cognitive impairment. Of course, as more and more research came out, the safe levels in the regulations came down and down. We realised that exposure was harmful even at lower levels. Again, it gets back to…actually needing the work to be able to do it. It would be impossible to think that, as new research was done, we'd find out that it's actually less harmful. Without question, with everything we do, when we go and find out we find it's not as safe as we thought.[51]

3.35 Concerns were expressed that the benefits of using no-emissions EVs may be reduced if the electricity were sourced from fossil fuels. The panel argued that if the power generated to recharge the EVs is from fossils fuels, then 'that's only going to remove the health effects from one site [roads] to another site [fossil fuel power generator]'.[52]

Noise

3.36 Many submitters and witnesses pointed out that EVs have the benefit of emitting less noise than their ICE equivalents.[53] A NSW Parliamentary Research Paper also highlighted the potential for reduced traffic noise due to increasing EV uptake:

> EVs at slower speeds are virtually silent, as they have no internal combustion engine and the only noise emitted from their electric motors is a barely perceptible high-pitched frequency. EVs do produce noise from wind resistance and tyre-road contact, but this noise only becomes perceptible at higher speeds.[54]

3.37 However, low levels of noise may 'pose an additional risk to pedestrian safety'. A recent paper identified that EVs are 'very difficult for [pedestrians who are vision impaired] to detect and respond to as they are unable to rely on their other sensory modalities such as hearing, to navigate when it is safe to cross roads.

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51 Dr Liz Hanna, Senior Fellow, Fenner School of Environment and Society, and Climate Change Institute, Australian National University, *Committee Hansard*, 17 August 2018, p. 41.

52 Professor Guy Marks, Chief Investigator, Centre for Air Pollution, Energy and Health Research, *Committee Hansard*, 17 August 2018, p. 40. See also: Dr Liz Hanna & Dr Ingrid Johnston, *Committee Hansard*, 17 August 2018, p. 40.

53 See, for example: Ms Michelle English, Associate Director, Sustainability, City of Adelaide, *Committee Hansard*, 10 August 2018, p. 48; Dr Matthew Stocks, Research Fellow, College of Engineering and Computer Science, Australian National University, *Committee Hansard*, 17 August 2018, p. 10; Hyundai Motor Company, *Submission 103*, p. [6].

54 NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, pp. 4–5.

Similarly, detection concerns have also been raised about cyclists'.[55] The paper also put forward a broad range of recommendations to address this issue including regulatory reform to fit acoustic alert systems and advanced driver assistance systems to EVs in order to avoid collisions with pedestrians.[56]

Fuel security—national security and resilience

3.38 A number of submitters highlighted the economic and national security implications of Australia's current reliance on imported oil.[57] The Victorian Government Department of Environment, Land, Water and Planning (DELWP) noted that 'Australia is increasingly reliant on imports for its liquid fuels' with 91 per cent of transport oil and 67 per cent of total oil imported. This makes 'Australia vulnerable to potential supply disruptions and to unexpected changes in demand from other customers in Asia'.[58] DELWP described the impact of EV uptake on Australia's reliance on oil imports:

> Electric vehicle adoption can help address the issue of fuel security. As Australia is vulnerable to a disruption to transport fuel supplies due to the current and increasingly high oil and fuel import dependency, local production of electricity as [a] fuel source for electric vehicles will decrease our international reliance on oil and enhance our fuel security. Analysis developed by ClimateWorks in its 2016 report, *The path forward for electric vehicles in Australia*[,] indicates that the increase of electric vehicles into the Australian fleet, consistent with the pathway to zero net emissions by 2050, would increase fuel stocks from 18 to 21 days in 2030, and 16 to 20 days in 2050 compared to a business as usual baseline. Oil/fuel imports would decrease 16% in 2030 and 28% in 2050.[59]

3.39 Air Vice-Marshall John Blackburn AO (Retired), a noted fuel security expert, told the Committee that:

> Electric vehicles could play a significant role by improving our energy security by reducing the demand for foreign sourced oil and fuels and by

55 Dr Sara Liu, Associate Professor Michael Fitzharris, Associate Professor Jennie Oxley, Mr Chris Edwards, *The impact of electric/hybrid vehicles and bicycles on pedestrians who are blind or have low vision*, Monash University Accident Research Centre and Vision Australia, October 2018, p. 10, http://apo.org.au/system/files/197121/apo-nid197121-1026741.pdf (accessed 17 October 2018).

56 Dr Sara Liu, Associate Professor Michael Fitzharris, Associate Professor Jennie Oxley, Mr Chris Edwards, *The impact of electric/hybrid vehicles and bicycles on pedestrians who are blind or have low vision*, Monash University Accident Research Centre and Vision Australia, October 2018, p. 13.

57 See, for example: 350 Canberra, *Submission 21*, p. 5; AEVA, *Submission 6*; AGL Energy, *Submission 55*.

58 Victorian Government Department of Environment, Land, Water and Planning, *Submission 129*, p. 6.

59 Victorian Government Department of Environment, Land, Water and Planning, *Submission 129*, p. 6.

providing a significant increase in the transport system resilience in the event of a fuel supply disruption.[60]

Challenges

3.40 Notwithstanding the considerable benefits of increased EV uptake, there are a number of associated challenges including range anxiety, a declining fuel excise revenue base, changes to demand and supply on the electricity grid, and industry transition including a reshaping of the job market.

Range anxiety

3.41 Concerns have been raised about range anxiety linked to limited charging infrastructure, particularly in non-metropolitan areas.[61] Although it is expected that most EV recharges are undertaken at home or at a workplace, concerns stem from the relatively shorter driving ranges of current model EVs—ranging from 150km to 489km on one charge—and the current dearth of charging infrastructure, both geographically and in total—there are 783 public charging stations compared to 6 400 petrol stations with multiple bowsers.[62] The majority of these stations are 'slow charging AC stations', with a little under one-tenth being 'fast charging DC stations'.[63] As noted in Chapter 2, newer fast charge stations enable close to full charging in as little as 15 minutes allowing travellers to recharge and undertake the next leg of their journey.

3.42 Mr Ali Asghar, Senior Associate at Bloomberg New Energy Finance told the Committee that many automakers are 'introducing more cars with longer driving ranges', further noting that 'greater model availability and reduced range anxiety should attract a larger consumer base for electric vehicles'.[64] The Committee notes the imminent release to market of a number of more affordable, longer range EVs such as the Hyundai Ioniq Electric, Nissan Leaf, and the Volkswagon I.D.[65]

3.43 Plug-in Hybrid Electric Vehicles (PHEV) can be seen as a viable transition technology to alleviate range anxiety as public charging infrastructure is built:

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60 Air Vice-Marshall John Blackburn AO (Retired), *Committee Hansard*, 18 October 2018, p. 20.

61 See, for example: Mr Adrian Dwyer, Chief Executive, Infrastructure Partnerships Australia, *Committee Hansard*, 31 August 2018, p. 27; Mr Ali Asghar, Senior Associate, Bloomberg NEF, *Committee Hansard*, 31 August 2018, p. 11.

62 Knight Frank Research and Consulting, *NSW Service Stations Insight*, February 2017, p. 1, https://www.knightfrank.com.au/resources/commercial/service-stations/kf_nsw-service-stations-insight-feb17.pdf (accessed 26 November 2018).

63 NSW Parliamentary Research Service, *Electric Vehicles in NSW*, May 2018, p. 9.

64 Mr Ali Asghar, Senior Associate, Bloomberg New Energy Finance, *Committee Hansard*, 31 August 2018, p. 7.

65 James Wong, 'EV Onslaught: 10 Electric Cars Coming By 2021—Update', *CarAdvice*, 17 April 2018, https://www.caradvice.com.au/618789/ev-onslaught-10-electric-cars-coming-by-2021/ (accessed 28 November 2018).

> PHEVs with electric range aligned with the typical day-to-day usage of the vehicle should be given especially close consideration in this respect. They will deliver the vast majority of benefits (economic, environmental, and social), without any issues around range anxiety caused by a lack of public charging infrastructure in the early days of the transition. Beyond its electric range, a PHEV functions very much like a typical petrol vehicle. The PHEV can be considered a stepping-stone on the journey to a future which is more fully electric.[66]

3.44 The issue of public charging infrastructure and consumer education will be discussed later in the report.

Fuel excise revenue

3.45 The Committee heard that one of the consequences of an increasing EV fleet and the corresponding reduction in liquid fuel consumption would be a decrease in the federal fuel excise tax. Mr Adrian Dwyer, Chief Executive Officer of Infrastructure Partnerships Australia noted that more EVs would 'drive a rapid and terminal decline in the major funding base for Australia's road network'.[67] Mr Dwyer noted recent trends associated with fuel excise:

> According to the [Parliamentary Budget Office], fuel excise has fallen from 1.6 per cent of GDP in 2001–02 to one per cent in the year 2016–17. At the same time, the number of vehicle kilometres travelled on Australian roads has increased to 250 billion. In short, revenue is going down while consumption is going up. This is the exact opposite of a good funding model. While fuel excise is not directly hypothecated, it's clear that a declining revenue base will not support the investment required to meet increasing demand for our road networks.[68]

3.46 Mr Steve Bletsos, Senior Research Analyst at VACC highlighted that fuel excise is 'roughly $16 billion per annum and that money has to come from somewhere' if it is not coming from excise.[69] The Committee has received evidence on a replacement scheme known as a road user charge—a distance based tax that would apply to all vehicles regardless of propulsion type.

3.47 The federal government has acknowledged the challenges around revenue in this space, and, in 2016 instigated a study into how road user charging might be

66 NHP, *Submission 95*, p. 4.

67 Mr Adrian Dwyer, Chief Executive Officer, Infrastructure Partnerships Australia, *Committee Hansard*, 31 August 2018, p. 25.

68 Mr Adrian Dwyer, Chief Executive Officer, Infrastructure Partnerships Australia, *Committee Hansard*, 31 August 2018, p. 25.

69 Mr Steve Bletsos, Senior Research Analyst, VACC, *Committee Hansard*, 31 August 2018, p. 78.

implemented as a replacement to fuel excise.[70] The Committee has not received evidence indicating significant progress since 2016.[71]

3.48 Dr Jake Whitehead of the University of Queensland identified 'public resistance' as the main challenge to implementation of a road user charge.[72] Dr Whitehead explained the current system and how it would translate into a road-user charge, and the challenges that a road user charge would need to overcome:

> At the moment we have fuel excise in terms of standard fossil fuel vehicles, and that effectively is a proxy for both how far people travel and how fuel-intensive their vehicles are. With electric vehicles, obviously they don't pay fuel excise, so there's been a lot of discussion about bringing in a per-kilometre charge. But what you see is that, in cases where that has been undertaken, you can have some pretty significant equity impacts. Obviously, in a country like Australia, where we have a significant population outside of urban areas, if we are charging them purely based on how far they travel, that's going to have a much more significant financial impact on them as opposed to those individuals who are driving in urban areas. The reality is, though, that it's those drivers in urban areas who are causing the greatest cost to society through congestion but also much higher emissions through that kind of stop-start-idle traffic.[73]

3.49 Road user charging will be discussed further in Chapter 5.

The electricity grid—energy demand and grid stability

3.50 An increased uptake of EVs would displace the transport sector's fuel source from petroleum to the electricity network, placing a range of unprecedented demands on the grid. The International Energy Agency made the point that 'power demand and road mobility demand are both characterised by peaks during morning and evening hours and a period of low demand during night time'.[74] The former Minister for the Environment and Energy, Hon Josh Frydenberg MP quantified this extra demand:

> An extra one million electric cars is the equivalent of 5.2 terawatt hours of power demand. This is about a 2 per cent increase in overall grid demand.[75]

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70 Mr Alex Foulds, Executive Director, Surface Transport Policy Division, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 17 August 2018, p. 73.

71 Mr Alex Foulds, Executive Director, Surface Transport Policy Division, Department of Infrastructure, Regional Development and Cities, *Committee Hansard*, 17 August 2018, p. 73.

72 Dr Jake Whitehead, Research Fellow, School of Civil Engineering, University of Queensland, *Committee Hansard*, 27 September 2018, p. 50.

73 Dr Jake Whitehead, Research Fellow, School of Civil Engineering, University of Queensland, *Committee Hansard*, 27 September 2018, p. 50.

74 International Energy Agency, *Global EV Outlook 2018*, May 2018, p. 56.

75 Hon Josh Frydenberg MP, 'Standby, Australia, for the electric car revolution', *The Sydney Morning Herald*, 12 January 2018, https://www.smh.com.au/opinion/stand-by-australia-for-the-electric-car-revolution-20180112-h0hazy.html (accessed 15 July 2018).

3.51 In its supplementary submission, Infrastructure Australia (IA) stated that EVs will have 'negligible effects on grid consumption' over the next five years, but that this demand is then expected to grow over the next 5–10 years:

> [Australian Energy Market Operator] AEMO [forecasts] that electric vehicles will begin to have sizeable impacts on consumption. In this period, consumption is forecast to increase at an annual average rate of approximately 1.3%. [The *Independent Review into the Future Security of the National Electricity Market* conducted by the Chief Scientist Dr Alan Finkel] found a 20% EV uptake could account for 4% of grid demand. Extrapolating on that figure, 100% uptake could account for [an additional] 20% of grid demand.[76]

3.52 It is likely that most of the power for EVs will be drawn from the grid—unless it is powered by on-site solar panels and batteries. During week days, most of the charging events are likely to occur when people return home from work for the day, potentially resulting in peak EV charging coinciding with the peak energy use period of the day.[77] This raises questions about additional generating capacity and how EV owners can be incentivised to charge during off-peak periods.

3.53 In addition to the abovementioned issues there will also be an impact on the transmission system as more electricity is demanded by households and public chargers. This may push the grid to its operating limits, hence requiring upgrades to substations and transmission infrastructure. Equally, this may lead to, and require a more coordinated approach to vehicle charging.

3.54 Energy Networks Australia (ENA), the peak national body representing gas distribution, electricity transmission and distribution businesses, noted that 'Australia's distribution networks were not designed for any significant uptake of electric vehicles and the consequential demand for charging'.[78] ENA flagged mass EV charging events at existing peak times such as when people arrive home from work at 5–6pm on an extremely hot day as a potential issue with the following effects:

- Exacerbation of electricity consumption peaks.
- Exceedance of low voltage (suburban) network capacity, causing poor reliability or restrictions on EV charging.[79]

3.55 IA stated that 'making sure EVs do not contribute to peak demand is crucial to keeping network costs down for consumers and taxpayers'.[80]

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76 Infrastructure Australia, *Submission 79.1*, p. 2. See also: Alan Finkel, Karen Moses, Chloe Munro, Terry Effeney, Mary O'Kane, *Independent Review into the Future Security of the Energy Markey: Blueprint for the Future*, June 2017, https://www.energy.gov.au/sites/g/files/net3411/f/independent-review-future-nem-blueprint-for-the-future-2017.pdf (accessed 7 November 2018).

77 Energy Networks Australia, *Submission 60*, pp. [2–3].

78 ENA, *Submission 60*, p. [2].

79 ENA, *Submission 60*, pp. [2–3].

80 Infrastructure Australia, *Submission 79.1*, p. 2.

3.56 AEMO stated that the lack of visibility on the location of distributed energy resources (DER) such as EVs, solar panels and home batteries make it difficult for AEMO to 'manage power system security in the short term and longer term'.[81] AEMO elaborated:

> Impacts of lack of visibility include barriers to operational planning and inefficiencies in asset utilisation, market operation, or investment decision-making, which ultimately lead to additional costs borne by consumers.[82]

3.57 AEMO is currently 'undertaking a broad [DER] work program to assess and address the challenges and opportunities of changing consumer behaviour'.[83]

3.58 There is an expectation that increased small-scale and large-scale solar photovoltaic (PV) will lead to an accentuated generation peak during the day.[84] There is also a potential role for EVs to charge during periods of low demand and discharge battery power into the grid at times of high demand.[85] In an answer to a question on notice, AEMO provided the Committee with a graph that outlined how the use of batteries (both stationary and mobile EVs) could assist in flattening out the demand and supply curve.

81 AEMO, *Submission 38*, p. 1.

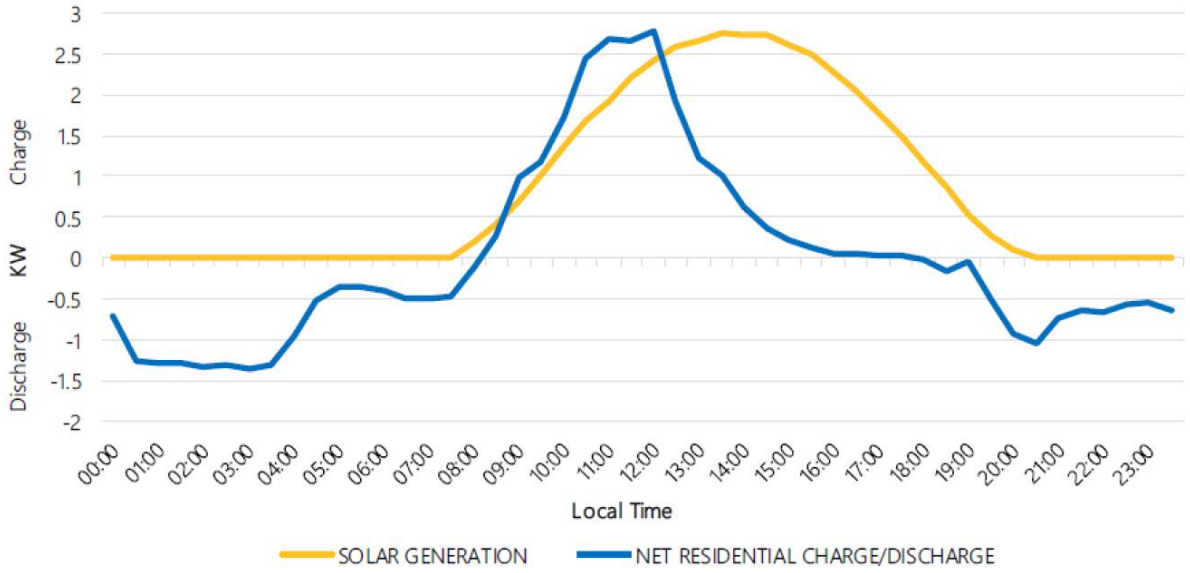
82 AEMO, *Submission 38*, p. 2.

83 AEMO, *Submission 38*, p. 1. See also: Australian Energy Market Operator - answers to questions taken on notice from public hearing in Melbourne on 31 August 2018 (received 27 September 2018), p. 4.

84 ENA, *Submission 60.1*, pp. 100–103.

85 Tesla Owners Club of Australia, *Submission* 28, p. 4. See also: Victorian Legislative Council Economy and Infrastructure Committee, *Inquiry into electric vehicles*, May 2018, pp. 19–21, https://www.parliament.vic.gov.au/eic/inquiries/article/3507 (accessed 15 July 2018).

Graph 3.1: National Energy Market battery charge and discharge profile overlaid with PV generation[86]



3.59 IA flagged that by 2030, there would be significant residential (small-scale) generation and storage:

> By 2030–31 AEMO estimates that consumers could have as much as 33,136 MW of solar PV and 4,969 MW of battery storage, as well as the battery capacity of their electric vehicles.[87]

3.60 ENA advised that changing consumer behaviour around charging would need to involve the use of incentives through changes to tariffs. For instance, modifications to flat tariff structures are required to incentivise consumers to move away from convenience charging at peak times to making vehicle batteries available for both charging during peak generation times and discharge during lower generation and higher demand periods.[88]

3.61 In addition to a projected increase in peaking requirements and overall electricity demand AEMO also raised the challenges in locating and establishing public charging equipment. [89]

3.62 Using fast chargers 'requires on-demand power similar to an industrial facility'.[90] For example, 'a large, fast charging station in a rural area will have a much greater impact on the surrounding network than charging stations in metropolitan areas' noting the following considerations:

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86 Australian Energy Market Operator - answers to questions taken on notice from public hearing in Melbourne on 31 August 2018 (received 27 September 2018), p. 4.

87 Infrastructure Australia, *Submission 79.1*, p. 3.

88 ENA, *Submission 60*, pp. 1–2. See also: Infrastructure Australia, *Submission 79.1*, p. 3.

89 AEMO, *Submission 38*, p. 3.

90 Infrastructure Australia, *Submission 79.1*, p. 2.

> The planning of public charging infrastructure needs to be closely coordinated with AEMO and network operators in order to:
>
> - Understand any limitations on the local network.
> - Determine technical requirements to effectively interface with the network at each location.
> - Understand requirements for any supporting technical infrastructure such as batteries.
> - Identify network areas where public charging infrastructure may provide benefits.
> - Determine efficient network connection processes.
> - Standardise regulation and technical standards for infrastructure.[91]

3.63 In its submission, TAI affirmed this view focusing on the need for coordinated EV charging to optimise the supply and demand of electricity. Coordinated charging would prevent [EV] charging from increasing the size of afternoon and evening peaks' and would 'shift the charging periods overnight to "fill" the demand "valley", when electricity is cheaper'.[92]

3.64 The *Electricity Network Transformation Roadmap: Final Report* found 'that there is a need to redefine the structure and architecture of the electricity system to meet the requirement for flexibility and agility in the future grid'.[93] IA highlighted that 'there could be a need for an [electricity sector] investment between $2.2 billion and $9.7 billion by 2046'.[94]

3.65 IA argued:

> With the right frameworks in place, electric vehicles will be useful grid assets whose benefits will increase the more electric vehicles are adopted. EVs used in a smart network could be used as a short-term storage of excess, off-peak electricity generated from renewable sources that could flexibly be dispatched [to] counteract peak demand. They could also be used for local, residential consumption.[95]

3.66 Transgrid suggested that by 2040 EVs could provide up to 350GWh of storage, and observed:

> If aggregated effectively, this level of storage could play a significant role in providing grid stability and ancillary services, with 350 GWh[,]

91 AEMO, *Submission 38*, p. 3.

92 The Australia Institute, *Submission 1.1*, p. 14.

93 ENA, *Submission 60.1*, p. 69.

94 Infrastructure Australia, *Submission 79.1*, p. 2.

95 Infrastructure Australia, *Submission 79.1*, p. 4.

> equivalent to the proposed capacity of the Commonwealth Government's Snowy 2.0 project.[96]

3.67 The impact of EV charging on the grid will be explored further in Chapter 5.

Industry transition

3.68 Earlier in the report, the Committee highlighted the projected net increase of 13 400 jobs as a result of an increased uptake in EVs.[97] Notwithstanding the increased job opportunities in EV sales, servicing, components and charging infrastructure, the paradigm shift away from an oil-based logistics, parts and servicing transportation system will result in job losses and negatively affect some businesses in these sectors.

3.69 Motor Trades Association of Queensland (MTAQ) explained the fundamental changes to the automotive sector resulting from the uptake of EVs:

> Business models in most cases will require profound changes to adapt to the progressive change in vehicle propulsion technology. There is likely to be extensive structural change needed within the automotive value chain that will have repercussions for the transport sector and the national economy.[98]

3.70 One submitter described a 'seismic shift in the fuel distribution network in Australia' arguing that major fuel retailers will be significantly affected:

> Fuel retailers will have difficulty competing with the convenience and cost of cheap home charging even if they install DC charging stations in local service stations. Most local service stations will disappear because electric cars will charge in homes.[99]

3.71 An August 2018 report from Infrastructure Victoria into automated and zero emissions vehicles infrastructure found that there would be a 25 per cent reduction in ongoing maintenance requirements for battery electric vehicles and nearly 11 000 job losses nationally in the fuelling sector.[100]

3.72 The VACC submission put forward a Victorian perspective on projected job losses of up to 6 000 as EV uptake increases and lower demand is experienced in sectors associated with ICE vehicles and then not replaced in the sectors associated with EVs. VACC highlighted that nearly 6 000 job losses and 2 000 automotive business closures are projected by 2030 if there is a high uptake of EV (20 per cent). These losses are projected across fuel retailing (910 jobs), automotive repair and maintenance (1 900 jobs), motor vehicle parts retailing (1 370 jobs) and car wholesaling and car retailing (1 200 jobs). The projected losses and closures are about halved under a scenario where 10 per cent of new cars are EVs by 2030.[101] The

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96 Transgrid, *Submission 90*, p. 4.

97 Electric Vehicle Council, *Submission 100*, p. 16.

98 Motor Trades Association of Queensland, *Submission 41*, p. [3].

99 Name withheld, *Submission 86*, p. 6.

100 Infrastructure Victoria, *Submission 88.1*, p. 46.

101 VACC, *Submission 26*, pp. 9–10.

primary reasons for the net loss of jobs relate to lower liquid fuel demand and lower servicing requirements for EVs discussed earlier in the chapter.

3.73 Noting the risk of job losses, the City of Adelaide highlighted the importance of supporting and encouraging the 'motor trades sector to transition to electric vehicle sales, servicing and potentially business models, such as car share and mobility as a service, which may result in lower levels of private car ownership'. Notwithstanding this commercial and industrial transformation, MTAQ was mindful that there would be significant new opportunities through the new propulsion technologies combined with emerging trends such as automation and car sharing.[102]

Concluding comment

3.74 Australia is on the cusp of the most significant disruption and transformation of our transport system since the advent of the internal combustion engine. Taking into account the evidence received during this inquiry, the Committee is optimistic about the environmental, economic, public health and national security benefits that increased uptake of EVs will bring to Australia. Reductions in greenhouse gas emissions, cost savings for vehicle owner-operators, increased job opportunities and economic growth, improved health outcomes and increased fuel security are just some of the benefits that Australia can realise as EV use begins to climb.

3.75 Notwithstanding the overwhelming benefits of increased EV use, the Committee is cognisant of some of the challenges that are emerging as Australia moves away from an oil-based transportation system towards EVs. A continued erosion of the fuel tax excise, questions about how we plan and manage our electricity generation and transmission, and transitional arrangements for employees and businesses reliant on the ICE vehicle are just some of the challenges that need to be met.

3.76 The Committee considers that the benefits of EV uptake are not to be taken for granted; likewise, the challenges that we now face will also not be resolved in the absence of a coordinated strategy. The pathway forward that seizes the opportunity and manages the risks of an EV future is discussed in Chapter 5.

102 MTAQ, *Submission 41*, p. [3].