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The state of electric vehicles in Australia

SECOND REPORT:
DRIVING MOMENTUM IN ELECTRIC MOBILITY

ClimateWorks AUSTRALIA

ELECTRIC VEHICLE COUNCIL

Acknowledgement

The report is written by ClimateWorks Australia on behalf of the Electric Vehicle Council, the national body representing the electric vehicle industry in Australia. The Electric Vehicle Council represents members involved in providing, powering and supporting electric vehicles, with a mission to accelerate the electrification of road transport for a more sustainable and prosperous Australia.

ClimateWorks Australia is an expert, independent adviser, acting as a bridge between research and action to enable new approaches and solutions that accelerate the transition to net zero emissions by 2050 for Australia and Asia Pacific countries. It was co-founded in 2009 by The Myer Foundation and Monash University and works within the Monash Sustainable Development Institute.

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Electric vehicle momentum is growing

This was reflected in the market growth, technology developments and policy ambition seen in 2017. Globally, there was a 56 per cent increase from 2016 to 2017 in sales volumes and there are now more than 3 million electric vehicles on the road.[1] There were also significant technological shifts in 2017 with a number of new lower cost models coming to market[2], along with continued decreases in electric vehicle battery costs.[3] Further, several countries have announced their intention to ban the sale of petrol and diesel vehicles[4] and a number of global automakers have put forward extensive plans to electrify vehicles.[5]

While Australia still trails behind global leaders in electric vehicle uptake, we have seen a number of small but important shifts across a range of electric vehicle indicators in 2017.

Over the past year we have seen a significant increase in media interest in electric vehicles. This occured alongside notable growth in electric vehicle sales.

There were 2,284 electric vehicles sold in Australia in 2017, representing a 67 per cent increase from the previous year. The number of electric vehicle models available for sale in Australia has also increased by 44 per cent from 2016 to 2017. While the majority of these new models have been in the more expensive vehicle segments, there are nine new plug-in hybrid and battery electric vehicle models expected to be introduced into the Australian market over the next 18 months. Five of these are expected to be priced at $60,000 or less.

The number of charging stations in Australia has also substantially increased, with a 64 per cent increase from 2017 to 2018. This currently equates to approximately one charging station for every six electric vehicles.

An important consideration for electric vehicles and charging infrastructure is the source of electricity used to power the vehicle. Analysis across all states and territories in Australia shows that an average electric vehicle charged from the grid in 2016 emitted less than an average internal combustion engine vehicle in all states except Victoria, where it is only slightly higher.

1 International Energy Agency (2018)
2 The Tesla Model 3, 2018 Nissan Leaf and Chevy Bolt were all launched internationally in 2017.
3 A Bloomberg New Energy Finance survey (2017) stated that lithium-ion battery packs were selling for an average price of US$209 a kilowatt-hour at the end of 2017, down 24 per cent from 2016 and about a fifth of the 2010 price.
4 Countries include China, France, Germany, India, Ireland, Israel, the Netherlands, Norway, Scotland, Taiwan, and the UK.
5 Volvo announced all its models introduced in 2019 and beyond would be hybrid or electric. BMW announced that by 2025 it would have 12 new battery electric vehicles (BEVs) and 13 new hybrids on the road.

In surveying 1,086 residents of Victoria, New South Wales and the Australian Capital Territory, respondents were asked, if they owned or were considering purchasing an electric vehicle, how they would source their electricity to charge their vehicle. 15 per cent answered that they would purchase electricity from the grid using a standard electricity contract, while an additional 15 per cent would purchase electricity from the grid with a green power or emissions offset contract. A further 32 per cent of respondents said they would consider solar and battery storage options.

Respondents were also asked about perceptions of government policies on electric vehicle uptake. They rated subsidies to reduce the purchase cost of electric vehicles, subsidies for the installation of home charging infrastructure, and provision of public charging infrastructure as the most important issues which policy should address.

There have been some notable policy developments in Australia over the past 12 months, occurring mainly at a state, territory and local government levels. These developments have been key to changing the narrative around policy support, and will help to address barriers regarding recharging concerns and consumer awareness. Today, the majority of state and territory governments across Australia have either announced or are developing an overarching electric vehicle policy framework or strategy. A Memorandum of Understanding (MoU) regarding Sub-National Collaboration on Electric Vehicles was also signed by a number of state, territory, capital city local governments and industry groups.

Introduction

The state of electric vehicles in Australia **report is an annual report providing an up-to-date assessment of the state of Australia's electric vehicle industry. The second edition of this report tracks Australia's progress towards a lower emissions, more cost effective light vehicle fleet.**

This report follows and builds on the structure of the previous report, covering four main sections and providing updated data for 2017 against a range of indicators and market barriers to electric vehicle uptake:

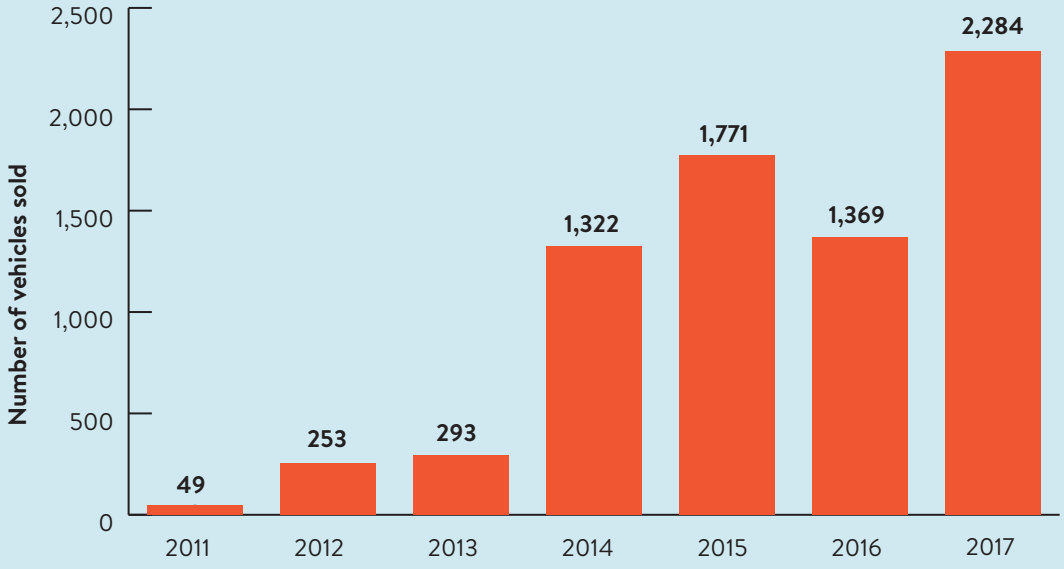
1. **Electric vehicle uptake in Australia**, including electric vehicle sales numbers from 2011 to 2017, both by jurisdiction and market segment. This section also provides an overview of historical, current and future model availability in Australia. An assessment of the second-hand electric vehicle market has been added in this report, providing comparisons and lessons learned from more established international markets;
2. **Charging Infrastructure**, reviewing the roll out of electric vehicle charging infrastructure across Australia by state and location. We have included data around the emissions intensity of electric vehicles when charged off the grid, by state and territory;
3. **Consumer attitudes**, the online survey was expanded in this report with both the Royal Automotive Club of Victoria (RACV) and the National Roads and Motorists' Association (NRMA) surveying residents of Victoria, New South Wales and the Australian Capital Territory about their perceptions of electric vehicles. The survey collected a total of 1,086 responses, with the results being consistent across jurisdictions surveyed this year and with the results outlined in the previous year's report; and
4. **Electric vehicle policy in Australia**, reviewing implemented and proposed policy across federal, state and territory jurisdictions. We have also included a brief assessment of the types of policies that would address key barriers and support the uptake of electric vehicles at the local government level.

1. Electric vehicle uptake in Australia

The year 2017 marked a step-change in the global uptake of electric vehicles, spearheaded by governments proposing targets to ban the sale of petrol and diesel vehicles and increased investment from industry. Australia's Macquarie Bank said that 2017 was the year that electric vehicles became mainstream[6], with the International Energy Agency noting an increase of 56 per cent globally from 2016 to 2017, to reach sales volumes of over 1 million in 2017. Internationally, there are now more than 3 million electric vehicles on the road.[7]

Albeit on a smaller scale, these percentage increases were mirrored in Australia with electric vehicle sales increasing 67 per cent from 2016 to 2017. In 2017, Australians purchased 1,076 plug-in hybrid electric vehicles, and 1,208 battery electric vehicles so these now make up 0.2 per cent of the Australian market.[8] The national increase in electric vehicle sales may be linked in part to an increase in the range of models available in 2017. It is worth noting too, that the majority of these new models were in the higher price range and were plug-in hybrid electric vehicles (see Model Availability section below). The significant increase in battery electric vehicles may also be attributed to the arrival of vehicles ordered in previous years.

Figure 1. Electric vehicle sales in Australia, 2011-2017.



Source: V-Facts (2018); Numbers include estimated Tesla sales (see Footnote 8).

6 Business Insider Australia (2018)
7 International Energy Agency (2018)
8 V-Facts (2018); Electric Vehicle Council industry engagement.
Note: Tesla does not publicly release its sales figures and has not supplied these figures. As the Electric Vehicle Council's Tesla sales estimate is not disaggregated by state or buyer type, some analyses in this report do not include Teslas and this is noted where applicable.

Australia's states and territories differ in their rate of electric vehicle uptake (Figure 2). In the last seven years, Victorians have purchased the highest number of electric vehicles, with 1,324 vehicles purchased between 2011 and 2017 (excluding Tesla vehicle numbers). When taking into account market size however, the ACT continues to outperform other jurisdictions: in 2017, ACT residents purchased 21 electric vehicles for every 10,000 vehicles sold (Figure 2).

Business continues to be the largest buyer of electric vehicles at 63 per cent of total sales in 2017 (excluding Teslas). A full breakdown of this category was published by the National Transport Commission in their recent emissions intensity of new Australian light vehicles report[9], with this figure primarily including manufacturer fleets and dealer demonstrators. As detailed in our 2017 report, Australia's developing electric vehicle market has seen vehicle manufacturers use their own fleet and demonstrator vehicles for promotion and education. As the electric vehicle market continues to mature, the proportion of vehicles in this category is expected to decrease.

Private buyers also make up a substantial portion of the market, remaining constant at 34 per cent of total sales. In contrast, electric vehicle sales in government fleets remains limited, contributing only 3 per cent of total sales. The low level of government sales represents a missed opportunity for governments to use their greater purchasing power to encourage broader uptake of electric vehicles. Promisingly however, there are a number of fleets demonstrating best practice (see Melbourne Water Case Study).

Figure 2. Sales of electric vehicles for Australia's states and territories (excluding Teslas). Chart shows electric vehicles purchased per 10,000 vehicle sales in 2017 and total sales for 2011 - 2017.

Source: V-Facts (2018).

9 National Transport Commission (2018)

Case Study:

Melbourne Water's ten year plan to a zero emissions vehicle fleet

Committed to becoming carbon neutral by 2030, Melbourne Water has developed a plan to shift all its current operating fleet, including 392 passenger and light commercial vehicles, to electric vehicles. Adopting zero emissions vehicle technology will allow them to completely eliminate their current fleet-generated emissions of approximately 2,752 tonnes of CO_2 per year.

Melbourne Water recognises that both electric vehicles and the required infrastructure are developing rapidly in Australia. A broader range of electric vehicle models will continue to be developed by most major manufacturers, and with this will come decreases in costs and improved capacity of batteries. Melbourne Water has identified several benefits of adopting electric vehicles to achieve their zero emissions vehicle fleet:

* **Total cost of ownership of electric vehicles is predicted to be lower** than that of internal combustion engine vehicles by 2025.[10] Melbourne Water is aware that electric vehicle technology has shown rapid development and prices have tended to decline even faster than predicted;
* Due to their simplicity and few moving parts (about 100 times less compared to typical internal combustion engine cars), electric vehicles require relatively **little servicing** and have **longer life** than petrol or diesel fuelled vehicles. In fact, detailed analysis conducted by Melbourne Water found that the operating life cycle of electric vehicles is expected to be more than double, compared to a typical internal combustion engine vehicle;
* Electric vehicles will lead to overall **cost savings** from maintenance services and fuel use. Melbourne Water has estimated costs savings of approximately $2,000 to $3,000 per year per electric vehicle in its fleet; and
* Aligned with Melbourne Water's commitment to provide its employees with the safest vehicles possible, new model electric vehicles tend to incorporate the latest in **safety** technology.

10 Bloomberg New Energy Finance (2017)

With all these benefits in mind, Melbourne Water has established a detailed annual plan to achieve a 100 per cent electric vehicle fleet by 2027. They will progressively roll out electric vehicles at a rate largely driven by suitability and model availability, and have projected all passenger vehicles will be electric by 2022. It is estimated that their light commercial vehicle fleet will achieve this goal by 2027.

To facilitate the transition, Melbourne Water is incorporating on-site charging infrastructure, with the first two chargers already installed at their Docklands Head Office. On site charging stations are also scheduled for installation across key Melbourne Water sites in 2018. The installation of solar is also being considered, to support zero emissions charging.

Melbourne Water has stated that to meet its 10 year target, it is vital to start planning for its zero emission vehicle fleet now. This includes, monitoring, analysing and reporting emissions, joining lobby and industry groups, and engaging with manufacturers.

Melbourne Water has committed to purchasing zero emissions vehicles in all cases where available, over internal combustion engines. They have already purchased two Renault Zoes as the first two electric vehicles of the year, and plan to purchase an additional three vehicles to replace existing combustion engine powered vehicles in 2018. They are considering up to a 10 year life cycle for their electric vehicles, to offset capital costs and ensure commercial viability.

Melbourne Water is leading the industry by transitioning to a zero emissions vehicle fleet within 10 years, as part of a 'drive' to be fully carbon neutral by 2030.

Source: Melbourne Water 2018.

Model availability

When analysing the leading electric vehicle markets around the world, evidence continues to highlight the strong correlation between cumulative electric vehicle sales and the number of vehicle models on offer. A greater number of models available across a range of market segments can increase consumer choice and sales.

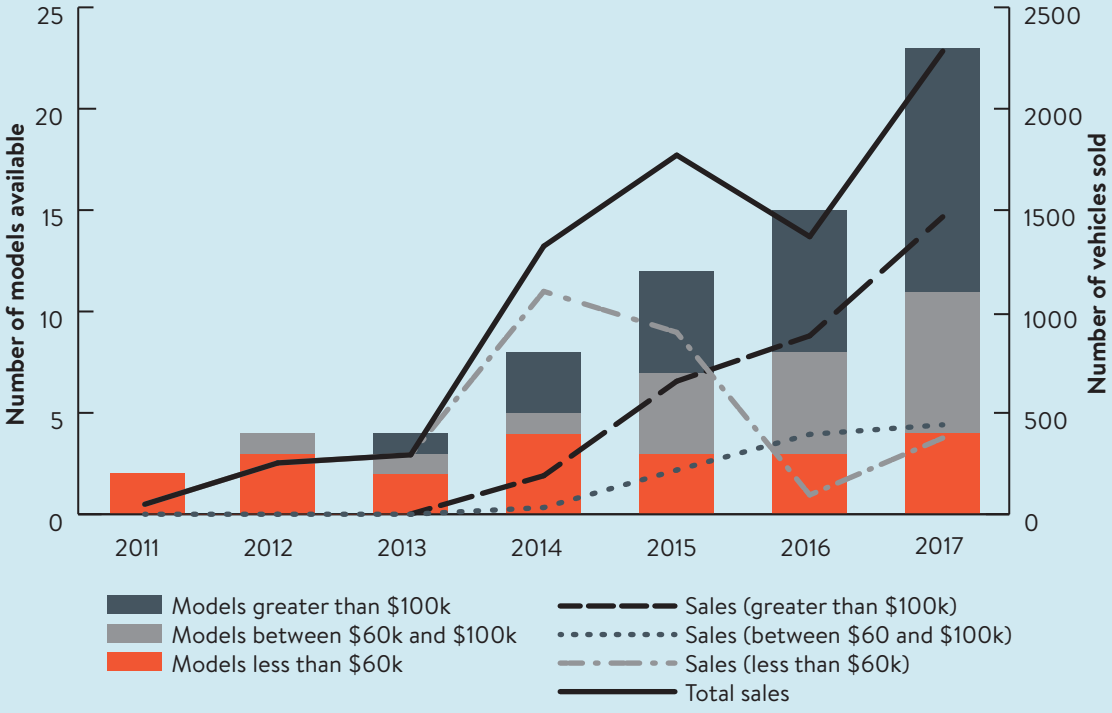
The number of electric vehicle models in Australia has continued to steadily increase over the last seven years, with the number of models available for sale increasing 44 per cent, from 16 in 2016 to 23 in 2017. The majority of this growth has come from the more expensive models, with 19 of the 23 models available priced at over $60,000 (Figure 3).

There has been significant growth in the total number of electric vehicle sales in 2017 (see Electric Vehicle Uptake section), driven largely by an increase in sales of vehicles in the higher price range. Interestingly, the previous year's report had speculated that the decrease in electric vehicle sales in 2016 may have been partially attributable to the low number of models available at less than $60,000. Data from 2017 however, highlights that a significant portion of the population is interested in electric vehicles as luxury vehicles. It is in these segments therefore, that we've seen the greatest growth, particularly as more models become available in the higher price ranges.

While these factors have been important to an overall increase in electric vehicle sales in 2017, sustained growth in electric vehicles sales and a move to a decarbonised transport sector in Australia will require more models to become available in the lower price ranges.

In 2017 there were four models available for less than $60,000: the Mini Cooper S E Countryman, the Mitsubishi Outlander, the Renault Kangoo ZE and the Renault Zoe. Note that the Mini Cooper was only available as a dealer demonstrator and the Renault Kangoo ZE and Renault Zoe were initially only available for fleet purchase.

Figure 3. Number of electric vehicle models available in Australia (including Teslas).



Source: Sales: V-Facts (2018), Tesla does not publicly release its sales figures and has not supplied these figures. Model availability: based on information published on Car Advice and Motoring.com.au.

Going forward, model availability in Australia is expected to continue to increase, with nine new plug-in hybrid and battery electric vehicle models expected to be introduced into the Australian market in the next 18 months. Five of these are expected to be priced at $60,000 or less (Table 1).

Table 1: Electric vehicle models available in Australia (including Teslas) previously, currently and in the future.

	MAKE	MODEL	SEGMENT	PRICE RANGE	YEAR AVAILABLE
No Longer Available	Holden	Volt	Small	low <$60k	2012 - 2015
	Mitsubishi	i-MiEV	Micro	low <$60k	2010 - 2013
	Nissan	LEAF Gen1	Small	low <$60k	2011 - 2016
Currently Available	Audi	A3 e-tron	Small	medium $60 - $100k	2015 - current
	BMW	330e	Medium	medium $60 - $100k	2016 - current
	BMW	530e	Large	high >$100k	2017 - current
	BMW	740e	Upper large	high >$100k	late 2016 - current
	BMW	i3 BEV & REX Gen1	Small	medium $60 - $100k	Nov-14 - 2016
	BMW	i3 BEV & REX Gen2	Small	medium $60 - $100k	2017
	BMW	X5 40e	SUV large	high >$100k	May-16 - current
	BMW	i8	Sports	high >$100k	early 2015 - current
	Mercedes-Benz	C350e	Medium	medium $60 - $100k	2015 - current
	Mercedes-Benz	C350T E	Medium	medium $60 - $100k	2015 - current
	Mercedes-Benz	E350E	Large	high >$100k	2017
	Mercedes-Benz	GLE500e	SUV large	high >$100k	Jul-16 - current
	Mercedes-Benz	S500e Gen2	Upper large	high >$100k	Jul-16 - current
	MINI Cooper	S E Countryman	SUV Small	low <$60k	Dealer demonstrator only, not for purchase
	Mitsubishi	Outlander PHEV	SUV medium	low <$60k	Apr-14 - current
	Porsche	Cayenne e-Hybrid	SUV large	high >$100k	Nov-14 - current
	Porsche	Panamera e-Hybrid	Upper large	high >$100k	Late 2013 - current
	Renault	Fluence	Small	medium $60 - $100k	Better Place 2012
	Renault	Kangoo ZE Gen2	Vans <= 2.5t	low <$60k	2017
	Renault	ZOE	Small	low <$60k	2017
	Tesla	Model S	Sports	high >$100k	Sep-14 - current
	Tesla	Model X	SUV large	high >$100k	Aug-16 - current
	Volvo	S90	Large	medium $60 - $100k	2017 - current
	Volvo	XC60 T8	SUV large	medium $60 - $100k	Late 2015 - current
	Volvo	XC90	SUV large	high >$100k	Late 2015 - current
Available In The Future	Audi	Q7 e-tron	SUV large	high >$100k	Early 2018
	Hyundai	Kona	SUV Small	low <$60k	2018/19
	Hyundai	Ioniq PHEV	Small	low <$60k	By end of 2018
	Hyundai	Ioniq BEV	Small	low <$60k	By end of 2018
	Jaguar	I-PACE	SUV medium	high >$100k	2018
	Mercedes-Benz	EQ C	SUV medium	medium $60 - $100k	2018/19
	Nissan	LEAF Gen3	Small	low <$60k	2018/19
	Range Rover	Sport P400e	SUV large	high >$100k	By end of 2018
	Tesla	Model 3	Medium	low <$60k	2018/19

Source: V-Facts (2018), and model availability based on information published on Car Advice and Motoring.com.au

A broad range of forecasts in electric vehicle uptake continue, however it is worth noting that 2017 saw some significant updates to previous predictions. Bloomberg New Energy Finance has projected that 530 million cumulative electric cars will be sold by 2040,[11] and the International Energy Agency more than doubled its previous estimate on global electric vehicle sales. The Organization of the Petroleum Exporting Countries (OPEC) increased its forecast for electric vehicle sales by 500 per cent compared to last year, and Exxon, BP and Statoil are all now expecting at least 100 million electric vehicles be on the road worldwide between 2030 and 2035.[12]

In considering electric vehicle forecasts, it is important to analyse market trends in combination with vehicle segment growth. Globally, purchasers continue to opt for SUV or crossover utility vehicles of all sizes over passenger sedans and hatchbacks.[13] This presents a potential issue in the short term, specifically for battery electric vehicles, as the majority of models currently on offer are compact five-door hatchbacks. It is in the larger vehicle segments however, that the most significant growth is expected (Table 1), with a number of plug-in hybrid and battery electric SUVs expected to become available on the Australian market in 2018 and 2019.

Second-hand market

Markets where there is greater uptake of electric vehicles tend to have greater availability of lower cost models to purchase new, along with a larger market for second-hand electric vehicles. In 2017, growth in Australia's electric vehicle sales was primarily seen in the luxury vehicle segment. For sustained growth however, we will need to see an increasing number of lower cost electric vehicle options become available to consumers.

To date, policy, research, pilot projects, and official information and guidance have tended to focus on the new electric vehicle market. Currently, the second-hand electric vehicle market in Australia is small, but as new electric vehicle uptake increases, a second-hand market will emerge. Policy-makers and industry should consider activities to foster this second hand market, as it will offer a lower cost option for buyers to purchase an electric vehicle.

In addition, a strong used vehicle market is essential for the stability of residual values, leading to a reduction in leasing costs for new vehicles and providing confidence for manufacturers to bring new models to market and increase sales volumes. Additional information and guidance around second-hand electric vehicles will play an important role in developing the market.

11 Bloomberg New Energy Finance (2017)
12 Greentech Media (2017)
13 Green Car Reports (2018)

2. Charging infrastructure

Around the world, the electric vehicle industry and policy-makers are working to better understand the relationship between public charging infrastructure and the uptake of electric vehicles.

A recent report by the International Council on Clean Transportation (ICCT) examined 350 cities around the world and found a positive correlation between the availability of charging infrastructure and the uptake of electric vehicles.[14] The ICCT concluded that while most electric vehicle drivers charge their cars at work or at home, public charging infrastructure forms an important part of the electric vehicle ecosystem. At the same time however, the level of public charging infrastructure required to encourage electric vehicle uptake may depend strongly on the urban planning characteristics of different cities around the world. For example, in the Netherlands, private parking is relatively rare and as such, there is one charging station for every two to seven electric vehicles. In California, drivers generally have access to home and workplace charging and therefore, the ratio equates to one charging station for every 25 to 30 electric vehicles.[15]

The number of charging stations in Australia has increased substantially, with a 64 per cent increase from 2017 to 2018 as data reveals that 476 charging locations available in 2017 has increased to 783 charging locations available in 2018.[16]

Table 2. Public charging infrastructure in Australia.

		ACT	NSW	NT	QLD	SA	TAS	VIC	WA
Total number of charging stations		20	161	5	162	76	21	216	122
Charging stations per 100,000 residents		3.17	2.04	2.03	3.27	4.40	4.02	3.40	4.72
Total #	AC	17	148	5	138	70	21	208	107
	DC	3	13	0	24	6	0	8	15
Total #	Capital City	20	86	3	58	32	4	114	77
	Regional	0	75	2	104	44	17	102	45

Source: PlugShare (2018) and Australian Bureau of Statistics (2018)

14 International Council on Clean Transportation (2017)

15 International Council on Clean Transportation (2017)

16 It is important to note that our data was drawn from the Plug Share website, which crowdsources data on electric vehicle charging infrastructure. There is no single resource in Australia that collates data on electric vehicle charging infrastructure, and as a result there may be some minor discrepancies in the total numbers provided in this report. We counted dedicated electric vehicle infrastructure, have applied a conservative approach to counting and have sense-checked samples of the data.

Of particular interest is the growth in the number of DC fast chargers in Queensland, from five in 2017 to 24 in 2018. This is largely the result of the Queensland Government's Electric Vehicle Superhighway initiative, which has rolled out 17 fast chargers between Coolangatta and Cairns.[17] The increase in charging infrastructure in South Australia, from 42 in 2017 to 76 in 2018 may also be linked to initiatives undertaken by the City of Adelaide (see Case Study below). The overall ratio of DC to AC chargers has remained the same, with about 90 per cent of charging locations offering slower AC charging.

In Australia, there is currently roughly one charging station for every six electric vehicles.[18] It is expected this ratio may change as electric vehicle numbers increase from current levels. A recent report by Energeia (2018) found there is currently no data available in Australia to show the proportion of drivers who would not have access to charging at home, and would therefore need to rely on public charging.[19] Energeia predicts that under the moderate intervention scenario, Australia will need close to 30,000 DC charging points to be deployed by 2040.[20]

Electric vehicles and the grid in Australia

A significant proportion of electric vehicle consumers consider where they source electricity to power their vehicle, choosing to install solar for charging or purchase green power to ensure zero emissions driving (see Consumer Attitudes section). When electric vehicles are charged directly from the grid, the emissions from power generation need to be considered to understand the environmental impact of electric vehicles.

Fuel sources used to generate electricity differ significantly between states and territories in Australia. Table 3 details the grams of CO_2 emitted per kilowatt hour (kWh) of electricity generated based on the fuel source generation mix for each state and territory.[21] Victoria continues to have the highest emissions intensity due to the higher proportion of brown coal generation[22], however this is expected to continue to decrease over time as the Victorian Renewable Energy Target is met. Tasmania has the lowest emissions intensity due to its use of hydro generation.

The average electricity consumption per kilometre driven for all electric vehicles sold in Australia in 2016 was calculated using and updated data from the Green Vehicle Guide Using this average of 0.173 kWh per km, combined with the grid emissions intensity by state and territory, the weighted average emissions intensity of all electric vehicles sold in 2016 in Australia can be calculated.[23]

Table 3: CO_2 emissions per kilometre for electric vehicles charged from the grid, by state and territory in Australia (including Teslas)

Grid intensity	ACT/ NSW	NT	QLD	SA	TAS	VIC	WA	Aus
grams CO_2 / kWh	830	640	790	490	140	1080	700	920
Weighted average of electric vehicles sold in 2016								
kWh / km	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173
g CO_2 / km	160	124	153	95	27	209	135	178

Source: V-Facts (2017) and Department of Energy and Environment (2017); Numbers include estimated Tesla sales (see Footnote 8)

17 Queensland Government (2017)
18 The number of electric vehicles was calculated based on those purchased between 2011 and 2017.
19 Energeia (2018)
20 Energeia (2018)
21 Department of Energy and Environment (2017)
22 The emissions intensity figure for 2016 in Victoria includes the closure of the Hazelwood Power Station in the Latrobe Valley in Victoria.
23 VFacts (2017) and ClimateWorks Australia (2017)

The average emissions intensity for all new vehicles in Australia in 2016 was 182 g CO_2/km[24], weighted for sales.[25] The analysis in Table 3 shows that an average electric vehicle charged from the grid in 2016 emitted less than an average internal combustion engine vehicle in all states except Victoria. The 2016 National Greenhouse Accounts Factors were used, as the updated 2017 figures were not released as the time this report was published.[26]

Another way to consider this same issue is by comparing an electric vehicle to an equivalent internal combustion engine vehicle for each state and territory. A comparison of the most popular electric vehicle models in Australia with similar internal combustion engine vehicles was also calculated.[27] This type of comparison introduces a range of new variables, as well as questions regarding what would be an appropriate electric vehicle and internal combustion engine vehicle comparison. These calculations yielded similar results as the state and territory comparison above, however with the BMW i3 and Tesla Model S emitting less than its comparable internal combustion engine vehicle in all state and territories, including Victoria, when charged from the grid in 2016.

It is also important to consider the emissions intensity of electric vehicles in the context of Australia's broader climate commitments. Australia is a signatory of the Paris Agreement, which commits countries to achieve net zero emissions by the second half of this century. In order to deliver on this commitment, Australia will need to completely decarbonise both its electricity and transport sectors. Electric vehicles are essential for the long-term decarbonisation of the transport sector, and charging from the grid will become progressively less emissions intensive as the penetration of renewables increases across Australia's electricity generation network.

24 Noting this figure is tailpipe rather than lifecycle emissions.
25 National Transport Commission (2017)
26 2016 data was used for this calculation, as the updated emissions factors for 2017 were not yet released.
27 The Nissan Leaf (2016), BMW i3 (2014-16) and Tesla Model S 75D (2016) were compared with the Toyota Corolla (2015), Mazda CX-3 (2015) and Mercedes-Benz C-Class C43 AMG (2016) respectively.

Case Study:

City of Adelaide accelerates EV uptake through charging infrastructure initiatives

The City of Adelaide has a vision for Adelaide to be the world's first carbon neutral city and has outlined how it will achieve this in their Carbon Neutral Adelaide Action Plan 2016-2021.

Transport emissions contributed over 27 per cent of total emissions for the City in 2017, with private vehicles representing the largest share of these emissions. Reducing transport emissions in a low density city with limited public transport services and a culture of private vehicle use presents significant challenges.

A number of opportunities are being pursued, to overcome these challenges and to support a move towards a zero emissions transport system. The Carbon Neutral Adelaide Action Plan 2016-2021 includes details on investments for electric vehicle charging infrastructure and a target to increase the number of publicly accessible electric vehicle recharge points in the city to 250 by 2020. Forty electric vehicle charging stations will be installed by mid-2018, with details of these initiatives outlined as follows:

World's first electric vehicle parking system

The City of Adelaide is constructing 20 electric vehicle charging bays at UPark car parks, that will utilise the new Internal Combustion Engine (ICE) to Electric Vehicle (EV) Parking System and pilot contactless payment.

The new ICE to EV Parking System combines occupancy sensors and overhead indicator lights to create an active parking management system, that matches electric vehicle parking space availability to actual demand in periods of high car park utilisation. By minimising potential lost revenue from vacant electric vehicle parking spaces and inconvenience to drivers of conventional internal combustion engine vehicles, the project will enable a rapid rollout of electric vehicle charging stations in off-street public car parks.

The project will pilot a contactless payment system to remove the need for drivers to pre-register with service providers, and the need for drivers to carry multiple membership cards to activate charging stations.

Behyad Jafari, Chief Executive Officer, EV Council (left) and Martin Haese, the Lord Mayor of Adelaide (right)

City of Adelaide Electric Vehicle Charging Hub

In September 2017, the City collaborated with SA Power Networks, Mitsubishi Motors Australia, Tesla and the Government of South Australia to construct the City of Adelaide Electric Vehicle Charging Hub.

Centrally located in Adelaide's CBD adjacent to the Adelaide Central Market, the Hub incorporates eight electric vehicle chargers which are compatible with all current plug-in hybrid and battery electric vehicle models available in Australia. The Charging Hub offers two hours free parking for electric vehicle owners.

On-street Electric Vehicle Charging Stations

Adelaide City Council in partnership with SA Power Networks is constructing ten on-street electric vehicle charging stations, including 4 stations in the Charging Hub.

The Carbon Neutral Adelaide partnership is helping SA Power Networks to develop and assess the benefits of active load control management and electricity distribution network demand tariff structures that could support higher electricity demand outside of peak network demand periods.

To further accelerate the rollout of electric vehicle charging infrastructure, the City of Adelaide's Sustainability Incentives Scheme provides rebates of up to $5,000 per electric vehicle charging bay to City property owners and tenants.

Source: City of Adelaide 2018.

3. Consumer attitudes

The early market growth for electric vehicles continues, however a number of barriers remain, including consumer understanding of the availability and viability of the technology. The ICCT has stated that the 'development of electric vehicle markets is fundamentally tied to prospective consumers' general awareness and understanding of the potential benefits of electric vehicles'.[28]

Through an online survey carried out by RACV and NRMA on behalf of the Electric Vehicle Council, 1,086 residents from ACT, NSW and Victoria were asked about their awareness and general perceptions of electric vehicles.[29] In reviewing responses, a relatively even response rate was seen based on gender (51 per cent female, 47 per cent male and 2 per cent did not wish to respond) and across age demographics (between 1-11 per cent across 13 age categories).

The results of the survey indicate there continues to be a significant proportion of respondents who are willing to consider purchasing an electric vehicle, with a number of these respondents having spent time researching electric vehicle options.

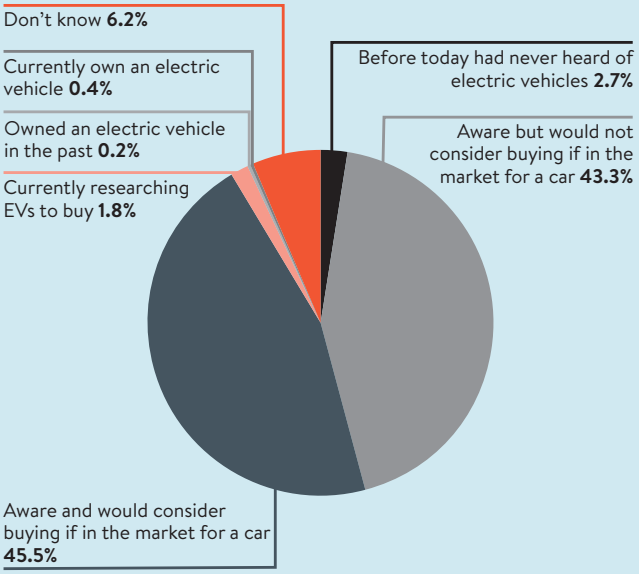
When responding to a question on current attitudes towards buying an electric vehicle (Figure 4), 45 per cent said that they would consider buying an electric vehicle, with the key selling points being the cost to run and maintain an electric vehicle and the convenience of recharging. Of the group who responded positively to this question,[30] 23 per cent had also spent time researching options for buying an electric vehicle. Conversely, 43 per cent of respondents said they would not consider buying an electric vehicle, highlighting concerns with the distance that can be travelled per charge, the purchase cost when compared to petrol or diesel vehicles, and concerns about electric vehicle technology reliability. Other barriers such as access to charging infrastructure and lack of incentives also remain key barriers to uptake.

28 International Council on Clean Transportation (2017)

29 Including 500 responses from RACV and 586 from NRMA.

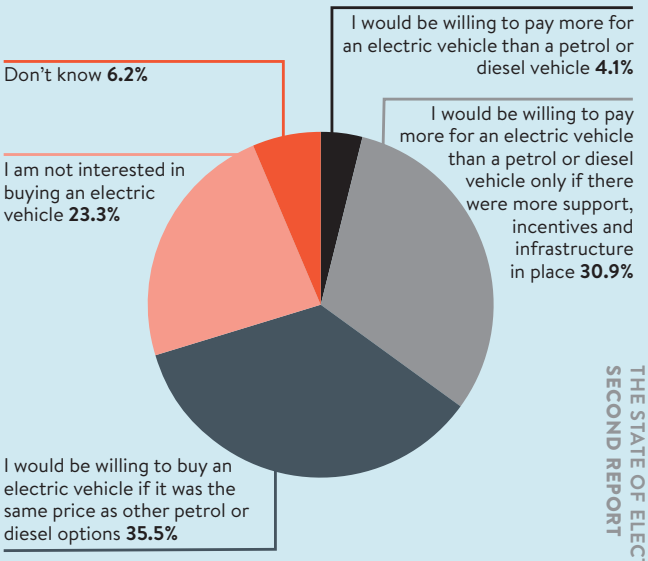
30 Response included 'Aware and would consider buying if in the market for a car', 'Owned an electric vehicle in the past' and 'Currently own an electric vehicle'.

Figure 4. Consumer attitudes towards electric vehicle purchase. Chart shows responses to the question "Which of the following statements best describes your current attitude towards buying an electric vehicle?" as a percentage.



The price of electric vehicles also continues to be a key issue for consumers, which reflects the lack of model availability in lower price ranges in Australia (see Model Availability section). While 34 per cent of respondents would be willing to pay more for an electric vehicle than a petrol or diesel vehicle, the majority (30 per cent) would only do so if there was more support, incentives and infrastructure in place (Figure 5). A further 35 per cent would be willing to buy an electric vehicle if it were at price parity with similar petrol or diesel options.

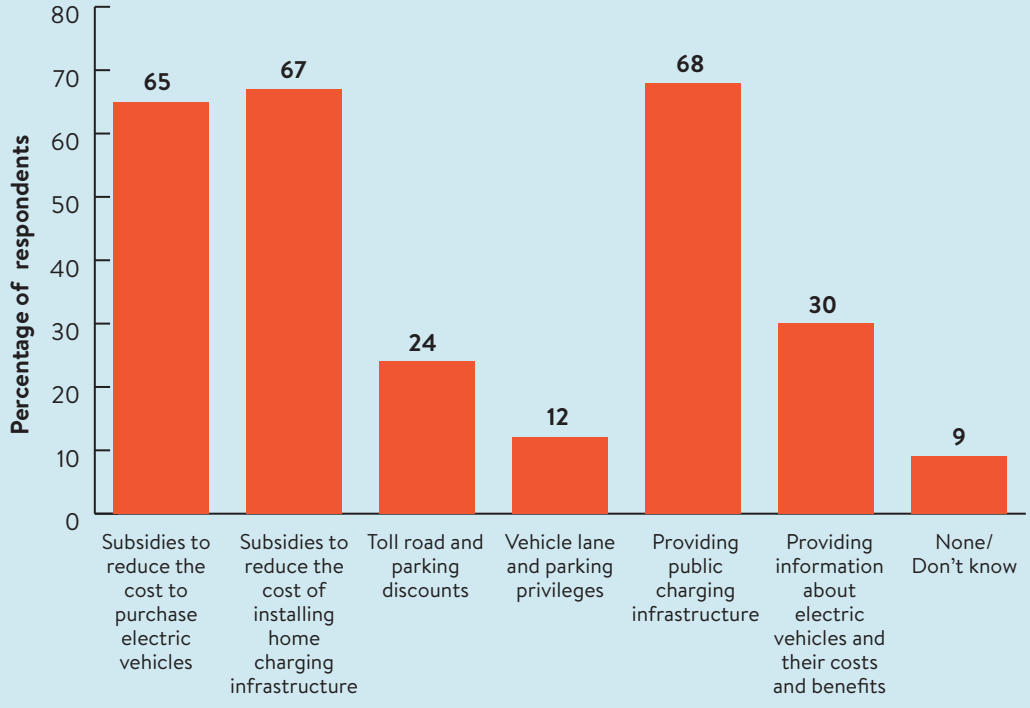
Figure 5. Consumer attitudes towards electric vehicle prices. Chart shows responses to the question "Which of the following statements best describes your attitude towards electric vehicles?" as a percentage.



Survey results also reflect international evidence that government policy can have an impact on consumer decision-making. Countries such as Norway and the United States, which offer a range of both financial and non-financial incentives to consumers, have experienced some of the highest rates of electric vehicle uptake.[31] When asked about perceptions of government policies on electric vehicle uptake, respondents rated subsidies to reduce the purchase cost of electric vehicles, subsidies for the installation of home charging infrastructure and provision of public charging infrastructure to be the most important (Figure 6).

When comparing this report to our 2017 report, limited change to consumer attitudes on electric vehicles illustrates an ongoing knowledge gap in the market. The survey results did indicate that consumers acknowledge potential changes in the market dynamic, noting the benefits that come from user experience such as lower cost of operations including maintenance, smooth acceleration, and smart phone connectivity for charging ease. As electric vehicle user data moves out of trial environments and into real-world data capture, consumer anecdotes about the benefits of electric vehicles will be evaluated as part of decision-making and broader discussions on future mobility.

Figure 6. Consumer perceptions of government policies on electric vehicle uptake. Chart shows percentage of respondents nominating each policy as a response to the question "What policies do you think the government could implement that would encourage you to purchase an electric vehicle? (please nominate your top three)".



31 Sheldon, DeShazo, Carson, & Krumholz (2017)

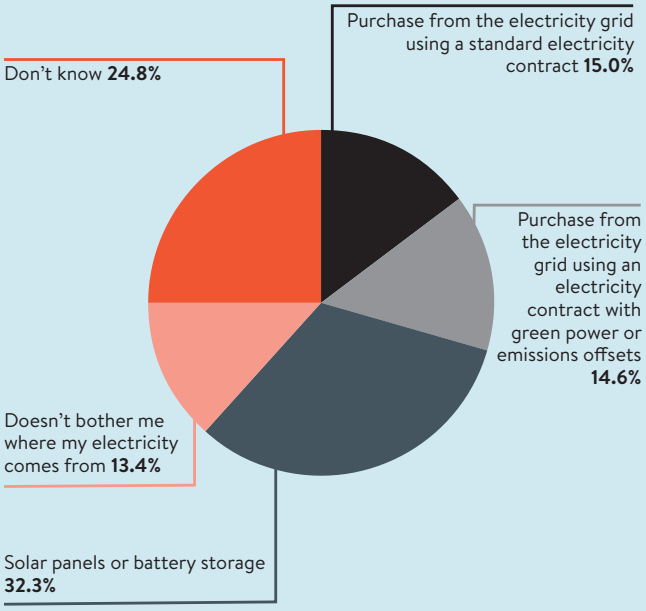
Consumer attitudes towards sourcing electricity

An important feature of electric vehicles is their capacity to reduce transport greenhouse gas emissions. When Australia's electricity grid becomes 100 per cent renewable, all electric vehicles will be zero emissions vehicles. Until that point, the way consumers choose to recharge their vehicles can result in different emissions outcomes.

Respondents were asked if they owned or were considering purchasing an electric vehicle, how would they source their electricity to charge their vehicle; 15 per cent said that they would purchase electricity from the grid using a standard electricity contract (see How Green are Electric Vehicles in Australia section) and an additional 15 per cent would purchase electricity from the grid with a green power or emissions offset contract. A further 32 per cent of respondents said that they would consider solar and battery storage options.

Interestingly, of the 1,086 respondents to the survey, approximately 20 per cent have solar panels installed at their household, with a further 11 per cent hoping to install them in the near future.

Figure 7. Consumer attitudes towards sourcing electricity to charge an electric vehicle. Chart shows responses to the question "If you own or are considering purchasing an electric vehicle how would you source electricity to charge your electric vehicle?" as a percentage.



Case Study:

Consumer expert Dr. Alina Dini on life with an electric vehicle in Australia

Alina has more experience that most when it comes to electric vehicles, with 12 years in the industry and a doctorate from Queensland University of Technology (QUT) in emerging technology adoption and the influence of new car buyers' purchase experience on plug-in vehicle demand. Additionally, she has been an electric vehicle owner and motorist for five years, so her first-hand experience and day-to-day use provide valuable lessons for other electric vehicle consumers.

Q: How did you come to develop your interest and expertise in EVs?

I have always had an appreciation for new ways of thinking - with an ever increasing population and finite resources, innovative solutions for improved cost savings and environmental outcomes are an imperative.

Yet while I have always thought this way, it was my second job out of university working in business development for Tesla, that helped me see the bigger picture. Even 12 years ago, Tesla understood what modern day motoring consumers were looking for: It's not just about environmentally conscious motoring or low-cost motoring, but rather, an innovative motoring paradigm. It was this concept that made me see how electric vehicles have the potential to unlock previously disparate sectors, driven by consumer choice.

Helping consumers access innovative products and business models to save energy, costs and time is what I am most passionate about.

Q: What was your experience purchasing your first electric vehicle?

My husband and I bought our first electric vehicle in 2013. We met while working at Tesla and continued after this, to work in the industry in Australia. So it was important to us that we had a car that 'walked the talk'. We also wanted to better utilise the solar panels that we'd installed at our house. It was actually our experience buying an electric vehicle that led me to research consumer purchase experiences. We turned up to the dealership, completely convinced on the electric vehicle we wanted purchase and with cash in hand. But were asked, "Why would you want to buy an electric vehicle when there are plenty of better petrol options?"! We were then told that, "We can't help you because we don't know anything about the car you want". I have since talked to electric vehicle consumers over the years to discover that this is a fairly common experience. Some persevered like us, and others gave up.[32] I am now working with governments, industry, and other stakeholders to avoid a repeat of this experience, as a range of new electric vehicle products come to market. We happily bought our first battery electric vehicle in 2013, using it almost every day since and have bought a second plug-in electric vehicle in 2016. I'm confident the replacement car we buy will also be an electric vehicle.

32 Dini and Buys (2018)

Dr. Alina Dini

Q: What is your daily routine as a household that uses electric vehicles?

As I mentioned, we have two electric vehicles in our household: a battery electric vehicle with 120km of all-electric real-world range, and a plug-in hybrid electric vehicle that has about 50km electric range before it automatically switches to petrol for longer trips.

On average, we drive about 20-30kms on a typical day - so we've found that we only need to plug in every second day and a typical recharge for us takes about three hours to fill the car to full. I generally use the battery electric vehicle, which has more than enough range for my daily driving needs to work and typical errands to the shops. My husband makes more frequent longer trips, often towing a trailer, so the plug-in hybrid electric vehicle suits his needs better. We also use this car more on weekends and family holidays.

Q: What features do you love about your electric vehicle, and why would you recommend the technology to other consumers?

In my experience, the lesser known features are the ones that have the most impact for electric vehicle motorists, even for those who take a short test drive. This is true of the consumers I've researched[33] and is also what has had the most positive effect on my day-to-day motoring. Electric vehicles are incredibly easy to operate; they offer a smooth, low-effort driving experience. The vehicles' inherent quietness while driving reduces stress in traffic - an attribute that most don't fully appreciate until they have experienced it.

And in terms of costs, our electric vehicles are without doubt the lowest-cost form of motorised transport available to us. To refuel with off peak electricity at home, it only costs about $0.70 per day. We have a capped-price warranty for vehicle servicing which is less than $500 a year, and also includes roadside assistance - but we have never needed to use it.

Q: How do you charge your electric vehicle?

We recharge both our electric vehicles at home and having solar on our house is a benefit. Even though our car is sometimes plugged in after the sun sets, digital technology which enables electric vehicle users to set charging time during the day is becoming more readily available. As the grid in Australia is gradually decarbonised with the increase of renewable energy, electric vehicles are also becoming less carbon intensive to drive in the majority of state and territories in Australia.

As we mostly charge at home, we have no trouble planning our trips around Southeast Queensland, including frequent visits to our relatives on the Sunshine and Gold Coasts. We rarely need to use public charging stations, but with the new Queensland Electric Superhighway we should now be able to travel even further with our electric vehicles.

33 Dini and Washington (2016)

Source: Alina Dini.

4. Electric vehicle policy in Australia

At this stage of global electric vehicle market deployment, policy support is still indispensable for lowering barriers to adoption. A supportive policy environment has been a key driver and enabled market growth in all leading electric vehicle countries, through a range of regulatory, financial and non-financial policies and incentives.

Policy can help address the three major barriers to electric vehicle uptake in Australia: cost and model availability, recharging concerns, and consumer awareness. Analysis conducted by the International Council on Clean Transportation (ICCT) on the evolution of electric vehicle incentives indicates that financial incentives will remain key to reducing the cost differential in most markets until 2020. Additional complementary policies will be required through to 2025 or later, to provide sustained support in the form of charging infrastructure rollout and consumer awareness initiatives.[34] As the electric vehicle market increases over time and the cost of electric vehicles decreases, governments will be able to adapt policy tools and reduce incentives to provide stable support to sustain market growth of new technology.

While there have been some notable policy developments in Australia in the past 12 months, these have occurred mainly at state, territory and local government levels. These developments have been key to changing the narrative around policy support, and will help address the barriers of recharging concerns and consumer awareness. However, to achieve a tangible impact on electric vehicle uptake, it will be essential for governments to use financial incentives to address the cost and model availability barrier.

34 International Council on Clean Transportation (2016)

The majority of state and territory governments across Australia have either announced or are developing an overarching electric vehicle policy framework or strategy, the ACT Government recently released their Transition to Zero Emissions Vehicles Action Plan 2018-21; the Queensland Government has released their electric vehicle strategy The Future is Electric; the Tasmanian Government outlines a range of electric vehicle action items in Climate Action 21: Tasmania's Climate Change Action Plan 2017-2021; and the New South Wales Government's Future Transport Strategy has been released for public consultation. The South Australian Government is also developing an electric vehicle strategy and the Northern Territory Government is considering a climate change framework. There is currently no overarching electric vehicle policy at the federal level.

Capital city local governments have an important role to play in providing consumer incentives, supporting deployment of charging infrastructure and undertaking planning and promotion activities. Local governments are also more likely to be the first point of contact for potential consumers, particularly with questions relating to charging access and infrastructure installation. The City of Adelaide has included electric vehicles into its City of Adelaide 2016-2020 Strategic Plan and the Carbon Neutral Action Plan 2016-2021 includes details on investments for electric vehicle charging infrastructure (see City of Adelaide Case Study). The City of Hobart is also developing a new Transport Strategy 2018-2030.

Additionally, a Memorandum of Understanding (MoU) regarding Sub-National Collaboration on Electric Vehicles was signed by a number of state, territory, capital city local governments and industry groups.[35] Under the MoU, parties have agreed to identify opportunities to collaborate in promoting and accelerating the transition to electric vehicles in Australia. Potential opportunities include coordinated planning and construction of infrastructure, sharing of information and lessons learned, and developing jurisdictional action plans to increase electric vehicle uptake in fleets.

35 Signatories included the Australian Capital Territory, South Australia, Western Australia, the City of Adelaide, the City of Hobart, and the Electric Vehicle Council.

The Commonwealth Government is currently considering the implementation of standards through the Ministerial Forum on Vehicle Emissions. As outlined in the previous report of this report, the introduction of light vehicle CO_2 emissions standards could deliver a broad and comprehensive policy that could encourage the uptake of electric vehicles. Australia is one of the few remaining developed countries without light vehicle CO_2 emissions standards in place, with such standards now covering over 80 per cent of the global automotive market.

Table 4. Overview of federal, state and territory government policy.

		ACT	NSW	NT	QLD	SA	TAS	VIC	WA	Cwth
Uptake	EV purchases 2011 - 2017	165	1238	13	688	957	61	1324	375	4821
	EV sales per 10,000 vehicles (2017)	21	10	1	6	22	3	10	8	7
Regulation	Vehicle CO_2 emissions standards									•
Financial incentives	Stamp duty, registration and tax discounts	✓	✓	✓	✓	•		✓		✓
	Direct vehicle subsidy									•
	Fleet incentive									✓
	Charging infrastructure incentive	✓		•	✓		✓			•
	Toll and parking discounts				✓					
Non financial incentives	Vehicle lane and parking privileges	✓								
	Electric vehicle public transport trials	✓		✓		✓				
	Government fleet policy	✓	✓			✓	✓			
	Information and education programs	✓	✓		✓	✓	✓	✓		✓

Table notes: Policies that are in place are marked ✓, and policies under consideration are marked •. This table was compiled through a survey of Australia's state, territory and federal governments on their electric vehicle policies. The Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania, Victoria and Western Australia provided a response to our survey. For the Commonwealth Government we used the response provided for the previous report and we undertook additional desktop research study. Vehicle purchase numbers do not include Teslas.

Appendix 1

Links for capital city, state, territory and federal government electric vehicle policies, based on responses to the electric vehicle policy surveys received.

The following list contains all of the information readily accessible on the internet on state, territory and federal currently implemented electric vehicle policies.

CAPITAL CITY LOCAL GOVERNMENTS

City of Adelaide

City of Adelaide 2016-2020 Strategic Plan
https://www.cityofadelaide.com.au/assets/Policies-Papers/docs/STRATEGY-strategic-plan.pdf

Carbon Neutral Adelaide Action Plan 2016-2021
https://www.cityofadelaide.com.au/city-living/sustainable-adelaide/carbon-neutral-adelaide/carbon-neutral-adelaide-policy-and-strategy

Sustainability Incentives Scheme
https://www.cityofadelaide.com.au/your-council/funding/sustainable-city-incentives-scheme

City of Adelaide Electric Vehicle Charging Hub and service fees
https://www.cityofadelaide.com.au/explore-the-city/city-travelling-transport/green-travel/electric-vehicle-charging-points

City of Hobart

Transport Strategy 2018-2030, Consultation Paper for Private Transport:
https://www.hobartcity.com.au/Council/Strategies-and-plans/Transport-Strategy

STATE AND TERRITORY GOVERNMENTS

Australian Capital Territory

Transition to Zero Emissions Vehicles Action Plan 2018-2021:
http://www.environment.act.gov.au/__data/assets/pdf_file/0012/1188498/2018-21-ACTs-transition-to-zero-emissions-vehicles-Action-Plan-ACCESS.pdf

Concession on stamp duty:
https://www.accesscanberra.act.gov.au/app/answers/detail/a_id/2928/~/duty-payable-upon-registration-or-transfer-of-a-motor-vehicle#!tabs-2

Concession on registration:
https://www.accesscanberra.act.gov.au/app/answers/detail/a_id/694/kw/registration%20concession#!tabs-8

Government fleet policy:
http://www.cmd.act.gov.au/__data/assets/pdf_file/0005/132098/non-exec_vehicle_guidelines_2010.pdf

New South Wales

Vehicle tax discount:
http://www.rms.nsw.gov.au/roads/registration/fees/

Government electric vehicle fleet trial:
https://www.resourcesandenergy.nsw.gov.au/about-us/news/2017/nsw-government-unveils-electric-vehicle-fleet

Electric vehicle parking signs:
http://www.rms.nsw.gov.au/cgi-bin/index.cgi?fuseaction=trafficsigns.show&id=regulatory/r5/r5-41-5

Electricity as a prescribed fuel under Section 58 of the NSW Fair Trading Act 1987 (the Act):
http://www.fairtrading.nsw.gov.au/biz_res/ftweb/pdfs/About_us/Statement%20of%20Regulatory%20Intent_price%20signs%20electricity%20charging%20stations.pdf

Northern Territory

Driverless electric bus trial:
https://dipl.nt.gov.au/transport/driverless-bus

Queensland

Discount on vehicle registration duty:
https://www.qld.gov.au/transport/registration/fees/duty/about/

Queensland Electric Super Highway:
https://www.qld.gov.au/transport/projects/electricvehicles/super-highway

The Future is Electric: Queensland Electric Vehicle Strategy:
https://www.qld.gov.au/transport/projects/electricvehicles

South Australia

Government fleet policy:
https://www.safa.sa.gov.au/__data/assets/pdf_file/0018/21186/SAFA-ANNUAL-REPORT-2016-17.pdf

Zero Emission Vehicles information on the Renewables SA website:
http://www.renewablessa.sa.gov.au/topic/zero-emission-vehicles

Charging infrastructure provision:
https://www.kangarooisland.sa.gov.au/e-vehicle

Future Mobility Lab autonomous electric vehicle public transport trials:
http://www.dpti.sa.gov.au/transportinnovation

Tasmania

Climate Change Action Plan 2017-2021:
http://www.dpac.tas.gov.au/divisions/climatechange/tasmanias_climate_change_action_plan_20172021

Government fleet policy:
http://www.dpac.tas.gov.au/divisions/climatechange/tasmanias_climate_change_action_plan_20172021/reducing_our_transport_emissions

TasNetworks (state-owned energy transmission corporation) Electric Vehicle Fast Charger Support Scheme:
https://www.tasnetworks.com.au/industry-and-development/electric-vehicle-fast-charger-scheme/

Information and education through fleet demonstration project:
http://www.dpac.tas.gov.au/divisions/climatechange/Climate_Change_Priorities/reducing_emissions/transport

Victoria

Registration discount:
https://www.vicroads.vic.gov.au/registration/registration-fees/concessions-and-discounts/hybrid-vehicle-registration-discount

Victorian Government Parliamentary Inquiry into Electric Vehicles:
https://www.parliament.vic.gov.au/eic/inquiries/article/3507

FEDERAL GOVERNMENT

Federal

Ministerial Forum on Vehicle Emissions:
https://infrastructure.gov.au/roads/environment/forum/

Luxury car tax - higher threshold for fuel efficient vehicles:
https://www.ato.gov.au/Rates/Luxury-car-tax-rate-and-thresholds/

Clean Energy Finance Corporation asset finance for electric vehicles:
https://www.cefc.com.au/where-we-invest/asset-finance.aspx

Information and education:
https://www.greenvehicleguide.gov.au/

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