

white paper;

Electric vehicles in Australia

What is the horizon for public charging infrastructure

November 2017

**parking;
traffic;
civil design;
communication;**

ptc.

Introduction

In Australia, electric vehicles (EVs) still represent a small component of new vehicle sales. In 2016 the EV market share of new vehicle sales was 1.12%, a 5% decrease in relation to 2015 primarily due to the 80% decrease in sales of battery electric vehicles (BEV).

Despite some European countries leaping ahead with EV implementation, there is currently a great level of uncertainty about when EVs will have a significant presence on Australian roads. Based on a number of independent projections we have reviewed, **ptc.** estimates that EV's will reach 20% share of the Australian car parc (total number of cars in use within a country) by 2035. Understandably, local authorities are keen to identify their role in this process, especially in relation to providing the necessary infrastructure. With Mosman Council's support, **ptc.** has prepared this White Paper to identify different approaches to the provision of charging networks.

Acronyms	
Hybrid electric vehicle (HEV)	Petrol and electric engine
Battery electric vehicle (BEV)	Fully electric engine
Electric Vehicle (EV)	Comprises both HEV and BEV

Electric Vehicles - Current Situation

EV market share

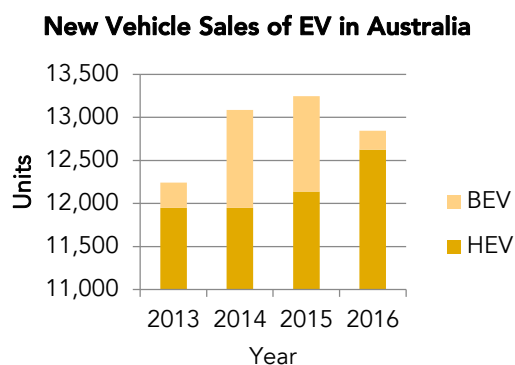
As of 2014, the USA were world leaders in EV sales with 19% of the country's total car sales, followed by China (17%), Japan (10%), and Norway (6%). This market share combines sales of fully electric and hybrid vehiclesⁱ. When considering the percentage of EVs on the road, Norway and Iceland are the leading countries in

“Australian market prefers HEV as oppose to BEV which implies that most users are less dependent on public charging stations”

Europe, with EVs representing respectively 35% and 12% of the domestic car parcⁱⁱ.

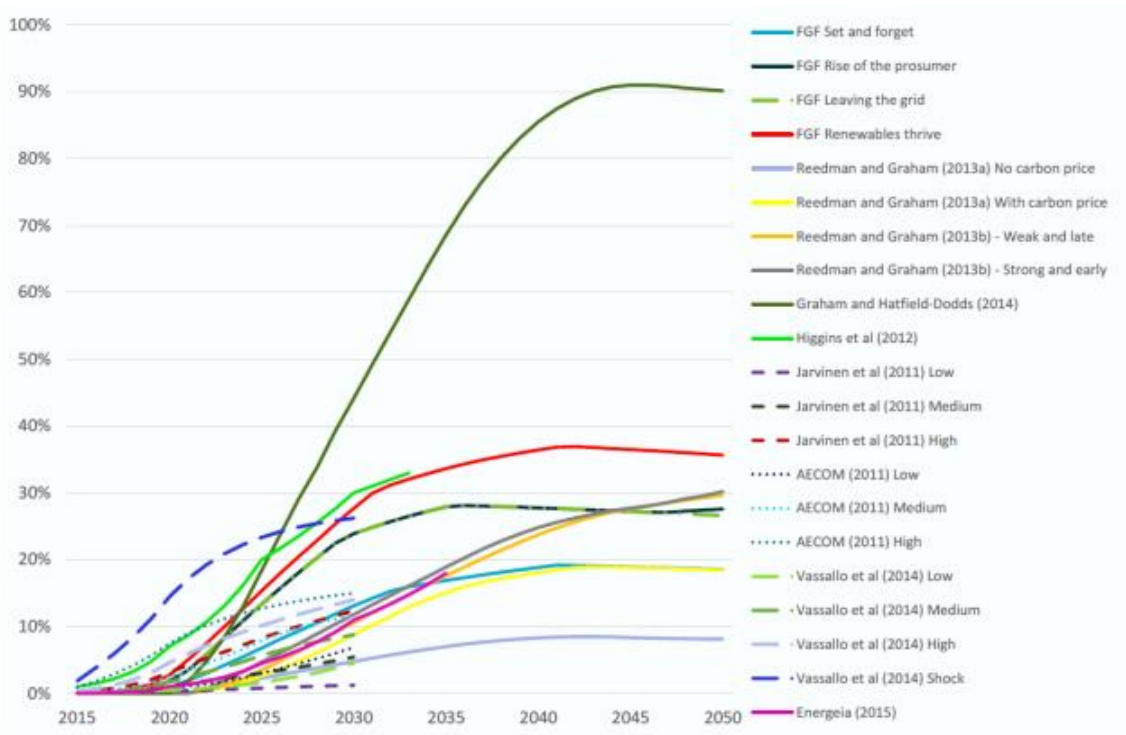
In Australia, EVs represented 1.12% of new sales in 2016, slightly lower than 2015 when it recorded 1.18% of market shareⁱⁱⁱ. It is important to observe that this data excludes the heavy vehicle category and Tesla vehicles, as the company doesn't disclose its sales information to the Federation Chamber of Automotive Industries (FCAT).

The surprisingly low sales of new BEVs accounts for EVs 2016 performance, with only 219 BEVs sold (a decrease of 80% in comparison to 2015). On the other hand, sales of HEVs reached 12,625 units, up 4% from the prior yearⁱⁱⁱ. The graph below shows the evolution of new EV sales in Australia:



1. Electric Vehicle Sales in Australia (excludes heavy vehicle category and Tesla models). Source: GovernmentNews (2017)

The Australian market prefers HEVs as opposed to BEVs which implies that most users want to be less dependent on public charging stations, being able to switch to petrol when necessary.



2. Projections of EV fleet shares in Australia. Source: Energy Network Association and CSIRO (2015, p.41)

EV growth projections

There are several studies on EV growth in Australia with significantly different projections, ranging from 2020 to 2030 as the year when EVs are expected to reach 10% of the Australian car fleet.

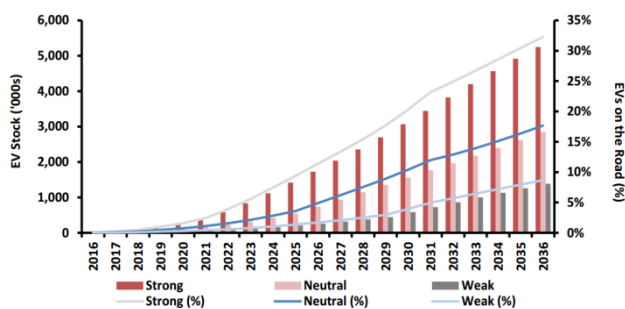
A 2015 report by Energy Networks Association and CSIRO includes multiple projections of the evolution of EV fleet shares in Australia^{iv} (see Figure 2).

The first half of the projections used CSIRO’s Energy Sector Model (EMS) which assumes that choices are made mostly based on an economic perspective, although, it also includes other factors such as the limited EV range available. The EMS comprises light vehicles and trucks while other projections focus on passenger vehicles only.

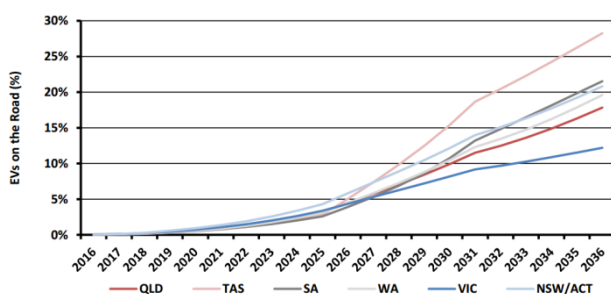
AEMO and Energeia^v projected three scenarios for electric vehicle uptake in Australia: weak, neutral (most likely to occur) and strong. The

proposed projection framework adopted several sensitivities affecting the EV uptake: vehicle premium, tariffs for home and fleet charging, model availability, national vehicle emissions standard, carbon price application to fuel purchases for passenger vehicles, and indirect EV policy support (e.g. priority parking). Figure 3 shows the sales share forecast according to each scenario.

The same study predicted a variation on the EV fleet share in six Australian regions considering the neutral scenario, see Figure 4.

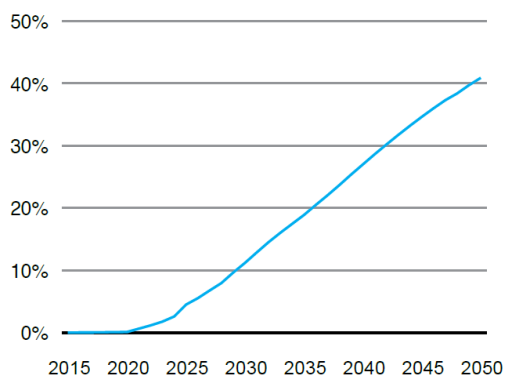


3. EV on the road share projections. Source AEMO and Energeia (2016, p. 15)



4. EV on the road by region. Source: AEMO and Energeia (2016, p.14)

A third study conducted by Energy Networks Australia and CSIRO^{vi} clustered various projections of electric light vehicle transportation and obtained an estimated 20% share of the Australian fleet by 2035, as can be seen in Figure 5.



5. Electric light vehicle transportation fleet share in Australia. Source: Energy Networks Australia and CSIRO (2017, p. 33)

In the foreseeable future, it is still uncertain when EV will represent a significant proportion of the Australian fleet, especially after the decrease in sales last year. In addition, there continues to be significant barriers to EV uptake which require a stronger government involvement to overcome.

Barriers to EV uptake

The main factors influencing EV uptake in Australia are the number of models available for the consumer market, economic viability, and government incentives and policies.

- Number of options

There is evidence of a correlation between the number of EV models available in the market and cumulative sales: the greater the number of options the higher are the sales^{vii}.

Whereas in other countries there are up to 30 different EV models available, Australian consumers only have 12 options. Furthermore, of the 30 existing vehicle segments in Australia, only 8 offer at least one EV model. Therefore, Australian consumers have limited options across different categories particularly in the lower price range.

- Economic Viability

The high price of EVs worldwide is a significant barrier and economic viability is the most significant source of uncertainty in adoption projections. On the one hand, manufacturers need economies of scale to reduce cost and offer a competitive price to consumers. On the other, large scale consumer adoption will only occur when price becomes competitive. In some countries, this 'chicken and egg paradox' is being addressed through government incentives which have been somewhat successful as global sales grew by 70% between 2014 and 2015^{vii}. In particular, financial incentives and availability of charging infrastructure have been positively correlated with the growth of EV market share.

Earlier this year, Tesla began the production of the Model 3, the cheapest model in its range, with a retail price of \$US35,000 (\$A44,600). However, it will take a while until Model 3 is available for Australians, as the production of the right-hand model is expected to begin only in 2019. The introduction of a more accessible EV model can have a positive impact in the adoption rates, especially if other manufacturers release entry models to compete with Tesla.

- Incentives and government policies

Globally the main drivers for EV related policies are associated with sustainability issues such as reduction of pollution levels, energy diversification and extenuating climate change^{vii}.

Currently, there is no EV national policy framework in Australia. States and local governments have developed some initiatives; however, they are generally limited to registration discounts and incentives for public charging stations¹. Table 1 presents the electric vehicle policy support in Australia by state.

range is relatively stable. There is only a slight downward trend, primarily due to the majority of BEVs designed with ranges between 100 and 200km. Tesla is the only major manufacturer consistently producing vehicles with high battery energy density, and consequently, extensive vehicle ranges of up to 400km.

Table 1: Current electric vehicle policy support measures in Australian states and local governments. Source: Energeia (2016).

Policy Type	QLD	NSW	SA	VIC	ACT	WA	Score
Direct Vehicle Incentive	x	x	x	x	x	x	0
Charging Infrastructure Support	✓	✓	✓	x	x	x	3
Registration Incentives	✓	✓	x	✓	✓	x	4
Stamp Duty Discounts	✓	x	x	x	✓	x	2
Government Fleet Incentives	x	x	x	x	x	x	0
Vehicle Lane Privileges	x	x	x	x	x	x	0
Toll Lane Exemption	x	x	x	x	x	x	0
Discounted Parking	✓	x	✓	✓	x	✓	4
Free Charging	✓	✓	✓	✓	x	✓	5
Score	5	3	3	3	2	2	-

In March 2017, the Ministerial Forum on Vehicle Emissions closed the public consultation process on possible measures to reduce vehicle emissions in Australia. According to the Department of Infrastructure and Regional Development, the Ministerial Forum will continue to evaluate, discuss and consider measures to encourage the uptake of low emission vehicles and intends to release a draft implementation plan on potential measures later this year. The Government approach to this report to EVs will indicate how likely the Government will encourage EV uptake, which in turn will have a significant impact on EV growth in the future.

EV travelling range

Our analysis of the travelling range of 46 BEVs over the past 10 years revealed that the average

HEVs usually have smaller batteries as they switch to the combustion engine to travel longer distances; therefore, these vehicles usually don't need to rely on public charging stations to complete their journey.

EV charging stations

EV charging station locations

A study conducted in the USA to understand EV drivers' charging patterns analysed data collected in 2012 and 2013 from 5,800 EVs across the country^{viii}. Despite the availability of an extensive charging network, 87% of the time drivers charged their vehicles at home. Nevertheless, it was highlighted that some public charging points were highly utilised and mostly used to extend travel range.

“Despite a widely available charging network, 87% of the time US drivers charged their vehicles at home”

Notwithstanding, public charge stations help to reduce one of the barriers to EV uptake, being “range anxiety”, or the fear of being stranded in an EV due to lack of battery capacity.

Research was not conclusive in pinpointing the success factors for public charging stations. While some of the most utilised public charging stations were installed in locations where vehicles were parked for longer periods, such as shopping centres and commuter lots, other popular stations were located in places with no apparent appeal. It is also important to note that many charging stations situated in seemingly ideal locations did not have a high usage rate. In addition, usage of public charging infrastructure was higher in locations with higher sales of EV. Therefore, it seems that the reason behind high usage is community-specific.

The Idaho National Laboratory observed that to increase the likelihood of implementing a highly utilised charging point the following aspects should be considered:

(1) There must be a large population of EV

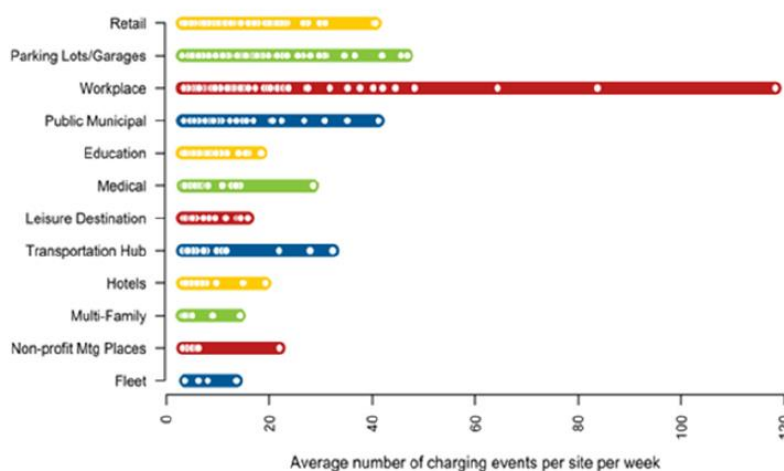
owners in the area. The most utilised stations observed in the study were located in San Francisco and Seattle, which were the first and fourth largest US sales markets of the Nissan Leaf, a compact hatchback EV.

(2) The station should be located within 800m of a major commute route.

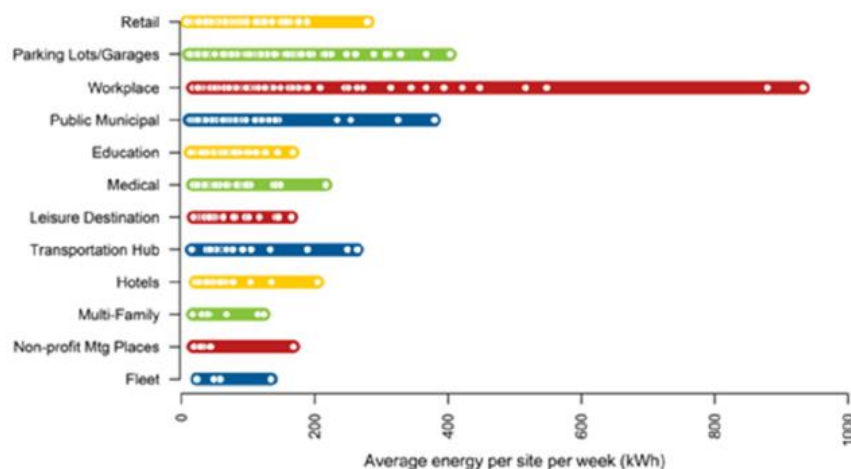
(3) Many of the highly utilised stations were located near to or associated with employers of a highly compensated work force, especially high-tech companies. It seems therefore advisable to install charging stations at, or near to, companies with those characteristics, where they can be available both to the workforce and to the general public available, and

(4) Charge stations should be placed in easily accessible locations. The most utilised EV charging stations observed in the study were installed in locations such as shopping centres and community colleges.

The Electric Vehicle Council recommends that Australian authorities ensure the installation of electric charging points in all new multi-dwelling, apartment and office buildings. It is suggested that federal, state and local government could establish grant programs stimulating businesses to install EV charging stations^{ix}.



6. Distribution of average charging events per week per site. Source: Idaho National Laboratory (2015, p. 12-5)



7. Distribution of average energy used per week per site. Source: Idaho National laboratory (2015, p. 12-6)

EV charging stations usage rates

Benchmark data for this section of the report is based on the study conducted in the USA by the Idaho National Laboratory^{viii}. The research analysed data from 774 public charging sites across the country. Over 75% of the charging stations analysed recorded 3 to 14 charging events per week. Stations located at workplaces were the most utilised registering an average up to 120 charging events per week.

Figure 6 presents the distribution of average charging events per week; the white circles indicate each site’s average charging frequency while the range is shown by the coloured bar.

The most utilised stations had an average of around 40 charging events per week, whilst the least utilised recorded around 3 events per week. The best performing car parks had an average energy consumption of around 400 kWh per week. Figure 7 shows the distribution of average energy consumption per week.

EV charging infrastructure in Australia

At the time of writing, there are 476 EV public charging stations in Australia^x, which include private and Government initiatives. The charging stations are mainly concentrated in Victoria and New South Wales, representing, respectively,

28% and 27%, followed by Queensland (16%), Western Australia (13%) and South Australia (9%).

Although VIC and NSW have more charging stations than other regions, these states don’t seem to have a specific plan to increase the local charging network.

In July 2017, the Queensland Government announced the development of an Electric Super Highway under Queensland Climate Transition Strategy towards a zero carbon economy. This highway will consist of several fast-charging stations along the Queensland coast between Gold Coast and Cairns. The aim of the development is to encourage EV uptake in the region.

With the same purpose of reducing carbon emissions by promoting the uptake of EVs, the Royal Automobile Club of WA (RAC) implemented 12 fast-charging points between Perth and Augusta.

What Councils are doing

City of Adelaide

The City of Adelaide seeks to become a smart, green, liveable, and creative city. In addition, the council aims to become one of the world’s first carbon neutral cities by 2025 and a leader in environmental change. One of the strategies adopted to achieve these goals is the reduction

of petrol/diesel vehicle emissions by encouraging EV uptake. The council believes that reducing the range anxiety by expanding the EV charging network is an important part of this plan.

By 30th June 2018, the city intends to install 40 new EV charging stations in addition to the 4 existing ones. These charging points will be placed on parking sites managed by the council, 32 of those at off-street car parks and 8, at on-street parking spaces. The council plans to install 38 fast charging stations (≤22kW) at an approximate unit cost of \$4,000, excluding installation cost, and 2 superfast stations (≤50kW) which cost around \$30,000 each.

Initially, 10 EV charging stations will be implemented at off-street car parks. This pilot process involves integrating these charging stations with a smart parking system which will enable the council to manage the car park occupancy and EV drivers to easily find available charging points. In this scheme, EV drivers will be able to check the availability of bays with charging points through an app or on the LED panels at the car park entrance. Inside the car park, EV bays will be identified by an orange overhead light.

The council will manage the parking supply by converting EV only bays into regular bays whenever the occupancy rate of the car park achieves or surpasses 84%, in which case, the overhead light of bays with charging points will turn green indicating that all vehicles can park in those spaces. This measure will be adopted to reduce the potential revenue loss of having empty EV only bays while the rest of the car park is full.

Furthermore, City of Adelaide is evaluating 9 potential locations for on-street EV charging stations, of which 4 will be selected for the installation of two charging points each. The sites being considered are near cafes, stores or restaurants potentially serving as a distraction to EV drivers while they charge their cars. Therefore, there is an expectation of bringing extra revenue

to local business, which would promote the economic development of those areas.

The council is analysing fee models for the charging stations, with EV drivers paying standard parking fees plus an hourly based charging fee. Table 2 presents the proposed fee structure for casual parking customers, which will be submitted to community consultation.

Charging Duration	Fast Charging Stations	Super-Fast Charging Stations	
	Cost per kilowatt hour (weekdays)		
	Peak Times (6am to 6pm)	Off Peak Times (6pm to 6am)	All times
≤ 1 hour	\$0.00	\$0.00	\$0.30
> 1 hour	\$0.20	\$0.10	\$0.30
	Cost per kilowatt hour (weekends and public holidays)		
≤ 1 hour	\$0.00	\$0.00	\$0.30
> 1 hour	\$0.10	\$0.10	\$0.30

Table 2: City of Adelaide Proposed Fee Structure for EV Charging Stations

An Expression of Interest process is being prepared to identify existing or potential customers who currently own or plan to purchase an EV in the next year. Up to eight off-street EV charging stations will be allocated to current or future permanent reserved customers. The City of Adelaide will fund the installation of the charging stations through its Climate Change Action Initiatives Fund and expects to partially or fully cover maintenance costs with the revenue obtained from the charging fees. Other sources of funding such as a private sector partnership or through the Government of South Australia are also being considered in this project.

New York City

New York City (NYC) has a plan to install up to 1,000 fast-chargers by 2020. As announced in September 2017, the city plans to have 50 charging hubs in all its boroughs with up to 20 fast-chargers in each one. Currently there are 542 chargers in the city and only 16 of those are fast-chargers.

The USD 10 million investment to implement a fast-charging network is part of the city’s climate action agenda which includes achieving 20% of new vehicle registrations to be EVs by 2025. “By helping develop the infrastructure necessary for electric vehicles, we’re going to make it easier than ever for New Yorkers to switch”, said Mayor Bill de Blasio^{xi}.

The city’s Council members are also proposing new regulations to incentivise EV ownership. Earlier this year, two members, Mark Levine and Costa Constantinides, proposed to let drivers of electric vehicles park for free in metered spaces on Saturdays^{xii}. It’s a small gesture meant to encourage more New Yorkers to buy electric cars. There are currently just over 2,000 EVs registered in NYC, according to Levine.

However, the parking equation is straightforward. Giving away metered parking causes people to consume more parking, and to circle streets in search of free spaces for longer, generating more traffic and congestion. That means buses move slower and walking and biking become less appealing. The greenest modes — and the ones that enable the city to function without freezing up in gridlock — will get crowded out.



8. With or without tailpipe emissions, cars are an inefficient use of scarce city street space that should prioritize walking, biking, or transit instead. Photo: Wikimedia Commons

London

An innovative solution adopted in London requires less intervention on the street’s current infrastructure in comparison to traditional charging stations. Instead of installing standalone

charging stations, the city is testing a technology that converts street lamps into charging points^{xiii}. A pilot is being conducted in Westminster, central London and more points will be installed in Hounslow, Richmond, Kensington, Chelsea and Barnes.

This mobile charging is provided by the German firm Ubitricity for a significantly cheaper cost than traditional stations, at £1,000 (A\$1,700) each compared to other charging stations installed in the city which cost £6,000/unit (A\$10,100). In addition, they don’t clutter the area having no intervention on the street furniture.



9. New electric charging points in London. Source: Independent

In Hounslow the council is taking advantage of the technology’s lower cost to install charging points at a ratio of three units for each person that requests it. Initially, the local authorities don’t intend to reserve parking bays for EVs, they will test if that ratio results in an appropriate amount of chargers to address local demand without restricting other drivers from using the spaces near the chargers.

In this model, the cost burden is shifted to the final user as the “smart” interface of the system controlled by the drivers of EV vehicles. Those willing to access this charging network need to purchase Ubitricity’s smartcable, which has an integrated power meter allowing the customer to be charged for the electricity usage. The downside is that the technology doesn’t enable

fast charging. Hence, it is targeted to serve drivers who park overnight or during work hours.

According to Councillor David Harvey, of Westminster City Council, the installation of these charging points is related with efforts to tackle air pollution by reducing vehicle emissions. Peter Buckwell, Richmond Council Cabinet Member for Highways, adds that the initiative aims to serve as an incentive for residents to purchase more electric vehicles.

Engaging with private and government partners

Councils and private companies may be able to attract partners for their EV charging initiatives. Energy providers, such as AGL or Origin Energy, car manufacturers, or even State Government Authorities could be interested in joining such partnerships.

For instance, the City of Adelaide is attempting to establish partnerships with the SA Government and private companies to ensure the economic viability of its charging station project. However, the terms of these partnerships have not been disclosed yet. In 2012, NRMA Motoring & Services, the City of Canada Bay and Origin Energy formed a partnership to provide EV charging services. While NRMA operated the station, Origin Energy provided 100% government accredited GreenPower energy and the City of Canada Bay allocated one on-street parking space to the station.

Recently, NRMA released their plans to invest \$10 million in fast charging infrastructure in Australia, especially in NSW and ACT, but also in VIC and QLD. The organisation plans to install at least 40 charging stations and is looking for Councils and community groups to become partners of this initiative.

Last year, Westfield and BMW announced a partnership to install 40 EV stations in Westfield car parks during 2017. EV vehicles will be able to use this charging infrastructure free of charge.

“Councils justify the installation of EV charging infrastructure to encourage low emission vehicle uptake”

At Tesla’s website, property owners can apply to receive Tesla chargers. Qualified properties receive the first two wall chargers at no cost, providing the stations are installed in visible and convenient locations.

Alternatives for councils and local authorities

In face of the evidence presented in this report, we outlined three main courses of action that can guide local government planning.

Alternative 1 – Maintain the status quo

In Australia, the lack of a national policy to tackle the main barriers to EV uptake as well as to guide federal, state and local governments’ initiatives is having a negative impact on the growth of EV on the roads. Therefore, the small EV market discourages the implementation of charging stations from an economic point of view. As mentioned in the section **Barriers to EV uptake**, if the Ministerial Forum on Vehicle Emissions adopts an approach to encourage EV uptake, the EV growth in Australia could be positively impacted.

Councils, such as Byron Shire Council, Willoughby Council and Moreland City, justify the installation of EV charging infrastructure to encourage low emission vehicle uptake, and in some cases it is part of a larger sustainability program.. For instance, the City of Adelaide’s main objective is to support and encourage EV uptake via its pricing structure, as the council doesn’t expect to recover the investment from the revenue obtained from EV charging.

EV charging stations in public places can open up "fuelling options", turning every EV car space into an energy hub. Sites can attract more

customers and increase dwell times by up to 45 minutes^{xiv}. In 2012, a North America based retail company specialising in consumer goods installed six charging stations in the car park of a new unit in California. The objective of this initiative was to verify if the charging points would attract new customers and increase their dwell time. After nine months, 1,134 charging sessions were recorded with an average length of 72 minutes, representing an increase of 50 minutes on the average customer dwell time^{xv}.

Increasing the length of stay may not necessarily represent an increase in customer spend. However, it would affect the turnover of the car park potentially resulting in a negative impact on revenue and parking supply during peak hours.

Installing charging stations would attract EV drivers to the area and may promote local businesses or facilities such as libraries. The adoption of EV charging initiatives can help councils to project an image of environmental sustainability and technological progressiveness - key differentiating factors when people decide where to shop, eat and play.

Alternative 2 – Install charging stations

If a council decides to install charging stations, we recommend that a study should be conducted to determine the most suitable location taking into account the occupancy data of existing parking infrastructure, if available as well as the points we identified in the section **EV charging station locations**.

Information on the number of EV sales or EV registrations by council is not publicly available, therefore council could conduct a survey to estimate the number of EV owners living in the LGA and working in the area.

After defining the ideal location, council should assess the advantages and disadvantages of the current available suppliers in Australia.

The next stage would be to develop a pricing strategy which could be based on the results of the survey, taking into account not only the

current number of EV owners in the area but also their willingness to pay for such a service.

Finally, operational plan for the charging stations should be prepared. In this context, to manage demand and capacity within off street car parks, a parking guidance system could potentially provide a management system similar to the one implemented by the City of Adelaide, where EV bays can be identified individually and converted to regular bays as required.

It is still unclear if the identification of EV only bays with a different overhead light and signage will deter petrol-fuelled vehicle drivers from parking in those spaces, particularly if the car park is close to capacity. The City of Adelaide plans to cross check data recorded by the bay sensor and the charger systems to identify the periods when vehicles were parked in the EV only bays but didn't use the chargers. If this type of anti-social behaviour is recurrent, the council will need to evaluate what measures can be put in place to educate drivers.

A similar situation currently occurs with bays allocated to parents with prams for example, and regular drivers parking their vehicles in these spaces. It is difficult to control and educate drivers to comply with this type of rule and even the implementation of a sophisticated system such as the one planned in the City of Adelaide does not guarantee full compliance.

Alternative 3 – Incentivise developers and property owners

Considering that most EV charging is done at home or at work, perhaps a more effective policy would be to promote the installation of EV charging points in new residential and commercial developments or to provide incentives for property owners to install their own EV charging stations at home.

Amendments in planning controls can be put in place making mandatory provisions for EV charging stations within private developments (similarly to the requirement to provide bicycle

spaces for example). A council can also consider changing the contributions plan including the installation of public charging stations as part of the conditions of new developments.

Final observations

This white paper doesn't presume to exhaust the EV topic. Our objective is to provide solid information on the Australian EV landscape as well as instigate the observation of different alternatives for Local Government Areas.

Each Council understands its local reality and has its own future objectives. Perhaps in an area where a sustainable mobility plan is in place investments in an extensive EV charging infrastructure makes complete sense whereas in a Council where basic public transport needs are not being met, EV charging network may not be a priority.

Finally, new solutions and advances arise constantly and we will be updating this white paper regularly.

ⁱ ClimateWorks, 2016, The Path Forward For Electric Vehicles In Australia Stakeholder Recommendations, available at: <http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/The-Path-Forward-for-Electric-Vehicles-in-Australia-Submission-to-the-Federal-Government-Vehicle-Emissions-Discussion-Paper.pdf>

ⁱⁱ European Alternative Fuel Observatory (EAFO), 2017, Top 5, available at: <http://www.eafo.eu/top-5>

ⁱⁱⁱ GovernmentNews, 2017, Electric vehicles – How can we do more?, available at: <http://www.governmentnews.com.au/2017/03/electric-vehicles-can/>

^{iv} Energy Networks Association and CSIRO, 2015, Electricity Network Transformation Roadmap: Future Grid Forum – 2015 Refresh, available at: http://www.energynetworks.com.au/sites/default/files/151215_ntr-wp1-iwp2_fgf_refresh_technical_report.pdf

^v AEMO and Energeia, 2016, AEMO Insights Electric Vehicles, available at: <http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/AEMO-Insights-Electric-Vehicles.pdf>

^{vi} Energy Networks Australia and CSIRO, 2017, Electricity Network Transformation Roadmap: Final Report, available at:

http://www.energynetworks.com.au/sites/default/files/entr_final_report_web.pdf

^{vii} International Energy Agency (IEA), 2016, Global EV Outlook2016, Beyond one million electric cars, available at: https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

^{viii} Idaho National Laboratory, 2015, Plug-in Electric Vehicle and Infrastructure Analysis, available at: <http://avt.inel.gov/pdf/arra/FinalReportHqlySept2015.pdf>

^{ix} Electric Vehicle Council, 2017, Submission to Ministerial Forum on Vehicle Emissions, available at: <http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/Electric-Vehicle-Council-Submission-to-Ministerial-Forum-on-Vehicle-Emissions1.pdf>

^x State of Electric Vehicles in Australia 2017, 2017, ClimateWorks Australia; Electric Vehicle Council, available at: <http://electricvehiclecouncil.com.au/wp-content/uploads/2015/05/State-of-EVs-in-Australia-2017.compressed.pdf>

^{xi} City of New York, 2017, Leading the Charge: Mayor Announces Fast-Charging EV Hubs in All 5 Boroughs <http://www1.nyc.gov/office-of-the-mayor/news/600-17/leading-charge-mayor-fast-charging-ev-hubs-all-5-boroughs>

^{xii} Meyer, D. 2017, Free Parking for Electric Cars Is a Bad Idea Any Day of the Week, StreetsBlog NYC, available at: <http://nyc.streetsblog.org/2017/05/11/free-parking-for-electric-cars-is-a-bad-idea-any-day-of-the-week/>

^{xiii} Eleftheriou-Smith, L. 2017, London street lamps are being turned into electric car charging points, available at: <http://www.independent.co.uk/environment/london-street-lamps-electric-car-charging-points-ubitricity-tech-firm-hounslow-council-richmond-a7809126.html>

^{xiv} JetCharger

^{xv} ChargePoint, Leading Retailer Partners with ChargePoint to Attract and Retain Loyal Customers, available at: <https://www.chargepoint.com/files/casestudies/cs-retail.pdf>

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