Electric Vehicle Feasibility Study and Business Case

Feasibility Report

December 2017

goulburn broken greenhouse alliance

NDEVR ENVIRONMENTAL

Executive summary

Section 1. Introduction

Ndevr Environmental has been engaged to deliver the Goulburn Broken Greenhouse Alliance (GBGA) Electric Vehicle (EV) Feasibility Study and Business Case. This Report constitutes the EV Feasibility Study, and investigates the feasibility of introducing EVs into the 11 regional participating councils' fleets.

More specifically, the objective of this Report is to: (a) analyse the strategic drivers for considering EVs and any barriers to their adoption; (b) obtain an understanding of the current fleet operations and policy context of the councils to determine the appropriateness; and (c) understand the current EV market and how this could impact GBGA councils.

Section 2. EV Market

EVs present an opportunity to reduce fleet greenhouse gas (GHG) emissions and operating costs due to the higher efficiency of the electric motor, less moving parts and the absence of tailpipe emissions. Further, the absence of tailpipe emissions has public health and broader environmental benefits.

There is limited EVs currently available in Australia. EVs are not yet at the same economy of scale as conventional vehicles to enable price competitiveness (and there has been limited government incentives), and EVs are required to overcome the fact that existing infrastructure and social behaviour is constructed around conventional vehicles (i.e. service stations, carparks etc). However, market analysis shows that there is a growing global demand for EVs, and notwithstanding relatively poor uptake and availability of EVs in Australia to date, the EV market is expected to grow in Australia in the near term. This expected growth will be driven, at least in part, by government policy and action at all three levels of government concerning both emissions reductions and EV-related policies, such as the introduction of a proposed fuel efficiency standard.

In Australia, local councils have to date led the early adoption of EVs, by incorporating solar PV installations to indirectly power recharge facilities, providing free charging to the public to encourage uptake in the community, and introducing electric and higher efficiency vehicles in their own fleets as a demonstration (e.g. City of Sydney, Moreland City Council, Melbourne City Council). These case studies described in this Report provide important insights for the GBGA councils on the introduction of EVs into council fleets, both from a strategic perspective and with regard to the design of criteria for Vehicle Fleet Policies to enhance EV uptake.

Section 3. GBGA Councils Context

This section of the Report details the prevailing context at the GBGA councils, including the strategic drivers for undertaking this project; the current fleet operations and internal policies; current attitudes and any existing EV infrastructure and/or demand. This context forms a vital backbone to the analysis of the feasibility of introducing EVS into the councils' fleets.

Overall, the fleet of the 11 participating councils exhibits the following characteristics relevant to this Study:

- Over the July 2016 – June 2017 period there were 593 light vehicles in operation across the 11 councils; travelling on average 83.6km per day.
- Currently, there are no EVs or plug-in hybrid vehicles, and 56 non-plug-in hybrid vehicles (5.9%).
- The ownership structure varied between the councils with a total of 92.6% vehicles owned and 7.4% leased.
- There was a mix of home garaged (63%) and those kept overnight at council depot (37%).
- Servicing and maintenance is mainly undertaken by local mechanics (62%), followed by vehicle manufacturers (24%) and council depots (14%).

- The average age of the 432 vehicles that provided year of manufacture was 2.73 years; and the reported turnover period between the councils ranged from 3 to 5 years with not all councils having a set period.
- The average environmental performance of the fleets able to provide fuel data is 191.9 gCO_2-e/km for passenger vehicles and 259.9 gCO_2-e/km for light commercial vehicles (LCVs). In comparison, the new Australian vehicle average was 180 gCO2-e/km and the proposed target for new vehicles by 2025 is 105 gCO2-e/km.

An analysis of the various councils' policies also revealed that there are varying internal targets, policies and commitments regarding their fleets, pointing to the need to consider clearer targets and actions in policies to support EV uptake.

A consideration of the context also necessitates an analysis of stakeholder attitudes, and the availability of existing support infrastructure (i.e. charging infrastructure). Regarding the former, the Study revealed that current council employee attitudes towards EVs in the region is largely positive with 81% of survey respondents wishing to see more EVs in their respective council's fleets; and only 8% of survey respondents not interested in driving one. Regarding the latter, the Study revealed that none of the participating councils currently has any EV or on-site charging infrastructure; and there were minimal public charging stations noted in the area. Currently the charging infrastructure is lacking to drive to regional Victoria from Melbourne with ease in a BEV.

Sections 4 & 5: Key Considerations & Findings

An overview of the key considerations identified through the study, and the respective findings, is provided in the table below.

Table 1: Overview of Key Considerations and Corresponding Findings

Considerations	Findings
Availability of EVs For EVs to be a feasible option they need to be available for purchase.	The majority of EVs currently available are in the luxury vehicle bracket although some non-luxury vehicles are available. Currently available non-luxury EVs include: Mitsubishi Outlander PHEV, Renault Zoe, Renault Kangoo, and Tesla Model 3. The Hyundai Ioniq non-plug-in hybrid is available for a 9-12month trial program, and the plug-in hybrid and full EV Ioniq variants will soon become available as well.
Suitability of EVs Available EVs also need to be suitable for Council applications. Stakeholders indicated range anxiety and off-road driving as barriers to EV adoption.	The data provided indicated that the average daily kilometres travelled was 84km/day, which would not require a recharge during the day. Hybrid electric variants provide an option with improved environmental performance but with the backing of the conventional engine for additional power that could be required for off-road driving. At this stage it is not recommended that any whole fleet be swapped for EVs, rather all vehicles to be fit for purpose. There are EVs on the market that could meet council needs.

Considerations	Findings
Local Sourcing Council's procurement practices preference support for local industry. Stakeholders indicated concern that local dealerships may be disadvantaged by a Council preference for EVs.	It was found that there were local dealerships in the region for the manufacturers scheduled to provide EVs. While the individual local dealerships may not currently stock EVs a demand for them would facilitate supply. There is further opportunity to support local industry by the need for new skills in the area associated with EVs and charging infrastructure.
Charging Infrastructure To incorporate EVs into the GBGA council fleets, sufficient charging infrastructure must be in place to support their use.	A level 2 station at Council depots would enable overnight charging for Council fleet vehicles; and public charging (level 2 and 3) stations would both raise community awareness and appease community range anxiety concerns to facilitate uptake. It was found that the largest cost associated with charging infrastructure is the installation, and accordingly any installations should allow for future stations to be added on.
Whole of life environmental benefit The driver for considering EVs is for the environmental benefit, and stakeholders wanted to ensure that implementation of EVs would have a whole of life environmental benefit.	The absence (for full EVs) or reduction (for hybrid variants) of tailpipe emissions results in improved air quality and removal of greenhouse gas emissions. It was found that even charging with Victorian grid electricity (i.e. not 100% carbon neutral) produced less emissions than a conventional engine vehicle. The additional benefit of using electricity is that there is the future option to charge from renewable power and to benefit from the Victorian renewable energy target and the resultant improvement in grid electricity. With respect to the battery, a Melbourne based company (re-electrify) has been established with ARENA funding to re-use EV batteries to power cooling systems. Further, manufacturers reportedly have processes in place to re-use and recycle batteries.
Whole of life costs The price premium of EVs was identified as a barrier to implementation, while the reduced operating costs was identified as an opportunity. Councils therefore sought to understand the whole of life cost comparison.	Previous research found that the reduced operational costs associated with EVs was enough to compensate for the purchase price premium. These cases were for the Nissan Leaf which is no longer available. This business case assessment will consider whole of life costs for currently available vehicles.

Considerations	Findings
Community stewardship The *Local Government Act* requires Councils to act in the best interests of their respective communities, and leadership was identified as one of the key drivers for considering EVs.	Research found that the Community is likely to become more receptive to EVs the more they are seen around the region. Any council EV should be adequately signed for maximum community impact.

Additional findings of this Study include:

- **Sound strategic drivers.** The analysis found that the primary reasons for GBGA Councils considering EVs were justified. The Study provides (preliminary) validation of the following key strategic drivers:
  - **Environmental benefit**. EVs are more efficient than conventional vehicles. The continual improvement in Victoria's grid emissions intensity will further enhance the environmental performance of EVs in the long term, with the use of renewables (which all councils are investing in) providing a means for zero GHG emissions. The absence of tailpipe emissions also results in improved urban air quality and associated community health benefits.
  - **Leadership role of Council**. Councils as stewards in the community have a responsibility to provide leadership to the community. Incorporating EVs within Council fleets will provide demonstrations of their use, create a demand for OEMs to release more EVs, and feed the second-hand vehicle market, rendering EVs more accessible to the community.
  - **Operating cost savings.** The higher energy conversion of the electric motor, and less moving parts result in substantial savings in annual vehicle operating costs (i.e. fuel and maintenance). For the business case, these need to be considered and balanced against the higher purchase price and the cost of associated infrastructure.
- **Suitable vehicles are available.** While vehicle choice remains limited to date, EVs that are suitable for GBGA council use, including off-road use, are now available. From the list of available vehicles, the following are considered suitable for further consideration in Council fleets (i.e. <$50/60k):
  - **Mitsubishi Outlander plug-in hybrid;** available now for purchase or lease.
  - **Tesla Model 3**, fully electric – available for purchase now delivery in 12 months.
  - **Renault Zoe, fully electric** – available for purchase since November 2017.
  - **Renault Kangoo, fully electric** - available for purchase since November 2017.
  - **The Hyundai Ioniq vehicles** - expected in 2018, while the price has not been released they are not expected to be in the luxury vehicle range and there is a potential opportunity for Councils to participate in a pilot/evaluation program of the non-plug in hybrid variant (Hyundai Motor Company of Australia 2017a).
- **Regional & EV Supplier Support.** There is support within Councils for the introduction of EVs into council fleets. There is also backing from the EV market to support EV growth in the regions, primarily through support for the installation of charging infrastructure and demonstration of vehicles. Opportunities exist for further collaboration with manufacturers and infrastructure providers for mutually beneficial outcomes through EV trials. Such collaboration will improve the business case by removing the price premium, and should therefore be sought out actively.
- **Policies and internal commitments could be strengthened.** It is evident from the Environmental Strategies that all Councils place a high value on environmentally sustainable outcomes. However, the emphasis put on transport opportunities varies between councils. An opportunity therefore exists for councils to identify specific targets for council and community fleets in relation to emission

reduction (number of EVs, maximum utilisation, alternate transport) and energy reduction (renewable energy to assist with charging infrastructure) in their Environmental Strategies. All councils should have a Fleet Policy addressing vehicle procurement and usage.

- **Staged installation of charging infrastructure.** To accommodate EVs within Council fleets a level-2 charging station could be installed at each Council where an EV is to be based. Future demand should be considered at the time to minimise the costs of future installations and/or upgrades. Installations can be staged from both a financial and change management perspective, with chargers installed to accommodate council EV fleets first; and public stations second. To ensure the most cost effective and strategic placement of charging stations, infrastructure providers could be asked to respond to an EOI to detail their suggested locations and pricing.

Section 6: Recommendations

The following recommendations arise from this Feasibility Study:

- The feasibility study should move to the next stage and a business case should be conducted to determine the potential cost of abatement for introducing EVs under a different range of scenarios, including considerations surrounding the need for charging infrastructure.
- The available EVs should considered by fleets and the vehicles highlighted for potential switching to EVs should be validated, ensuring fit for purpose selections are made.
- Councils without emission reduction targets/ strategies in place should investigate establishing them to ensure the internal framework is established to better facilitate the business case.
- Councils should consider participation in OEM trials.
- Councils should engage with their local utility providers early.
- Councils without existing data management systems should consider investing in such systems as the only way to improve performance is to have access to data to monitor it.
- Councils should consider the change management advice in Appendix E to this Report to ensure effective engagement with internal and external stakeholders.

TABLE OF CONTENTS

Version	Date	Author	Checked by	Description of Change
Final vA.0	18/01/2018	Stephen Christos / Hannah Meade	Micha Young	Incorporating feedback
Final VA.1	3/04/2018	Juliana Bedggood / Hannah Meade		For public distribution

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1 Introduction

Ndevr Environmental has been engaged to undertake the delivery of the Goulburn Broken Greenhouse Alliance (GBGA) Electric Vehicle (EV) Feasibility Study and Business Case.

Objective

"To determine the viability and business case for the uptake of electric vehicles by 11 regional councils and support efficient and viable collaborative procurement of this technology"

Electric and low emission vehicles present an opportunity to significantly reduce greenhouse gas emissions from fleet operations. The GBGA seeks to investigate the opportunities for EV uptake within its councils by joining together to capitalise on shared infrastructure and group buying power.

This study investigates the feasibility of introducing EVs into the participating councils' fleets by considering the current needs of councils, and the latest information available on the EV industry, to inform fleet managers.

Background

The GBGA was established to facilitate collaboration between the local councils in the Goulburn Broken region to reduce greenhouse gas emissions, with a vision of "***a prosperous, resilient and well informed regional community that is adapting to a changing climate***". In October 2016, during Round 2 of the Collaborative Council – Sustainability Funder Partnership program, Greater Shepparton City Council received approved funding as the lead council to undertake this project with the aim of 'building a case for EVs in regional council fleets'. Due to location and proximity to travel destinations regional fleets generally travel further than metropolitan fleets. The increased mileage travelled results in additional costs (i.e. operating and maintenance), and resultant emissions from higher fuel use. While the environmental and operational cost benefit presents a case for action, range limitations of EVs present a potential obstacle for EVs in the region. The feasibility of introducing EVs into the fleets of the participating councils therefore needs to be assessed carefully.

Figure 1: GBGA Region (source: www.gbga.com.au)

The 11 GBGA councils participating in this project include Greater Shepparton City Council, Benalla Rural City Council, Campaspe Shire Council, Indigo Shire Council, Mansfield Shire Council, Mitchell Shire Council, Moira Shire Council, Strathbogie Shire Council, Wangaratta Rural City Council, Wodonga City Council, and Murrindindi Shire Council.

The GBGA is a founding member of the Victorian Government's TAKE2 climate change action pledge program; with two councils also pledging. Further, individual councils have signed on to the 'Cities for Climate Protection' program to reduce council and community emissions. In alignment with these commitments, this project is a collaboration of the GBGA councils for the benefit of both their individual councils and respective communities.

Project Methodology

This Report constitutes the Feasibility Report, the first of two reports to be produced by the study team under the umbrella of the current commission. Figure 2 below outlines the project methodology.

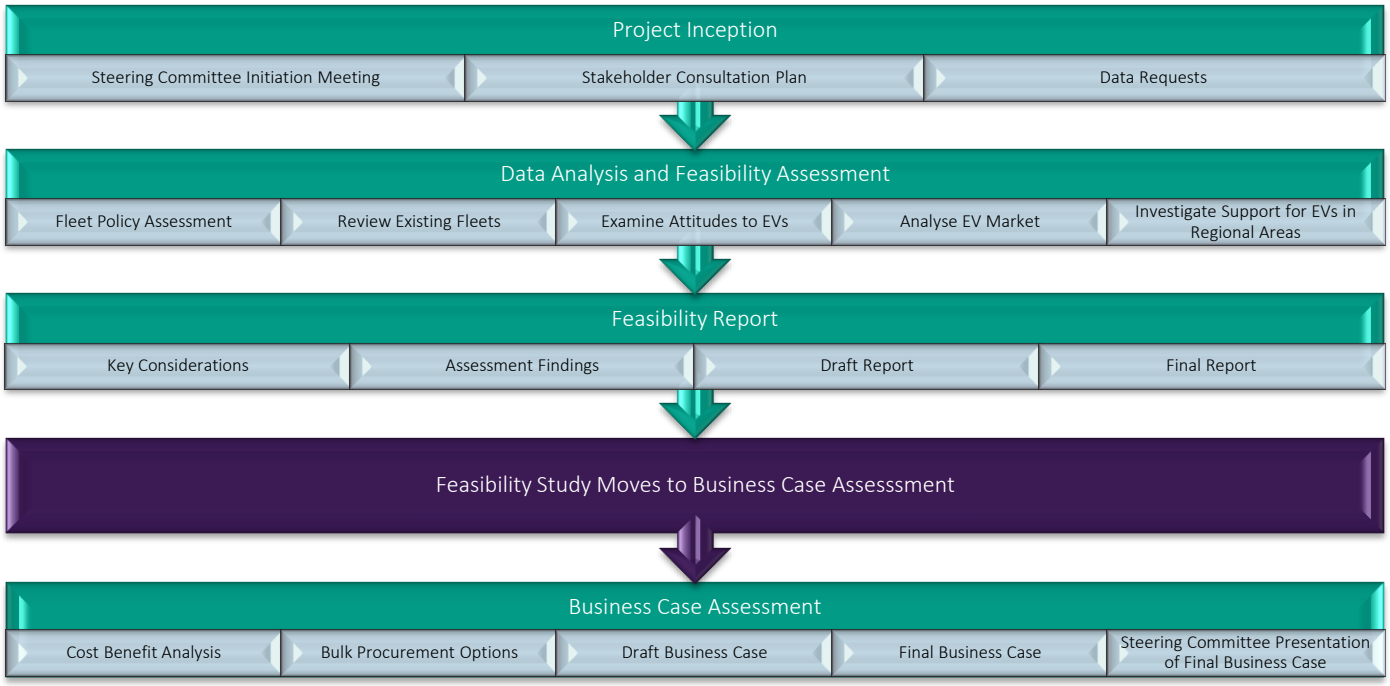


Figure 2: Project Methodology

The principal purpose of this stage is to provide GBGA with advice about the feasibility of incorporating EVs into its member councils' fleets. To achieve this, it was necessary to (a) determine the strategic drivers for considering EVs and any barriers to their adoption; (b) obtain an understanding of the current fleet operations and policy context to determine the appropriateness; and (c) understand the current EV market and how this could impact GBGA councils. Information was collected from individual Council data request forms; an online survey, the workshop, and consultations with industry stakeholders. This report is structured as follows:

- **Section 2** aims to provide the reader with a background and overview of the EV market in Australia; the key benefits and operational considerations associated with EVs (i.e. vehicles and associated infrastructure; learnings from other councils that have incorporated EVs; and an idea of market trends.
- **Section 3** details the current context. Namely, the drivers from councils for undertaking this project; the current fleet operations and internal policies; current attitudes and any existing EV infrastructure and/or demand.
- **Section 4** addresses each of the key considerations either raised by GBGA Councils or necessary to be addressed in determining feasibility.
- **Section 5** synthesises the findings from Section 3 and Section 4 to answer the questions raised above to recommend next steps outlined in **Section 6.** It should be noted that a cost-benefit analysis does not form part of this Report, but will be undertaken in the business case stage if EVs are considered feasible for the GBGA councils.

This Report also includes several attachments for further detail, including a copy of the data request provided to councils; the aggregated survey results; and stakeholder summary notes are also attached.

2 Electric Vehicle Market

This section contains a high-level overview of EVs in general and key environmental and operational considerations associated with their use.

Overview of Electric Vehicles

The EV is not a new technology. The first EV was built in the 1800s and was ironically originally more popular than the gasoline vehicle due to being quieter, easier to drive and not emitting pollutants. However, its popularity was short-lived following the mass production of the Ford Model T making gasoline/ petrol vehicles more affordable (i.e. in 1912 it was $650 for the Model T compared to $1,750 for an electric roadster).

Fast forward to today and the EV market has been reinvigorated following climate pressures and energy security concerns, yet faces a similar price premium quandary in comparison to the well-established internal combustion engine (ICE) vehicles. The greatest EV choice is currently offered in the luxury car segment.

Figure 3: History of Electric Vehicle (a) English electric vehicle, 1884 (b) Electric vehicles were popular with urban residents, 1899 (c) Thomas Edison and the first hybrid electric car, 1901, (d) Tesla Roadster in Australia for the Eco Challenge, 2009

Figure 4, below illustrates the different propulsion schematics between an internal combustion engine, different hybrid variants and EVs. Parallel hybrids allow the engine to operate in both ICE and electric mode; while series hybrids utilise a smaller ICE engine to deliver electric energy to support wholesale use of the electric motor for motive force. Series hybrids present a significant opportunity for realisation of efficiency benefits without the constraints that currently retard consumer demand for fully electric vehicles.

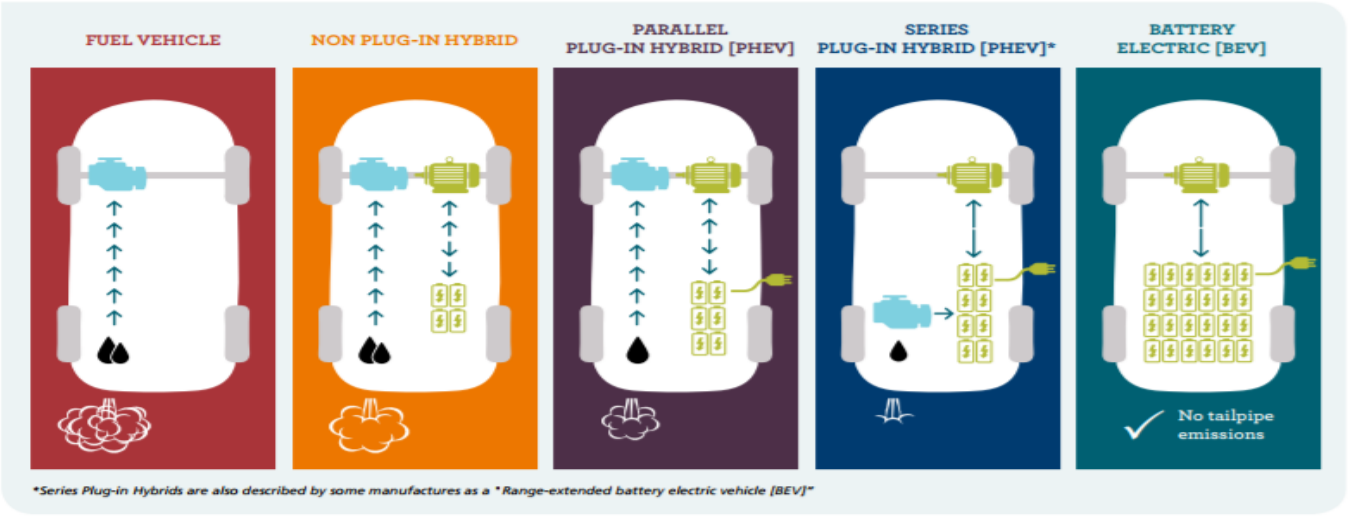


Figure 4: Diagram of different type propulsion vehicles (source: GWRC 2016)

The EV presents an opportunity to reduce fleet greenhouse gas (GHG) emissions and operating costs due to the higher efficiency of the electric motor, less moving parts and absence of tailpipe emissions. Relative to conventional ICE technology, electric motors convert a much higher proportion of the energy stored on the vehicle (e.g. fuel or battery storage) to motive traction. Pure Battery Electric Vehicles (BEV) are estimated to deliver an improvement in energy conversion efficiency (relative to ICEs) of up to 45% (NSW OEH 2016). This efficiency results in reduced operating costs, less maintenance requirements due to less moving parts, and no Scope 1[1] GHG emissions. Further GHG benefits can arise from utilising renewable energy as the electricity source.

Additionally, the reduction or absence of tailpipe emissions associated with EVs provides public health and environmental benefits.

The current motor vehicle fleet is a significant contributor to air pollution; particularly, through the emission of carbon monoxide, nitrous oxides and particulate matter. The detrimental effects on health are exacerbated in comparison to other sources due to the proximity and exposure of the population (i.e. ground level and in populated areas, in comparison to industrial emissions from stacks that are diluted prior to reaching the population). In Australia, it has been suggested that vehicle emissions cause 40% more deaths than the road toll; and there is increasing evidence suggesting links between the level of air pollution and serious health consequences (Schofield, Walter, Silver, Brear, Rayner and Bush 2017). Recent studies (which included Australia) also reveal the severity of the global human health impact from diesel emissions; in 2015 about 38,000 premature deaths (heart disease, lung disease and strokes) were attributed to the fact that most diesel cars produce more toxic nitrogen oxides (NOx) than regulations allow (Anenberg et al 2017). In Australia, it was estimated in 2015 that the cost to the economy of premature deaths caused by air pollution was $17.8 billion, with a further $4.5 billion in welfare losses and foregone labour. Fully EVs have no tailpipe emissions and do not contribute to local air pollution, and PHEVs have less tailpipe emissions than conventional vehicles and therefore also less of an impact than conventional vehicles.

However, as a new technology (in modern vehicle times) the manufacturing production of EVs is not yet at the same economy of scale as conventional vehicles to enable price competitiveness. Further, EVs must overcome the fact that existing infrastructure and social behaviour is constructed around conventional vehicles (i.e. service stations, carparks etc).

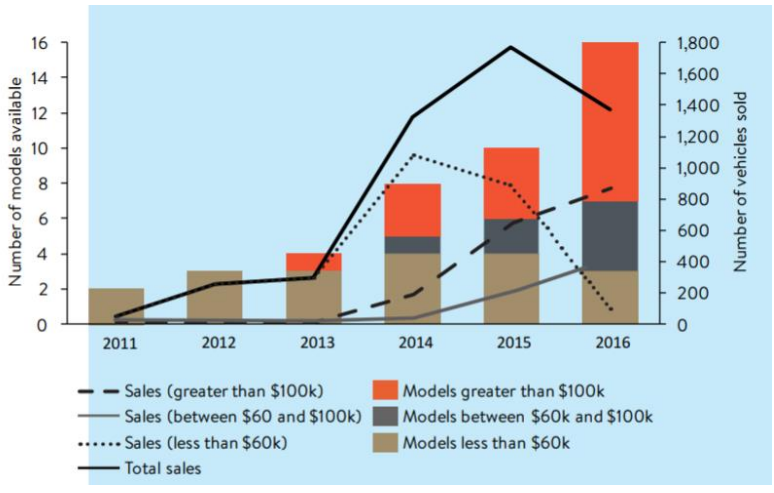


Figure 5: Number of EV Models available per price range (ClimateWorks 2017)

While there have been EV trials, State government support for charging infrastructure, and some registration discounts, there have been no large financial incentives to increase EV uptake in Australia, in contrast to other countries, which have done much more to promote EV uptake.

As a result, there is a limited supply of EVs in Australia due to the delayed local demand deterring Original Engine Manufacturers (OEMs) from providing all models to the market. The majority of EVs introduced to date have been in the luxury vehicle segment (Figure 5), and targeted at on-road driving with limited carrying capacity.

[1] Scope 1 emissions, as defined by the GHG protocol are direct emissions from sources that are owned or controlled by the organisation.

Current & Future Australian EV Market

Australia's total EV fleet is approximately 5000 vehicles. To put that in perspective, there are currently around 18 million vehicles registered in Australia, more than 1.1 million new vehicles are sold each year, and around 4 million vehicles are sold in the used car market each year (DOI 2016b).

While BEVs and PHEVs currently account for less than 1% of the cars produced worldwide, it is reported that this is the beginning of a global electric vehicle revolution particularly given the growth in the Chinese market (IEA 2017) (Figure 6). The global electric car stock surpassed 2 million vehicles in 2016. Of those cars 507,000 EVs and PHEVs were sold in China (53% increase from 2015); 222,200 EVs and PHEVs were sold in Europe (14% increase); and 157,130 units were sold in the United States (36% increase) (Perkowski 2017).

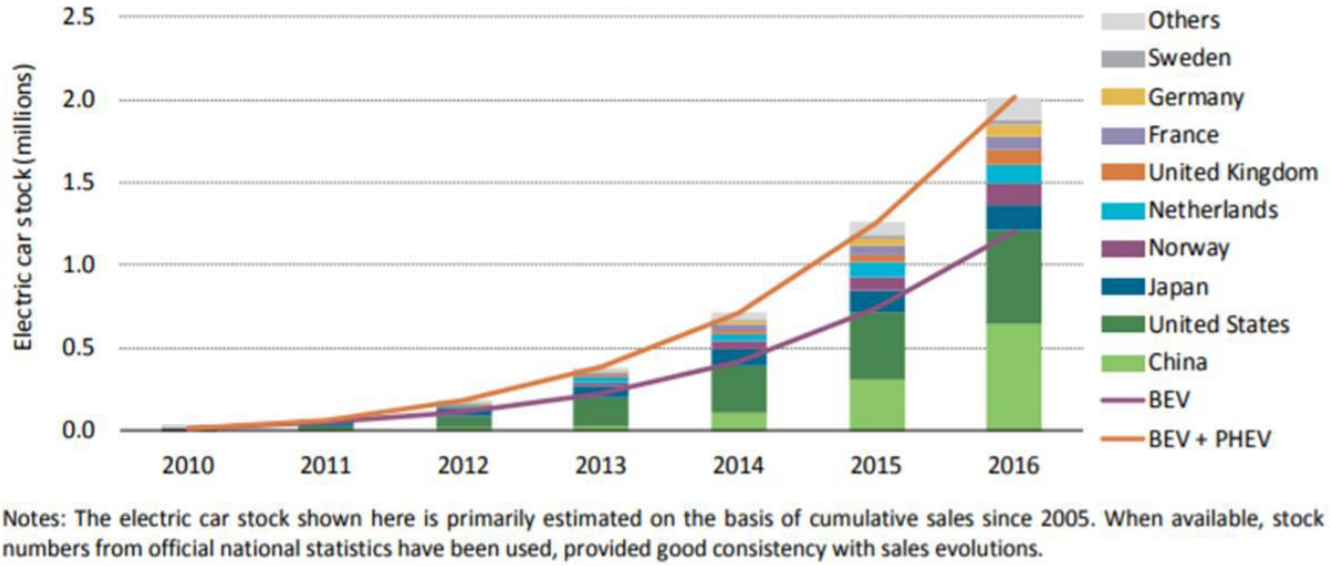


Figure 6: Evolution of the Global Electric Car Stock, 2010 – 2016 (IEA 2017)

There has been a total worldwide sales growth of 40%, the International Energy Agency attributes this to the *expansion in production capacity, a bigger range of models and improved vehicle performance* (IEA 2017). Technology costs have also declined significantly, with battery costs approximately 20% of their cost five years ago. The EV market is thus clearly growing, and in the long-term costs are expected to decrease, given the decreasing technology costs and increasing demand.

Despite international sales of EVs on the increase, Australia's market has not followed suit. EV sales dropped in 2016 (Figure 7); with only 0.1% of new vehicle sales in 2016 being EVs; half fully electric and the rest hybrid-electric vehicles (Climate Works 2017).

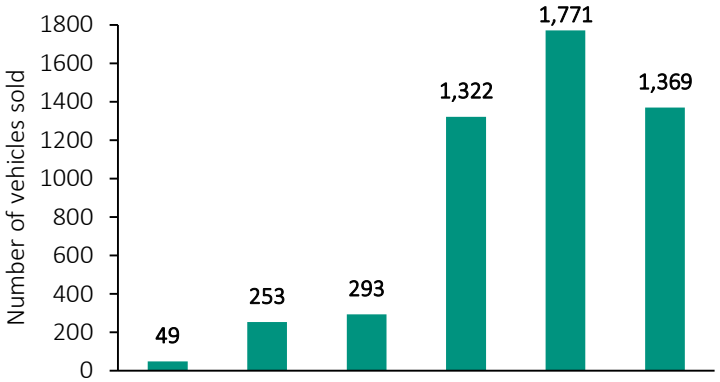


Figure 7: Electric Vehicle Sales in Australia, including estimated Tesla sales (source Climate Works 2017)

Government action worldwide has also developed the infant EV market to the point that the provision of charging infrastructure (and supporting technology) is fast becoming a commercial proposition for the private sector. To this end, the following has occurred in recent years:

- Tesla has built a network of 'Supercharger' fast chargers where Tesla owners can recharge for free, and Nissan has built a network of quick charging stations across the US.
- American Automobile Association has developed an EV mobile charging unit to assist drivers who have run out of charge.
- Development of various phone apps and navigation systems to provide EV drivers with information about remaining range and the closest charging stations.
- Retail chains (including Walgreens, Kroger, IKEA, McDonald's, Target and Kohl's) volunteering EV recharge facilities, because the relatively low cost of charging is worth the value of the time of the driver in their store (ESAA 2013).
- BMW and Audi area addressing the need for more public charging stations in a different way by providing EV owners with petrol-fuelled loan vehicles for longer journeys. Owners can use their EV for daily commuting and lease a petrol vehicle for their occasional long journeys.
- Royal Automotive Club (RAC) of Western Australia is establishing a user-pays[2] RAC Electric Highway® that will feature 12 locations in Perth and throughout the South West with publicly accessible electric vehicle fast-charging DC stations. Charging stations have been funded by RAC but are owned and maintained by local governments in the region (RAC 2017).

Over the past decade, all three east-coast State governments have participated to some extent in schemes designed to promote the establishment of public charging infrastructure for EV's, with the Victorian Government committing to a multi-year trial (2010-2014) that delivered mixed results. Current major State government electric vehicle charging initiatives in Australia include:

- Queensland Electric Vehicle Super highway - Eighteen fast-charging charging stations installed around Queensland to allow electric vehicles to travel from the Gold Coast to Cairns (Ergon mapped its network in 2016 to identify potential charging point sites) (Ergon Energy 2017).
- City of Adelaide Electric Vehicle Charging Hub. Two fast Charging Stations (AC 22kW) and two Super Fast Charging Stations (DC 50kW) serviced by the City of Adelaide; four Tesla Superchargers (125 kW) serviced by Tesla; and 40 charging stations to be rolled out in the City during 2017.

[2] The user pays 45 cents per kilowatt-hour of electricity consumed, plus a $1 per transaction fee (RAC 2017).

Overview of Charging Infrastructure

Charging infrastructure requires the consideration of multiple variables: charging level/mode, plug, and vehicle standards.

There are three levels of charging available, varying in the output of voltage and amps and thus charging time:

- **Level 1 trickle charging.** EVs can be charged from a wall power socket involving voltages of 240 volts and transfer rates in the order of 15 amps; this process takes approximately 8 hours and is suited to a domestic environment.
- **Level 2 fast charging**. This form of charging uses the same voltages as trickle charging but involves higher electric currents (typically 30–80 amps); and takes approximately 3 - 4 hours to recharge.
- **Level 3 rapid charging**. This form uses high voltages (around 400 volts) and high transfer rates (up to 600 amps); and takes in the order of 30 minutes to recharge. Tesla also offers their own superchargers which is reported to add 270kms of range to Tesla vehicles in only 30 minutes.

All car batteries are direct current (DC), so power must go into them as DC. Level 1 and 2 require the EVSE[3] (electric vehicle supply equipment) outputs alternating current (AC) to be rectified to DC within the vehicle's onboard system. Level 3 chargers output DC which flows directly into the battery. This is faster than AC charging because the DC Charger can rectify more power than the car.

There are several types of plugs, as there are currently multiple plug standards for both AC and DC charging. Some vehicles may be compatible with multiple plugs; however, the Tesla Supercharger plug is only compatible with Tesla EVs. For AC charging, there is a Type 1 and Type 2 plug design. The DC chargers also base their designs off the AC chargers, with the exception of CHAdeMO. The designs can be seen in Appendix B2. Car manufacturers currently incorporate different plug standards for different regions. There is currently a push to implement a single standard before the mass rollout of public EV charging infrastructure, as replacement and retrofitting is expensive (ClimateWorks 2016).

Table 2 overleaf provides an overview of the charging options aligned with level, mode, plug type and compatible vehicle standards.

[3] EVSE includes all the components required to supply electricity from an electricity source to the electric vehicle battery.

Table 2: Charging options aligned with level, mode, plug type and compatible vehicle standards. (Source: EVSE 2017; Chargepoint 2017; Jetcharge 2017a; Jetcharge 2017c; Bräunl 2017).

Charging Outlet	Power	Capacity	Mode: Safety communication protocol between EV and charging outlet	Plug	Standards
Level 1 **Trickle Charging (AC)**	Wall socket: 240V, 15A 2.5-7kW	7.5-15km/h Full charge in ~8hrs More suitable for PHEVs with smaller battery sizes or if longer charging time is available.	Mode 1: standard power outlet with standard extension cord. Mode 2: Standard power outlet with 'smart' cable – power will only flow once cable has detected it is safe enough to do so (e.g., no over-current or over-temperature errors).	Type 1 – J1772 » Single phase	**Level 1** **Trickle Charging (AC)**
				Type 2 – Mennekes » Single and 3-phase	Tesla, Renault
Level 2 **Fast Charging (AC)**	Charging station: 240-400V 15-30A 7-25kW	18-40km/hr Full charge in ~3.5hrs	Mode 3: Wired-in AC charging station. The vehicle is connected directly to the electrical network via specific socket and plug and a dedicated circuit.	Type 1 – J1772 » Single phase	**Level 2** **Fast Charging (AC)**
				Type 2 – Mennekes » Single and 3-phase	Tesla, Renault
Level 3 **Rapid Charging (DC)**	Charging station: 400-500V 100-125A 25-135kW Tesla SuperCharger (135kW)	70km/10min 420km/hr 80% charge within 30min	Mode 4: Wired in DC charging station. Charger is part of station, not part of car.	CHAdeMO	**Level 3** **Rapid Charging (DC)**
				CCS Combo » AC compatible, therefore Type 1 and 2 variants	Volkswagen, BMW, Ford, Hyundai
				Tesla Supercharger » Uses Type 2 plug	Only work with Tesla cars; incompatible with other cars even if they have a type 2 plug.

Case Studies / Best Practice

To date local councils have led the early adoption of EVs in Australia, incorporating solar PV installations to indirectly power recharge facilities, providing free charging to the public to encourage uptake in the community, and introducing electric and higher efficiency vehicles in their own fleet as a demonstration (e.g. City of Sydney, Moreland City Council, Melbourne City Council).

- **Moreland City Council** has been an EV pioneer since joining the Victorian Government's EV trial program in 2010. It has the highest number of council-owned, publicly provided charging stations in Australia. There are currently 11 recharge stations in the municipality. In April 2007, Council endorsed the Climate Action Plan (revised and updated since inception), which included a commitment to the goal of zero net emissions for Council's corporate emissions by 2020 and the goal of zero net emissions for the Moreland community by 2030. Since 2013, MCC have begun to tackle emissions of their light vehicle fleet, and assist the public with their first EV charging infrastructure installed at council offices in 2013. They have, and continue to, incorporate EVs into their fleet. MCC are certified carbon neutral under the National Carbon Offset Standard (NCOS) and it was ensured that EVs were branded accordingly. MCC is now looking to reduce the emissions of their heavy vehicle fleet through their hydrogen waste truck project.

Figure 8: Moreland EV charging (source: Sustainable Fawkner)

- **City of Sydney** became the first of any level of government to be certified as Carbon Neutral under the NCOS in 2011. The City has a long-term target of 70% reduction in GHG emissions by 2030. It achieved a 26% reduction over four years through the implementation of a Fleet Management Strategy, which included incorporating Mitsubishi i-miev and Nissan Leafs into its fleet, recharged from renewable power. Electric fleet bicycles are provided for work-related travel and after completing a half day 'cycling in the city' training course. The City also provides free public charging infrastructure in carparks around the municipality (City of Sydney 2014).
- **Greater Wellington Regional Council (GWRC)** implemented an "electric first" vehicle policy in 2016 (Figure 9). When vehicles are reviewed employees must have an EV unless they are able to provide good reason otherwise. This stance was a result of the Council's Climate Change Strategy and Sustainability Action Plan identifying that 40.8% of the GWRC organisational GHG emissions were from fleet. The GWRC is working towards being the first region in New Zealand with an electric bus fleet and wants to encourage the uptake of EVs. Table 3 lists advice from GWRC on incorporating EVs into council fleets. The New Zealand Transport Agency (2017a) has developed a plan for the installation DC fast/ rapid charging stations every 75kms (state highways), and AC charging stations every 50km (state highways and collector routes).

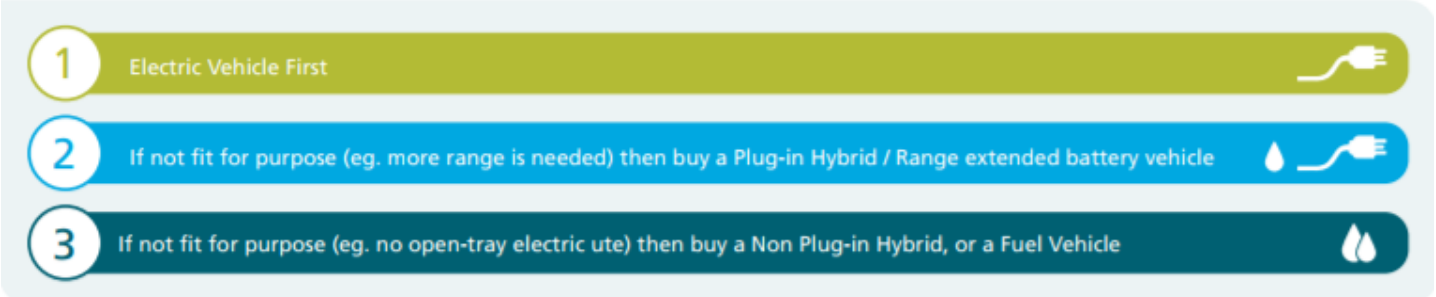


Figure 9: GWRC Electric First Fleet Policy (source: GWRC 2016)

Table 3: Advice from the GWRC on introducing EVs into fleets

How to introduce EVs into fleet
1 *Find out how many of your vehicles and days a year that your vehicles drive under 100km daily to identify the proportion can than already go full-electric today. Where an existing vehicle is only occasionally driven long distance, it may well be replaced by a full electric, with the driver booking a shared pool plug-in hybrid for long trips.* 2 *Identify specialised vehicle requirements beyond passenger capacity (e.g. open trays, 2000 KG towing capacity) and minimise the use of fuel vehicles through providing only enough such vehicles to meet actual demand. Bookable 'heavy duty' vehicles in a pool may help.* 3 *Perform a fleet analysis and identify the mileage or age needed for electric vehicles to cost the same as fuel vehicles. Consider extending your vehicle age replacement criteria necessary.* 4 *Organise a selection of trial vehicles for staff. Ensure they are shown the basics and have the opportunity to drive far enough to get a good sense for the vehicles. Capture feedback.* 5 *Update your vehicle purchasing policy to give preference to electric vehicles. Use the text found later as inspiration. While numerical and written explanations are clearly necessary, be sure to lead with staff driving trials to encourage support.* 6 *Proudly purchase electric vehicles. Sign-write cars and charging stations, and publish information about EVs to your website, social media, and in community and customer publications. Bring your EVs out to events.* *Annually monitor your progress annually and adapt your policies to complete the transition of all vehicles to electric* Source: GWRC 2016

Council officers reported that taking a leadership role has flow-on effects to the community (NSW OEH 2016), which is one of the objectives of the GBGA through this project. This subsection provides an overview of the key learnings from the experiences of councils and others in implementing EVs. Further details on the case studies is included in Appendix C Additional Detail on Case Studies.

The C40 Cities[4] Climate Leadership Group has developed several Best Practice Guides based on its cities' experiences. The key points from the Best Practice Guide for Low Emission Vehicles is provided in Table 4. GBGA as a collaboration of Councils already address point 1 and 6.

[4] network of large cities across the globe cooperating on actions to address climate change

Table 4: Key Points from the C40 Cities Best Practice Guide for Low Emission Vehicles

The C40 Best Practice Guide for Low Emission Vehicles[5]
» **Focus on city fleets.** Demonstrate benefits to the community and generate market potential for manufacturers through incorporation within councils' own fleets. » **Provide infrastructure.** This improves the viability of EVs over conventional vehicles. Their presence also increases public awareness. » **Tackle purchasing and technology**. To address the high purchase price of the battery, some cities determined the actual size they needed and purchased smaller BEVs. » **Provide incentives.** While state and federal government have the greatest scope for providing incentives, councils can provide incentives through prioritised parking, cheaper parking permits, or through access to recharge infrastructure. » **Introduce zoning**. Cities have implemented initiatives to limit vehicle traffic in high urban areas and only low emission vehicles in such areas. » **Work with partners.** Collaboration with partners (private or otherwise) to support EV uptake and charging infrastructure development. As well as strategies to support policy development and understanding vehicle use patterns. » **Focus on education and awareness**. It is important to develop city-specific education and awareness programmes to overcome misperceptions and empower consumers and stakeholders to shift to low emission vehicles. Source: C40 Cities Climate Leadership Group 2016

Some additional learnings include:

- For public recharge infrastructure utilise a network road classification system to identify priority journeys, and roads (to ensure that the roads that deliver the greatest benefit to community are utilised first (NZ Transport Agency 2017a).
- EV trials found that most users would recharge at home overnight.
- From observing markets with high EV uptake there is no set ratio of vehicles to charge points (International Council on Clean Transportation 2017).
- In fleets utilise EVs for travel that can be completed within range restrictions of the vehicle battery, and plug-in hybrids for longer distance travel. Pool heavier vehicles to limit their use to only when needed.
- Engage staff and drivers early. Conduct trials, and market the presence of EVs through vehicle signage.
- The visible presence of EV charging stations has a recognised impact upon EV take-up.
- If a recharge station is in an area with extreme climate, consider placing stations in covered areas when possible as extreme weather can impact battery range. Delta in partnership with CSIRO are currently undertaking a study investigating battery performance over different temperature profiles (Dinkelmeyer 2017).
- Consider user accessibility and safety when designing charging infrastructure site (i.e. convenience and avoiding hazards).
- Think through preventative strategies such as placing stations under lighting and in locked enclosures to prevent vandalism (U.S. General Services Administration 2016).

[5] Low emission vehicles include electric and hybrid vehicles.

Broader Government Policy Context

This section details the broader government policy context in terms of both emissions reduction and EV related policies, which may have an impact on the EV market.

2.1.1 Emissions Related Policy and Commitments

Following Australia's ratification of the UNFCC Paris Agreement, which seeks to avoid a global temperature increase of more than 2°C above pre-industrial levels, Federal and State Governments have reviewed and updated their climate change policies. Transport was identified as a key sector requiring attention in meeting set climate change targets.

In Australia, at the Commonwealth level, Department of Infrastructure and Regional Development (2107) is holding the Ministerial Forum on Vehicle Emissions (incorporating the infrastructure, energy and environment portfolios). It was established on 31 October 2015 to examine current policy settings as well as a range of Commonwealth commitments including Australia's 2030 target, the National Clean Air Agreement, the Direct-Action Plan and National Energy Productivity Plan. On the Forum's agenda, in addition to reducing vehicle tailpipe emissions, was investigating the case for vehicle fuel efficiency standards and labelling. To date the Forum has released:

- *a draft Regulation Impact Statement on improving the efficiency of new light vehicles;*
- *a draft Regulation Impact Statement on strengthening noxious emissions standards for light and heavy vehicles; and*
- *a discussion paper on improving fuel quality standards (DOI 2017).*

The proposed fuel efficiency standard for light vehicles, if passed through parliament, will come into place in 2020 and require car companies to start reporting sales and efficiency levels. By 2022, 65% of their vehicles sales would have to comply with the emissions target, rising to 100% by 2025. The proposed standard put forward by the Forum **is 105 grams of CO2/kilometre**, which would incentivise OEMs to introduce more EVs to Australia. The figure below outlines some key benefits of the proposed fuel emission standards.

Benefits of Vehicle Emission Standard (Source: Australian Government Climate Change Authority 2013)

Other countries are making bold commitments to banning petrol and diesel cars altogether for air quality and climate reasons. For example:

- **Britain**. Ban on petrol and diesel cars by 2040
- **India**. All-electric car fleet by 2030
- **France.** Ban on petrol motor vehicles by 2040
- **China.** Target for 35 million new energy vehicle sales by 2025 (battery electric, hybrid electric, and fuel cell vehicles).
- **Germany.** As of 2030, all new cars registered in Germany must be emissions free
- **Norway.** 100% EVs by 2025
- **Netherlands.** No new sales of petrol or diesel vehicles by 2025

Efficiency standards across the world that cover transport end-use are illustrated in Figure 10. Given that this is the direction in which the rest of the world is moving, it is envisaged that Australia will either eventually follow suit, or at least benefit from manufacturers producing lower-emission vehicles for those other countries.

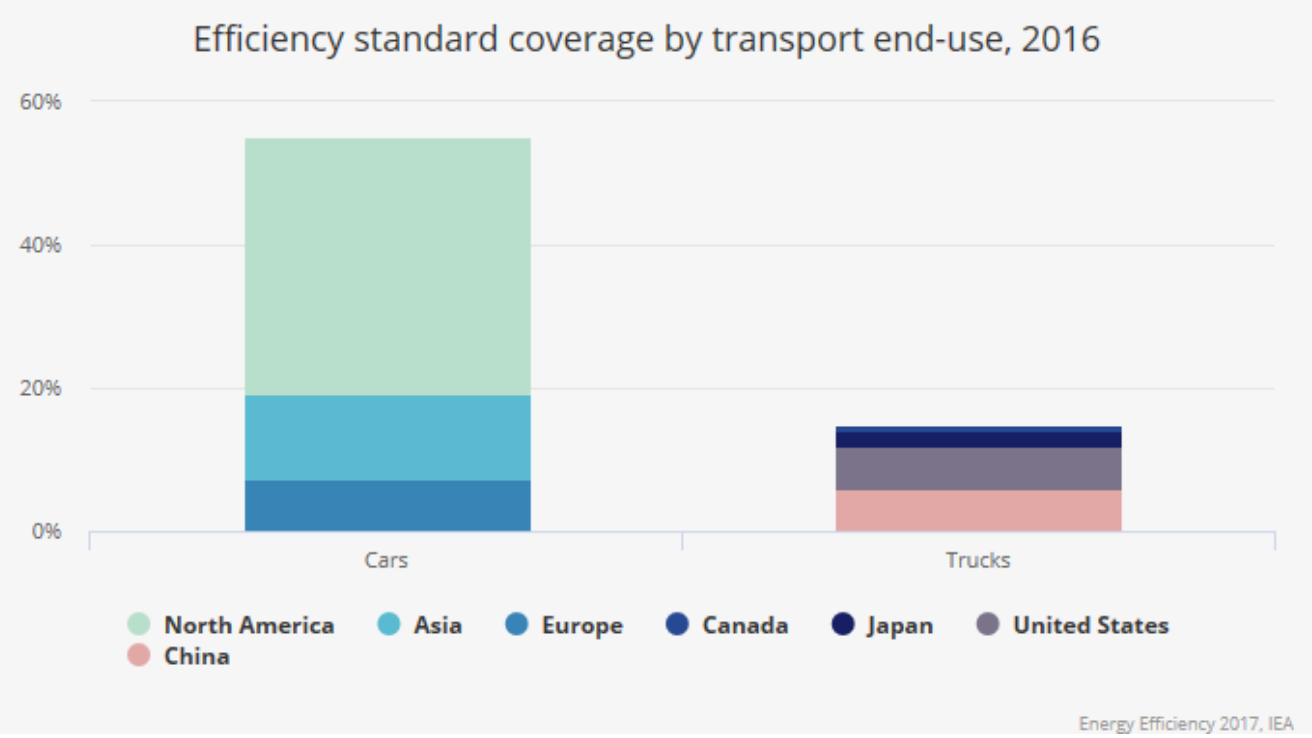


Figure 10 Efficiency Standard coverage by transport end use, 2016 (source: IEA 2017)

2.1.2 Victorian Government Climate Change Act 2017

At a State level, Victoria has enacted the *Victorian Climate Change Act 2017* which came into force on 1 November 2017. It sets a long-term emissions reduction target of net zero greenhouse gas emissions by 2050 (State Government of Victoria 2017).

The "Take 2" program calls on all Victorians, including government organisations, to make a pledge towards implementing emission reduction strategies to aid in achieving this target.

The Act envisages that one of the actions to be taken by the State to achieve its targets is to shift from fossil fuel energy (gas, petrol, diesel, etc) for transport towards clean energy options.

2.1.3 Councils Around the World

Councils around the world are demonstrating leadership in addressing climate change. Initiatives and collaborations such as the Compact of Mayors and C40 (described below) illustrate the power of collaboration between local councils in implementing change.

» **Compact of Mayors.** Launched at the 2014 United Nations Climate Summit, the Compact of Mayors is the world's largest coalition of city leaders addressing climate change by pledging to reduce their greenhouse gas emissions, tracking their progress and preparing for the impacts of climate change. It is based on the concept that local governments have the power and innovation to drive aggressive climate targets, and will generally act faster than higher levels of government. The Compact establishes a common platform to capture the impact of cities' collective actions through standardised measurement of emissions and climate risk, and consistent public

reporting of their efforts. The ultimate objective of the Compact is to encourage a co-operative effort among cities to reduce greenhouse gas emissions, track progress and prepare for the impacts of climate change.

» **C40 Cities.** Established by the Mayor of London in 2005, C40 Cities is a network of large cities across the globe cooperating on actions to address climate change. The C40 Cities Climate Leadership Group have developed a number of Best Practice Guides based on their cities' experiences, including one for Low Emission Vehicles which has been referenced in this Report. Further, the C40 Cities has recently announced a fossil-free streets declaration which involves a pledge to: (a) *procuring only zero-emission buses from 2025*; and (b) *ensuring a major area of the city is zero emission by 2030*; an action within this is to "*lead by example by procuring zero emission vehicles for our city fleets as quickly as possible)* (C40 Cities 2017).

The Victorian greenhouse alliance, follows this collaborative approach between local council areas. Similar to this project being undertaken by GBGA, the Northern Alliance on Greenhouse Action (NAGA) is also undertaking an investigation into reducing its respective councils' fleet emissions, with a particular focus on low emission vehicles.

2.1.4 Victorian Electric Vehicle Inquiry

It is suspected that these initiatives, coupled with advocacy work undertaken by ClimateWorks and the recently established Electric Vehicle Council into promoting the uptake of electric vehicles, have contributed to the electric vehicles inquiry currently underway by the Victorian Parliament's Economy and Infrastructure Committee.

The inquiry has been established to examine the potential pros and cons, manufacturing and applicability of EVs in Victoria. The areas being investigated by the inqury are as follows:

> *1. The* ***potential benefits of widespread uptake of EVs in Victoria*** *to the environment, including greenhouse gas emissions, air quality, noise and amenity, whereby EVs are defined as vehicles that both:*
>
> *a. use one or more electric motors as their sole means of propulsion; and*
>
> *b. require recharge from an off-board electricity source.*
>
> *2. The* ***regulatory, infrastructure, economic, employment and incentive options*** *for supporting the uptake of privately owned EVs.*
>
> *3. The* ***applicability of EVs*** *in public transport bus fleets and* ***public-sector fleets****.*
>
> *4. Options for supporting the manufacture and assembly of EVs in Victoria, including transition of workers and suppliers affected by the closure of vehicle manufacturing in Victoria.*
>
> *5. The applicability of EVs to the car share providers market* (Parliament of Victoria 2017).

Submissions were due on 11 December 2017 and 24 parties submitted comments including: Hyundai, Beyond Zero Emissions, and Central Victorian Greenhouse Alliance. The submissions can be accessed at: https://www.parliament.vic.gov.au/eic/article/3495

2.1.5 Demand Management Support

While there was initially concern over the potential impact on the grid from the extra demand from EV charging, EVs are now being viewed as a potential measure to improve grid utilisation. The Finkel Review 2017 stated that *it is possible, in principle, for EVs to be used as distributed energy storage facilities, releasing energy back to the grid at peak times, and also helping in addressing the management of frequency, reactive power and voltage to improve grid security and reliability* (Commonwealth of Australia 2017).

3 GBGA Councils' Current Context

The overview provided in the previous chapter illustrates that there is a growing demand for EVs around the world, and that notwithstanding relatively poor uptake and availability of EVs in Australia to date, the EV market is expected to grow in Australia in the near term.

To answer the question posed for this investigation (i.e. whether it is feasible to incorporate EVs into the GBGA regional council fleets); it was necessary to determine the context for their consideration by the councils. This involved consultation with stakeholders and an analysis of the current fleet compositions and historical fleet data to determine the potential demand for electric vehicles and to identify important operational considerations.

Council Drivers

The most common responses to the question: "What are the main reasons you want to see more EVs in your fleet?" by survey respondents was:

- "To aid in meeting greenhouse gas emission reduction targets"
- "It is a good image for council to be portraying"
- "Reduced operating costs"

Discussions with council stakeholders, survey responses, and a review of existing policies identified the following key strategic drivers for the consideration of EVs:

- **Environmental benefit.** While there are varying degrees of emission reduction targets and commitments between the participating councils (see Section 0) all participating councils expressed interest in EVs for the potential environmental benefit (63% of survey respondents see EVs as helping to meet emission reduction targets, and 18% for public health concerns).
- **Leadership.** All councils highlighted the value of their involvement in the project as means to demonstrate actions in both adopting new technology and reducing emissions as a leadership role to the community. Further, 62% of survey respondents selected that incorporating EVs would portray a positive of image of council.
- **Potential financial benefit.** The reduced operating costs associated with use of EVs was highlighted as a reason for their consideration by 50% of survey respondents. The price associated with their purchase was also raised as a barrier and the two will need to be considered together in a whole of life costs analysis.
- **Tourism** and encouraging visitors to the region was identified as a key driver for councils in general. Stakeholders raised concern that an absence of a local EV market could be inhibiting a segment of potential tourists – and introducing EVs could provide an additional tourism market. 33% of survey respondents saw the potential co-benefits associated with EVs (including tourism) as an opportunity for GBGA Councils.

Council Fleet Overview

Fleet data was collected from each of the participating councils to obtain an understanding of the current performance and usage of the fleets. Over the July 2016 – June 2017 period there were 593 light vehicles in operation across the 11 councils; travelling on average 83.6km per day. An overview of council fleet performance is provided in Table 5 below.

Table 5: Fleet Overview

Council	Council Size	Council Maintained Road Network	Number of LCV Vehicles	Number of Passenger Vehicles	Total number of vehicles	Total kilometres travelled	Average annual kilometres
Council A	Regional City	416km (sealed)	30	28	58	880,000	15,172
Council B	Regional City	691km (sealed) 1288km (unsealed)	37	26	63		5,815
Council C	Small Shire		4	22	26	1,152,782	44,338
Council D	Regional City	1,163km (sealed) 1,123km (unsealed)	72	65	137	2,612,097	19,066
Council E	Small Shire	474km (sealed) 668km (unsealed)	14	23	37	1,400,557	37,853
Council F	Large Shire	4,000km (sealed and unsealed)	39	35	74	2,470,512	33,385
Council G	Large Shire	668km (sealed) 715km (unsealed)	55	52	107	2,725,437	25,471
Council H	Small Shire	244km (sealed) 581km (unsealed)	10	3	13	327,753	25,212
Council I	Small Shire	436km (sealed) 1,027km (unsealed)	13	24	37	852,561	23,682
Council J	Large Shire	1150km (sealed) 2100km (unsealed)	0	4	4	139,000	34,750
Council K	Small Shire	615km (sealed) 732km (unsealed)	18	19	37	1,422,925	20,659
Total			***292***	***301***	***593***	***14,344,178***	***25,946***

Currently, there are no EVs or plug-in hybrid vehicles, and 56 non-plug-in hybrid vehicles (5.9%). The ownership structure varied between the councils with a total of 92.6% vehicles owned and 7.4% leased. There was a mix of home garaged (63%) and those kept overnight at council depot (37%). Servicing and maintenance is mainly undertaken by local mechanics (62%), followed by vehicle manufacturers (24%) and council depots (14%).

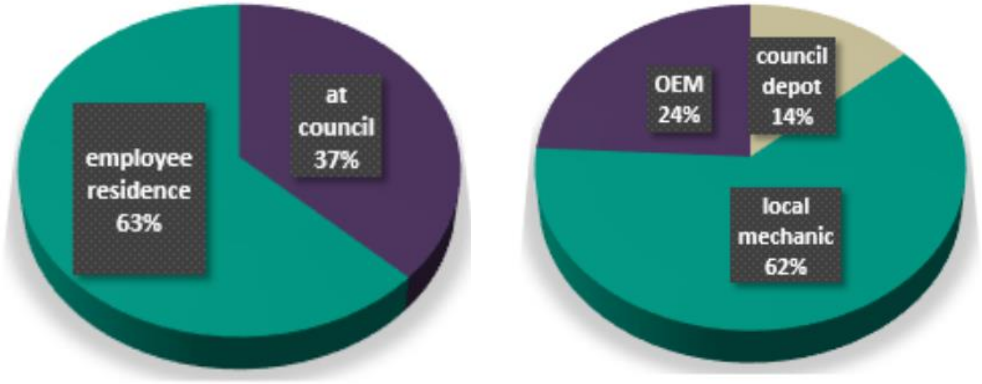


Figure 11: (a) Vehicle Garaging Location *(b) Servicing Location*

The average age of the 432 vehicles that provided year of manufacture was 2.73 years; and the reported turnover period between the councils ranged from 3 to 5 years with not all councils having a set period (Table 6).

Table 6: Fleet Ownership Structures

Council	Own or Lease	Fleet Policy on Turnover	Survey Respondent Turnover Rate
Council A	Leased	Unknown	Unknown
Council B	Lease	Unknown	Unknown
Council C	Owned	Unknown	Unknown
Council D	Mixed 95% Owned 5% leased	» 3 years and 100,000 km for passenger cars and » 5 years 120,000 km for commercial vehicles	3 years; Procurement policy provides clear guidelines for fit for purpose vehicle selection; Via an internal fleet committee

Council	Own or Lease	Fleet Policy on Turnover	Survey Respondent Turnover Rate
Council E	Mixed 81% owned 19% leased	» 4 years or 100,000km for 4cyl sedan or 120,000km for larger sedans » 4years or 120,000km for SUVs » 4 years or 100,000 – 130,000km for commercial vehicles	3 years; Procurement policy provides clear guidelines for fit for purpose vehicle selection
Council F	Owned	Unknown	Unknown
Council G	Owned	» 4 years / 120,000 km for passenger vehicles » 4 years / 150,000 km for light commercial/utilities	4 years, Procurement policy provides clear guidelines for fit for purpose vehicle selection
Council H	Mixed 50% owned 50% leased	Vehicle replacement should occur approximately as follows: » Standard passenger vehicles - 80,000 - 100,000 km » Light commercial - 140,000 km » Modified light commercial - life of vehicle » Four Wheel Drive passenger vehicles - 150,000 km	No response received
Council I	Mixed 68% owned 32% leased	3-4 years 100-200,000 for passenger vehicles	4-5 years; in negotiation with individual business units to meet their needs.
Council J	Leased		Responses ranged from < 2 years; 3 years; 4 years; > 5 years
Council K	Leased (excluding one owned)		3 years

Not all councils were able to populate their data request templates. The six councils (346 vehicles) with sufficient fuel data were estimated to have emitted 2,247tCO_2-e for the 2017 financial year. Assuming this could be extrapolated across the 11-council fleets, this indicates an environmental footprint in the order of 4,000 tCO_2-e[6] per annum.

The environmental performance of the initial six fleets was found to have an average of 191.9 gCO_2-e/km for passenger vehicles and 259.9 gCO_2-e/km for light commercial vehicles (LCVs). In comparison, the new Australian vehicle average was 180 gCO2-e/km and the proposed target for new vehicles by 2025 is 105 gCO2-e/km.

Council Environmental Policy Overview

While all councils are engaged in this process for the environmental outcomes, there are varying internal targets, policies and commitments regarding fleet. Figure 12 illustrates the policies and strategies provided by the GBGA Councils; and while some of the councils reported in the survey that fleet emissions were incorporated in their overarching emission reduction targets/strategies none of them reported having a specific fleet emission reduction target.

Figure 12: Current Policies & Strategies in GBGA Councils

Table 7 below provides an overview publicly available policies and survey responses specifically around the environmental considerations within fleet management.

Table 7: Current Emission Reduction Targets and Fleet Initiatives

Council	Emission Reduction Target	Existing Policy Environmental Fleet Alignment	Survey Response
Council A	None	n.p	Environment/Sustainability Department and the Fleet Department are collaborating on this engagement

[6] Assuming average emissions per vehicle across the whole fleet population.

Council	Emission Reduction Target	Existing Policy Environmental Fleet Alignment	Survey Response
Council B	None	*Environmental Sustainable Strategy* Relevant objectives include: - Reducing fuel use by reviewing and updating the Fleet Management Policy Promoting alternative energy use by supporting EVs.	*NA*
Council C	None	*Environmental Strategy 2011:* - *Committed to conserving energy, including training staff in car use and implementing a green procurement policy for fleet*	*NA*
Council D	20% reduction of Council energy use and cost of 2010 figures by 2020	*Greater Shepparton Environmental Sustainability Strategy 2014 – 2030:* One objective of the strategy is to reduce the environmental impacts of council staff travel requirements: - Environmental impacts are minimised from Council's fleet purchases - The number of staff who commute via walking or cycling is increased - The number of staff who commute via car-pooling is increased.	Environment/Sustainability Department is actively pursuing opportunities with the Fleet Department
Council E	None	*Environment Policy 2008:* Identifying and continually reducing greenhouse gas emissions across all Council operations, including Councils buildings, fleet, public lighting and waste facilities.	Environment/Sustainability Department is not currently focussing on fleet due to time and resource constraints.
Council F	Net-zero greenhouse gas emissions for council by 2050	*Environmental Sustainability Strategy 2017-2021:* An action of the strategy is listed as: to investigate and evaluate use of EVs as part of Council fleet.	*NA*
Council G	Emissions and water use reduction target of 20% on 2009/10 base levels by 2020	*Sustainable Resource Management Strategy:* Both fleet and waste have their own dedicated management documents, which also have a significant focus on the reduction of greenhouse gas emissions and consideration of the natural environment. These are listed as 'additional focus areas' for the strategy.	Environment/Sustainability Department is actively pursuing opportunities with the Fleet Department

Council	Emission Reduction Target	Existing Policy Environmental Fleet Alignment	Survey Response
Council H	None	*Procurement Policy 2016:* An aim of the policy is to ensure sustainable procurement and consideration of environmental impacts. *Vehicle Fleet Policy and Operational Procedures 2017:* A purpose and objective of the policy is that 'the vehicle fleet shall be managed to minimise overall environmental impacts…'	*NA*
Council I	20% reduction in corporate emissions on 2005-06 levels by 2015-16. 20% reduction in community emissions on 2005-06 levels by 2015-16.	*Environment Strategy 2009 – 2012:* Council must consider resource use through its energy and purchasing under an array of business operations including fleet vehicles. Down-sizing fleet is listed as an implemented action for achieving the 2015-16 emission reduction targets. *Procurement Policy 2015:* Procurement decisions will factor in environmental sustainability and preference will be given to products that minimise: waste, greenhouse emissions, habitat destruction, pollution, soil degradation and maximise water and energy efficiency.	Environment/Sustainability Department does have emission reduction targets that includes all Council operations, including fleet. However, the department is not actively working directly with the Fleet Department due to time and resource constraints.
Council J	In process of development	Environment Strategy 2012/2015: To minimise council energy consumption, associated costs, and reduce the impact of future price increase, it was identified that council should have more control over the energy sources and energy consumption associated with its vehicle fleet. The Built Environment, Energy Management section has an action listed: 'Greening our car fleet. Refers to including hybrid vehicles.'.	Environment/Sustainability Department is not currently focussing on fleet as it is not a priority area; and due to time and resource constraints.
Council K	In process of development	*Environmental Strategy 2016 – 2020:* 'Making environmentally responsible travel decisions' is an area where council could reduce greenhouse gas emissions. *Benalla Climate Change Adaptation Plan 2013-2025*: The community and Council are less reliant on fossil fuels and have access to less fossil fuel dependent transport options.	Environment/Sustainability Department is actively pursuing opportunities with the Fleet Department

Attitudes towards Electric Vehicles

Current council employee attitudes towards EVs in the region is largely positive with 81% of survey respondents wishing to see more EVs in their respective council's fleets; and only 8% of survey respondents not interested in driving one (Figure 13).

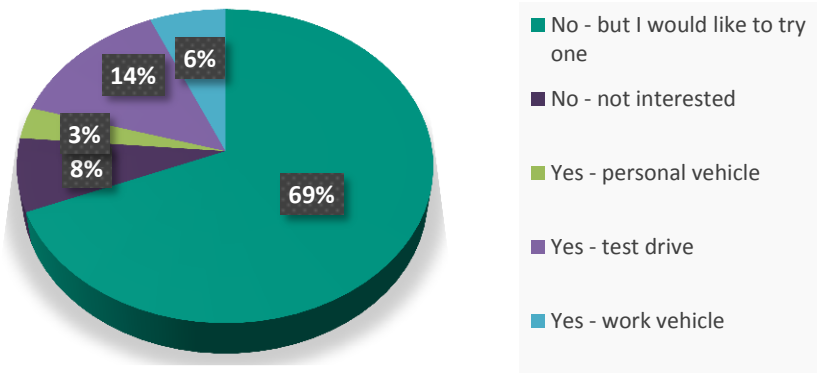


Figure 13: Survey Responses to "Have you driven an EV?"

Out of all survey respondents, the most common responses to the questions: "What circumstances would need to exist for EVs to make sense for your fleet?" were:

- "More vehicle choices available"
- "More recharge stations available in the area"
- "Financial business case".

Out of all survey respondents, the most common responses to the questions: "What do you see as the biggest barriers to introducing more EVs into your fleet?" were:

- "Range anxiety, availability of recharge infrastructure"
- "Range anxiety, length of trips exceeding battery charge"
- "Price of the vehicle"
- "Types of vehicles available".

Out of all survey respondents, the most common responses to the questions: "What are the main reasons you want to see more EVs in your fleet?" were:

- "To aid in meeting greenhouse gas emission reduction targets"
- "It is a good image for council to be portraying"
- "reduced operating costs".

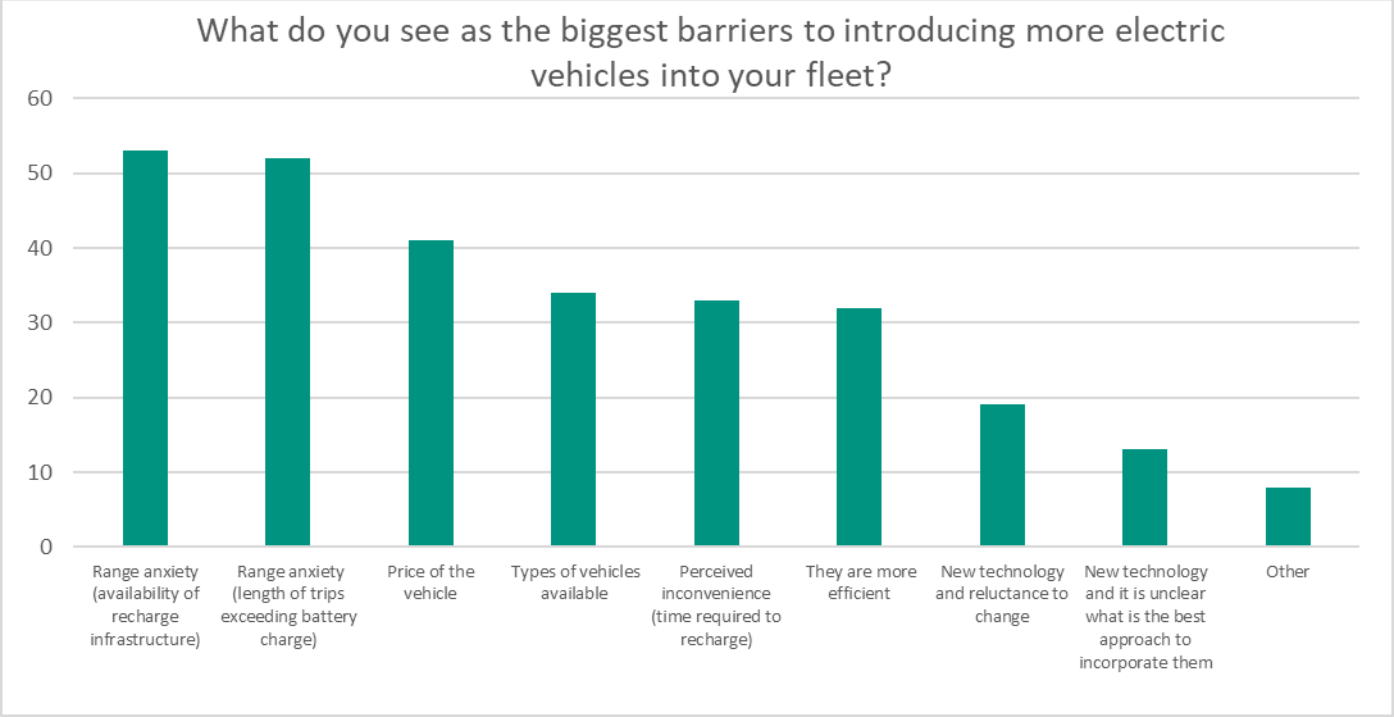
The most prevalent respondents to the survey were from the Environment/Sustainability departments of the various councils. This department saw the biggest barriers to introducing EVs as range anxiety and price of the vehicle. This department saw the main reason for procuring more EVs was that it is a good image for council to portray and to aid in meeting greenhouse has emission reduction targets.

The next most prevalent respondents to the survey were from the Fleet/Infrastructure departments of the various councils. This department saw the biggest barriers to introducing EVs as range anxiety, types of vehicles available and new technology (reluctance to change). This department saw the main reason for procuring more EVs was to aid in greenhouse gas emission reduction targets, reduced operating costs and that it is a good image for council to be portraying.

The following two tables provide an overview of the main perceived barriers as answered by those in favour of more EVs and those against.

Table 8: Biggest Barriers for Adoptoin

Biggest barriers (for those pro EVs)	Biggest barriers (for those against EVs)
Range Anxiety (availability of recharge infrastructure)	Limited vehicle choices available
Range anxiety (length of trips exceeding battery charge)	Insufficient information on their performance within fleet
Price of the vehicle	No existing recharge stations
Types of vehicles available	Guaranteed battery range
New technology and reluctance to change	Price of the vehicle
New technology and uncertain on the best approach to incorporate EVs	Financial business case
Other: vehicle utility, whole of life considerations, limited local dealerships, no power connection	Perceived environmental considerations



While at this stage the local community has not been officially engaged on this project, communities in the area have demonstrated an interest in addressing climate change – a survey completed by Benalla in 2013 revealed that the *community residing in the Goulburn Broken catchment has a very strong belief that human use of fossil fuels is changing the climate*. This indicates that the community is likely to be receptive to initiatives that address climate change.

Further, Eastlink recently undertook a Vehicle Survey to identify future vehicle type preferences. The survey revealed that while less than 2% currently owned a hybrid or 100% BEV, 25% preferred a 100% BEV for their next vehicle (Eastlink 2017), indicating that the market demand is growing.

Existing Charging Stations

None of the participating councils currently has any EV or on-site charging infrastructure; and there were minimal public charging stations noted in the area. Figure 14 below illustrates current charging stations in the region.

Currently the charging infrastructure is lacking to drive to regional Victoria from Melbourne with ease in a BEV (Unny 2017). While there is a Tesla highway to the east, there is a notable absence of charging infrastructure available between the participating councils.

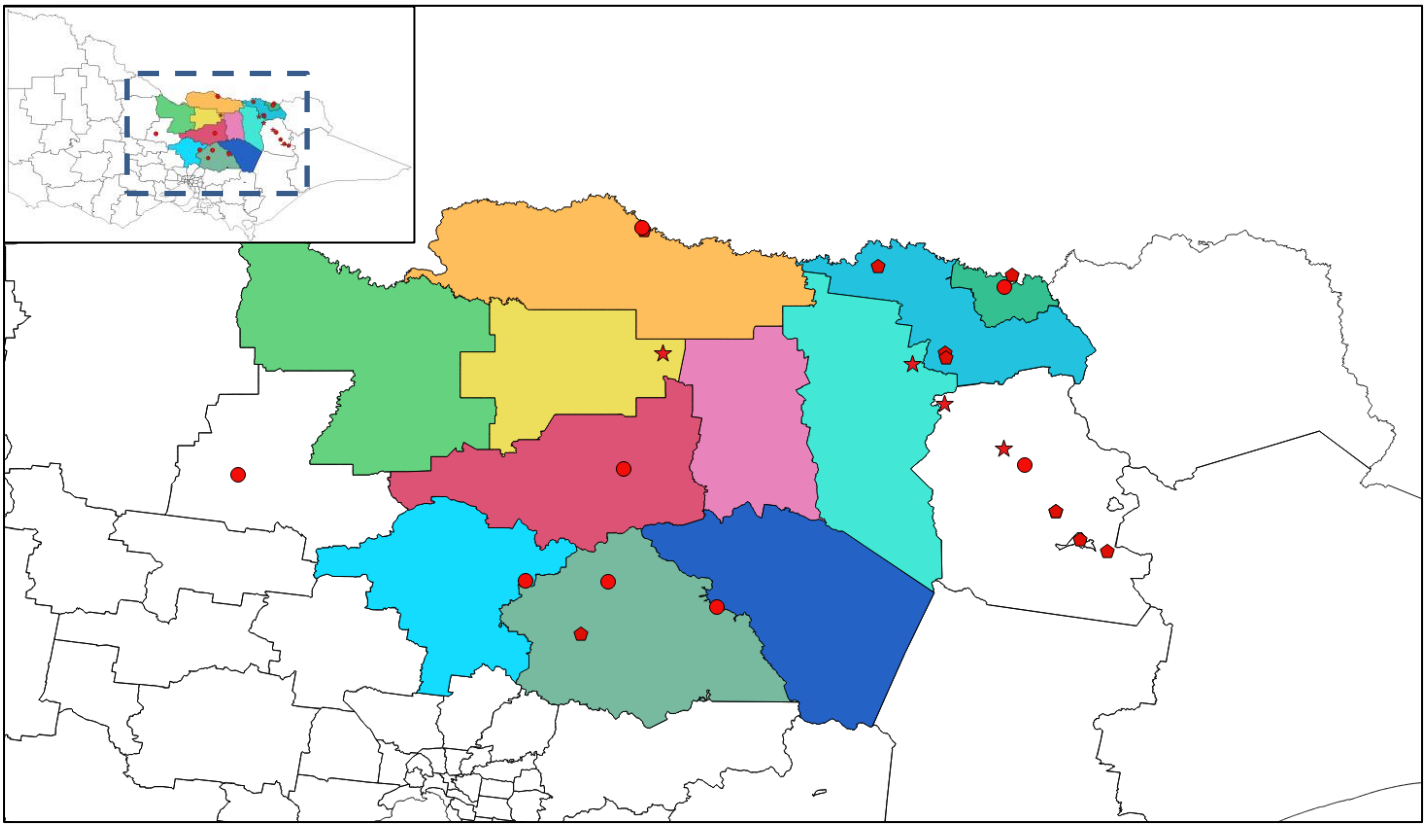


Figure 14: Charging locations in GBGA region. (source: adapted from Electric Vehicle Council Charger Map) (Electric Vehicle Council 2017)

There was a mixed response from Council officers on whether there was sufficient space available on site for charging infrastructure, with many being unsure. However, it is considered to be a possibility at one of the Reginal City's and one of the Large Shires.

4 Key Considerations

This section details key considerations as raised by GBGA Council stakeholders.

Availability and Suitability of EVs

To incorporate EVs into the GBGA council fleets, vehicles need to be available for purchase. A full list of EVs (100% and plug-in hybrid) available in Australia now or in the near term is provided in Table 9 below.

Table 9: Details on Electric Vehicles (fully electric and plug-in hybrid) available in Australia in the near-term

Vehicles	Availability	Vehicle Type	Range	Vehicle Plug	Fuel Efficiency	Price Range
Fully Electric						
BMW i3	Available	Small	Up to 312km	Type 1 (SAE J1772)	12.6 kWh/100km 0g CO_2e/km	$70,000 - $81,000
Tesla Model S	Available	Sedan	75kWh Battery (490km); 100kWh battery (632km)	Tesla SuperChargers CHAdeMO and Level 1,2 SAE J1772 compatible	0g CO_2e/km	$124,677 – $180,884
Tesla Model X	Available	Sedan	75kWh Battery (417 km); 100kWh battery (565km)	Tesla SuperChargers CHAdeMO and Type 2 (IEC 62196/Mennekes)	0g CO_2e/km	$150,591- $184,717
Tesla Model 3 (100% Electric)	Can reserve vehicle (12 to 18 months delivery)	Sedan	345km	Tesla SuperChargers; CHAdeMO and Level 1,2 SAE J1772 compatible	TBA	~$50,000
Renault ZOE (100% Electric)	Available	5 door Hatch	Up to 270km NEDC* (120-200km 'real life' driving range)	Type 2 (IEC 62196/Mennekes) 22kW	13.3 kWh/100km	~$47,000
Renault Kangoo Z.E. (100% Electric)	Available	Small Commercial Van	Up to 403km NDEC* (200-300km 'real life' driving range)	Type 2 (IEC 62196/ Mennekes)	15.5kWh/100km	~$45,000
Hyundai IONIQ EV (100% Electric)	Expected mid 2018	Sedan	280km - TBC	Type 2 (IEC 62196/Mennekes) 22kW	TBC	TBC
New Nissan Leaf (100% Electric)	TBC	Hatch back	240km	Type 1 (SAE J1772)	NA	$US28,992

Vehicles	Availability	Vehicle Type	Range	Vehicle Plug	Fuel Efficiency	Price Range
Plug-in Hybrid						
Mitsubishi Outlander PHEV	Available	SUV	Electric Range 40-50km EV + petrol 500-600km	Type 1 (SAE J1772) CHAdeMO	1.7 l/100km 41g CO_2e/km 9.8kWh/100km	$50,490 - $55,490
BMW 740e	Available	Sedan	Electric only up to 44km	Type 1 (SAE J1772)	2.2l/100 km 50gCO_2e/km 13.3kWh/100km	$250,000
Volvo XC90 T8	Available	7 seat luxury SUV	Electric only up to 22km	Type 1 (SAE J1772)	2.1 l/100km 49g CO_2e/km	$136,167
BMW i8	Available	Coupe	Electric range 37km Maximum range 440km	Type 1 (SAE J1772)	2.1 l/100km 49g CO_2e/km 11.9 kWh/100km	$324,643
BMW x5 x Drive40e	Available	SAV	Electric only up to 31km	Type 1 (SAE J1772)	3.4 l/100km 78g CO_2e/km 15.4 kWh/100km	$135,543
Mercedes-Benz C 350 e	Available	Sedan	Electric only up to 31km	Type 1 (SAE J1772)	11-13.2 kWh/km 2.4 l/100km 48-54g CO_2e/km	$84,045
Mercedes-Benz E 350 e	Available	Sedan	Electric only up to 33km	Type 1 (SAE J1772)	2.5 l/100km 49-57 gCO_2e/km 11.5-14kWh/100km	$142,907
Mercedes-Benz GLE 500 e	Available	SUV	Electric only up to 30km	Type 1 (SAE J1772)	16.7 kWh/km 3.3L/100km 78g CO_2e/km	$140,692
Mercedes-Benz S 500 e	Available	Long Saloon	Electric only up to 33km	Type 1 (SAE J1772)	13.5 kWh/km 2.8/100km 78g CO_2e/km	$341,279
Porsche Cayenne S E-Hybrid	Available	SUV	Electric only up to 18-38km	Type 1 (SAE J1772)	3.4 l/100lm 79g CO_2e/km 20.8 kWh/100km	$161,202
Porsche Panamera 4 E-Hybrid	Available	Sedan	Electric only up to 25-51km	L Type 1 (SAE J1772)	2.5 l/100lm 56g CO_2e/km 15.9 kWh/100km	$270,000
BMW 330e	Available	Sedan	Electric only up to 37 km	Type 1 (SAE J1772)	11.9 kWh/100km 49g CO_2e/km 2.1 l/100 km	$80,097

Vehicles	Availability	Vehicle Type	Range	Vehicle Plug	Fuel Efficiency	Price Range
Hyundai IONIQ (PHEV)	Expected mid-2018	Sedan	TBC	Type 2 (IEC 62196/Mennekes) 22kW	1.1 l/100km	TBC
Volkswagen Golf GTE (PHEV)	Possible 2018 release	Hatchback	49km electric 827km total (NDEC)	Type 2 (IEC 62196/Mennekes)	1.6l/100km	£UK28,139

There is a greater range of EVs available internationally (a list of EVs available in the UK is provided in Appendix B1 Vehicle Technology). However, importation of vehicles requires approval from the Department of Immigration and Border Protection in accordance with the *Motor Vehicle Standards Regulations1989*, and will be subject to additional costs and taxes. There is currently a proposed reform to the *Motor Vehicle Standards Regulations 1989* to include 'Environmental Performance Vehicles' as an option in the 'Specialist and Enthusiast Vehicle Register'; enabling businesses to import low emission vehicles not currently available in Australia. These reforms will likely be introduced by 2019 (Minister for Urban Infrastructure 2017). Currently the easiest way to import a vehicle not available in Australia is through the manufacturer. Nissan was approached to provide minimum numbers required for it to provide the new Leaf, however details are still to be advised.

Accordingly, from the available vehicles the following are considered suitable for further consideration in Council fleets (i.e. <$50/60k):

- Mitsubishi Outlander plug-in hybrid; available now for purchase or lease.
- Tesla Model 3, fully electric – available for purchase now delivery in 12 months.
- Renault Zoe, fully electric – available for purchase now
- Renault Kangoo, fully electric - available for purchase now
- The Hyundai Ioniq vehicles - expected in 2018, while the price has not been released they are not expected to be in the luxury vehicle range and there is a potential opportunity for Councils to participate in a pilot/evaluation program of the non-plug in hybrid variant (Hyundai Motor Company of Australia 2017a).

Additional details on these manufacturers and vehicles is provided in Appendix B1 Vehicle Technology.

To incorporate EVs into the GBGA council fleets, vehicles need to be suitable for council applications; and respondents to the survey expressed concern that EVs may not be suitable for the regional site visits the fleet is required to support.

Examples of Comments Made in the Survey:

"I think it is a great idea but I am concerned about the impact it will have on our day to day job. Some of the cars we currently have are not suitable for us to complete our field work."

"I agree that there is an opportunity to have a fleet of electric vehicles that would be adequate for township travelling, however I do not believe they are suitable for all of Council's fleet needs, such as going off road in remote rural areas."

"Council's Fleet needs to accommodate cars for all positions within Council particularly those who often visit rural properties on dirt roads, paddocks etc. These people are indoor staff not just outdoor so the indoor fleet should have cars of all kinds to suit different roads and areas etc"

"Would need a 4wd vehicle for the type of work I do."

The plug-in hybrid Mitsubishi Outlander is an AWD with off-road capability. Unlike a purely EV, which can have limited towing capacity, plug-in hybrids have a conventional engine for those times when more power is required. The Outlander switches automatically between three modes: fully electric, series hybrid (the petrol engine charges the battery, while the battery drives) and parallel hybrid mode (petrol engine will take over for steep hills). It is envisaged that it would address these concerns raised.

Further, 68% of survey respondents raised the concern that the length of trips required for council operations would exceed the battery charge and 69% of respondents were concerned that insufficient charge stations are available. Considerations in connection with charging infrastructure and location are discussed in Section 0, but it should be noted here that EVs do not need to replace an entire fleet; and in instances where a vehicle is required to travel a longer distance than is expected to be met by the battery range, then a different fleet vehicle could be utilised.

The fleet data provided indicated that the average daily distance travelled across the fleets was 83km/day which can be managed comfortably by a standard electric vehicle battery (different ranges are listed in Table 9). Figure 15 below illustrates the large portion of vehicles that travel under 100km per day. Of these, 17 passenger vehicles are due for replacement in 2017 and 37 passenger vehicles are due for replacement in 2018.

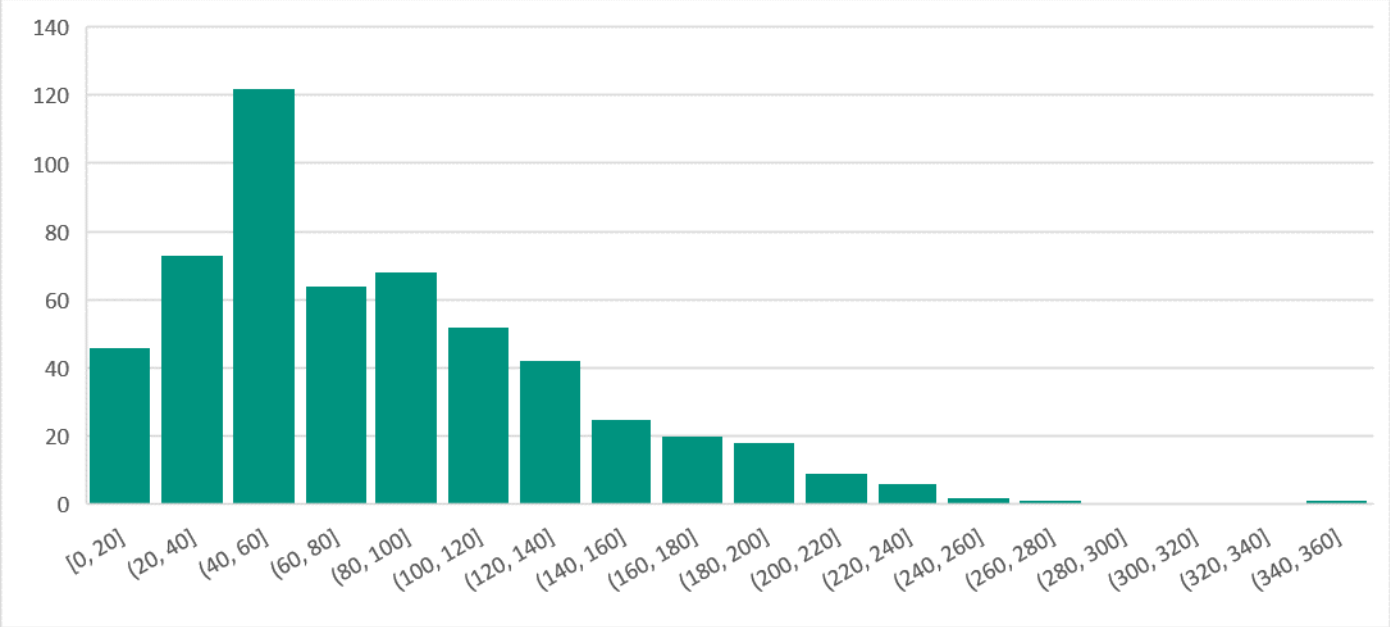


Figure 15: Number of Vehicles by- Average Daily Kilometres Categories

The average daily kilometre calculations were based on the following assumptions:

- 4 councils provided actual data
- 1 council provided one value for whole fleet
- 1 council provided no km data, so was excluded
- Remaining five councils calculated based on annual kilometres provided divided by number of business days.

Local Sourcing

In the workshop councils expressed that it was generally a Council requirement to support local dealerships. Survey respondents indicated that the majority of fleet procurement purchases were guided by the procurement policy, with limited procurement decisions being made in negotiation with local dealerships or individuals. However, the policies themselves reference and give additional weighting to local support as listed below:

- Council A – procurement policy – no mention of local sourcing, just that it follows Local Govt Act for best practice procurement
- Council B – procurement policy – value-for-money principle: local content (10% weighting will be given when using tender evaluation method – tenderers will be given local content schedule)
- Council C – procurement policy – "Consistent with value for money principles, where equivalent value can be sourced either locally or regionally, preference will be given to local suppliers"
- Council D – fleet corporate procedure – no specific mention of local sourcing
- Council E - Procurement policy – "preference to these suppliers where their price is within 5% of the highest scoring value for money offer and they have demonstrated that they can meet Council's requirements with minimal risk."
- Council F – procurement policy – strategy, policy principles, value-for-money principles sections discuss importance of local sourcing
- Council G – procurement policy – key principle: local and economic competition (5% weighting given to local suppliers, if Council identify supplier, Council will request quote from them)
- Council H - Procurement policy – "sustained value" principle: local sourcing (weighting mentioned here but no specific value); value for money: source locally; policy principle: support local
- Council I – procurement policy – objective: support, value-for-money principle: local where possible (specifies application to cars)
- Council J – procurement policy – principle: local sourcing (weighted @ 10%)
- Council K – procurement policy – principle: local content

A number of local dealerships in the area are dealerships of OEMS that currently offer or will soon offer EVs in Australia (Table 10). While the dealerships may not intend to stock the EVs as a standard option, there is scope for them to source them in.

Table 10: Local Dealerships of Manufacturers Scheduled to Provide Electric Vehicles

Local Dealerships	Suburb	Website
Mitsubishi		
Shepparton Mitsubishi	Shepparton	sheppartonmitsubishi.com.au
Echuca Mitsubishi	Echuca	echucamitsubishi.com.au
Baker Mitsubishi	Wodonga	bakermitsubishi.com.au
Wangaratta Mitsubishi	Wangaratta	wangarattamitsubishi.com.au
De Maria Mitsubishi	Cobram	demariamitsubishi.com.au
Bendigo Mitsubishi	Bendigo	bendigomitsubishi.com.au
Neil Beer	Seymour	neilbeermitsubishi.com.au
Renault		
Alessi Renault	Albury	alessirenault.com.au
Shepparton Renault	Shepparton	sheppartonrenault.com.au
Bendigo Renault	Bendigo	bendigorenault.com.au
Hyundai		
Shepparton Hyundai	Shepparton	sheppartonhyundai.com.au
Rich River Hyundai	Echuca	richriverhyundai.com.au
Wangaratta Hyundai	Wangaratta	wangarattahyundai.com.au

Local Dealerships	Suburb	Website
Nissan		
Neil Beer Nissan	Seymour	neilbeernissan.com.au
Yarra Valley Nissan	Lilydale	yarravalleynissan.com.au
Thompson Nissan	Shepparton	thompsonnissan.com.au
McRae Nissan	Wodonga	mcraenissan.com.au
BMW		
Blacklocks Prestige BMW	Albury	blacklocksprestigebmw.com.au
Shepparton BMW	Shepparton	sheppartonbmw.com.au

Further, Section 0 illustrated that 65% of vehicles are currently serviced by a local mechanic. While EVs require less maintenance; it may need to be confirmed if local mechanics have suitable capability to complete the service (i.e. have undertaken "make safe training") (Hyundai Motor Company of Australia 2017a).

An additional consideration for local sourcing, while perhaps not directly tied to the intent of these policies, is the energy security concern in Australia. Australia's transport fleet relies on imported crude oil and finished transport fuel products. This results in exposure to changes in international markets that are outside of our control, which can have significant impact on the economy and society. Transport is the most vulnerable to fuel price fluctuations. Accordingly, any strategies to reduce the dependency on conventional fuel may mitigate the risk of price fluctuations or supply disruptions. In addition, local renewable energy could be utilised to power these vehicles, and therefore would also support local renewable energy markets.

Electric Vehicle Charging Infrastructure

To incorporate EVs into the GBGA council fleets, there needs to be sufficient charging infrastructure in place to support their use. An overview of the different types of charging options was provided in Section 0. The different providers and infrastructure available in Australia and their indicative price is provided in Appendix B2 Charging Technology.

The type of infrastructure required depends on the type and number of vehicles proposed to use them; their battery size and duty cycle.

The duty cycle of the council fleet Is general back to base (i.e. from Council to meetings or inspections around the region and then back), garaged either at Council or an employee's residence. This duty cycle can be catered for by charging infrastructure situated at the base (i.e. council). Given that Council fleets are to deliver council services it is not productive use of employee time to be waiting at a public charging station (unless it is a rapid charge during a required rest stop for a longer than normal journey). Accordingly, charging infrastructure for council fleet is most appropriately located at Council facilities for either charging overnight or when the vehicle is not in use.

Many survey respondents also viewed increased tourism as a reason for introducing EVs and charging infrastructure into the councils. To realise any tourism related benefits, consideration would also need to be given to the type of charging infrastructure and locations that would support tourism in the best possible manner. The duty cycle of desired tourists to the region from Melbourne or otherwise, is to spend time at regional attractions; which is suitable for level 2 and 3 charging infrastructure (A tourist will not be wanting to wait 8 hours for a level 1 charge). As of February 2017, there were 137 privately owned EVs registered with VicRoads within the GBGA Councils (Central Victoria Greenhouse Alliance 2017); and therefore, there is likely to be low demand in the short term from locals, and given that less than 1% of vehicles in Australia are EVs, the likely tourism demand would also be low in the short term.

The concentration of Tesla charges in wineries and accommodation facilities in regional areas shows there is interest from businesses to use charging as a strategic initiative, to encourage people to use their services and purchase their

goods. While survey respondents indicated that the installation at Dookie and Tallis has been successful, there was no indication of other specific sites having expressed interest to councils. There are numerous potential tourist destinations in the area that could be suitable.

Figure 16: Potential Tourist Destinations Suitable for Public Recharge Infrastructure

ChargePoint (the largest public charging infrastructure provider in Australia) has expressed interest in presenting to the GBGA Councils, as the current network of stations is not developed in regional Victoria. This could be arranged for one of the project workshops.

Table 11 provides a general guide for selecting locations. It is advised that if the business case progresses for public charging infrastructure that Expressions of Interest (EOIs) are sought from providers on suitable locations and costs.

Table 11: Guidance on Locations for the Different Charge Level (adapted from CrossChasm Technologies 2017)

Charging Level	Time Required	Best Location
Level 1	Overnight	Parking lots, apartment buildings.
Level 2	Spend several hours	Parking structures near a tourist destination, winery, shopping centres, cinemas, restaurants.
Level 3	Spend short periods of time (30 minutes)	Highway rest stops, and other spots where drivers plan to spend short periods of time. Charging spots are more attractive if there are amenities provided at the site.

In addition to the type of location and charging infrastructure there are other site considerations which impact the amenity and installation costs. To identify suitable locations Table 12 provides an overview of key factors to consider.

Table 12: Location Considerations for Recharge Infrastructure

Area of consideration	Explanation
Location of vehicle overnight	Charging infrastructure should be conveniently placed where the vehicle can be parked overnight given that generally (for ease of use) vehicles are charged overnight.
Availability of power	The charging infrastructure needs access to power (single or three-phase depending on the unit). Typically, level 2 and 3 chargers require three phase AC power. A switchboard upgrade may be required if a switchboard does not meet electrical requirements. Further, additional costs could be incurred in accessing power and utility specified required metering. For example, a regional Victorian Council incurred an additional $10,000 installation cost as the utility provider required the unit to have a dedicated meter installed. Consultation with the electricity distributors will be required to ensure network capacity, like the process undertaken with Ergon in mapping out potential charging stations for Queensland's electric super highway (Ergon Energy 2017).
Location-specific installation costs	The location chosen for the charger can greatly affect the overall installation cost. For example, a charging station that stands alone will likely require trenching to connect to the power supply and switchboard. This can add significant costs to the installation of a charging unit
Energy pricing - Peak and off-peak	Charging at off-peak times may reduce charging costs (Fleetcarma 2017). Some charging units can be 'smart', having a timer to charge during off-peak electricity rates.
Switchboard	A dedicated circuit from the switchboard to the charging station is required (Jet Charge 2017b). This means the charging unit will have a dedicated wiring from the charging unit to the switchboard.
Tips to keeping installation costs low	If the charging infrastructure can be wall mounted, and not require a switchboard upgrade or trenching then it will keep costs down (Jet Charge 2017b). It is usually less expensive to install extra panel and conduit capacity during initial construction than to modify the site later.
Other Considerations	Data requirements - wireless connectivity for monitoring? Who can use the site - user ID cards or open access?

Lastly, to address one survey respondent's query on Tesla vs other charging infrastructure:

Table 13: Key Points of Difference between Tesla and Other Charging Stations

Tesla	Other
» Superchargers are only suitable for Tesla Vehicles. » Level 2 is also generally only suitable for Tesla vehicles (Tesla reports it is suitable for other EVs through an adaptor, however other manufacturers have provided mixed responses. It is currently a "grey zone".) » Free to businesses (excluding installation and power costs)	» Suitable for all plug types » Incurs a cost of purchase, in addition to installation and power. » Accessible by all vehicles (including Tesla)

Whole of Life Environmental Impact

One of the primary reasons why the GBGA is considering EVs is for the environmental benefit of reducing GHG emissions. Stakeholders, therefore, wish to understand the actual emissions reduction potential that could be achieved, particularly when considering Victoria's grid electricity. Further, councils wish to understand the whole of life environmental impact (i.e. the end of the battery life, and manufacturing process). Some comments made in the survey are provided below:

Examples of Comments Made in the Survey:
"The supply of electricity needs to come from a better source of electricity otherwise leave me to drive my fuel operational vehicle"
"The steering committee should be aware that electric vehicles are not zero emissions unless the charge is from renewably sourced electricity. The survey is a bit disingenuous in suggesting electric vehicles per se will reduce greenhouse gas emissions, as using the regular electricity mix (primarily coal based) emissions to drive an electric vehicle results in the same emissions as driving a petrol-powered vehicle. Any program to introduce electric vehicles must be incorporating an initiative to procure renewable energy."
"Look at more renewable energies for the community before looking at the vehicles as you are not saving the planet with this approach."
"To know the emission reductions that can be achieved through the use of electric vehicles"
"I would like to understand the] manufacturing impact on the environment"

A report prepared by the Victorian Government in 2012 (shown in Figure 17) investigated the whole of life environmental impact for EVs in comparison to ICE vehicles (including a battery replacement during the EV life). This report illustrates that an EV charged from the grid has higher emissions than a comparable ICE vehicle (State Government of Victoria 2013). However, these figures were based on the 2012 Victorian grid intensity and the technology at the time and must now be considered as outdated.

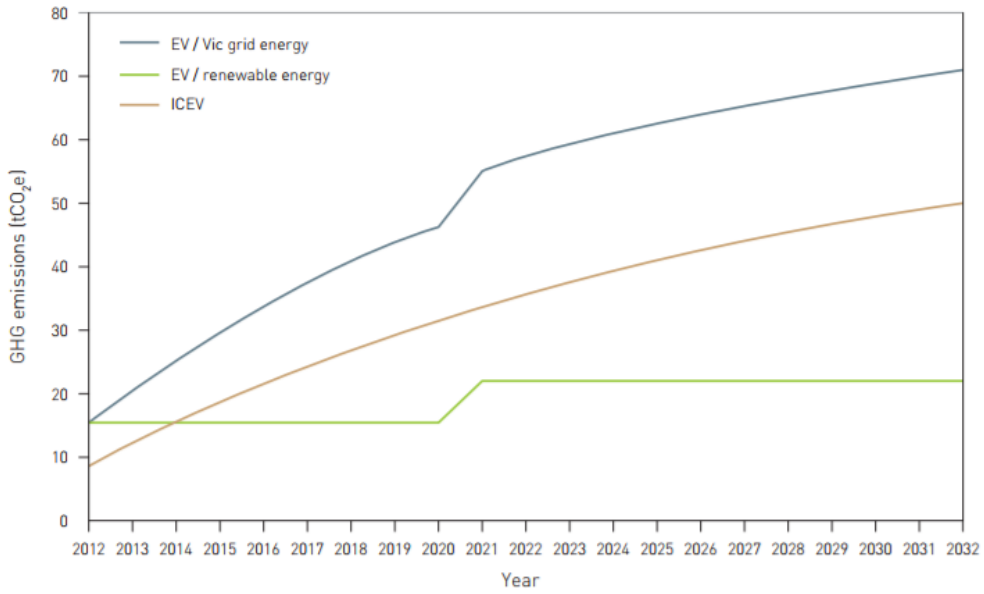


Figure 17: Cumulative GHG Emissions for an average EV (grid energy), EV (RE), ICEV (Source: State Government of Victoria 2013)

Victoria does currently have a relatively dirty electricity network in comparison to other States (i.e. 1.08kg CO_2e/kWh compared to 0.49kg/kWh in South Australia). However, it has been continually improving and will continue to do so following the recently legislated renewable energy target of 40% by 2025, and 25% target by 2020; which is estimated to reduce the electricity sector's emissions by 16% by 2034-35 (Renew Economy 2017b). Further, the use of EVs enables the Councils to utilise their own generated renewable electricity, which provides the ideal scenario of achieving zero emissions from EVs.

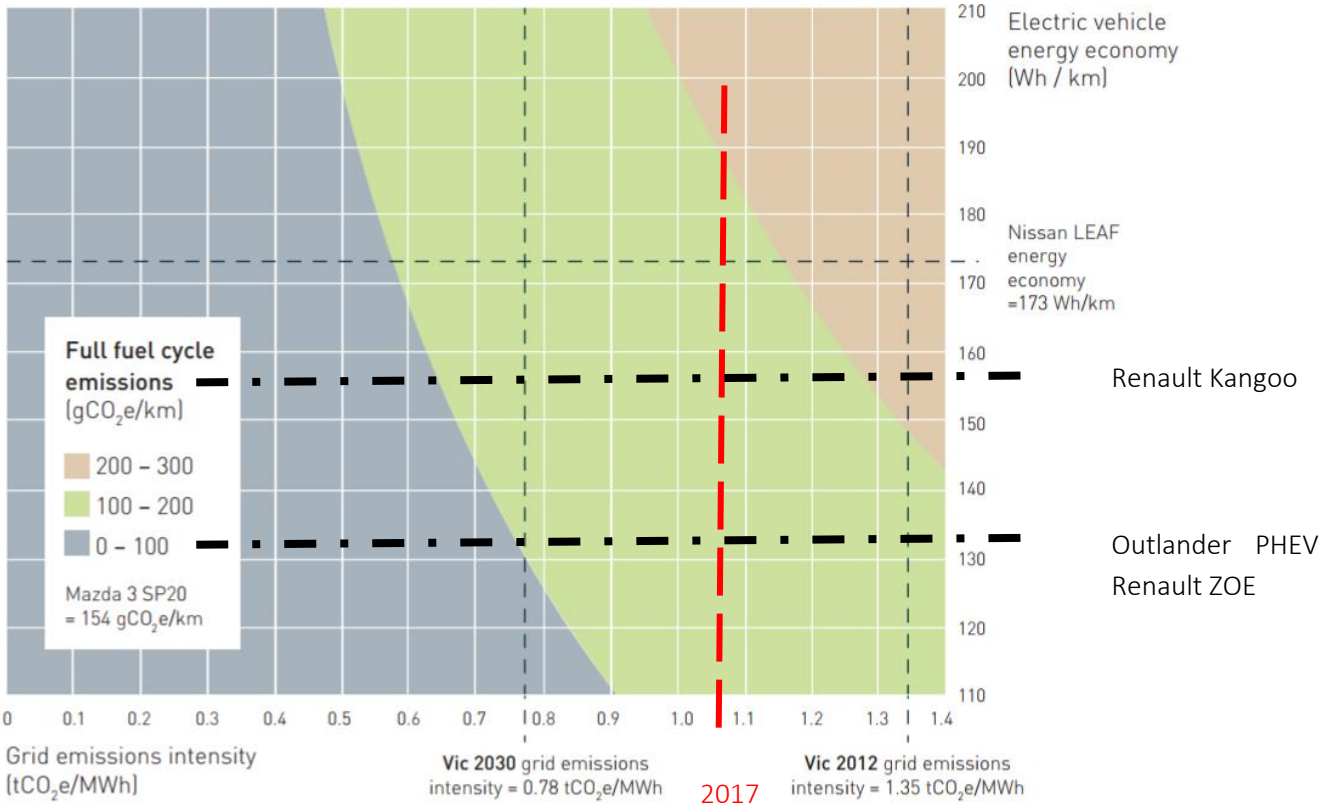


Figure 18: The interrelationship between EV energy economy and the electricity grid emissions intensity (source: State Government of Victoria 2013)

In contrast, while acknowledging that newer vehicles are continually becoming more fuel efficient (therefore consuming less fuel) with better exhaust systems (i.e. reduced detriment to local air quality), the GHG emissions associated with the combustion of fossil fuels will not change (i.e. 2.38kg CO_2e/litre of unleaded petrol and 2.72kg CO_2e/litre of diesel). Figure 18, below, shows the relationship between the Victorian grid emissions intensity – the energy economy of an EV and the associated full fuel cycle emissions equivalent; and

Table 14 provides estimated GHG emissions over 23,000km[7] for a selection of EVs and common vehicles found within the fleet.

[7]The average distance travelled per year by the GBGA council fleets

Table 14: Estimated Emissions over 23,000km based on GVG ratings.

Vehicles for Comparison	Reported Efficiency (GVG)	Estimated emissions over 23000km[8]
Toyota Camry (ULP)	226 gCO2/km	5.20 tCO2
Toyota Camry (hybrid ULP)	133 gCO2/km	3.06 tCO2
Holden Colorado LT Crew (Diesel)	249 gCO2/km	5.73 tCO2
Nissan Pathfinder (hybrid ULP)	200 gCO2/km	4.60 tCO2
Subaru Forester (ULP)	221 gCO2/km	5.08 tCO2
Mitsubishi Outlander- Charged from the grid (VIC)	13.4 kWh/km; 1.7L/100km	4.26 tCO2
Mitsubishi Outlander – Charged by solar	13.4 kWh/km; 1.7L/100km	0.93 tCO2
Renault Zoe - Charged from the grid (VIC)	13.3 kWh/km	3.30 tCO2
Renault Zoe - Charged by solar	13.3 kWh/km	0.00 tCO2
Renault Kangoo - Charged from the grid (VIC)	15.5 kWh/km	3.85 tCO2
Renault Kangoo - Charged by solar	15.5 kWh/km	0.00 tCO2

All the GBGA Councils are implementing or investigating renewable energy projects. Projects include a 100MW solar farm in Moira; a 20MW facility in Wangaratta; Shepparton has issued an EOI for a large-scale solar facility; and Wodonga is investigating a large-scale community solar farm. If Councils continue their investment with renewables it will greatly increase the environmental benefit of EVs. However, as shown above even without renewables there is still an emission reduction improvement.

In terms of whole of life environmental considerations, the other main area of concern was the battery. EV batteries are forecasted to account for 90% of the lithium-ion battery market by 2025. The State Government of Victoria's (2013) report into EVs found that vehicle disposal impacts, including those of the EV battery, were negligible due to the high expected rate of material recycling. This has not yet been validated given the low level of EV disposal to date. Notably, there are currently very few battery recycling facilities; and almost all lithium-ion batteries (from smartphones etc.) end up in landfill or unused (Sanderson, 2017). Similarly, in the EU 5% of lithium-ion batteries are currently recycled (Gardiner 2017). The Victorian Government recently announced that it is committed to banning e-waste from landfill; and the Australian Renewable Energy Agency (ARENA) has provided funding to Melbourne based company *RELECTRIFY* whose business model is based on re-using retired EV batteries for home and business use.

[8] Estimated using the gCO2/km rating for petrol and diesel; and the kWh/km ratings from Green Vehicle Guide with the latest NGA factor for Victorian electricity.

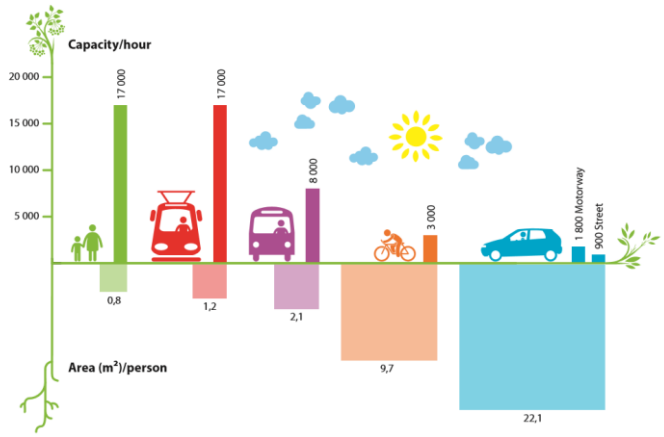


Figure 19 Environmental impact by capacity to move people (source: NSW 2016)

Given the turnover period for GBGA Council fleets, it is more likely that a battery would need replacing in an EVs second ownership cycle. GBGA Councils could provide facilities and information to ensure that recycling occurs.

From a purely environmental perspective the best thing to do is not drive (Figure 19). However, while mass transit public transport modes and active alternatives provide the greatest scale of abatement potential in terms of people movement; the current societal construct is unlikely to see the disappearance of the demand for the utility provided by the motor vehicle. Accordingly, EVs are the most environmentally preferred solution.

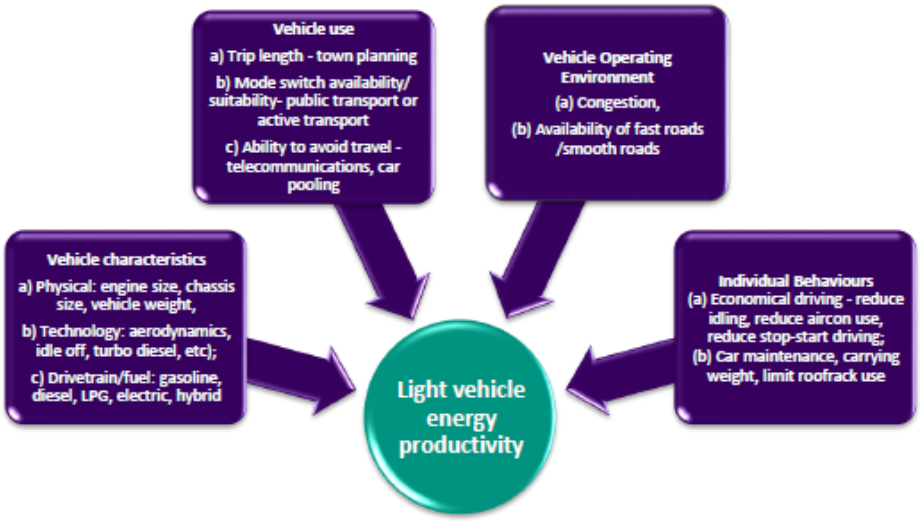


Figure 20: Impacts on light vehicle energy productivity (Ndevr Environmental 2016)

There are more impacts on emissions and energy usage than just the vehicle type (Figure 20) and any strategy to reduce transport emissions should take these into consideration.

Whole of Life Costs

Councils' budgets are subject to public scrutiny and there is a requirement, as per most organisations, to ensure best use of funds. The price premium of EVs was identified as a barrier to implementation, while reduced operating costs was identified as an opportunity. Councils therefore sought to understand the whole of life cost comparison. While the business case stage will include a cost-benefit analysis, this subsection provides an overview of whole of life costings.

Examples of Comments Made in the Survey:
"Being able to justify the amount of electricity used is cost effective in relation to the cost of petrol"
"Probably need to add in the cost of additional solar capacity to ensure that we achieve maximum cost benefit."

The GWRC investigated whole of life costs for its investigation, and found the second-hand Nissan Leaf to be the best performer, as shown in Figure 21 (It should be borne in mind that market and other conditions in New Zealand may differ and that results are not necessarily directly comparable).

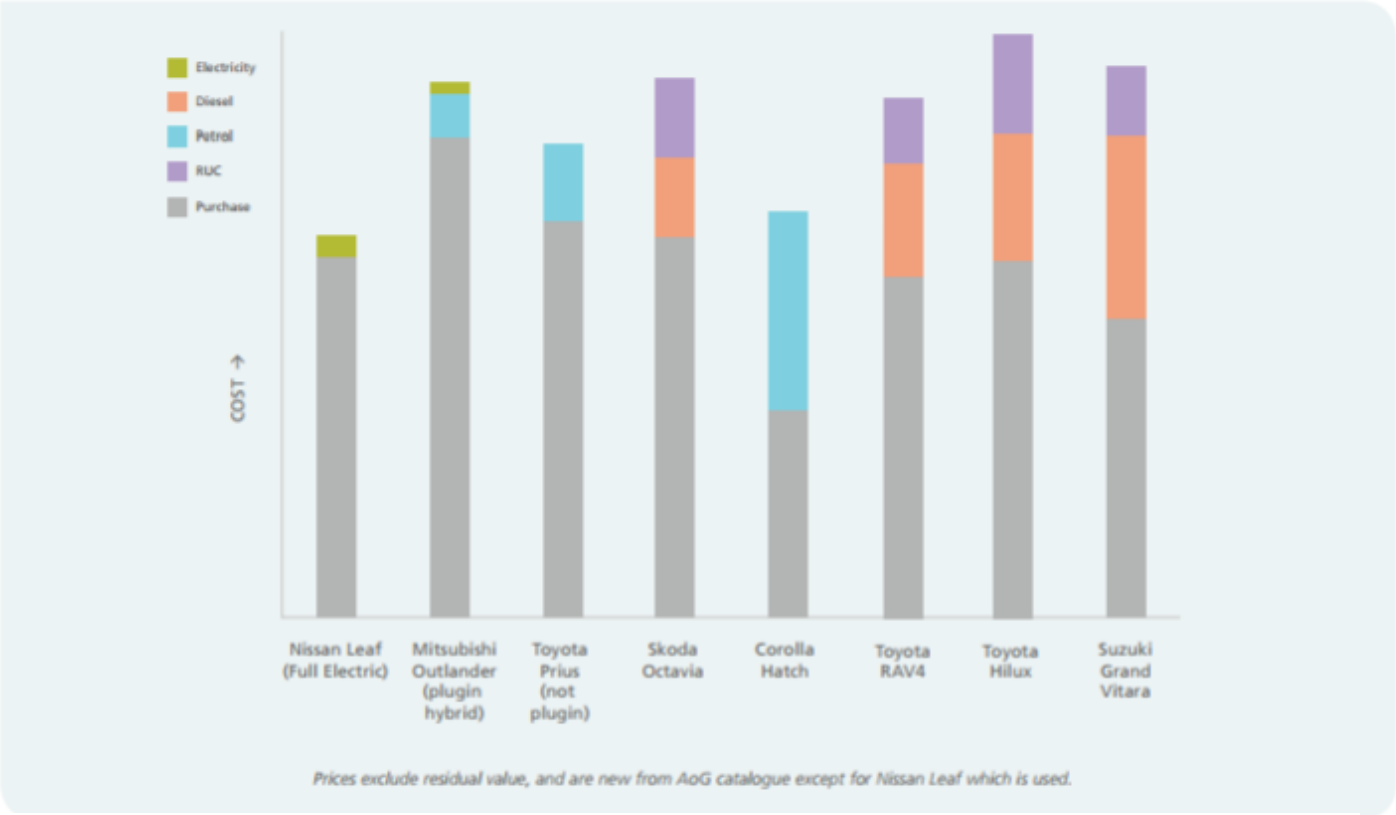


Figure 21: GWRC total operating cost comparison over 120,000km (source: image from GWRC 2016)

The price premium of EVs is a function of the higher unit costs of production; and the capital premium is expected to reduce over time in the face of increased demand leading to scale benefits in production and technology costs, which has already been witnessed in recent years. Further, resale value of EVs will improve, given the increasing demand for second hand EVs and stabilising of the technology.

Using the vehicles and energy conversion ratings from Section 0, the estimated annual energy cost to travel 23,000km was compared and is shown in Figure 22 below.

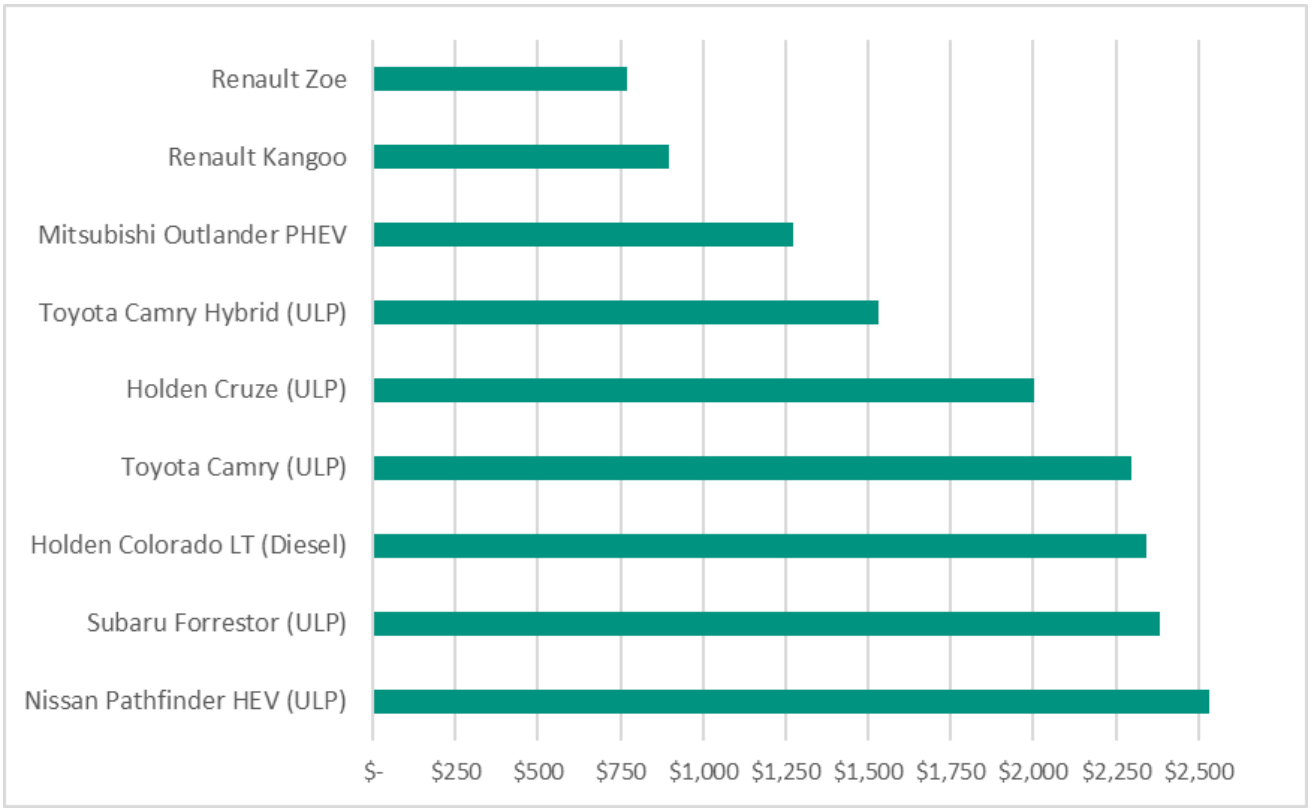


Figure 22: Estimated Comparative Fuel Costs for one year travelling 23,000km

The cost benefit analysis undertaken for Moreland City Council (MCC 2012) found in favour of the Nissan Leaf (then new) from a financial and environmental business case (Pit and Sherry 2014). However, unlike the GBGA Councils MCC already had charging infrastructure in place through the Victorian Government trial which did not need to be considered in the business case.

A study undertaken by Beyond Zero Emissions (2015) considered the total costs involved in replacing the entire Australian transport fleet with EVs, and found that if the price premium associated with EVs has been negated by 2025 then even considering the charging infrastructure the two technologies will be on an even playing field (Figure 24).

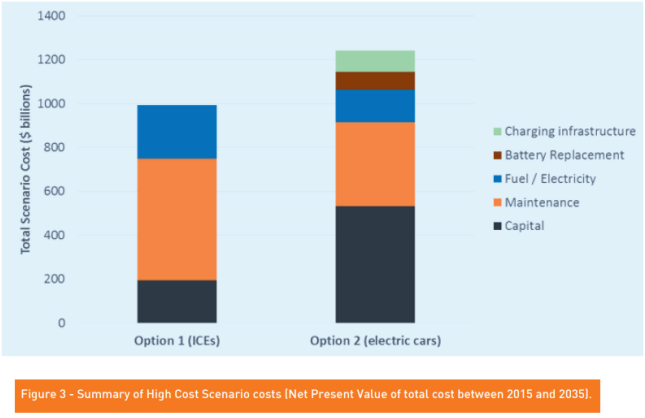


Figure 23: Total Costs assuming EVs achieve purchase price parity with ICE vehicles in 2035 (BZE 2015)

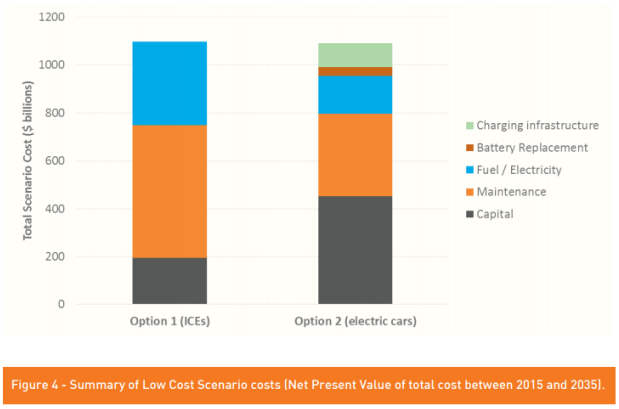


Figure 24: Total Costs assuming EVs achieve purchase price parity with ICE vehicles in 2025 (BZE 2015)

The main cost associated with the charging infrastructure is the installation cost. While the units in themselves range from complimentary by the OEM to a few thousand dollars, the cost of installation can escalate depending on location. The Figure below details potential costs associated with installation during the Victorian EV trial.

Initiatives to keep installation costs to a minimum were detailed in section 0.

Further, at the recent All Energy Australia Conference, Delta Energy highlighted the importance of installing charging infrastructure that is *capable for today's requirements but ready for the future* (Dinkelmeyer 2017) to minimise the need to reinstall cables and undertake potentially costly electrical works.

Item	Cost	Comments
Site preparation	$ 2,000 – 4,000	Includes review of site, works planning, applications and submissions for permits / approvals
Trenching	$ 10,000 – 50,000	Varies according to site specific issues including extent of cable-run, allowances for existing ground assets/utilities encountered, special excavation requirements, possible soil contamination/asbestos/ geotechnical issues, consultation required with affected land owners etc.
Pipe, pits, conduit	$ 3,000 – 6,000	Varies according to extent of cable-run, size of conduit; typically 3 pits for 50 metre cable-run
Cabling	$ 1,000 – 1,500	Varies according to extent of cable-run; 16 mm diameter typical cable size cost is around $20 – 30 per metre
Cabling pull-through	$ 250 – 500	Varies according to extent of cable-run; typical cost is around $5 – 10 per metre
Distribution board	$ 1,500	Varies according to distances, capacity and supply
Slab, mounting, installation	$ 5,000 – 7,000	For a typical slab length/width/depth of 1.2 x 0.8 x 0.2 metres
Termination and commissioning	$ 1,000	Includes connection of cables, RCD installation, equipment testing and commissioning, customer handover and training; note that this excludes network testing and commissioning
Total	**$ 23,750 – 80,500**	**Establishment costs only – excludes quick charger hardware cost**

Table 15. Quick charger establishment cost estimates for a 'brownfield' site, where distance between the 25 kW quick charger and the point of electrical supply is around 50 metres and electrical supply upgrades are not required.

Figure 25: Charging Infrastructure Installation Costing Example from Victorian EV Trial 2013 (source: State Government of Victoria 2013)

The current process for establishing fleet budgets varies between councils, with an internal allocation of funding to provide and maintain vehicles. Notably, no council survey respondents indicated having a specific emission reduction activity budget. Given that Councils are establishing targets and environmental commitments, internal funding should be allocated to achieving these, which the incorporation of EVs could then 'compete' for – should it deliver the best value per tCO_2e reduction.

Potential external funding could be sourced from:

- Created in 2012, the Clean Energy Finance Corporation (CEFC) invests commercially to increase financing into renewable energy, energy efficiency and low emissions technologies. The CEFC currently invests in *"Low emission, electric and hydrogen technologies"* (CEFC 2017a) which offer an alternative to fossil fuel reliant transport. The CEFC provides asset finance at low interest rates to corporate, government and not-for-profit fleet buyers through its co-financing arrangements to encourage those organisations to choose low emission passenger and light commercial vehicles as well as electric vehicles.
- In September 2017, Macquarie Leasing and the CEFC have started a $100 million asset finance program in a push to accelerate the use of EVs in Australia. "*The program offers a 0.7% discount on finance for electric vehicles, as well as plug-in hybrid electric vehicles, and a range of eligible energy efficient and renewable energy equipment. Customers who choose eligible lower emissions passenger vehicles can also benefit from the program, with a 0.5% finance discount" (CEFC 2017b).*
- In its Investment Plan 2017 ARENA has outlined that one of its investment priorities is to improve energy productivity. ARENA hopes to achieve this by "*supporting replicable, innovative and efficient energy use and adoption of renewable energy across the industry, built environment and transport sectors" (ARENA 2017).* ARENA has co-funded research from the ClimateWorks Australia organisation to analyse the current EV market in Australia and propose ways that demand for EVs can be increased. ARENA has also recently run several workshops entitled 'ARENA Energy Productivity Scoping Study, Light Vehicle Fleet Case Study Workshop Results' (Event Brite 2017).

Community Stewardship

Leadership was identified as one of the key drivers for considering EVs. 62% of respondents identified the main reason they wanted to see EVs in their fleet was that it is a good image for council to be portraying.

Examples of Comments Made in the Survey
"The best ways for rural Councils to incorporate electric vehicles into our fleet and support community usage of electric vehicles."

The incorporation of EVs into the GBGA councils' fleets supports community uptake through:

- **Leading by example**. Community perception will become more receptive to EVs the more they are seen around the region. Any council EV should be adequately signed for maximum community impact.
- **Providing a second-hand EV market**. The choices in vehicles selected by government and corporate fleets feeds the choice of vehicles available to the community to purchase, with fleet vehicles populating 80% of the second-hand vehicle market. Councils as stewards for the community have a corporate responsibility to ensure that low emission vehicles are entering the second-hand vehicle market and available as a choice for that consumer base. The turnover rate and buying power of government bodies, have the potential power to provide a further demand to manufacturers to stimulate growth in the Australian EV market.

Current community ownership of EV is shown in (Figure 26). For comparison two metro Melbourne and Moreland Council (who utilise EVs within their own fleets) have been shown to highlight the current low levels in the region.

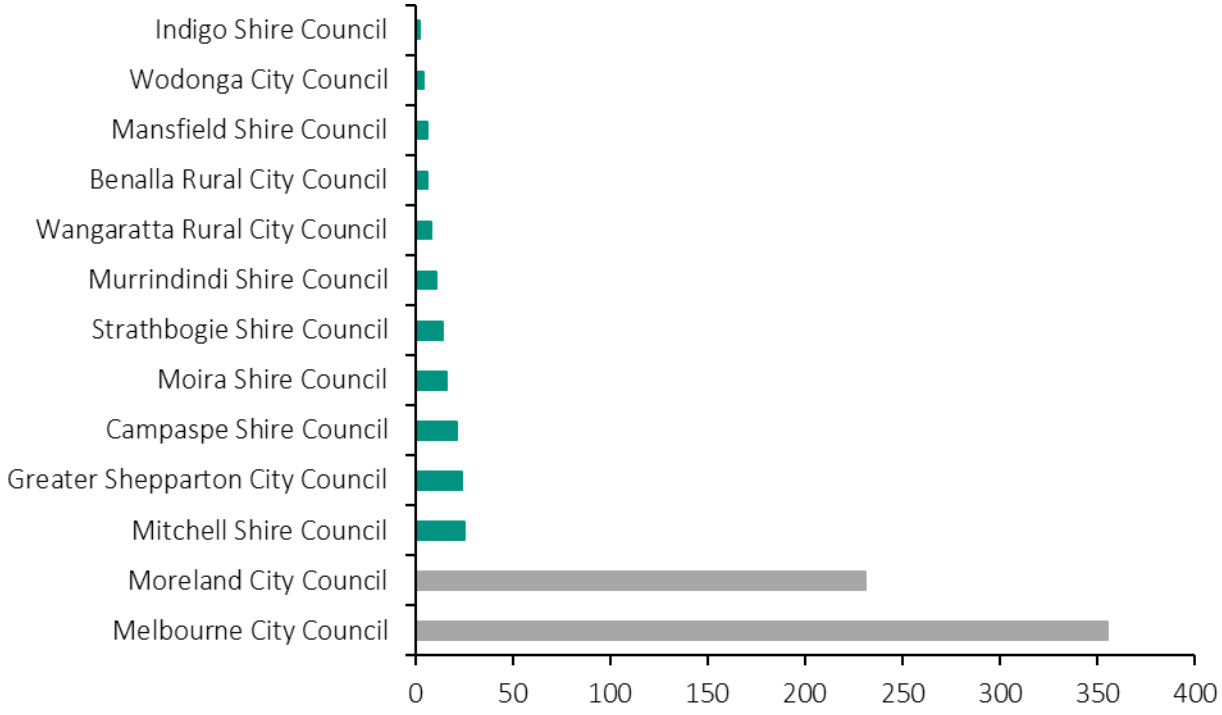


Figure 26 Number of Electric Vehicles in each Council Area

Table is adapted from data provided to the Central Victorian Greenhouse Alliance (2017) by VIC Roads (showing the number of electric vehicles by postcode as of February 2017).

Given community leadership was identified as a key driver for GBGA councils' involvement, weighting needs to be given to the public good benefit.

5 Findings

The analysis of the key considerations and current fleet operations gives rise to the following findings.

The GBGA Strategic Drivers for EV Consideration are Sound

The analysis found that the primary reasons for GBGA Councils considering EVs were justified.

The environmental benefit. EVs are more energy efficient than conventional vehicles. The continual improvement in Victoria's grid emissions intensity will further enhance the environmental performance of EVs in the long term, with the use of renewables (which all councils are investing in) providing a means for zero GHG emissions. The absence of tailpipe emissions also results in improved urban air quality and associated community health benefits.

Leadership role of Council. Councils as stewards in the community have a responsibility to provide leadership to the community. Incorporating EVs within Council fleets will provide demonstrations of their use, create a demand for OEMs to release more EVs, and feed the second-hand vehicle market, rendering EVs more accessible to the community.

Operating cost savings. The higher energy conversion of the electric motor, and less moving parts result in substantial savings in annual vehicle operating costs (i.e. fuel and maintenance). For the business case, these need to be considered and balanced against the higher purchase price and the cost of associated infrastructure.

Suitable Vehicles are Available

The majority of EVs available in Australia are in the luxury vehicle segment. However, while vehicle choice is limited, the analysis found that EVs suitable for GBGA council use are available.

EVs available below the luxury vehicle threshold include: Mitsubishi Outlander PHEV, Renault Zoe, Renault Kangoo, Tesla Model 3, and BMW i3. Further, Hyundai have the Ioniq non-plug-in hybrid available for a 9-12month trial program, as a pre-cursor to releasing the plug-in hybrid and full EV Ioniq variants in Australia.

Stakeholders indicated range anxiety as a barrier to EV adoption, and off-road driving. The analysis found that the average daily kilometres travelled was 84km/day, which would not require a recharge during the day; and the Mitsubishi Outlander PHEV is an AWD vehicle suitable to address council concerns with regional roads. It should be noted that since the Outlander is a PHEV, it will still consume conventional fuel and as such will not have the same environmental benefit as a fully EV. However, hybrid electric variants have the added benefit of extended range to alleviate concern and facilitate a transition to EV.

All vehicles introduced into council fleets should be fit for purpose. At this stage it is not likely that entire fleets could be replaced with EVs. However, it is feasible for them to be introduced.

Regional & EV Supplier Support exists

There is support within Councils for participation in this project and the introduction of EVs into council fleets. There is also support from the EV market to encourage EV growth in the regions, and the analysis found that opportunities exist for further collaboration with manufacturers and infrastructure providers for mutually beneficial outcomes through EV trials. GBGA Councils are wishing to learn more and OEMs are trying to prove their products to the market. As such, it is an opportune time to collaborate as it will improve the business case by reducing/removing the price premium.

Policies and Internal commitments can be strengthened

It is evident from the Environmental Strategies that all Councils place a high value on environmentally sustainable outcomes; whether it is council-specific operations, community lifestyle or a holistic approach. However, the emphasis put on transport opportunities varies between councils.

An opportunity exists for councils to identify specific targets for council and community fleets in relation to emission reduction (number of EVs, maximum utilisation, alternate transport) and energy reduction (renewable energy to assist with charging infrastructure) in their Environmental Strategies.

All councils should have a Fleet Policy where specific details regarding vehicle procurement and usage will reside. Some councils did not have a Fleet Policy. Of the existing Fleet Policies, there was only one that required the use of alternative vehicles (i.e. hybrids), with others specifying basic environmental criteria of the 'highest' or a high range rating from the Green Vehicle Guide.

Council fleet departments should monitor the utilisation of their vehicles – commuter use, private and pooled. Low utilisation assets should be removed, and not replaced. Policies should not encourage full private vehicle ownership (through novated lease or otherwise) as a mechanism to reduce fleet size as this only brings economic benefit to the council, and neglects environmental impacts.

In addition, Fleet Policies should include details on monitoring systems. Such systems enable the monitoring of utilisation percentage, maintenance/replacement updates, an efficient and secure booking system, and can ensure accountability that private and commuter cars are pooled.

Procurement policies vary in length and vary in their focus on environmentally sustainable procurement (aka Green Procurement). Procurement policies should indeed be generalised to provide principles to guide the procurement of any product or service and ensure alignment with other Council policies and strategies. A common barrier to the achievement of Green Procurement in some of the councils' policies is a confusion around 'Value for Money' and 'Sustainability' as guiding principles. There was also confusion around Value for Money and Best Value.

Procurement Policies should outline the legislation which they seek to implement, and which forms the regulatory backbone of the procurement system, as well as any local policies and strategies (e.g. Fleet Policy). An overview of best practice principles should be provided, where best practice is determined by a Value for Money assessment, and where Value for Money contains a myriad of considerations including sustainability which is measured by three pillars. Items associated with fair and ethical procurement should be outlined (i.e. competitive thresholds, transparency, etc).

Charging Infrastructure is needed but implementation can be staged

To accommodate EVs within Council fleets a level-2 charging station should be installed at each Council where an EV is to be based. Future demand should be considered to minimise the costs of future installations and/or upgrades and capacity built in for further charging stations.

Installations can be staged from both a financial and change management perspective, with chargers installed to accommodate council EV fleets first; and public stations second (unless the installation of public use stations forms part of a PR initiative). The reasoning behind this approach is that council EV fleets will provide the demonstration, while the installation of public use charging stations will support EV uptake by the community.

To ensure the most cost effective and strategic placement of charging stations, infrastructure providers should be asked to respond to an EOI to detail their suggested locations and pricing.

6 Recommendations

The following recommendations are made:

- The feasibility study move to the next stage and a business case is conducted to determine the potential cost of abatement for introducing EVs under a different range of scenarios, including considerations surrounding the need for charging infrastructure.
- The available EVs are considered by fleets and that the vehicles highlighted for potential switching to EVs are validated, ensuring fit for purpose selections are made.
- Councils without emission reduction targets/ strategies in place investigate establishing them to ensure the internal framework is established to better facilitate the business case.
- Councils consider participation in the OEM trials.
- Councils engage with their local utility providers early.
- Councils without existing data management systems consider investing as the only way to improve performance is to have access to data to monitor it.
- Councils should consider the change management advice in Appendix E to engage with internal and external stakeholders.

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Council Assessment References

*In report for GBGA

Appendix A1 Data Template

To complete the fleet data assessments, councils were asked to populate a data template in excel format (Figure 27) to provide detail on individual vehicle details including make, model, mileage, fuel consumption, expenditure, maximum daily kilometres, and when they are due for replacement.

goulburn broken greenhouse alliance

Fleet Data Template

This sheet is to collect data on the individual vehicles in operation during the 2016/17 financial year

This sheet has been populated by

Name:
Council:
Contact Details:

Vehicle ID	Year of manufacture	Vehicle make	Vehicle model	Model detail	Passenger or Light Commercial Vehicle	Type of fuel	Annual kilometres travelled (kms)	Annual fuel consumption (litres)	Annual fuel cost ($/year)	Annual electricity consumption (kWh)	Annual electricity cost ($/year)	Business unit	owned or leased?	Is the vehicle current or retired now?	approx. average daily kms	approx. maximum daily kms	vehicle garage location	Service/ maintenance undertaken by:	Year due for repacement	Carrying requirements
(enter rego here)	2009	eg. Honda	Civic	sports model	passenger	ULP	20,800	2,100	$2,940			e.g. head office	leased	current						

Figure 27: excerpt from data request form

Appendix B1 Vehicle Technology

Manufactures Information

This section contains additional detail from EV manufacturers that are considered non-luxury.

7.1.1 Mitsubishi

The Mitsubishi Outlander PHEV is an AWD, which aims to *bridge the gap between pure EV range and affordability*. The most recent model was released in April 2017 (with an approximate 18-month cycle).

The Outlander has three driving modes. The vehicle automatically switches between the three modes:

1. EV mode (approximately 40-50kms with full battery)
2. Series hybrid mode – petrol acts as generator to battery (when battery low)
3. Parallel Hybrid mode – petrol jumps in automatically and supports front wheels (when vehicle needs extra power)

The charging times for the Outlander PHEV vary depending on the type of charging infrastructure utilised. Below are charging time estimates:

Charging Infrastructure	≈ charging time
Nominal Power Point	6.5 hours
Level 2 charging station	3 hours
DC Fast Charger	80% in 25 minutes

Figure 28: Mitsubishi Outlander PHEV (source Mitsubishi Motors Australia 2017)

Lease and Purchase Price Options

Below are the fleet options for the Outlander PHEV, Leasing Option and Purchase Price as provided by Mitsubishi itemised below.

	24 Month Term Lease (Ex GST) *	36 Month Term Lease (Ex GST) *	Purchase Price (Ex GST, Inc Dealer Delivery) **
Outlander PHEV LS	$732 per month	$645 per month	$43, 545
Outlander PHEV Exceed	$823 per month	$737 per month	$47,590

* Lease Based on 20,000kms per year, excess kilometres to be charged at 12 cents per kilometre.

** Purchase Price (includes government fleet discount), additional fee for metallic paint and accessories (Mitsubishi Motors PHEV 2017).

Lease Considerations

There are important considerations when deciding whether to lease or purchase a vehicle. Below are the inclusions and exclusions for the Mitsubishi leasing option:

Inclusions

- Registration
- Stamp Duty
- Scheduled Servicing
- Comprehensive Insurance

Exclusions

- Electricity/Power Costs
- Fuel Costs
- Insurance Excess costs $500

7.1.2 Nissan

Figure 29: 2018 Nissan Leaf (source Nissan USA 2017)

New Nissan LEAF – 100% electric

Australian release date is yet to be announced. The vehicle has been launched, and is available in Japan since 2 October 2017 and globally from 2018 (USA Early 2018). Has a 240km range.

Price starting at $US28,992

Nissan ProPILOT™ ASSIST

- Following the car ahead at a pre-set distance (maintains your speed, accelerates for you)
- Helping keep you centred in your lane (steers for you)
- Bring vehicle to a full stop based on the traffic flow, and hold you there (breaks for you)

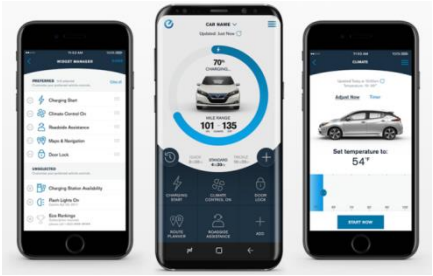

Figure 30: Nissan Connect® EV App (source Nissan USA 2017)

NissanConnect® EV App

Charge your LEAF on a timer, bring your vehicle to the perfect temperature before you even get in, and get up-to-date traffic reports, all from your compatible phone (Nissan USA 2017).

7.1.3 Hyundai Australia

Hyundai is considering four electric vehicles from the Ioniq range for Australia - EV (CCS type 2), PHEV, HEV and FCEV (fuel cell/hydrogen) (Hyundai Motor Company Australia 2017a). Pricing and possible release date is yet to be confirmed.

Figure 31: Hyundai Ioniq PHEV (source Hyundai UK Ioniq Brochure)

7.1.4 Renault Australia

Renault Australia announced that it will be bringing two pure electric vehicles to Australia - the ZOE (a light-segment 5-door hatch) and the Kangoo Z.E. (a small commercial van) and (Renault Australia 2017).

These EVs have a 'real life' driving range of 200-300km and 120-200km respectively.

The recommended retail price of the ZOE is $46,520, and the Kangoo is $46,990 (Renault 2018).

Figure 32: (a) Renault ZOE *(b) Renault Kangoo*

7.1.5 SAE Electric - Victorian Electric Vans and Medium duty trucks

Victorian electric vehicle manufacturer SAE Electric has a line of commercial vans and medium-duty trucks that are converted into electric vehicles (SAE Electric 2017). Below is the range of vehicles SAE Electric (2017) have available:

Vehicle	Vehicle Type	Drive Train, Range
SEA E4V	delivery van/mini bus	100% electric, range up to 180km
SEA EV10	9t to 12t medium duty truck	100% electric, range up to 180km
SEA EV14	15t medium duty truck	100% electric, range up to 180km

SEA Electric received $5 million in CEFC finance though the Clean Energy Innovation Fund (announced August 2017) (CEFC 2017c). And the Victorian Government also announced would receive $516,720 through the New Energy Jobs Fund (to support the manufacturing and developing an innovative range of electric powered commercial vehicles) (State Government of Victoria 2016).

facility

Figure 33: SAE E4V (source: SAE Electric 2017)

Internationally Available Vehicles

The UK, similar to Australia, has right-side drive vehicles. Table 15 below reveals some of the 100% battery electric vehicles currently available in the UK.

Table 15: Electric Vehicles Available in the UK (image and content source: Next Green Car 2017)

Vehicle	Real World Driving Range	OTR*[9]
VW e-UP! Electric Car 	93 miles (150km)	£20,780 (~$35,343)
Hyundai ICONIQ Electric Premium Auto 	174 miles (280km)	£24,995 (~$42,512)
SMART fortwo coupe Electric Drive 60kW Auto 	99 miles (159km)	£16,420 (~$27,927)
Peugeot iOn Electric 47kw Auto	93 miles (150km)	£16,995 (~$28,905

[9] Price shown is on road cost in the UK, which includes UK Government EV subsidies and does not include any Australian importation taxes.

Vehicle	Real World Driving Range	OTR*[9]
		
Renault Kangoo Van ZE 	106 miles (170km)	£14,200 (~$24,151) plus option to lease battery at £50 (~$85) per month
For Focus Electric 107kw Auto 	170 miles (274km)	£27,180 ($46,228)
Nissan e-NV200 Combi Electric 80kW Tekna Rapid Auto 7-seat 	106 miles (170km)	£27,400 ($46,602)

Appendix B2 Charging Technology

Infrastructure Providers

Below is a list of some of the charging infrastructure providers available in Australia.

Table 16: Recharge Infrastructure Providers (list source: Electric Vehicle Council 2017)

Company	About	Source
JET Charge	JET Charge has developed EV charging solutions for residential premises, apartment complexes, workplaces and public charging stations. They have installed many stations Australia-wide. The company specialises in infrastructure for Tesla, Volvo, Audi and Porsche' and are also compatible with Mitsubishi, Renault, BMW and Nissan.	http://www.jetcharge.com.au/
ChargePoint	ChargePoint is a network operator of public and private charging stations. ChargePoint is the most common public infrastructure provider in Victoria – they charge for the infrastructure and then manage the site on Councils behalf. The company has also provided stations to BMW, Mitsubishi, Nissan, Holden to be branded as their own.	https://www.chargepoint.com/en-au/
E-station	E-stations aims to serve the emerging Electric Vehicle market in Australia by providing low cost plug in charge points to cities, local councils and private operators.	http://e-station.com.au/
Tritium	Tritium has developed a product portfolio of technologies that have been used in numerous solar car, electric vehicle and renewable energy projects globally.	http://tritium.com.au/
Keba	Keba provides holistic infrastructure solution for electromobility. Charging stations that are easy to install and operate.	http://www.kecontact.com/en/
Egodock	eGo Dock exclusively supplies and installs high quality and easy-to-use JuiceBox chargers direct from the USA.	http://www.egodock.com.au/
Tesla	Tesla provides level 2 and 3 charging infrastructures to support Tesla vehicles. Tesla claims the level 2 can service all vehicles (with an appropriate adaptor). However, the level 3 super charger is only suitable for Tesla vehicles.	www.tesla.com.au

Infrastructure Available

The specific infrastructure provided by the above providers in Australia, is listed below.

Table 17: Charging Infrastructure Available in Australia

Charger Name	Details	Price Estimate
Jet Charge		
Wall Pod 	Type 2 socket Suitable for both home and light commercial deployment 50,000 units sold worldwide (made in UK) Optional built-in time clock for charging during cheap rate tariff (Jet Charge 2017c)	From **$1,200**
Secure 	Type 2 Socket Universal socket charging station, this unit can charge any EV on the market with the right cord (Jet Charge 2017c).	Unit Price approximately: **$1,900** Installation costs (estimate): **$850 to $3000** (Jet Charge 2017b)
Autocharge 	Comes with one or two sockets Aimed at fleet, industrial and public market (Jet Charge 2017c) Ground mounted – wiring needs to come in underneath the unit, bollards for mechanical protection are required (Jet Charge 2017c)	Unit Price from approximately: **$3,900** Installation costs (estimate): **$1,500 to $4,000** (Jet Charge 2017b)
Delta AC Mini Plus EV Charger 	Delta AC Mini Plus Charger. RFDI authentication 3G modem (more suitable for residential use)	Unit Price approximately **$1,300** ex GST (if you connect to the Chargefox online management system) (Jet Charge 2017b)

Charger Name	Details	Price Estimate
AEVA – Guidance (DIY)		
Basic 3 Phase, 32 Amp Socket 	Need to be wired to a protected three-phase circuit rated to 32 amps per phase.	From **$40** (plus **$300 – $500** for installation) (per coms AEVA)
ChargePoint		
	You own the asset, but are connected to ChargePoint's 24-hour Customer Service Centre.	tbc
Tritium		
Veefil-RT Fast (Rapid) Charger 	100-140km range car in about 20 minutes Being rolled out in the Queensland Electric Vehicle Super Highway, $3 million-dollar project (minimum 18 charging stations)	$50,000+ GWRC found that the cost of this fast charging equipment is currently too high to consider purchasing and installing themselves (GWRC 2016).

Plug Types

a)

b)

c)

d)

e)

f)

Figure 34: Electric Vehicle plug types (source: Jet Charge 2017c).a) Type 1 – J1772; b) Type 2 – Mekennes; c) CCS Type 1; d) CCS Type 2; e) CHAdeMO; f) Tesla SuperCharger

Cables and Adapters

A cable can refer to a wide range of items in the world of EV charging. Listed below are some of the more specific terms that refer to cables. There are two types of sockets used in vehicles and charging stations. This is comparable to the standard wall plugs at home/work, and the fact that phones are commonly charged with an iPhone or android charger. Adapters or leads may need to be purchased to charge the vehicles.

Leads

A lead typically refers to a cable used for public socket charging stations. Lead and socket charging stations allow any vehicles with any plug standard to charge from the station. This is achieved by having one end of the lead standard for the socket and the other end as plug standard of the vehicle (Jet Charge 2017c).

For example, the Mitsubishi Outlander standard plug is Type 1, yet Type 2 Socket chargers are becoming common in Australia (WA and ACT).

Figure 35: Type 2 to Type 1 Lead (source EVnomics 2017)

Adapters

Adapters allow an electric vehicle to use chargers with a different plug standard. For example, the cable seen on the right (Figure 36) would allow a type 2 vehicle (such as a Renault electric vehicle) to charge from any station with a type 1 connector (J1772) (Jet Charge 2017c).

Figure 36: Type 2 to Type 1 Adapter (source EVnomics 2017)

Portable Chargers

Portable chargers are smaller devices that allow the vehicle to be charged directly from a power point or industry socket. This means no charging station is required. These are especially useful when traveling but tend to provide a lower charge rate than an installed electric vehicle charger (Jet Charge 2017c).

Figure 37: Type 1 Portable Charger (source: EVnomics 2017)

Example of an online charging platform

Chargefox is JET Charge's online fleet charging and management system suitable for private, fleet and public use. Chargefox would give Councils easy access to data on who is charging, at what time, and how much electricity is being used (Jet Charge 2017b).

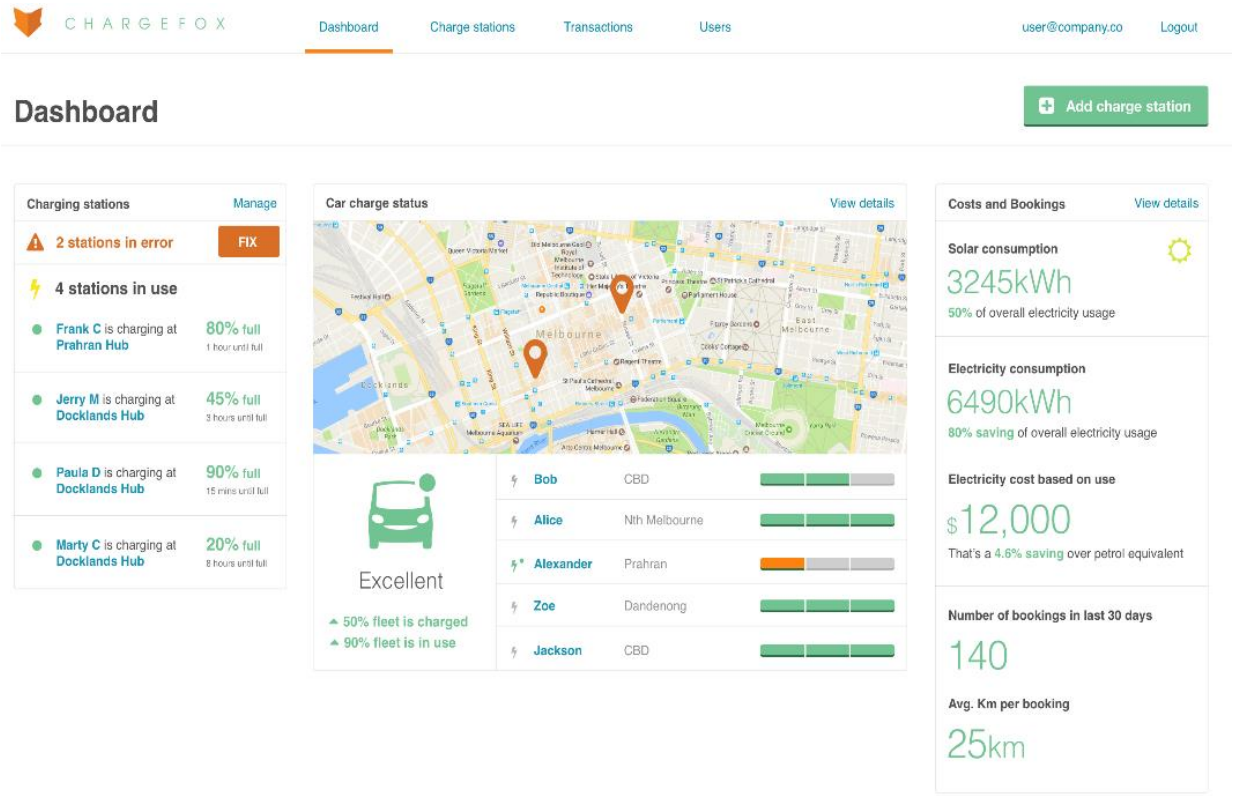

Figure 37: Chargefox Dashboard (source: Chargefox 2017)

Appendix C Additional Detail on Case Studies

Greater Wellington Regional Council

In addition to the detail provided in text, GWRC has also implemented the following emission standards on new vehicles:

	Maximum CO2 Emissions	Fuel Economy
Utes	230 g/km CO2	8.5 L/100km
Other vehicles:		
Petrol	140 g/km CO2	6 L/100km
Diesel	160 g/km CO2	6 L/100km

City of Sydney

City of Sydney has a long-term target of 70% reduction in greenhouse gas emissions by 2030. The City of Sydney adopted a shorter-term target to reduce CO2 emissions over a four-year period by 20% (to the end of 2013/14). This was considered achievable by adopting a fleet management strategy. The program achieved a 26 % reduction in fleet emissions over the four years, without any reduction in the services to the community (City of Sydney 2014).

The implementation of the strategy included:

- Electric Vehicles – introduced Mitsubishi electric vehicles and Nissan Leafs
- Sustainable Biodiesel – installation of two 28,500 litre storage tanks; average emission reduction per vehicle of 18%; 75% of the total fuel consumed
- Eco drive – training for staff
- Hybrids – 40 hybrids cars and 30 hybrid trucks were introduced to the fleet, with each vehicle saving about 30% in CO2 emissions
- Retrofits – 84 heavy vehicles were fitted with new exhaust systems and filters, resulting in 60% less NOX gases and particulates
- Bicycle Fleet – Business trips 3,900km over 18 months
- Tendering – minimum environmental standards have been applied to vehicle and fuel tenders
- Asset Management – whole-of-life costs and sustainability assessment of fleet items; identify ideal timing for procurement and disposal
- Composition – fit-for-purpose and utilisation review; from 600 to 450 vehicles; disposal of oversize vehicles and emission limits on vehicles

The City of Sydney (2017) has continued to monitor and improve their fleet management. Ongoing improvements and learnings include:

- Fleet project is on-going; seek to keep fleet emissions at 2014 levels during 2017/18
- A data collection system utilising telematics is being introduced to improve understanding of vehicle use and support finding further emission reductions
- Eco-driving supports safer driving (learned through experience and research). The City introduced a Low-risk and Eco-driving handbook in September 2016; The City expects emissions to further reduce through promoting and supporting safe driving practices

For Fleets – Number and Type of Charging Units

To determine the requirement of charging infrastructure for council fleets it is advised that councils consider what fleet needs are now and what the needs will be over the coming years – one should consider both projected EV procurement and future changes in charging requirements (e.g. fleet transition from PHEVs to EVs) (U.S. Department of Energy 2012).

If undergoing any electrical and/or ground works, it is worth considering adding extra circuits, electrical capacity, and conduit from the switchboard to future charging location (U.S. Department of Energy 2012). This was also reiterated at the recent All Energy Australia Conference where Delta Energy (global leaders in EV charging infrastructure) highlighted the importance of installing charging infrastructure that is capable for today's requirements but ready for the future (Dinkelmeyer 2017). Consideration should be given to running extra electrical cables for the future if electrical works are already being undertaken.

The U.S. Department of Energy (2012) recommends an analysis of a fleet's electricity requirements and charging-time needs. One way this can be done is by determining electricity-use (noting peak and off peak) and charging time requirements (time of day, time of use) for all BEVs (currently used or considering purchasing). Doing this will help determine if there are any electrical upgrades required (switch board upgrade, wiring, additional meter) and to select a suitable type of charging infrastructure and the number of units.

Level 2 charging stations usually require one unit per vehicle (to enable overnight charging when the vehicle is not in use and to use off-peak tariffs), while DC fast charging station are able to service multiple vehicles. It is suggested that, DC fast charging may be necessary for BEVs that drive more than 160 kms in a day (daily) (U.S. Department of Energy 2012).

Note: The U.S. Department of Energy (2012) recommends that if a DC fast charging station is installed for a fleet, to check with the vehicle manufactures that the regular use does not void any battery warranty. Battery degradation warranties and conditions should also be checked.

Charging Infrastructure Case Studies

7.1.6 Synergy and AEVA

In collaboration between Synergy (electricity Distributor) and the Western (WA) Australian branch of the Australian Electric Vehicle Association (AEVA) more than 70 electric vehicle charge points are flagged to be installed throughout regional parts of Western Australia (Renew Economy 2017). Charge points will be installed in towns and roadhouses on all major roads (this will be mostly in the south and east of the state, with some remote locations in the north gaining charge points) (Renew Economy 2017a).

Figure 38: AEVA socket at Williams Woolshed WA (source: Renew Economy 2017a)

How did the partnership with AEVA and Synergy develop?

The AEVA previously had a program of supplying charging sockets (at a small cost) to roadhouses and rural towns to encourage electric vehicle travellers to stop at a locality, while on their way to their destination (AEVA WA 2017).

Concurrently Synergy was working on a program of supporting electric vehicle charge points (mostly in metropolitan region). Synergy agreed to a partnership with AEVA and paid for all the three-phase sockets and stickers to re-brand existing sockets (AEVA WA 2017).

Current Program

AEVA have has been engaging businesses in the state that might like to install the sockets. The sockets are from an Australian on-line retailer of electrical equipment, and cost about $40 each. The business pays for their installation, which is usually between $300 and $500 depending on the site and how remote it is (AEVA WA 2017).

Socket Requirements

The sockets must be wired to a protected three-phase circuit rated to 32 amps per phase. The neutral pin must be connected - as all EV chargers need to access the 240 V potential between a phase and neutral (AEVA WA 2017).

7.1.7 RAC Electric Highway®

The Royal Automotive Club of WA (RAC) has funded 12 fast-charging stations in Perth and through the South West (RAC 2017).

The stations will be owned and maintained by local governments in the region and will form the RAC Electric Highway® (RAC 2017).

To use the station users will pay 45 cents per kilowatt-hour of electricity consumed, plus a $1 transaction fee (RAC 2017).

Figure 3: RAC Electric Highway (source: ChargeMap)

7.1.8 Queensland Government

The Queensland government has embarked on the *world's longest electric vehicle superhighway* in one State. The $3 million project (News Mail 2017) will make it possible to drive an EV from Gold Coast to Cairns. The highway will consist of Tritium Fast-charging stations at no cost for consumers during the initial phase.

Green energy will be purchased through green energy credits or offsets. The project is a collaboration between Energy Queensland, several State Government Departments, and local councils (Queensland Government 2017).

Figure 4: Queensland Electric Highway (source: Queensland Government Renewable Energy Qld Twitter)

7.1.9 London Street Lights Converted to Charge Electric Vehicles

There are innovative ways in which public charging infrastructure is being integrated into Councils. Ubitricity a German renewable energy firm has been steering this initiative by converting standard streetlights into charging points for vehicles in London (Web Urbanist 2017).

EV owners can order a custom charging cable (with inbuilt electricity meter). This allows for simple billing to the customer. Electric car owners can also request for charge points to be installed near their residents (Web Urbanist 2017).

Figure 5: Uditricity Street Light Charge Point (source: Web Urbanist 2017)

7.1.10 New Zealand – National Approach

The NZ Government is supporting a nationwide network of EV public charging infrastructure.

Charging Infrastructure Highway Coverage

The goal is for EV drivers to feel confident to journey across New Zealand's state highways. As such there is a goal for:

- *Nationwide coverage of fast/ rapid DC charging stations every 75kms (state highways)* (NZ Transport Agency 2017a)
- *Supplemented by a network of AC charging stations every 50km (state highways and collector routes)* (NZ Transport Agency 2017a)

Infrastructure Locations Determination System

The '*one network road classification system*' was used as a tool to identify priority journeys, and roads. This is to ensure that the roads that deliver the greatest benefit to the community are first utilised.

The government used this system as it *accounts for the quantity of people and goods that move along the road and has been jointly developed by road controlling authorities. It is a prioritisation system that also considers the social and economic value of a road* (NZ Transport Agency 2017b).

The box below provides an overview of the minimum network requirements that the New Zealand Transport Agency has set for the charging stations.

Network Minimum Requirements
Safety: » Minimum Mode 3 or Mode 4 charger » Designed and intended for use by the public » Endorsed and sign-posted by the road controlling authority Reliability: » Monitored for reliability by the charging operator » Available (ideally 24/7) for use by the public Interoperable: » DC – Must have Chademo & CCS Type 2 connectors » AC – Type 2 socket » Universal payment system The charging stations must also be located within reasonable proximity of the roads in question Source: NZ Transport Agency 2017a

USA – largest plug-in electric vehicle infrastructure demonstration in the world

Findings from the 'largest plug-in electric vehicle infrastructure demonstration in the world' – which examined how people in the USA charge their electric vehicles – provides some insight into how public charging stations are used.

The project installed AC Level 2 and DC fast charging stations in a wide variety of locations (public, private and workplace). It was over three years, followed 8,399 EVs, nearly 17,000 residential, commercial, and public AC Level 2 charging stations, and over 100 DC fast charging stations. The study found that public charging station usage varied significantly by region. There were highly utilised individual public charging sites found in most regions, however public charging station utilisation is dependent on local factors (Idaho National Laboratory 2015). Popular public charging stations were:

- *well-designed charging sites at retail stores, especially shopping malls, and parking lots and garages serving multiple venues demonstrated the potential to support many chargers per day (Level 2)* (Idaho National Laboratory 2015)
- *average utilisation rates of public charging stations generally tracked with regional PEV sales* (Idaho National Laboratory 2015)

The study found that to identify the best location to support high utilisation of public charging stations more research is needed. It also found that public and workplace charging infrastructure support drivers to increase their electric driving range, although most drivers did not charge away from home frequently (Idaho National Laboratory 2015).

ChargePoint

ChargePoint operates a network of public charging stations in Australia (Unny 2017).

For public charging systems an entity (government or business) purchases a charging station from ChargePoint and pays the associated installation costs. The entity owns the infrastructure and becomes part of ChargePoints network (Unny 2017).

Being part of the networks takes some of the complexity out of a public charging station as ChargePoint provides 24-hour support to drivers, as well as ongoing monitoring, maintenance, and continued software upgrade of charging stations. ChargePoint also provide the associated software required for payment systems, whereby users set up a payment account with ChargePoint (Unny 2017).

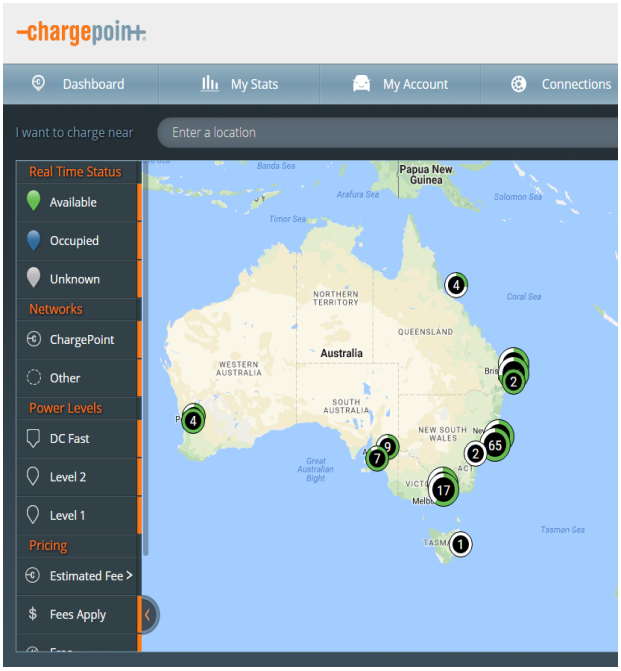

Figure 6: ChargePoint Public Charging Stations Australia. (source: ChargePoint)

The ChargePoint systems can also be used with commercial plans. Organisations can offer charge stations to employees, fleet and/or residents. This allows organisations to use EVs as a strategic investment to attract certain people to the business or area (Unny 2017). Owners of the station can limit the use of charging stations to certain people or make it available as open access to the public (ChargePoint 2017).

Electric Vehicle Incentives Around the World

The table below provides an overview to the types of incentives governments around the would have been adopting to support the uptake of EVs.

Country	Incentive
Victoria, Australia	» $100 annual registration discount for Hybrid and EVs
ACT, Australia	» Reduced stamp duty for lower emission vehicles Zero stamp duty for EVs with zero tailpipe emissions
USA	» Federal fuel tax credit worth up to $7,500 » State Incentives, tax exemptions, utility-rate breaks, and other non-monetary incentives such as free parking and high-occupancy vehicle lane access across almost 40 states, including California where 24,000 plug-in EVs and hybrids were sold over three years
United Kingdom	» £5,000 grant for EVs. £200 million available for Plug-in Car Grant » Exempt from London's Congestion Charge.
Netherlands	» Exemptions from registration fees and road taxes » €3,000 subsidy on the purchase of all-electric taxis or delivery vans » In Amsterdam EV owners also have access to parking spaces reserved for battery electric vehicles
Norway	» Full exemptions from non-recurring vehicle fees, including purchase taxes » Full exemptions from annual road taxes Allowed to use bus lanes
Denmark	» Exemptions from the vehicle registration tax of 80%
France	» Bonus for EVs up to €7,000 but capped at 30% of the vehicle price including VAT
Germany	» EVs and plug-in hybrids are exempt from the annual circulation tax for a period of five years from the date of their first registration Local governments given the authority to allow these vehicles into bus lanes, and to offer free parking and reserved parking spaces in locations with charging points
Italy	» EVs are exempt from the annual circulation tax or ownership tax for five years from the date of their first registration. Thereafter, EVs benefit from a 75% reduction of the tax rate applied to equivalent gasoline-powered vehicles
Greece	» All electric and hybrid vehicles are exempt from the registration tax
Ireland	» Government grants of up to €5000 for EV purchases » Exemptions from vehicle registration taxes » Electric car owners eligible for lowest amount of annual road tax
Portugal	• Exemption from the Vehicle Tax due upon purchase and annual circulation tax • Personal income tax provides an allowance of EUR 803 upon the purchase of EVs • EVs are exempt from the 5%-10% company car tax rates • Subsidy of €5,000 for the first 5,000 new electric cars sold in the country. In addition, there is in place a €1,500 incentive if the consumer turns in a used car as part of the down payment for the new electric car.

Country	Incentive
Spain	• The incentives include direct subsidies for the acquisition of new electric cars for up to 25% of the purchase price, before tax, to a maximum of €6,000 per vehicle
New Zealand	• Exemptions from paying road user charges
China	• Provides a maximum of US$9,800 toward the purchase of an all-electric passenger vehicle and up to US$81,600 for an electric bus. The subsidies are part of the government's efforts to address China's problematic air pollution
India	• Subsidies up to ₹150,000 for cars and ₹30,000 on two wheelers • States of Delhi, Rajasthan, Uttarakhand and Lakshadweep don't levy VAT Chandigarh, Madhya Pradesh, Kerala, Gujarat & West Bengal offer partial rebate on VAT • Delhi also provides a 15% subsidy of the base price of select electric cars. It also exempts such cars from road tax and registration fees
Japan	• 'Green Vehicle Purchasing Promotion Measure' offered tax deductions and exemptions.

Table source: The Greens 2016

Driver Behaviour Efficiency Improvements

The table provides driver behaviour tips that can improve fuel efficiency in general.

Table 18: Driver Behaviour Improvements (DOE 2008, NSW RMS 2014, WA DoER)

Driver behaviour	Potential fuel efficiency gain
Drive smoothly Stop/start driving is much less efficient than driving at a constant speed. Maintaining adequate distance between vehicles allows scanning ahead and anticipating traffic to avoid unnecessary acceleration and frequent repetitive braking that wastes fuel.	save up to 20%
Correct gear selection Driving in a gear lower than required wastes fuel, as does an engine labouring in top gear.	save up to 10%
Reduce idling Idling burns fuel with no transport output. It is more efficient to turn off a light vehicle and re-start it than to idle for any stop of 30 seconds or longer.	save up to 10%
Optimum speed for fuel efficiency Engines work harder at higher speeds. At 110 kph light vehicles can use 25% more fuel than when cruising at 90 kph. 50kph on urban roads and 90 kph on highways are the most efficient speeds for passenger vehicles.	save up to 10%
Keep up vehicle maintenance Well maintained vehicles are more efficient.	save up to 15%
Check and maintain tyre pressure Under-inflated tyres increase rolling resistance from friction against the road. Tyre pressure should be regularly checked and maintained at highest pressure recommended by manufacturer.	save up to 10%
Remove excess loads and roof racks The more weight a vehicle carries the more fuel it uses - each extra 50kg can increase fuel use by 2%. Exterior equipment such as roof racks and spoilers increase wind resistance and impact fuel economy, up to 20% extra fuel at high speeds.	save from 10% up to 20%
Air conditioning or open windows? Air conditioners can use 10% extra fuel when operating, however open windows increase wind resistance at higher speeds. Over 80kph the drag caused by open windows is greater than the load of the air conditioner and can reduce fuel efficiency by 5%.	Save up to 10%

Further, similar to the above, there are several driver behaviours that that can extend or reduce the range of an EV:

Consideration	Impact	Source
Full van payload	Can halve the range of electric vans	Grigorjeva 2016
Driver's driving style	Impact on the range.	Renault Australia 2017b
Vehicle air-conditioning	Significantly impact fuel economy and tailpipe emissions of conventional and hybrid electric vehicles (HEV) and reduce electric vehicle (EV) range	Farrington and Rugh 2000
Car is idling	Greater fuel consumption and thus decreasing range	Vehicle Air Conditioning 2013

Appendix E: Change Management Principles

Change Management

Should EVs be deemed feasible, it is likely that change management strategies will need to be implemented to ensure a smooth transition. Ensuring that all stakeholders (council and community) are brought on the journey will enhance the success of any changes. Identification of any issues early will enable targeted measures to overcome them.

Understanding behaviour change

Complete integration of EVs into the National Electricity Market will require business model innovation, consumer awareness, and understanding and acceptance of the technology (ClimateWorks 2016).

Change management strategies must be appropriately aligned with the decision-making processes of individuals, or the organisation. The decision-making process leading to behaviour change involves three phases (Pelletier and Sharp 2008):

1. Detection phase - involves becoming aware of the problem and its importance;
2. Decision phase - involves choosing to take action by weighing risks of negative or business-as-usual behaviour and desirability of achieving the goal to reduce risks;
3. Implementation phase - involves understanding how to implement and integrate the behaviour.

Kotter (1995) suggests several elements that are key to a change management strategy that successfully integrates new behaviours. These elements have been outlined in Figure 39, under the three decision-making phases.

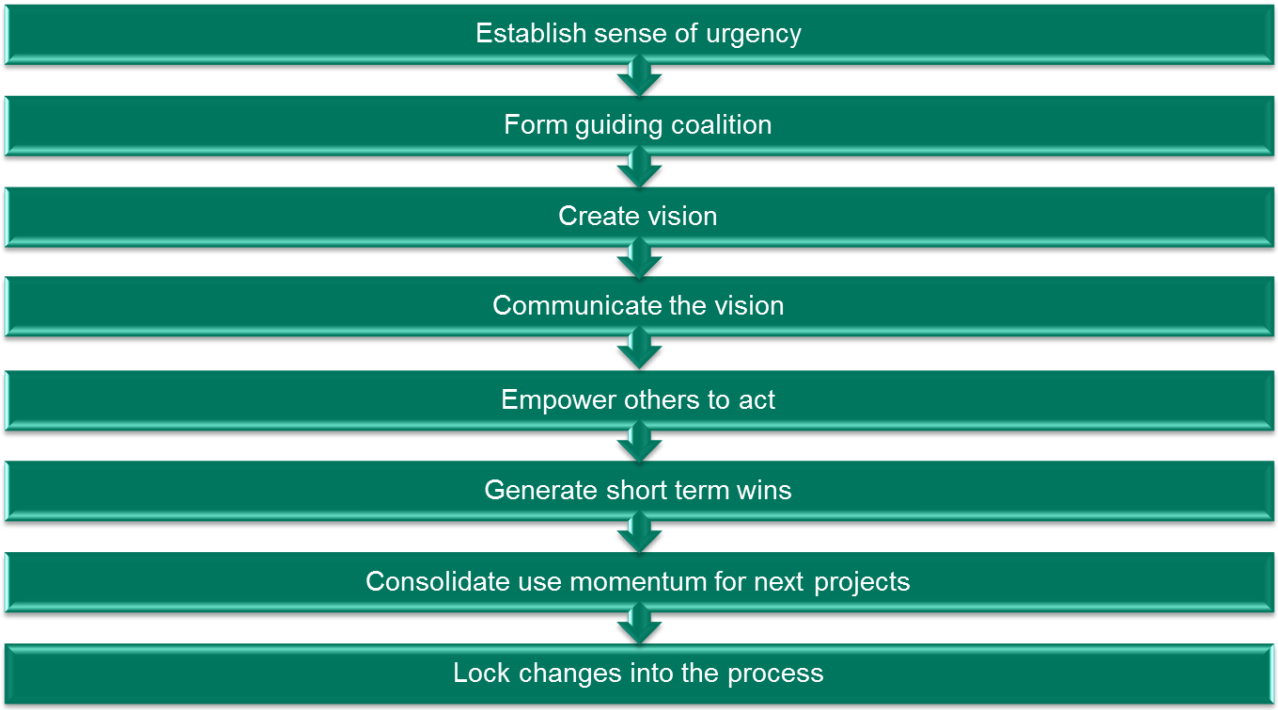

Figure 39: Change management process (Kotter et al 1995; Pelletier & Sharp 2008).

For any effective change management strategy, each stage should involve some level of involvement of the people, from ensuring they understand the change and the need for it, to identifying challenges or barriers in implementing the change. Individuals may also be able to provide insights into the planning and implementation of the change. Check that people affected by the change agree with, or at least understand, the need for change.

It is recommended that a comprehensive change management strategy incorporates a plan that covers the all elements at the appropriate decision-making phases. In additional, behavioural change must be realistic, achievable and measurable (Talloo 2007, p. 254).

Guide to change management

The process outlined in Figure 39 will now be discussed in detail (Table 19) with examples of mechanisms that can be used to achieve each of the elements required for change.

Table 19: Change Management Guide using Kotter's Elements

Element	Mechanisms and examples
Form a guiding coalition	Without a good governance structure, organisations will remain frozen in an unsustainable model (Doppelt 2009). Integration of LEVs into the National Electricity Market will require business model innovation (ClimateWorks 2016). Successful behaviour change is led by managers from different departments that **share power and authority**, revealing that the organisation values all constituents. Hence, the executive leadership committee for implementing an EV fleet should consist of a representative from each department – fleet, environmental, economic, social (if community is to be influenced). This also reduces the silo effect that commonly impedes on the effective roll out of policies. The governance structure should also be published in the sustainable vehicle policy and clearly outline the roles of each member. Effective governance systems typically have good leadership. "Management is about doing things right while leadership is about doing the right thing" (Doppelt 2009). This means that an effective governance system will contain leaders that understand the key steps required for the organisation to become more environmentally sustainable and do not let up before the change process is complete.
Establish a sense of urgency	Integration of EVs will require understanding and acceptance of the technology (ClimateWorks 2016). Messages should be clear and concise, and appeal to a variety of concerns (e.g. environment, health, safety, and finance). Acceptance of EVs and associated policies can grow if it is marketed in a way that shows its **alignment** with organisational culture, instilled in existing policies and **organisational identity**. It is a good idea to promote the values and vision of a council as the organisation identity and show how LEVs will meet targets set out in strategies. This can be essential to transforming council culture away from that just because you work for Council you are entitled to a vehicle.

	Tasmanian DHHS found that **appealing to safety** – driver fatigue and crash risk – when implementing a new sustainable fleet policy was useful in changing staff mindset on travelling, and encouraging teleconferencing where face-to-face meetings are not imperative. A study (Asensio & Delmas 2014) found that **environment and health-based messages**, which communicate the environmental and public health externalities, motivated 8% energy savings.
Communicate & engage	Behaviour change is more likely to be successful if there is **cooperation** between the executive leadership and employees (and community). Integration of EVs will require business stakeholder awareness technology (ClimateWorks 2016). Also, ensure to capture their feedback, as this will show that the opinions of those affected are valued and that they are included in the decision-making process. **Inclusion** is also seen as a positive factor in effective change management. The best way to be inclusive is via **face-to-face** communication (e.g., seminars, workshops). Marketing materials of the changes can be used in addition. All communications should occur **early** and recurrently.
Communicate the vision	Inclusion of stakeholders and early communication is necessary through each phase of behaviour change. In this second phase, there are two items to consider: 1. **Preparation** is key; stakeholders should be informed of how their day-to-day work will change (this is separate to information dissemination in the first phase). 2. Bring stakeholders together in their decision-making. Using **social networks** as a platform for employees to communicate and share their travel experience and performance with each other is a way to: boost their achievement and trigger competition; help promote group behaviour; increase trust among users and reduce social ambiguity (Poslad et al 2015). Social awards can be created for employees who have the lowest carbon footprint and/or whose carbon reduction from previous performance is the greatest. Another mechanism utilising social networks in the workplace can be, for example, step-counting competitions where groups compete against each other over a 30-day period and perhaps attract sponsors.

Empower others	It is imperative that the supportive executive leadership empower employees to make decisions towards the desired behaviour change, and adopt a sense of **accountability and responsibility** to achieve the behaviour within the context of the organisational culture (Price et al 2004). A hands-on approach to empowerment would be to host **exposure events** and encourage short term **test drives** (ClimateWorks 2016). Council could partner with motoring clubs to organise test drive events with the latest EVs. A test drive event would prove useful for employee compliance in the early stages of applying a new council sustainable fleet policy (GWRC 2016). Ensure they are shown the basics and have the opportunity to drive far enough to **ease range anxiety**. Pelletier & Sharp (2008) indicate that a new behaviour – particularly an environmentally positive one – is likely to be adopted if individuals feel like they have the **freedom to choose** from several options that will lead to the desired outcome. For example, with the range of EVs available, employees are still able to choose from a hatchback, sedan or all-wheel drive; or employees can choose from an EV or PHEV; or telematics conducts a trip analysis to determine what mode of transport is most appropriate – bicycling, train, car, etc.
Generate short-term wins	Once individuals choose to adopt a new behaviour, it can be reinforced through rewards. The aim is to transition the new behaviour into the 'norm'. Rewards can include social awards, monetary benefits, promotion, new change leaders, etc. Reinforcement can also occur through regular reminders such as **prompts** to accept when booking a vehicle acknowledging acceptance. **Travel Feedback Programs** provide personalised feedback on individual travel behaviour. Employees can be sent quarterly summaries outlining the mode of transport used for work purposes and associated cost, time, distance and calories (for bicycle riding or walking) and carbon footprint. Such information can be gathered when a telematics system is in place. A review of the effectiveness of 10 Japanese Travel Feedback Programs found that such programs can reduce CO_2 emissions by about 19% and car use by about 18%, while increasing the use of public transport by about 50% (Poslad et al 2015). ClimateWorks (2016) reports that *The EV Project* in the United States found that the vast majority of charging was done at home and work despite installation of extensive public charging infrastructure. Therefore, targeted programs aimed at encouraging workplace and home charging would benefit electric vehicle drivers. For example, the UK Office for Low Emissions Vehicles administer a **Homecharge Scheme**, designed to offset approximately 75% of the capital and installation costs of installing an electric vehicle charging station (up to £700). At a local government level, this may be an appropriate mechanism for employee behaviour change. The money to fund this can come from a revolving green fleet fund, where money saved can be reinvested for an initial uptake period (e.g., 5 years).

Generate short-term wins, use momentum for next project	Targets to be achieved through the integration of LEVs and/or the adoption of a sustainable vehicle policy should be clear and prominent from the beginning of the behaviour change process. Smaller targets and delegated time intervals provide good **stepping stones** and encourage integration of the behaviour. Utilisation of **telematics** will provide consistent and robust data collection to allow for effective monitoring and **reporting**. Such reporting should be advertised concisely to employees and the community – email updates, provision of a milestone report on the website, advertising space on the website, billboards, community letters, etc.