# Electric Vehicle Fleet Feasibility Study

transport | community | industrial & mining | carbon & energy

pitt&sherry

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# Executive Summary

Rare Consulting (a division of **pitt&sherry**) was commissioned by Moreland City Council to conduct a feasibility study for the adoption of electric vehicles (namely, the Nissan LEAF) as a permanent option in their fleet procurement.

Moreland City Council is a carbon neutral certified Council and has clear strategic objectives in place to reduce greenhouse gas emissions from both Council operations and the Moreland Community as a whole. Electric vehicles hold one of the greatest opportunities for reducing air pollution and greenhouse gas emissions from the light vehicle fleet, producing zero of each when recharged via renewable sources – which would be further reinforced with Moreland City Council beginning the roll out of commercial scale solar PV systems across its buildings.

There has been significant movement in the Australian electric vehicle market over the past few years with a number of state and industry trials taking place, a more evident recharge network being established, and the release of electric vehicle standards.

The results of this study indicate that adoption of additional Nissan LEAFs within the Moreland fleet is a sound investment.

- On a purely fiscal comparison to the Camry Hybrid it achieved a positive BCR of 1.48 (at a 7% discount rate) - saving council in the order of $2,300 per vehicle replacement per three year cycle - attributable to the discounted purchase price, low cost electricity rate, recharge infrastructure already in place and the low ongoing costs
- Additional cost benefit analysis was performed at discount rates of 5% and 10% to examine sensitivity. Purchase of Nissan LEAF vehicles in place of Toyota Hybrid Camrys were determined to be better option under each scenario, as per the table of results below
- Adoption of further electric vehicles within the fleet allows Moreland City Council to continue to demonstrate that it is the electrical vehicle hub of Victoria – raising the Councils profile nationally and internationally
- The more electric vehicles in operation in the fleet in place of conventional vehicles, the lower the greenhouse gas output
- Adoption of electric vehicles, allows Moreland City Council to lead by example encouraging its constituents to reach the 10% electric vehicle sales by 2020 set out in the Zero Carbon Evolution Strategy
- Avoided public health cost benefits (from lower vehicle emissions) and reduced offset purchase requirements for Council to achieve carbon neutrality of fleet operations were not included in this analysis, but if included would improve the results in favour of the Nissan LEAF

**Results for comparison of Nissan LEAF and Toyota Hybrid Camry in Moreland City Council fleet**

| Discount rate | 5% | 7% | 10% |
|---|---|---|---|
| **Net Present Value ($A2014)** | $2,841 | **$2,344** | $1,649 |
| **Benefit Cost Ratio** | 1.58 | **1.48** | 1.34 |

# 1. Introduction

Moreland City Council engaged **pitt&sherry** to verify the economic viability of adopting electric vehicles as a permanent option in their fleet procurement.

In order to do effectively determine the feasibility of introducing additional electric vehicles into Moreland City Councils fleet the following study aims to do two things:(a) give the reader an appreciation of the current state of the Australian electric vehicle market, and (b) present a cost benefit analysis of a Nissan Leaf and Hybrid Camry based on those currently in operation in Moreland City Council's light vehicle fleet.

# 2. Strategic context

Declining domestic oil production and projected increases in demand for transport fuels point to the likelihood that Australia will face a significant decrease in oil self-sufficiency in the future. Recent studies suggest that the future deficit between domestic fuel supply and domestic fuel consumption is likely to be in the order of 335 million barrels p.a. by 2030. Australian fleets are also expected to face higher and more volatile fuel prices, as Australia increasingly becomes a price taker on international markets. (ABARE 2011, ACIL Tasman et al 2009).

There is also growing concern regarding the increasing greenhouse gas emissions and detrimental impacts on air quality related to transport, in particular from passenger vehicles.

Alternative fuels and technologies, including electric vehicles, present an opportunity to mitigate against fuel security risks and environmental impacts. However, there is a degree of uncertainty and contestability regarding future projection for these alternatives in Australia.

## 2.1 Moreland Specific Strategic Context

Moreland City Council has a clear commitment to reducing emissions and taking action on climate change as demonstrated its status as one of the few local government authorities to have been awarded carbon neutrality certification. Council achieved this recognition through their Carbon Management Strategy implementing a significant number of large-scale energy efficiency projects and purchasing offsets for the remaining emissions.

This commitment to emissions reduction extends beyond Councils own corporate actions to that of the Moreland Community as a whole. The recently endorsed Zero Carbon Evolution Strategy sets a road map for a 22% reduction in the emissions of municipal Moreland as a whole by 2020. A third of Moreland community's emissions come from transport, and an objective under the low emission transport component of the strategy is that by 2020 10% of new vehicle registrations will be electric vehicles (MCC 2014). This goal is supported by the installation of a public electric vehicle recharge network across the municipality in partnership with the State government and the Victorian Electric Vehicle trial.

Moreland City Council is known as Victoria's electric vehicle hub. This status has gained Council national and global recognition with Moreland set to host the Australian Electric Vehicle Associations annual expo event later this year, and Tesla Motors – manufacturers of the world's most advanced production electric cars – offering their recharge infrastructure within Moreland. This type of press and event is good for generating visitors to the Moreland municipality and growing the local economy.

Moreland City Council will be installing 150kW capacity of solar PVs on Council buildings in 2014/2015 in order to generate electricity from a renewable energy source, which in combination with offsetting its entire electric vehicle charging stations with accredited green power ensures that the recharging of any electric vehicle in Moreland generates no scope 1 or 2 GHG emissions.

# 3. Australian Electric Vehicle Market Overview

On a global scale the electric vehicle market is continuing to develop. In 2014, the world's first fully-electric racing series will be launched, competing in 10 cities around the world including London, Beijing & Los Angeles. The FIA Formula-E Championship, commencing this September, demonstrates the automotive industries commitment to the electric vehicle. FIA are promoting the championship around three core values Energy, Environment, and Entertainment with intent to redefine the perception of electric vehicles amongst the teenage to early thirties demographic and facilitate early adoption (FIA 2014, Drayson 2014). While not yet confirmed Australia has been identified as a potential location for the second series.


Figure 1 Example Formula-E vehicle (source FIA Formula E website)

The publicity and technology advancements brought with events of this nature are invaluable to the market and its growth through community acceptance. This is beginning to resonate in Australia, where earlier this year at the Clipsal 500 in Adelaide, Nissan demonstrated their Nissan Leaf NISMO RC – an electric car that has the same battery pack and motor as the Leaf, but is designed and constructed as a racing car, weighing nearly 40% lighter than the production Leaf.


Figure 2 All Electric Nissan Nismo LEAF Supercar

This section of the report discusses provides an overview of the electric vehicle market in Australia, the current government policies, the barriers to market adoption, examples of industry and government take-up and the likely future projection.

## 3.1 Government policy context

Despite the recent repeal of the Australian carbon pricing mechanism (carbon tax) and the cessation of the federal Energy Efficiency Opportunities program – Australia still has a stated objective to reduce greenhouse gas emissions and to ensure the future security of domestic energy. Proposed federal Emissions Reduction Fund legislation is scheduled to go before the Senate in late August, and federal Energy Green and then White papers are due for release later this year. Additionally, headway has been made towards meeting the objectives set out in the Alternative Fuels Strategy from 2011. These policies and measures are described below.

### 3.1.1 Energy White Paper

An Energy White Paper is currently being developed by the Department of Industry, with the primary objectives including maintaining energy security and prosperity, and ensuring that Australia continues to have a secure, competitive, efficient and sustainable energy sector to 2030 and beyond.

The issues paper released for comment by the Australian Department of Industry in December 2013 included an element on increasing the development and deployment of electric vehicles. The issues paper noted that '*currently the widespread adoption of fully electric vehicles is limited due to high upfront capital costs, battery storage constraints, lack of vehicle recharging infrastructure, electricity grid integration challenges and capacity constraints and consumer performance uncertainty*'. Comment was sought on any barriers to the increased uptake of electric vehicles. Submissions to the issues paper will form the basis of the Energy Policy Green Paper due for release shortly.

### 3.1.2 Alternative Fuels Strategic Paper

In the latter half of 2011, in light of the high level of uncertainty and contestability regarding future projections for alternative transport fuels in Australia, the federal Department of Resources, Energy and Tourism (DRET) undertook an extensive consultation process with the key stakeholders involved in the national alternative fuels agenda (i.e. fuel providers, technology providers, end-users and government agencies).

The views and experiences of these key stakeholders were subsequently used to develop the Strategic framework for alternative transport fuels (the Strategy), which was released by DRET in December 2011. This Strategy outlined the development directions for a range of alternative fuels and technologies for both passenger and heavy duty vehicles in Australia and, in turn, identified a number of market opportunities and existing adoption barriers for each particular fuel/technology.

Table **1** summarises the key opportunities for electric vehicles as identified by stakeholders, including government, industry (vehicle manufacturers, technology providers) and industry bodies, during DRET's consultative process to support the Strategy's development.

**Table 1 Nature of Market Opportunities for Electric Vehicles**

| Market opportunities | Nature of opportunity |
|---|---|
| Energy security | Electric vehicles can diversify transport energy away from the current near-complete dependence on conventional fuels (much of it imported). |
| Enhancement of existing stationary energy generation | Adoption of electric vehicles (high adoption rates) can flatten the overall demand profile on the energy network. This could assist in maximising the return on current distribution assets, and finance future capital expansion. |

| Market opportunities | Nature of opportunity |
|---|---|
| Smart grid technology | Electric vehicles may eventually be used to feed energy back into the grid. |
| Environmental benefits | Electric vehicles have no tailpipe emissions (i.e. air quality benefits). If sourced by green power, electric vehicles have zero GHG emissions. |
| Community dividends | Employment creation (e.g. electric vehicle component manufacture). |

Source: DRET (2011)

Despite the abovementioned market opportunities, there was a high level of uncertainty in relation to the future uptake of electric vehicles in Australia. The relatively modest uptake projections for EVs, which resonated strongly with industry feedback in relation to market constraints, were attributed to a number of key adoption barriers. In its Strategy, the government identified the following barriers to be redressed to ensure growth in the emerging electric market:

- **PERFORMANCE UNCERTAINTY.** The economic, environmental and operational performance of alternative fuels can vary according to technology type and combustion efficiency. In the case of electric vehicles, this uncertainty was identified to have led to 'range anxiety' among perspective customers.

- **MARKET AVAILABILITY OF TECHNOLOGY/PRODUCTS**. Australia is generally a technology taker as far as transport is concerned. This limits the availability of some alternative fuel vehicles in the Australian market. Mass produced electric vehicles have only been available in Australia since 2010.

- **HIGH ADJUSTMENT COSTS.** This generally includes the higher capital costs associated with the purchase of electric vehicles, as well as costs relating to the recharging infrastructure. It also includes write-down costs arising from the early retirement of existing equipment

- **INFRASTRUCTURE BARRIERS.** A lack of recharging infrastructure was identified as a major barrier in the uptake of electric vehicles. Although electric vehicles have the added advantage of being able to plug into an existing network, there are limitations arising from grid capacity constraints that were identified as needing to be addressed.

- **INVESTMENT UNCERTAINTY.** Difficulties in estimating the return on investment due to prevailing uncertainty about the future price outlook of both conventional fuels and electricity results in investment uncertainty and delays in the uptake of electric vehicles.

- **LACK OF STANDARDS.** The lack of standards for electric vehicles and for vehicle-recharging equipment was recognised as constraining the market commercialisation of electric vehicles.

The government believed that market-led approaches could address some of the above barriers. However, in its Strategy it also acknowledged that the significant uptake of alternative fuels/technology requires government intervention. As such, the Strategy outlined four broad categories (along with required actions) to address the uptake barriers of alternative fuels including electric vehicles, Table 2.

Table 2 Australian Governments Categories to address the uptake barriers for alternative fuels.

| Category | Example Actions |
|---|---|
| LEADERSHIP AND CERTAINTY | This aspect includes the establishment and appointment of an 'implementation advisory group' to advise the Australian Government on the implementation of the Strategy. |
| RESEARCH AND DEVELOPMENT | The Australian Government flagged its support for research, development and demonstration on a 'technology neutral' and competitive merit basis |
| COMMERCIALISATION | This included collaborative actions (i.e. industry and government) to facilitate the commercialisation of alternative fuels and technologies by overcoming barriers relating to lack of real-world performance data (economic and environmental), access to finance and skill gaps. |
| INFORMATION AND VERIFICATION | These actions included the development of communication strategies to better convey the benefits of alternative fuels/technologies. Industry was also required to provide up-to-date status information (e.g. production, consumption, technology improvements) on alternative fuels/technology; and the development of fuel quality standards and GHG verification methodologies was to be pursued by the Government. |

Source: DRET (2011)

As far as electric vehicles were concerned, the following improvement actions to support the adoption of electric vehicles in Australia were identified through the Strategic Framework for Alternative Fuels:

- The provision of end-user incentives to offset the high technology costs
- Fast-tracking of public EV recharging infrastructure
- Promotion of end-user awareness
- Development of EV standards (including vehicle components and recharging infrastructure)

The implementation of these suggested improvements was deemed paramount by both government and industry in redressing the current barriers, and action towards these, despite an initial delay, has commenced in some form across the country.

### 3.1.3 Electric Vehicle Standards

Standards Australia published nine electric vehicle standards drafts for comment in April this year, six of which have been recently released.

- **AS ISO 6469-1:2014** Electrically propelled road vehicles – Safety Specification – Part 1: on board rechargeable energy storage system (RESS)
- **AS ISO 6469-2:2014** Electrically propelled road vehicles – Safety Specification – Part 2: Vehicle operational safety means and protection against failures
- **AS ISO 6469-3:2014** Electrically propelled road vehicles – Safety Specifications – Part 3: Protection of persons against electric shock
- **AS IEC 61851 – 23:2014** Electric vehicle conductive charging system – Part 23; D.C electric vehicle recharging station
- **AS IEC 61851 – 24:2014** Electric vehicle conductive charging system – Part 24: Digital communication between a D.C EV charging station and electric vehicle for control of D.C charging
- **AS IEC 62196.2:2014** Plugs: socket-outlets: vehicle connectors and vehicle inlets – Conductive charging of electric vehicle – Part 2: Dimensional compatibility and interchangeability requirements for A.C pin and contact.
- **SA TR ISO 8713:2014** Electrically propelled road vehicles – Vocabulary
- **SA TR IEC 60783:2014** Wiring and connectors for electric road vehicles
- **SA TS IEC TS 62763:2014** Pilot function through a control pilot circuit using PWM modulation and a control pilot wire

The provision of these standards will facilitate the market commercialisation of electric vehicles in Australia.

### 3.1.4 Low Emissions Vehicle Strategies

The Climate Change Authority is recommending that the first phase of mandatory low emission vehicle standards take effect in Australia from 2018.

*"The standards would progressively reduce carbon dioxide emissions from new light vehicles to 105g/km in 2025, almost half the current level of 192g/km. This 2025 standard would broadly bring Australia into line with the United States, and still trail the tighter European Union targets by several years".* (CCA 2014)

These standards target conventional internal combustion engines, and are already in place around the world – and as such, OEMs have vehicles available to meet them. However, the standards will still support electric vehicles in that they already meet any limit that might be imposed with zero tailpipe emissions.

There has been discussion around the implementation of these standards for a number of years and in the interim the ACT and South Australia have introduced their own strategies to encourage the uptake of low emission vehicles, as follows.

### *Australian Capital Territory*

The ACT currently has the Low Emission Vehicle Strategy Discussion Paper available for public comment. The ACT Low Emissions Vehicle Strategy aims to reduce transport generated greenhouse gas emissions by promoting the purchase and use of low emission vehicles by the public; mandating low emission vehicle use by the government (so as to lead by example); and promoting driver behaviour change (ACT 2014).

The ACT LEV Strategy highlights a lack of extensive refuelling infrastructure as a challenge to reducing vehicle emissions through electric vehicle adoption, in addition to high capital costs of low emission vehicles, and a lack of market choice. The proposed options to achieve the strategy objectives include:

- Increasing the Green Vehicle Duty Scheme
- Increasing the Green Vehicle Registration discount
- Travel time and convenience options including transit access, reserved priority parking
- Develop an ACT government sustainable fleet strategy
- Car Sharing Programs – encouraging the use of electric vehicles

### *South Australia*

The South Australian Low Emission Vehicle Strategy (2012-2016) aims to remove the barriers to low emission vehicle uptake and incorporates a dedicated strategic theme to establish electric vehicles within the state. Namely, "*The South Australian Government will endeavour to remove information, policy and market barriers to electric vehicles and accordingly, increase the number of electric vehicles on our road*" (SA 2012). In order to do this, the SA government committed to:

- Reduce light vehicle emissions by 10% per kilometre
- Establish a grant program for electric vehicle recharging stations. This has been established and the government offers $4,000 to assist with the installation and maintenance of recharging infrastructure for public use.
- Install smart electric vehicle recharging bollards
- Provide information on electric vehicles and recharging infrastructure to increase awareness and acceptance

## 3.1.5 Existing End-User Incentives for Electric Vehicles

While some states/territories in Australia have commenced implementation of end-user incentives to help offset the cost impost of purchasing electric and low emission vehicles (for example reduced registration costs in Victoria and ACT, and reduced stamp duty in ACT) they are significantly less than those provided in other markets (i.e up to $12,500 in California) .

## 3.1.6 Internationally

In comparison, the rest of the world has made significant progress in growing their electric vehicle markets. Growth in the global electric vehicle market can largely be attributed to the growth in the United States and Europe who have experienced increasing sales in electric vehicle in the past few years, as shown in Figure 3.

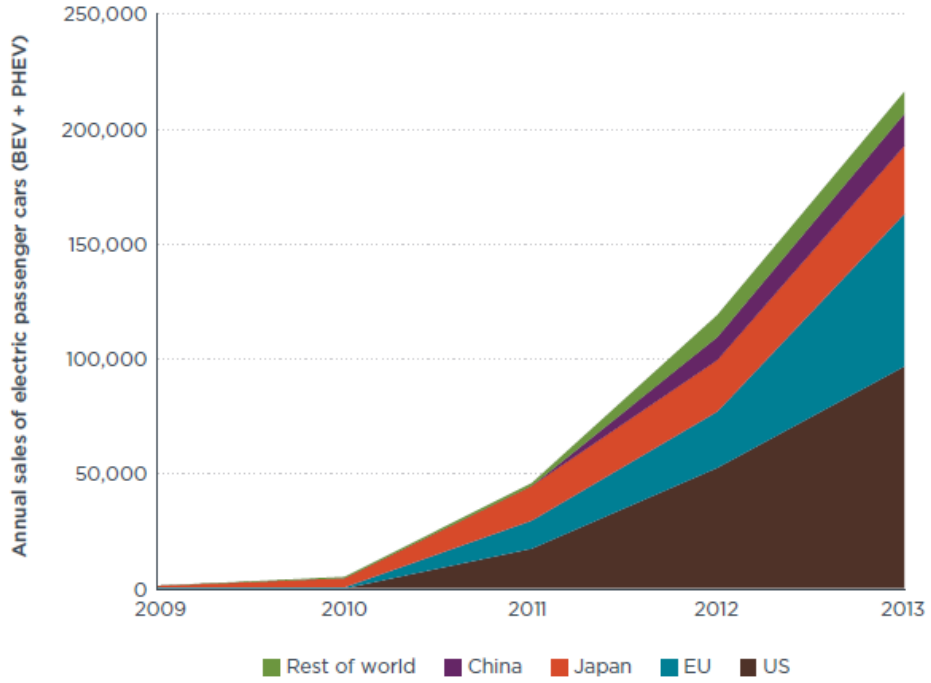



Figure 3 Global sales of Electric vehicles (passenger cars) 2009- 2013 (source: ICCT 2014)

The high growth in these countries can be largely attributed to the government policies in place. Financial incentives, tax reductions, bonus payments and premiums exist for the purchase of electric vehicles in the majority of countries within the European Union, an overview is provided in Appendix A. In the United States a range of fiscal incentives are in place across the country, with more than 50% of the States having incentives in place including: discounted recharging, tax exemptions, parking fee exemptions, purchase rebates, conversion cost rebates, and transit access lane access.

The policy progress in Australia (discussed above), while not as established is heading in the right direction.

## 3.2 Electric Vehicle Trials

### 3.2.1 Smart Grids Smart City Electric Vehicle Project

The $490 million Smart Grid, Smart City Program funded by the Australian Government and industry, sought to gather information about the costs and benefits of smart grids to help inform future decisions about smart grid technologies by government, electricity providers, technology suppliers and consumers across Australia.

The consortium that led the program, undertaken in NSW, included: Ausgrid (one of the three New South Wales electricity distribution entities); IBM Australia; GE Energy Australia; Grid Net; CSIRO; TransGrid; EnergyAustralia; Landis+Gyr; Sydney Water; Hunter Water; the University of Newcastle; the University of Sydney; Lake Macquarie City Council and the City of Newcastle.

The Smart Grids Smart Cities Electric Vehicle project was one of the projects in the Smart Grids Smart City Program and aimed to investigate the potential impact of wide-scale uptake of electric vehicles in Australia on the electricity distribution network. The project comprised of four components charging infrastructure deployment; road trials; uptake and behaviour modelling; and grid impact modelling. Twenty Mitsubishi iMiEV electric vehicles were used in the trials that included business trialling at Ausgrid and separate fleet and home trials.

The results of the project found that while uncontrolled electric vehicle charging leads to an increase in the evening peak demand, smart charging can minimise the increase in peak demand from electric vehicle charging, which can reduce and /or defer generator capital and operational expenditure and network capital expenditure. The net benefit of this was estimated to be $89 million in present value terms in Australia through to 2034 (ARUP 2014). The report, just released, recommends that Standard's Australia incorporate demand response capabilities within AS4755.3.4 for electric vehicle charging to ensure electric vehicle charging points installed today will be compatible with managed charging schemes in the future.

The ability of smart grids to remove the potential impact on peak demand and to use electric vehicle as a means of distributed storage alleviates the identified barrier to adoption of the affect on the network.

### 3.2.2 State Government Trials

The Western Australian EV trial was the first Australian trial. It operated between November 2010 – 2012 and involved eleven Ford Focuses converted to electric power (due to no OEM vehicles being available at the time of trial commencement) and monitored for performance, environmental benefits and practical implications for electric fleets.

Findings from the Western Australia trial were that the converted vehicles were able to travel 131km on a full tank; on average though they were driven 25km between charges; they consumed 242Wh/km (including 25Wh/km of charging losses); peak charging time occurred between 8am-10am; charging stations were only utilised if they were in convenient locations; and charging stations were often occupied for a full working day, despite charging only requiring a few hours. The barriers identified at the end of the trial included: high capital costs, lack of recharging infrastructure; impact on the electricity networks and a lack of standards (Mader, Brunel 2012).

The Victorian EV trial only concluded recently, in June 2014, having been in operation since October 2010, and involving over 80 organisations and 120 households. The trials electric vehicle "ecosystem" design, which drew together vehicle suppliers, the electricity market, charging infrastructure, vehicle operators (private and public), universities, industry bodies and others, allowed it to examine all facets of the electric vehicle market and was of a much larger scale than the Western Australian trial.

The results discussed in the Victorian electric vehicle mid-term report (2012) suggested that electric vehicles were likely to be an important part of Victoria's transport future and given the significant market growth that has occurred since then it is assumed that the final report, due for release shortly, will further support those findings.

Additionally, while not 'trials' as such other States have also been promoting electric vehicles. The ACT State government has begun to introduce electric and hybrid vehicles into its fleet and has undertaken a pilot car pooling scheme for ACT government staff – as a means to lead by example; the South Australian Government has an Electric Vehicle Demonstration Project; and the NSW government has an EV taskforce looking at the economic viability of electric vehicles in greater metropolitan Sydney. The NSW government was also involved in the Smarter Grids Smarter Cities project.

## 3.3 Australian Local Council case studies

Many local governments around Australia are investing in electric vehicle trials and adoption. Appendix B provides an overview of the electric vehicle use from a sample of local governments (note it is not intended as an exhaustive list), which demonstrates that there are a range of EV trials underway around the country and a number of councils have begun a wider adoption.

In Victoria, following the large scale electric vehicle trial run by the Department of Transport, Planning and Local Infrastructure (formerly known as Department of Transport), a number of participating councils have continued with their electric vehicle similar to Moreland City Council. Additionally, some had been looking at electric vehicles before the trial.

### *Melbourne City Council*

The City of Melbourne was the first local government in Victoria to introduce electric vehicles into its fleet operations, with the introduction of the locally developed Electric Blade technology. This was done with support from the Department of Transport and the Department of Innovation, Industry and Regional Development in April 2008.

Rare Consulting was commissioned by the City of Melbourne in early 2010, prior to the launch of the Victorian trial, to prepare a report on the key policy considerations in promoting electric vehicle usage in Melbourne. The findings included:

- The development of an umbrella policy for the introduction of Electric Vehicles in Melbourne that aligned with the following public policy areas: Road Safety; Public Safety and Streetscape Design; Sustainable Transport; GHG emissions reductions; Urban Amenity; CBD traffic congestion; Fleet Procurement; CBD parking; Services Procurement (waste management); Social Equity; and Cultural Heritage
- The development of a package of Transitionary Incentives for electric vehicles in Melbourne for a fixed term to encourage early adopters (i.e free parking permits, and free recharging)

Melbourne City Council currently has four electric vehicles permanently in their fleet and a fleet of electric bicycles for staff use which has been with Council since 2006

Additionally, there are a number of electric vehicle recharge points located around the municipality free to public use, including two charging bays at Federation Square.

### *City of Sydney*

The City of Sydney was heavily involved in the Smart Grid Smart City Electric Vehicle Project and currently has a fleet of 14 Nissan Leafs. These were purchased in 2013 to replace 10 Toyota Priuses. The electric vehicles are recharged with renewable energy from electricity generated from solar PV systems installed on Council building roofs. The City of Sydney plan to phase in additional electric vehicles to eventually run 50 within their passenger vehicle fleet, and are exploring low emission technology in other sectors of their fleet, such as a recently purchased hybrid diesel excavator.

The City of Sydney is also promoting public uptake of electric vehicles by offering free recharging facilities at council car parks, using 100% renewable energy from solar PV electricity generation. The council also supports a GoGet charge point in the municipality – the first public vehicle charge point in Australia when it was installed. This charge point uses purchased Greenpower and is managed by ChargePoint and is used by a GoGet plug-in hybrid Prius.

## 3.4 Barriers/Challenges to adoption

### 3.4.1 Demand Side

In order for the electric vehicle to become a serious contender for market presence there needs to be a strong demand from consumers. Without government incentives in Australia to the same extent as those in place overseas, electric vehicles must compete in an already well-established playing field. There are

two distinct light vehicle markets, in which the electrical vehicle must compete: the private buyer market and the fleet buyer market.

In recent years there has been a gradual shift away from larger vehicles from domestic OEMs (Holden, Ford) and imported vehicles now account for the majority of the domestic market. A considerable decline in the residual values of larger vehicles, and higher average fuel prices along with a greater availability of imported options, have resulted in consumers favouring smaller and more efficient vehicles. This is evidenced by the steady growth and increasing market share of Mazda, VW and Hyundai, all of which have improved the fuel economy and carbon intensity of their offerings in recent times – in part to comply with existing and emerging fuel efficiency targets in a number of jurisdictions including Europe and North America.

Australian fleet buyers, who account for 51% of the market, have historically preferred larger vehicles and in relation to government fleets there has traditionally been mandates and favourable funding for locally made vehicles. Given that soon this will no longer be an option the main factors that influence procurement decisions of fleets are:

- Whole of life considerations (residual value, operating costs, maintenance costs)
- Safety
- Environment (particularly for government fleets)
- Human Resources considerations
- Utility (i.e fit-for-purpose)

In comparison, market surveys have indicated that in general private buyers are in general aware of the environmental benefits of emerging technologies such as electric vehicles. However, the following factors are likely to outweigh these benefits for most consumers when it comes to purchasing a new vehicle (Deloitte 2011):

- Capital cost
- Fuel efficiency
- Aspirations and needs
- Operability/utility

Accordingly, these demand requirements present a number of challenges/ barriers to the adoption for electric vehicles, namely:

- **CAPITAL COST PREMIUM.** The high cost of electric vehicles is attributed to the cost of the battery pack, which accounts for approximately 30% of total vehicle costs. As illustrated in Figure 4, battery pack prices must fall to under $300/kWh (and petrol prices must stay above $1.20/L) for electric vehicles to be economically competitive. Until recently, market analysis suggested this was unrealistic. However, the Victorian electric vehicle trial predicted that by 2020 the operating cost benefit of an electric vehicle would outweigh the purchase price penalty. Additionally, Tesla's recent release of their high performing lithium-ion battery patent is expected to accelerate the uptake of electric vehicles, but its impact has not yet been modelled, to both drive down the costs associated with battery development and address the range anxiety concerns.

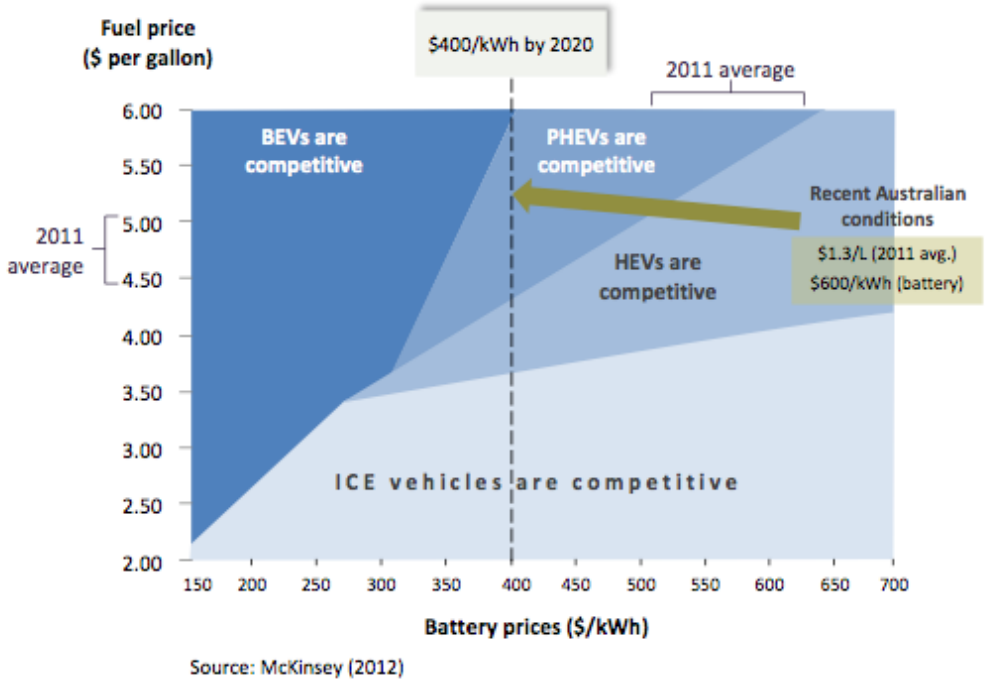


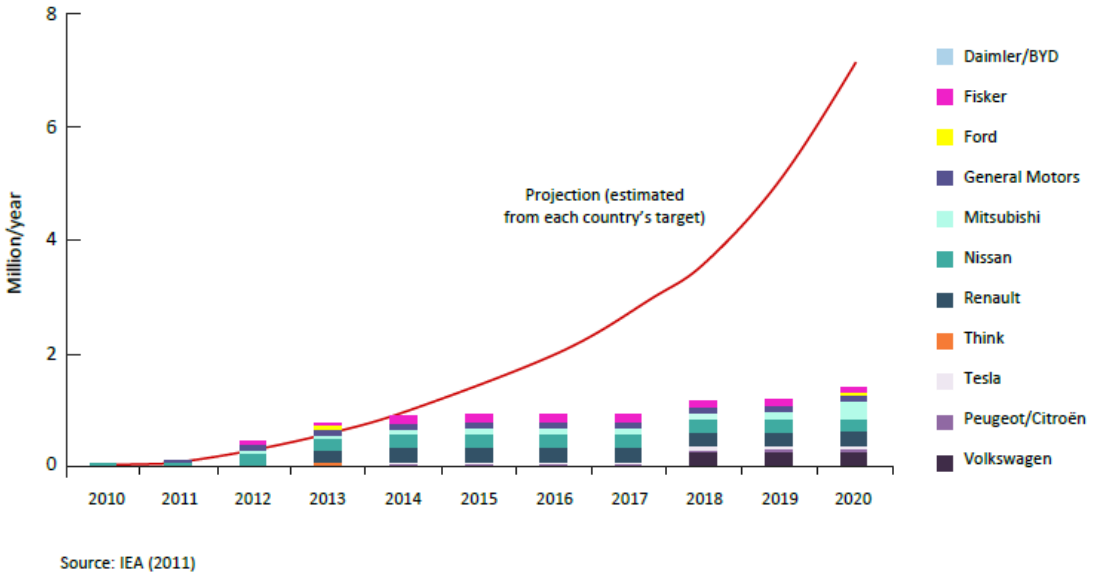

Figure 4 Interaction of fuel price, batter prices and electric vehicle technology transition

- **RANGE ANXIETY**. Aside from the Tesla models, the electric vehicles currently available in Australia have a range between 100 and 130km/h. While this exceeds the average daily kilometres travelled it still causes some concern amongst potential buyers around the fear of running out of charge.
- **VEHICLE CHOICE**. There is limited vehicle choice in Australia in terms of electric vehicles: the few electric vehicles already here or planned for introduction over the next 2–3 years are spread across different segments (light cars, small hatchback, medium sedan, sports car and commercial vehicles), meaning that in a buyers chosen segment they will generally only have one electric vehicle option.
- **UTILITY**. The lengthy charging times and a lack of convenient charging points are barriers to adoption. The transition to longer recharging times require a change in customer behaviour. However, level 3 charging stations, like that at Moreland Council, will require less behavioural change.

### 3.4.2 Supply Side

#### *Vehicle supply*

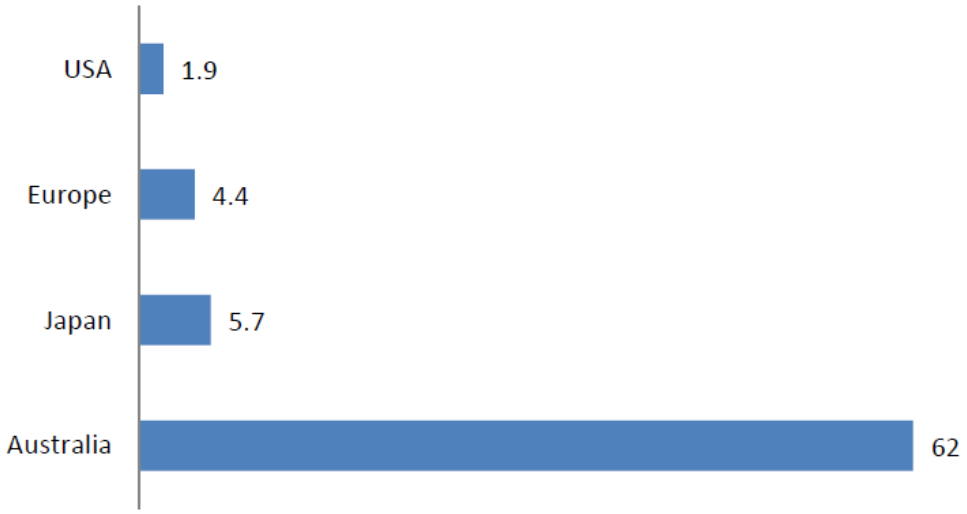
Although the global electric vehicle industry is in its infancy relative to the conventional automotive industry, the number of electric vehicle models is growing rapidly. Most major vehicle manufacturers have an electric vehicle program of sorts; some have several models already available or planned. However, the projections for global electric vehicle uptake currently exceeds the capacity for the manufacturers to produce them, Figure 5. To address this Tesla, as mentioned previously, has released the patent for its lithium-ion battery for use by other manufacturers. In addition Tesla has announced it will co-operate with Panasonic to develop a new US based battery production facility (the Gigafactory) that will be capable of producing batteries for 500,000 electric vehicles per year by the year 2020 (Venture Beat 2014).




Source: IEA (2011)

Figure 5 Government targets and EV/PHEV production/sales by OEMs

The Australian vehicle market is among the most diverse in the world with a total of 62 vehicle marques per million vehicles sold each year – fifteen times higher than in Europe and thirty-eight times higher than the United States, Figure 6. Thus making it a difficult market to succeed in.




Source: FCAI (2011)

Figure 6 Number of brands per million new passenger cars sold

The Tesla Roadster was the first publicly available OEM electric vehicle available in Australia, launched in August 2010 two years after its release in other markets. Prior to that Blade EV, an Australian start-up company, offered electric conversion kits for the Hyundai Getz with lithium-ion battery technology and regenerative braking systems. The company has ceased trading due to component supply problems.

Currently, the variety of fully electric vehicles in Australia is still limited with the only OEM fully electric vehicles available being the Tesla Model S, Nissan LEAF, Mitsibushi iMiev, and Renaut Kangoo (as described in Table 3. In addition, conversions are available from Energetique, an Australian start-up company; marketing a fully electric conversion of a Mazda2 using lithium polymer battery technology and reporting an operating range of approximately 200 km. Additional vehicles are set to come to Australia in

the near future. For example, the Renaut ZOE model is due for arrival in 2015 and BMW's i3 set to be available later this year.

Table 3 Fully Electric Vehicles Currently Available in Australia

| Vehicle Model | Details |
|---|---|
| Tesla Model S | New release luxury sedan model, starting at $80,000 reporting a range of 500km.<br>Tesla is establishing a dealership and network in Sydney and support network in Melbourne, and has contacted Moreland with regard to installing their recharging infrastructure. |
| Nissan LEAF | A small, fully electric four-door sedan first released to the Australian market in June 2012, starting at $51,500.<br>The vehicle is powered by lithium-ion batteries and while expected to have a design operating range of around 170 km, it in practice is around 130km. 83 LEAFs were sold in Australia between 2012 -2013. |
| Mitsubishi iMiev | First generation electric vehicle predominantly developed for the Japanese car market. Retail sales commenced in August 2011 starting at $48,800. The Mitsubishi i-MiEV is powered by lithium-ion batteries and has an advertised operating range of up to 160 km, although in practice 100–110km. |
| Renault ZE Kangoo | Small van launched recently in partnership with Australia Post for use in their fleet. The Kangoo is powered by a lithium-ion battery, and does not currently offer a fast charge option trial. The range is reported as between 80-125km. |

Figure 7 BMW i3

Figure 8 Tesla Model S


Figure 9 Renault ZE Kangoo Australia Post vehicle

### *Electricity supply*

At a national level, studies have suggested that the impact of the increased demand imposed by the market adoption of electric vehicles can be accommodated without significant adverse cost or consequences for transmission and generation capacity (AECOM 2009, McLennan Magasanik Associates 2009). However, unmanaged or mismanaged recharging of electric vehicles, if undertaken in clusters, can potentially have significant implications for local distribution network infrastructure.

Given typical electric vehicle battery sizes, and Australian driving patterns, electric vehicles used for passenger transport may require somewhere between 2 kWh and 20 kWh of electrical energy from the grid to meet their daily driving distance requirements (Usher et al. 2011). This is an entirely new load on the electricity grid, and potentially presents a significant additional demand that needs to be incorporated into future electricity market planning. Otherwise, even small numbers of EVs connected to the electricity grid simultaneously at times of peak demand will exacerbate current demand problems. If clustered around substations that are already near or at capacity, this could result in wiring, grid or transformer failure and blackouts. Such a scenario can also seriously reduce the operating life of key distribution assets such as transformers.

While, rapid electric vehicle adoption may potentially bring forward requirements for investment in network augmentation, particularly where the distribution network already demonstrates weaknesses - the emergence of EVs also constitutes an opportunity to better leverage existing assets by creating demand during periods of traditionally very low demand as demonstrated through the Smart Grid Smart Cities project (section 3.2.1). In the longer term, there are suggestions that vehicle-to-grid functionality could be used to assist with load management during peak periods of electricity demand.

The CSIRO Electric Driveway Project (2012) suggested that in a worst-case scenario, charging of a fully electric passenger vehicle fleet could increase peak electricity demand by more than 30 per cent; but that under the most likely electric vehicle uptake scenario, peak load impacts are mostly under two per cent if charging activities are managed.

Ultimately, the value or threat posed by electric vehicles to electricity networks will be a function of four key aspects of the EV market and their relationship to distributed generation, namely:

- The rate and types of electric vehicle adopted;
- The patterns of electric vehicle charging, with particular reference to the timing, rate and location of charging;
- The interplay between aspects of the distributed generation market in the future (i.e. both grid-connected generation and grid-connected storage) and electric vehicle demand;
- The degree to which dynamic load control (by way of smart grids) and electricity pricing can be applied to minimise electric vehicle charging during periods of high demand.

### *Recharge network*

The adoption of electric vehicles is constrained by the availability of recharging infrastructure. This is a barrier common to other infrastructure-dependent fuels such as natural gas (CNG/LNG), hydrogen and, to some extent, the future expansion of LPG. This dependence on infrastructure will likely limit the growth of pure electric vehicles in the sense that those purchasers who are either cost-focused or efficiency-focused may opt for hybrid powertrain or diesel models to reduce fuel consumption – neither of which rely on new refuelling infrastructure. Rapid growth in the uptake of diesel for passenger cars (at the expense of traditional petrol) is already evident.

Additionally, electric vehicle customers are likely to be discouraged from adopting the technology if their ability to charge their vehicles outside their homes is restricted. Deloitte's survey of Australian consumers (Deloitte 2011) revealed that over 80% of those surveyed identified convenience to charge, range and

cost to charge as important factors likely to influence their decision to purchase an electric vehicle in the near future.

While, the simplicity of trickle charging (i.e. 240 volts), the ready availability of standard power outlets in Australian homes, and the small number of electric vehicle sales in the short term, indicates that home charging will be the most common form of vehicle recharging in the early stages of market development. There is still a need for public infrastructure to increase the daily driving range of electric vehicle drivers however, which will accelerate the uptake of electric vehicles, and State-level electric vehicle trials as well as a number of industry and government partnerships have resulted in an expansion in the number of public charging points.

The challenging Australian market conditions has seen two battery-recharge and infrastructure providers depart the local market in recent years – Ecotality and Better Place; leaving ChargePoint Australia as the main provider. ChargePoint Australia, owned by Leighton Contractors, provides level 1, 2 and 3 recharging infrastructure and operates sites across Australia and New Zealand (Figure 10). Charge Point offers a smart phone app to users to provide real-time status and locations of charging stations, track vehicle charging progress and to make reservations increasing the utility of the electric vehicle experience.

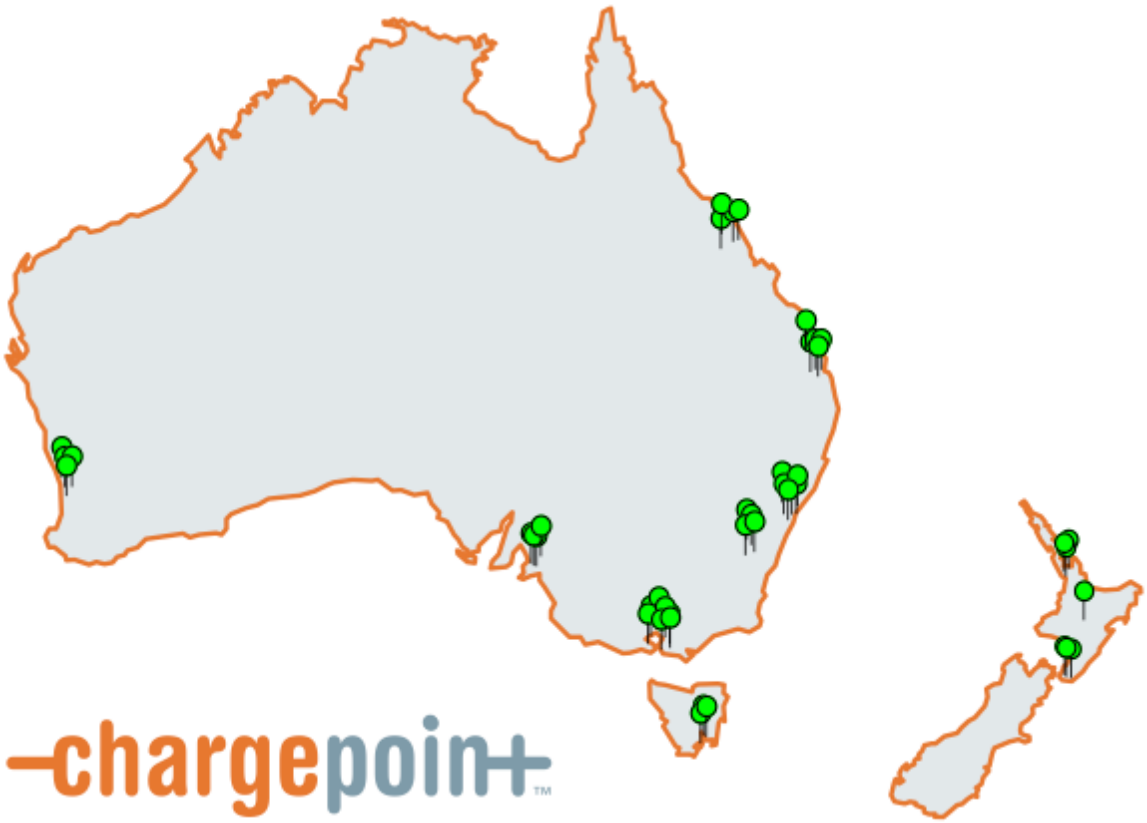



Figure 10 ChargePoint recharge stations

## 3.5 Future Projections for Electrical Vehicles in Australia

The exact outlook for electrical vehicle adoption globally is still relatively uncertain and susceptible to the confluence of many internal factors (battery range, cost premium, availability) and external factors (oil and electricity prices, government incentives, recharging infrastructure deployment and transport preferences). However, it is definitely strongly evolving as evidenced by recent increases in global vehicle sales (Figure 3) and the existing predicted demand from government targets exceeding the OEM supply capacity (Figure 5). The recent developments from Tesla and the introduction of an electric vehicle motorsports industry will only further drive demand and technology advancements.

The latest US EIA report illustrates, Figure 11, that the capital cost of electric vehicles is expected to reduce but to remain higher than conventional vehicles while the fuel efficiency of electric vehicles is predicted to remain substantially superior to its counterparts.

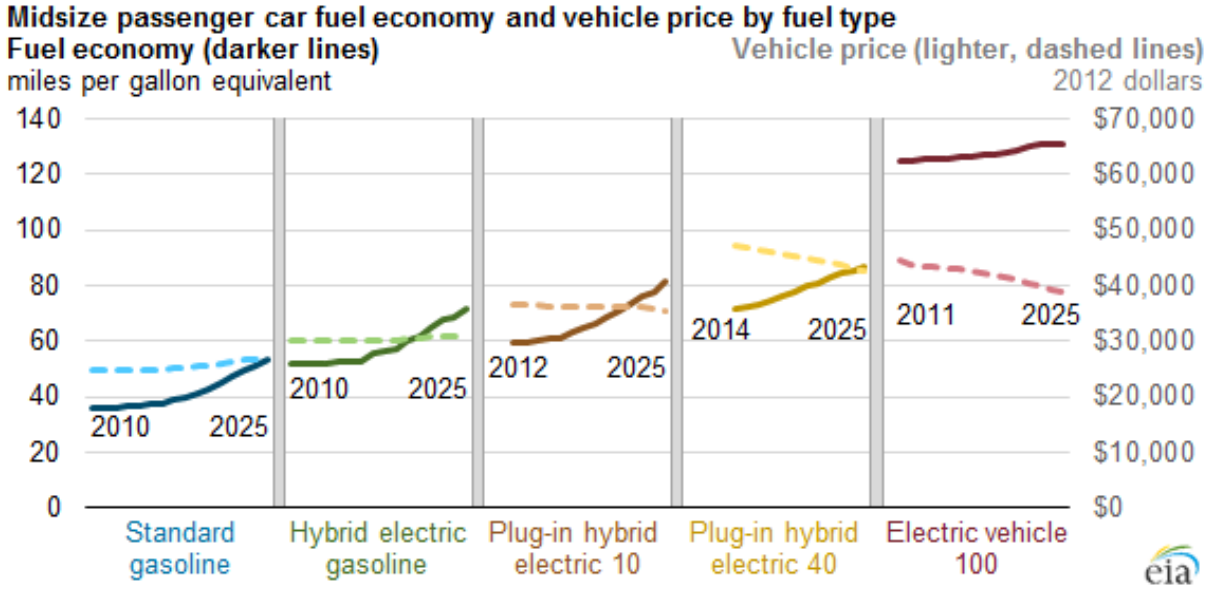



Figure 11 US Energy Information Administration Passenger Vehicle Comparison

In comparison to the rest of the world, the Australian electric vehicle market is still in its infancy, but as discussed in earlier sections, significant advancement has been made in the past couple of years in terms of vehicle uptake, trials undertaken, and recharge facilities installed – indicating that it will likely follow the global trend. Vehicle sales projections for Australia have estimated that electric vehicles and plug in electric hybrids will dominate the new vehicle sales mix by 2040, Figure 12.

A number of electric vehicle trial programs and demonstration projects around Australia have been success to date. The Victorian Department of Transport for example, have recently completed their electric vehicle trial and are now considering what the next step in their involvement in the electric vehicle space will be. It is expected that the electric vehicle agenda will continue to be strong.

The electricity market, while initially concerned with the pressure electric vehicles could place on the grid are now seeing them as a potential opportunity in combination with smart grids to provide distributed storage capacity, such that electricity providers are expected to support, even encourage, uptake of electric vehicles.

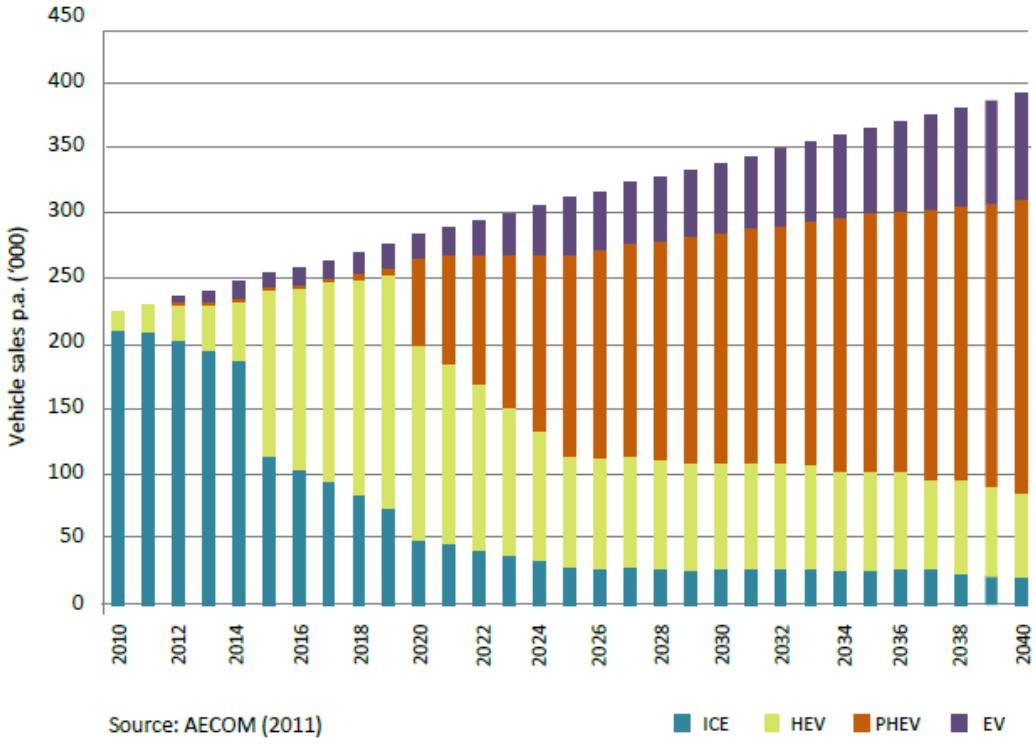



Figure 12 Vehicle Sales Projections in Australia to 2040

# 4. Moreland City Councils Existing Fleet Operations

## 4.1 Moreland Passenger Vehicle Fleet

Moreland City Council operates a light and heavy vehicle fleet with maintenance undertaken at the Hadfield depot. The light vehicle fleet incorporates both light commercial vehicles and passenger vehicles. The passenger fleet is of interest for this study.

Moreland City Council currently has 51 vehicles in its passenger vehicle fleet segment, 44% of these are for shared council use where the vehicles remains on-site as a pool vehicle, 35% for commuter use where the vehicle is housed at a delegated employees overnight but available for council pool use during the day, and 21% for full private use.

Over the 2013 financial year period these vehicles:

- Travelled in the order 792,500 kilometres,
- Consumed approximately 72,000L of ULP, 4,000L of diesel, and 10,000L of LPG
- Purchased in the order of $121,000 in fuel
- Produced approximately 197 tonnes of $CO_{2\text{-}e}$ greenhouse gas (GHG) emissions.
- Operated at an average fleet GHG intensity of 249g$CO_{2\text{-}e}$ per kilometre

Passenger vehicles are generally utilised by the different Council business units as presented in Table 4 below.

Table 4 Passenger Vehicles by Business Unit

| Business Unit | Number of Passenger Vehicles | Estimated average kilometres travelled per day* |
|---|---|---|
| City Development | 1 | <120 |
| Org Dev & Urban Safety | 16 | 61 |
| City Infrastructure | 14 | 78 |
| Social Development | 15 | 51 |
| Corporate Services | 1 | 135 |
| Planning & Eco Development | 4 | 83 |
| Organisation Development | 1 | 158 |

*average kilometres per day estimated based on annual kilometres and estimated number of days in use

The vehicle marques currently comprising the Moreland passenger vehicle fleet include: Toyota Prius, Toyota Camry (standard and hybrid), Toyota Yaris, Toyota Corolla, Holden Commodore (SIDI), Holden Cruze, Holden Captiva (diesel), Ford Falcon (LPi) and a single Nissan Leaf.

Notably, all of these vehicles are relatively fuel-efficient vehicles.


Figure 13 Moreland City Councils existing Nissan Leaf vehicle

## 4.2 Existing Procurement Strategy

Moreland City Council's passenger vehicle procurement is guided by the *draft passenger fleet purchasing protocol*, as shown below in Figure 14.

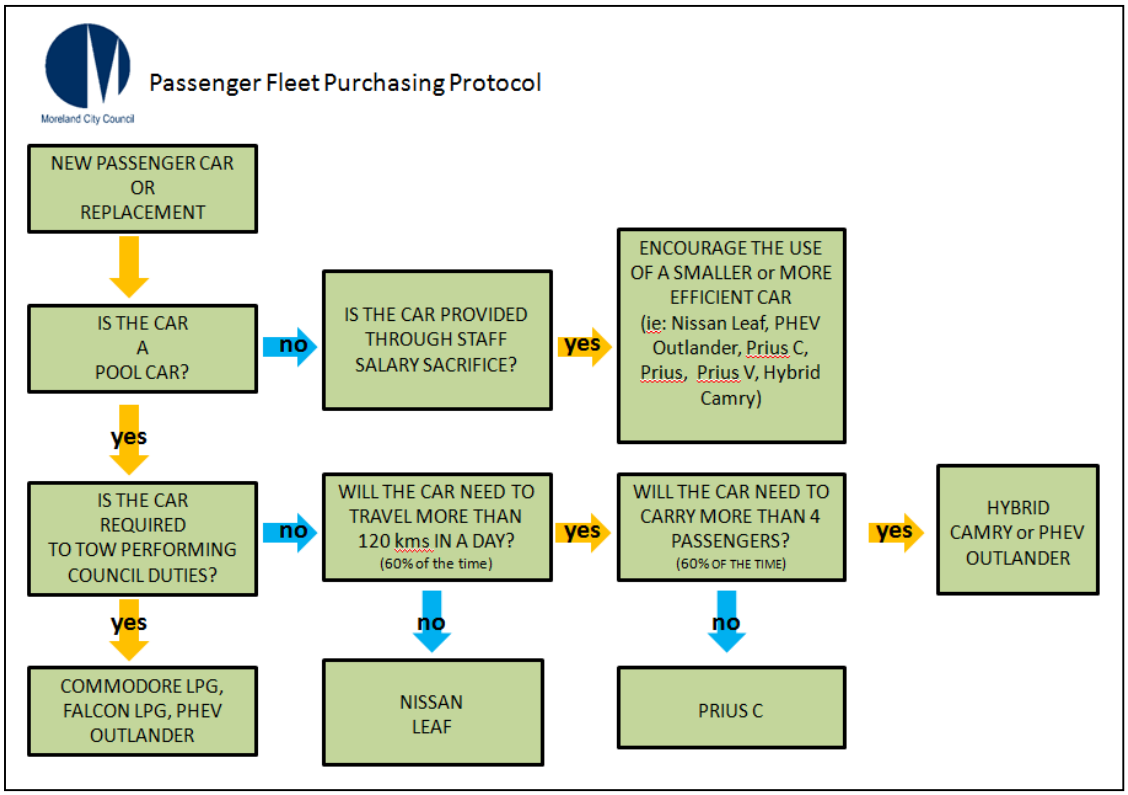



Figure 14 Moreland City Council Passenger Fleet Purchasing Protocol

## 4.3 Electric Vehicle Recharging Infrastructure

In conjunction with the Victorian Department of Transport's electric vehicle trial Moreland City Council installed on-site at Council offices two level 2 and one level 3 fast charge station (Figure 15 and Figure 16). These are available for use to Council and the general public, with Council currently subsidising the costs of electricity.

The level 3 recharge station has received a lot of publicity being one of the few available, and having a highly marketable branding image.

Additionally, Moreland City Council has five level 2 recharge stations located throughout the Moreland municipality for use the general public (currently provided free of charge), and one private facility at Council's depot.


Figure 15 The 'Zap n Go' level 3 fast charging station at Moreland Civic Centre


Figure 16 Moreland's Level 2 recharge stations – including the GoGet electric vehicle

## 4.4 Existing Electric Vehicle Usage

The Nissan LEAF has been in operation with Moreland City Council's fleet for the past year as a council pool vehicle at the civic centre, and prior to that it was on loan as part of the Department of Transport's electric vehicle trial for six months. Current statistics provided by Moreland City Council suggest that the Nissan LEAF is utilised 60% of the time placing it as one of the more popular pool vehicles.

Additionally, Moreland City Council has an agreement with GoGet who houses a Toyota plug in hybrid at the Moreland Civic Centre. Council is entitled to use this as an additional pool vehicle within their fleet free of charge provided the GoGet meets a minimum quota of public use per month (which it has achieved to date).

To determine Council employee response to the use of the electric vehicle, Moreland City Council undertook a user-survey, which found that drivers of the LEAF were happy with its performance in that it was comfortable and easy to drive.

# 5. Cost Benefit Analysis

Moreland City Council wish to determine the economic viability of replacing Toyota Hybrid Camry pool vehicles with Nissan LEAFs. The following is a cost-benefit analysis comparing the two vehicles based on how the existing Hybrid Camry and LEAF operate within the fleet.

## 5.1 Assumptions

### *Annual Kilometres*

To ensure a like for like comparison it has been assumed that the vehicles travel 20,000km/year for the purposes of the cost benefit analysis.

### *Vehicle Capital Costs*

The capital cost used for both vehicles in the assessment was provided by Moreland City Council's Fleet Manager based on the purchasing price of the existing vehicles.

- $36,000 for the Nissan LEAF
- $26,000 for the Hybrid Camry

(It is noted that these prices are discounted from what a private buyer would be required to pay.)

### *Vehicle residual value*

The forecasted residual value of the vehicles at replacement (after 3 years and 60,000km) according to Glass's Guide is:

- $20,400 - $24,500 for the Nissan LEAF
- $11,400 - $14,200 for the Hybrid Camry

It is assumed that council would be trading the vehicles in at the end of their life and accordingly the lower numbers have been used for both.

### *Annual registration costs*

As advised by Moreland City Councils Fleet Manager there is no price differential in registration costs between the two vehicles, with VicRoads offering a $100 registration discount for both electric and hybrid vehicles relative to conventional vehicle registration.

Additionally, as the vehicles are assumed to be undertaking the same role within the fleet no variation in the income and convenience generated by ownership of the vehicles has been included.

### Hybrid Camry Fuel Usage

The fuel consumption and petrol price for the Camry Hybrid was based on the average of the four currently in operation within Moreland City Councils fleet, as shown in Table 5 below.

Table 5 Existing Hybrid Camry Fuel Consumption and petrol costs for 2013FY

| Hybrid Camry | Average Fuel Consumption | Average |
|---|---|---|
| 1AU6TH | 9.72L/100km | $1.51/litre |
| 1AU6TI | 7.66L/100km | $1.46/litre |
| YYY742 | 7.15L/100km | $1.48/litre |
| YYY743 | 6.49L/100km | $1.47/litre |
| ***Average*** | ***7.76L/100km*** | ***$1.48/litre*** |

The average fuel consumption of 7.76L/100km, is slightly higher than the estimated fuel consumption rate from the Australian Green Vehicle Guide (5.7L/100km in urban setting +/- 20%); and the average fuel cost of $1.48/litre is in line with current pump prices.

Accordingly, it has been assumed that the Hybrid Camry consumes 1,552 litres of unleaded petrol at a cost to council of $2,297 per annum in $A2014.

Future fluctuations in petrol prices is an additional consideration, which as council pays the varying retail cost of petrol (as opposed to a set agreement on electricity price) it will have an impact.

In Victoria, based on data from the Australian Institute of Petrol, petrol prices have increased an average of 5.2c/L over the past 12 years (including CPI). However, for simplicity and the assessment has assumed $A2014.

### Hybrid Camry Maintenance Costs

Moreland City Council services their conventional vehicles on site at the Hadfield depot. The following maintenance costs have been provided by the fleet management team.

The Hybrid Camry, similar to the other conventional vehicles, receives a service twice a year which involves two hours or labour (at $100 per hour) and $85 in parts (oil, fuel service etc); additionally once a year it has a minor check (one hour labour).

In total this equates to $670 per year to maintain.

### Nissan LEAF fuel costs

Electricity consumption for the recharge stations is aggregated and at this point in time does not provide a record to Council of the amount of electricity provided per vehicle per charge. However, the Nissan LEAF on board diagnostics recorded that the average consumption rate of the vehicle to date has been 150W/km (in line with the Green Vehicle Guide figure of 173W/km) and it has been assumed that this rate continues for the duration of the analysis period.

Moreland City Council receives a discount electricity rate from the network provider, which bundling peak and off-peak is an average of $0.10 /kWh. This rate has been secured for at least the next three years.

Accordingly, for the assumed 20,000km per year the Nissan LEAF is expected to consume $300/year.

### *Nissan LEAF maintenance costs*

Maintenance of the LEAF is required to be undertaken by Nissan. Moreland City Council has an arrangement with Nissan where the first year of vehicle ownership is under warranty and servicing is free of charge. The additional years have been assumed at the standard Nissan LEAF service charge out rates provided by Nissan, refer Appendix B, equating to the assumed costs provided in Table 6 below.

**Table 6 Nissan LEAF assumed maintenance costs**

| Scheduled Services | Cost | Total Year Cost |
|---|---|---|
| 6 months/10,000km | Free to Council | $0 |
| 12 months/ 20,000km | Free to Council | |
| 18 months/ 30,000km | $94.80 | $438.37 |
| 24 months/40,000km | $343.57 | |
| 30 months/50,000km | $94.80 | $358.40 |
| 36 months/60,000km | $263.60 | |

### *Electric vehicle recharge infrastructure costs*

Moreland City Council already has in place seven recharge stations, which it can use. The capital cost of their installations was primarily covered by the Victorian government as part of the Victorian Electric Vehicle Trial. Maintenance costs are covered by Moreland City Council with an annual flat rate service agreement with ChargePoint (for all seven) of $1,400pa.

At maximum capacity the network is capable of dispensing 421 Megawatt hours of electricity per annum. Since commissioning in July 2013 Moreland City Council electric vehicle recharge network has dispensed 7 Megawatt hours of power, with the one council vehicle and general public use only utilising 2% of the existing infrastructure maximum capacity (Nesbitt 2014).

Accordingly, as no additional infrastructure is seen to be required in the short-medium term with the existing infrastructure capable of handing a significantly larger load, costs for additional infrastructure have not been included in the analysis. Additionally, as the existing infrastructure will remain in place regardless of whether council purchase additional vehicles these costs have not been included in this analysis.

### *Discount Rates*

In order to the compare the financial implications of different flows of costs and benefits through time, a discount rate must be applied. This represents the relative value of benefits or costs now relative to delaying those things to a time in the future. Interest charges on borrowings or bank deposits are examples of the need to ‘pay’ lenders for access to money now that will be repaid at a future time.

The real (ie. inflation adjusted) interest rate on borrowings represents a ‘benchmark’ for the discount rate applied in cost benefit analysis. This can vary according to the size and security of the borrower, and the state of capital markets. For this reason, a range of feasible discount rates is commonly applied.

For long lived capital works projects and regulatory measures being considered by State governments and the Commonwealth, an argument for risk free and 'social' discount rates can be made. State Treasuries often suggest lower bound discount rates of 4 or 5% pa (real), and a 'central' rate for assessing government projects of 7% pa real. In recognition of projects and regulations that impose significant costs (and benefits) on private entities facing a more constrained cash position, greater risk or higher borrowing costs a 'high end' rate of around 10%pa is recommended.

For the analysis presented here, discounts rates of 5%,7% and 10% pa are used to test sensitivity of the net present value (NPV – the net benefit or cost of the project calculated in 'today's' dollars once the future stream of costs and benefits is estimated) of the proposed electric vehicle procurement. We suggest the 7% pa and 10% pa may be most relevant to the Council's consideration of financial performance.

## 5.2 Potential Considerations

### *Associated Health Costs*

Fortunately, urban air quality in Australia is generally good however there are still significant health concerns in relation to concentrations of air pollutants. The zero tail pipe emissions produced by electric vehicles has a health benefit to the urban environment surrounds, in comparison to conventional vehicles which produce a mix of hydrocarbons, nitrous oxides, and particulate matter and is seen as a major contributor to air pollutants and the major cause of photochemical smog.

The adverse human health effects attributable to these include cardiovascular affects, daily mortality, hospital admissions due to asthma, chronic obstructive pulmonary disease and heart disease. (DTR 2009)

Vehicle ADR standards are increasingly improving to mitigate these affects, and hybrid vehicles produce less than their standard petrol/diesel counterparts. The grams of pollutant produced per kilometre of travel by a post 2010 petrol hybrid vehicle is presented below in Table 7.

Table 7 Grams of air quality emissions generated per kilometre for a Euro IV petrol hybrid passenger vehicle (ATF 2010)

| $CH_4$ | $N_2O$ | $PM_{10}$ | CO (40km/h) | NOx (40km/h) | NMVOC (40km/h) |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.011 | 0.002 | 0.0041 | 0.000 |

The estimated human health cost per unit of health pollutant produced is derived from an assessment of human morbidity and mortality impacts from exposure to the pollutants and the monetary costs associated with addressing those impacts (DTR 2009). The figure is an economic exposure measure and is therefore higher in areas of high human population exposure and lower in less densely populated areas. Moreland City Council as an inner suburban area has been assumed as the more densely populated rate presented below in Table 8.

Table 8 A$2014 avoided health costs per tonne of pollutant

| | HC | NOx | PM10 |
|---|---|---|---|
| Capital City Low | $5,169.18 | $618.05 | $137,693.14 |
| Capital City Median | $10,338.35 | $1,236.11 | $275,386.29 |

| | HC | NOx | PM10 |
|---|---|---|---|
| Capital City High | $15,507.53 | $1,854.16 | $413,079.43 |

Source: draft RIS 2009 prices assuming 3% CPI

As such, the expected annual health costs associated with the operation of a hybrid vehicle travelling 20,000km around Moreland municipality is between $30.34 and $91.03, with a median of $60.69.

While this is not a cost that will be borne by Council as such, it is a cost that will be borne by the economy/society at large, which council as a government body shares in the responsibility of reducing.

### *Carbon Footprint Costs*

As mentioned, Moreland City Council is a Carbon Neutral Council and while the recent repeal of the carbon tax (which granted did not include vehicle emissions) suggests that there will be some delay before Australia forms an Emission Trading Scheme or some alternative emissions reduction mechanism, Moreland has their own self imposed cost of carbon as any produced by non-renewable sources will require offsets to be purchased.

Given that in the near future Moreland City Council's electricity is expected to be provided by renewable sources and is currently using green power for its electric vehicle recharging stations this is an additional incentive for the use of electric vehicles.

Greenhouse gas emissions have been estimated based on the latest NGA factors:

- Hybrid Camry consuming 1,552 litres of unleaded petrol produces 3.7 tonnes of CO2-e
- Nissan LEAF consuming 3 MWh of green power or renewable electricity produces 0 tonnes of CO2-e

Council might consider the range of carbon prices that are relevant to assessment of environmental damage and financial risk. There is likely to be little risk of a carbon price impacting fuel prices within the next 2 to 3 years. However, carbon offsets are readily available within a cost range of $4 to $8 per tonne. Against this, there is ample analysis to suggest that these prices are not sufficient to put economies on an emissions path that would ameliorate serious longer term climate risks. The carbon price necessary to achieve this outcome (and be sustained across major global emitters) would be several times currently observed values.

## 5.3 Analysis

The three year cost benefit analysis of the Nissan LEAF vs. the Toyota Camry Hybrid based on the tangible monetary benefits over a three year period resulted in sound favour of the LEAF. Table 9 below provides an outline of the assessment (with no discounting applied), with Table 10 providing the net present value and benefit cost ratio for the (real) discount rates of 5%, 7% and 10% pa.

Table 9 Cost Benefit Analysis (with no discounting applied - $A2014)

| | 2015 | 2016 | 2017 |
|---|---|---|---|
| BASE (Camry Hybrid) | | | |
| ***Costs (Money Out)*** | | | |
| Capital | $26,000 | - | - |
| Maintenance | $670 | $670 | $670 |
| Fuel Costs | $2,297 | $2,297 | $2,297 |
| ***Benefits (Money In)*** | | | |
| Income & convenience | Assumed equal | | |
| Re-sale value | | | $11,400 |
| LEAF | | | |
| ***Costs (Money Out)*** | | | |
| Capital | $38,000.00 | | |
| Maintenance | | $438.37 | $358.40 |
| Fuel Costs | $300.00 | $300.00 | $300.00 |
| ***Benefits (Money In)*** | | | |
| Income & convenience | Assumed equal | | |
| Re-sale value | | | $20,400 |
| Extra Costs of LEAF | $9,333.04 | ($2,228.59) | ($2,308.56) |
| Extra Benefits of LEAF | - | - | $9,000 |
| NPV | **$4,204.11** | | |
| BCR | **1.87** | | |

A BCR greater than 1 indicates a positive return on investment under the relevant discount rate requirement. As demonstrated in Table 9 under all relevant discount rates the BCR exceeds 1.3 – making it a solid investment. Noting this does not include the added public image benefits, reduced greenhouse gas and avoided health cost benefits, and the fact that reduced GHG emissions means less offsets for Council to buy, which are all further in favour of the LEAF making it an even better purchase option.

Table 10 Net Present Value and Benefit Cost Ratio for LEAF vs. Hybrid ($A2014)

| | 5% | 7% | 10% |
|---|---|---|---|
| **NPV** | $2,841 | **$2,344** | $1,649 |
| **BCR** | 1.58 | **1.48** | 1.34 |

## 5.4 Comparison to other fleet vehicles

Hybrid vehicles are more fuel efficient than standard internal combustion engine vehicles, and as such it can be expected that the LEAF, in terms of operational costs, will also be more cost effective than them. For example, the average fuel consumption for the standard Camrys within the fleet is 14.4L/100km, and at 20,000km/year the expected annual fuel costs in $A2014 is $4,262 ($2,000 more than the hybrid).

Ideally, the Nissan LEAF will need to be adopted into a business unit that travels less than 120km per day, which as noted in Table 4 includes all but two vehicles in Council's fleet. Any vehicle travelling further than 120km/day would require recharging during the day. Moreland City Council has the facilities to do this however, and if required on the odd occasion this should not present minimal inconvenience.

The primary benefit of the LEAF is the reduced fuel operating costs - accordingly the electric vehicle will be most viable replacing vehicles with higher fuel consumption rates, high annual kilometres travelled, and inner city driving to make use of the regenerative braking.

# 6. Conclusions

The findings of this study strongly indicate the viability of the further adoption of electric vehicles in Moreland City Council's fleet.

### *Positive BCR*

The benefit cost ratio for the adoption of additional Nissan LEAFs in the Moreland City Council fleet in place of Hybrid Camry's at 7% discount rate was 1.48 indicating a sound investment.

Moreland City Council already has the infrastructure in place to support electric vehicles, a secured low electricity rate, and a discounted purchase price placing it in a position to capture benefits sooner than other purchasers might.

The overall benefit is likely to be higher, as this calculation has not included the affect of potential fuel price increases, offset costs required to subsidise the resultant greenhouse gas emissions, or avoided health costs.

### *Council Image – Public Image*

Moreland City Council is known as the electrical vehicle hub of Victoria, providing it with national and international recognition.

The adoption of additional electric vehicles into the fleet to be charged via renewable energy is in line with Moreland City Councils Carbon Neutrality objectives (with the LEAF charged through renewable energy producing zero emissions). Additionally, it will demonstrate to its constituents that Moreland City Council leads by example to promote the achievement of 10% electric vehicles by 2020 as stated in their Zero Carbon Evolution Strategy.

### *The Australian Electric Vehicle Market will continue to grow*

The Australian electric vehicle market, while behind the rest of the world, is on the rise with future projections speculating that electric and electric hybrid vehicles will be the majority of new vehicle sales in Australia by 2040.

The Energy White and Green Paper to be released this year is expected to incorporate some strategic objectives regarding the increased uptake of electric vehicles; and the electric vehicle strategies developed in the Alternative Fuels Strategic Paper are already underway (ie. electric vehicle standards).

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# Appendix A

# European Union EV Purchase and Tax Incentives

ACEA

01.04.2014

# OVERVIEW OF PURCHASE AND TAX INCENTIVES FOR ELECTRIC VEHICLES IN THE EU

This table provides an overview of the incentives that are granted in the Member States of the European Union for the purchase and use of electric and hybrid electric vehicles including plug-in hybrid and conventional hybrid vehicles. Unless specified otherwise, the term “electric vehicles” refers to vehicles that are powered exclusively by an electric motor.

The incentives that are listed here relate only to the vehicle itself. Additional incentives may exist in certain counties for the installation of the necessary recharging infrastructure.

More details regarding motor vehicle taxation in the European Union and other major markets can be found in the ACEA Tax Guide.

| COUNTRY | INCENTIVES |
|---|---|
| **AT (AUSTRIA)** | Electric vehicles are exempt from the fuel consumption tax and from the monthly vehicle tax.<br><br>The Austrian automobile club ÖAMTC publishes the incentives granted by local authorities on its website (www.oeamtc.at/elektrofahrzeuge). |
| **BE (BELGIUM)** | Electric vehicles are exempt from registration tax in Flanders.<br><br>They pay the lowest rate of tax under the annual circulation tax in all three regions.<br><br>“Ecology premiums” are available in Flanders for companies investing in the purchase of pure electric, plug-in hybrid and extended range electric vehicles.<br><br>The deductibility from corporate income of expenses related to the use of company cars is 120% for zero-emissions vehicles and 100% for vehicles emitting between 1 and 60 g/km of CO 2. Above 60 g/km, the deductibility rate decreases gradually from 90% to 50%. |
| **BG (BULGARIA)** | None |
| **CY (CYPRUS)** | None |
| **CZ (CZECH REPUBLIC)** | Electric, hybrid and other alternative fuel vehicles are exempt from the road tax (this tax applies to cars used for business purposes only). |
| **DE (GERMANY)** | Electric vehicles are exempt from the annual circulation tax for a period of ten years from the date of their first registration. |
| **DK (DENMARK)** | Electric vehicles weighing less than 2,000 kg are exempt from the registration tax. This exemption does not apply to hybrid vehicles. |

| | |
|---|---|
| **EE (ESTONIA)** | None |
| **ES (SPAIN)** | None |
| **FI (FINLAND)** | Electric vehicles pay the minimum rate (5%) of the CO2 based registration tax. |
| **FR (FRANCE)** | Vehicles emitting 20 g/km or less of CO 2 benefit from a premium of € 6,300 under a bonus-malus scheme. For vehicles emitting between 20 and 60 g/km, the premium is € 4,000.<br><br>For such vehicles, the amount of the incentive cannot exceed 20% of the vehicle purchase price including VAT, increased with the cost of the battery if this is rented. For vehicles emitting less than 20 g/km, this is 27% of the purchase price.<br><br>Hybrid vehicles emitting 110 g/km or less of CO 2 benefit from a premium of € 3,300.<br><br>Electric vehicles are exempt from the company car tax. Hybrid vehicles emitting less than 110 g/km are exempt during the first two years after registration. |
| **GR (GREECE)** | Electric and hybrid vehicles are exempt from the registration tax, the luxury tax and the luxury living tax. Electric passenger cars and hybrid passenger cars with an engine up to 1,929 cc, are exempt from the circulation tax. Hybrid cars with a higher engine capacity pay 50% of the normal circulation tax rate. |
| **HR (CROATIA)** | None |
| **HU (HUNGARY)** | Electric vehicles are exempt from the registration tax and the annual circulation tax. |
| **IE (IRELAND)** | Electric vehicles benefit from VRT (registration tax) relief up to a maximum of € 5,000. For plug-in hybrids, the maximum relief is € 2,500. For conventional hybrid vehicles and other flexible fuel vehicles, the maximum relief is € 1,500. |
| **IT (ITALY)** | Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of their first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to equivalent petrol vehicles in many regions. |

| | |
|---|---|
| **LT (LITHUANIA)** | None |
| **LU (LUXEMBOURG)** | Purchasers of electric or plug-in hybrid vehicles emitting 60 g/km or less of CO 2 receive a premium of € 5,000. The purchaser must have concluded an agreement to buy electricity from renewable energy sources in order to obtain the premium. |
| **LV (LATVIA)** | Electric vehicles are exempt from the registration tax. |
| **MT (MALTA)** | None |
| **NL (NETHERLANDS)** | Electric vehicles are exempt from the registration tax BPM. Other vehicles including hybrid vehicles are also exempt from the registration tax if they emit maximum 85 g/km (diesel) or 88 g/km (petrol) of CO 2 respectively. Vehicles emitting maximum 50 g/km of CO 2 are exempt from the annual circulation tax. |
| **PL (POLAND)** | None |
| **PT (PORTUGAL)** | Electric vehicles are exempt from the registration tax ISV and from the annual circulation tax.<br><br>Hybrid vehicles benefit from a 50% reduction of the registration tax. |
| **RO (ROMANIA)** | Electric and hybrid vehicles are exempt from the registration tax. |

| | |
|---|---|
| **SE (SWEDEN)** | **Five year exemption from paying annual circulation tax:** Electric vehicles with an energy consumption of 37 kWh per 100 km or less are exempt from the annual circulation tax for a period of five years from the first registration. The same five year exemption applies to electric hybrid and plug-in hybrid vehicles that fulfill the new green car definition applied for new registrations from 1 January 2013. The definition is dependent on the CO2 emission in relation to the curb weight of the car. The formula for petrol, diesel, electric hybrid cars and plug-in cars is as follows:<br>Maximum CO2-emission allowed=95 g/km CO2-emission + 0,0457 x (the curb weight of the car – 1372 kg curb weight).<br>Example: a plug-in hybrid car has a CO2-emission of 50 g/km and a curb weight of 1 500 kg:<br>95 + 0.0457 x (1500-1372) = 100.8. The actual CO2-value 50 g/km is less than the calculated value 100.8 which means that the car is classified as a green car with a five year exemption from paying annual circulation tax. Moreover, for both electric cars and plug-in hybrids the electrical energy consumption per 100 km must not exceed 37 kwh to be regarded as a green car.<br><br>**Reduction of company car taxation:** For electric and plug-in hybrid vehicles, the taxable value of the car for the purposes of calculating the benefit in kind of a company car under personal income tax is reduced by 40% compared with the corresponding or comparable petrol or diesel car. The maximum reduction of the taxable value is SEK 16,000 per year.<br><br>**Super green car premium new cars:** A so called “Super green car premium” (Supermiljöbilspremie) of SEK 40,000 is available for the purchase of new cars with CO2 emissions of maximum 50 g/km. The premium is applied both for the purchase by private persons and companies. For companies purchasing a super green car, the premium is calculated as 35% of the price difference between the super green car and a corresponding petrol/diesel car, with a maximum of SEK 40,000. The premium will be paid for a total of maximum 5000 cars. |

| | |
|---|---|
| **SI (SLOVENIA)** | None |
| **SK (SLOVAKIA)** | None |
| **UK (UNITED KINGDOM)** | Purchasers of electric vehicles and plug-in hybrid vehicles with CO2 emissions below 75 g/km receive a premium of £ 5,000 (maximum) or 25% of the value of a new car or £ 8,000 (maximum) or 20% of the value of a new LCV meeting eligibility criteria (for example, minimum range 70 miles for electric vehicles, 10 miles electric range for plug-in hybrid vehicles).<br><br>Electric vehicles are exempt from the annual circulation tax. This tax is based on CO2 emissions and all vehicles with emissions below 100 g/km are exempt from it.<br><br>Electric cars are exempt from company car tax until April 2015 and electric vans are exempt from the van benefit charge until that date too.<br><br>Electric vehicles and other vehicles emitting less than 95 g/km of CO 2 can claim a 100% first-year allowance for depreciation. |

# Appendix B

# Australian Councils Electric Vehicle Usage

| State | LGA | EV trials & studies | EV fleet activities | EV fleet |
|---|---|---|---|---|
| **Qld** | Townsville | Supported Ergon Energy Queensland EV trial (2010) looking at electric vehicle use. 5 Townsville households involved in trial<br>Review of locations for recharging station on the Strand | | Prius PHEV (Council)<br>Mazda2 conversion (Ergon) |
| | Gold Coast | 2010 trialled all electric vehicle | | i-MiEV |
| | Brisbane City Council | Yes | 2 fully electric vehicles in fleet (retrofit vehicles) and 70 hybrid electric vehicles (including one truck)<br>Offer free public recharge facilities in King George Square Carpark and encourage hybrid and electric vehicle use with 50% off car park fees at both council carparks<br>Buy offsets for council transport (and stationary gas) emissions since 2007, and purchase 100% GreenPower electricity since 2010 | Blade |
| **NSW** | City of Sydney | Ausgrid Smart Grid Smart City Trial with 20 IMiEVs deployed in Sydney + Newcastle + central coast | City of Sydney now includes 14 EVs in there fleet – charged with renewable (PV) energy.<br>They plan to run 50 EVs within their council fleet eventually – phase in<br>Public recharge facilities available (4 points at Goulburn st carpark, and 3 at Kings Cross Car park – no additional fees to use charge points – 100% renewable / solar electricity)<br>also a GoGet charge point in Glebe (managed by ChargePoint) – the first public charge point in Australia when it was installed, for use of GoGet plug-in hybrid Prius, purchased Greenpower<br>Hybrid diesel excavator in equipment fleet | PHEV Prius, i-MiEV |
| | Newcastle City | Ausgrid Smart Grid | | Mitsubishi, i-MiEV |

| State | LGA | EV trials & studies | EV fleet activities | EV fleet |
|---|---|---|---|---|
| | Council | Smart City Trial | | |
| | Lake Macquarie City Council | Ausgrid Smart Grid Smart City Trial | | Mitsubishi, i-MiEV |
| | Leichhardt Council | | Council officers use electric bicycles | |
| **Vic.** | City of Melbourne<br>Manningham City Council<br>Mornington Peninsula Shire<br>City of Frankston<br>City of Kingston<br>City of Casey<br>Cardinia Shire Council | All part of Victorian EV trial (VIC DoT) | Fleet operator and charge point host in Vic EV trial<br>Has several EVs in fleet | Blade<br>PHEV Toyota Prius<br>Mitsubishi i-MiEV<br>Nissan Leaf<br>EV Commodore |
| | Bayside City Council<br>City of Greater Dandenong<br>City of Maribrynong<br>City of Melton<br>City of Monash<br>City of Port Philip<br>Colac Otway Shire Council<br>Wellington Shire Council | | Fleet operator and charge point host | |

| State | LGA | EV trials & studies | EV fleet activities | EV fleet |
|---|---|---|---|---|
| | Yarra City Council | | | |
| | Mornington Peninsula Shire Council | | | |
| | Mount Alexander Shire Council | | | |
| **SA** | Adelaide City Council | Yes | Run an electric bus (free bus connector service) – powered with solar electricity<br>Mayor drives Nissan Leaf, council officers use electric bicycles<br>Two free electric vehicle charge points at council carparks | Tindo Bus |
| | City of Marion | Yes | | Mitsubishi i-MiEV |
| **WA** | City of Perth | Electric cars for Perth study<br>WA Electric Vehicle Trial (2010-12) | Fleet operator in WA trial<br>Have power points for charging in Elder Street carpark (no dedicated stations / bays) | Converted Ford Focus |
| | City of Swan | | Fleet operator in WA trial | |
| | City of Mandurah | Fleet operators in trial | Fleet operator in WA trial | |
| **NT** | Darwin City Council | 3 month trial Nissan Leaf (start Jul 2013) | | Nissan Leaf |

# Appendix C

# Nissan Leaf Servicing Costs

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# LEAF

6 YEARS/120,000KM*

# CAPPED PRICE SERVICING

| Scheduled Service Intervals | LEAF |
|---|---|
| 6 months/10,000km | $94.80 |
| 12 months/20,000km | $263.60 |
| 18 months/30,000km | $94.80 |
| 24 months/40,000km | $343.57 |
| 30 months/50,000km | $94.80 |
| 36 months/60,000km | $263.60 |
| 42 months/70,000km | $94.80 |
| 48 months/80,000km | $343.57 |
| 54 months/90,000km | $94.80 |
| 60 months/100,000km | $263.60 |
| 66 months/110,000km | $94.80 |
| 72 months/120,000km | $343.57 |

Capped Prices effective from 1st April 2014.
Actual prices may vary from Dealer to Dealer, but rest assured you will not pay more than the Capped Price applicable at the time of your Scheduled Service. Contact your local Nissan Dealer for a service quote. Capped Prices are subject to change. Visit nissan.com.au/cpstcs for full terms and conditions.

**nissan.com.au**

*Applies to each of the first 12 x 10,000km Scheduled Service intervals as detailed in the Owner's Handbook for up to 6 years (from Manufacturer's Warranty start date) or the first 120,000kms (whichever occurs first) where vehicle is used in normal driving conditions. Applies to Normal Maintenance Services (only). Excludes maintenance for Severe Driving Conditions, Unscheduled Maintenance, General Maintenance and replacement of wear and tear items. Some exclusions apply. Your Nissan Service Advisor will be able to assist in determining your individual service requirements. Contact your Nissan Dealer or visit nissan.com.au/cpstcs for full terms and conditions.

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