



The Future is **Electric**

Queensland's Electric Vehicle Strategy



Queensland
Government



Hyundai Ioniq Electric. The Ioniq will also be available in a plug-in hybrid electric (PHEV) variant.

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Foreword

Queensland is preparing for a transition to electric vehicles (EVs) – an innovative technology which has the potential to provide Queenslanders with a range of social, environmental and economic benefits.

The first simple EV was invented over 100 years ago. Its technological development to the advanced vehicles we can purchase today is a great example of the value of combining inventive science and business innovation for the benefit of our society and economy.

The Queensland Government is committed to supporting science and innovation opportunities for EVs through our research, small business and industry sectors. We believe that this emerging industry is the beginning of a new business ecosystem in

Queensland. It will diversify our economy with new products, services and jobs, and reduce our vehicle emissions and their impact on the environment and our communities.

Queensland business Tritium is already leading the world in the development of EV fast-charging stations. Under the Advance Queensland Business Development Fund, the Queensland Government has invested \$2.5 million in Tritium to support the development of this technology. This Queensland innovation is an example of a new knowledge-based product advancement which is creating jobs in Queensland today.

EVs will support the Queensland Government's commitments to reducing emissions. EVs and renewable energy have a natural synergy and will both be crucial in the effort to reduce Queensland's greenhouse gas emissions over the next decade.



BMW i8 (left) and BMW i3 (right)

As global battery costs continue to decrease, and manufacturing costs are reduced through economies-of-scale, the upfront costs of EVs will fall to a point where they are cost-competitive with fossil fuel vehicles. It is then that we are likely to see a significant number of EVs on our roads.

The Future is Electric (the Strategy) demonstrates that the Queensland Government recognises the enormous potential of this innovative technology and we are starting the process of preparing Queensland for a transition to EVs. As outlined in this Strategy, the Queensland Government will work with industry partners and local communities to ensure the state is best placed to capitalise on the numerous benefits of EVs, and to ensure our state remains internationally competitive. With this Strategy, Queensland is leading Australia in a cleaner road transport future.

We encourage you to learn more about this innovative technology and join the conversation on how we can start to prepare for the upcoming transition to EVs.



**Deputy Premier,
Minister for Transport
and Minister for
Infrastructure and
Planning**
Jackie Trad

**Minister for Main Roads,
Road Safety and Ports
and Minister for Energy,
Biofuels and Water Supply**
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**Minister for Innovation,
Science and the Digital
Economy and Minister for
Small Business**
Leeanne Enoch





Mitsubishi Outlander PHEV

Executive

Summary

Transport systems around the world are currently undergoing a major phase of transformation with the electrification of vehicles, the popular rise in ride- and vehicle-sharing schemes, and the development of driverless vehicles. Each of these transformations will affect the way our transport systems operate, and have the potential to greatly improve accessibility, reduce emissions and decrease transport costs. The Queensland Government is taking an active role in preparing for these transformations to ensure the state is best placed to capture the benefits that these changes will bring.

The EV is an innovative technology that presents a unique opportunity for Queensland to deliver a range of economic, environmental and social benefits. The Queensland Government is embracing innovative transport technology opportunities with *The Future is Electric – Queensland's Electric Vehicle Strategy (The Strategy)*. This follows the Queensland Government's recent release of the *Queensland Biofutures 10-Year Roadmap and Action Plan* and supports the *Advancing Climate Action in Queensland: Making the transition to a low-carbon future*.

This Strategy outlines sixteen cost-effective programs that the Queensland Government is implementing to start the process of preparing for the transition to EVs in Queensland. Together these programs have been designed to **Empower** consumers, **Enable** charging infrastructure, **Explore** cost-effective programs to support the uptake of EVs, and **Envisage** what future government action may be required to ensure Queenslanders benefit from this transition. Collectively, these programs aim to:

- ▶ **empower consumers** to learn about this new technology and to make informed choices
- ▶ **increase the uptake** of EVs by government, commercial fleets and the community
- ▶ **improve EV model availability** in Queensland and Australia
- ▶ **support the efficient rollout** of EV infrastructure and,
- ▶ **foster growth** in EV technology innovation.



The transition to EVs will expand over the next decade and beyond, and will be a dynamic process as the technology improves and the market continues to develop.

It is important that the Queensland Government also remains dynamic and is in the best position to support this beneficial technology. This Strategy outlines what the Queensland Government will do in the short-term to support this transition whilst acknowledging the need to investigate additional opportunities and to actively adjust its approach as the market continues to mature.

Given the full emissions reduction benefits of EVs can only be realised if these vehicles are charged using renewable energy, the Queensland Government is also actively pursuing credible pathways to decarbonise our electricity sector including: setting a target for one million rooftops or 3000 megawatts of solar photovoltaics in Queensland by 2020, supporting up to 150 megawatts of solar generation through its Solar 150 initiative and a commitment to meeting a state target of 50 percent renewable energy generation by 2030.

The Queensland Climate Transition Strategy

The transport sector is projected to experience one of the largest proportional growths in emissions for Queensland to 2030. This includes the emissions generated from cars, trains, trucks, buses, aeroplanes and boats.

While managing emissions in this sector is a particular challenge for a large and decentralised state like Queensland, where long distance travel is common and often unavoidable, low-emission transport technologies, such as EVs, provide a unique opportunity to reduce Queensland's transport-related emissions.

The *Queensland Climate Transition Strategy* (QCTS) outlines the government's comprehensive response to tackle the challenge of climate change, whilst making investments in new and emerging technologies that can lead to long-term reductions in greenhouse gas emissions. This Strategy supports the QCTS and the uptake and transition to EVs in Queensland.



Audi A3 e-tron



What is a kilowatt-hour (kWh)?

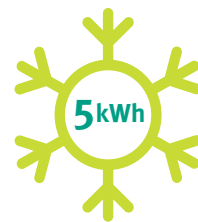
A kWh is a measurement of the 'volume' of electricity - similar to litres of water.



You may be familiar with kWh from reading your electricity bill.

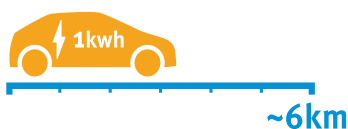


kWh is a way to represent the amount of electricity stored in a battery, or used over a period of time.



For example, a 5kW air-conditioner running at 100% over the course of 1 hour would use 5kWh of electricity.

How expensive is an electric vehicle to run compared to a fossil fuel vehicle?



An EV uses approximately 1 kWh of battery electricity for every 5-6 km of travel.



This means that the average EV uses 15-20 kWh for every 100km.



If you pay 16 cents per kWh for your off-peak electricity, this would equate to \$2-3 per 100km (or effectively free if you use your home solar system!).



Figure 1



Figure 2

Figure 1 - Two examples of battery electric vehicles (BEVs): 2018 Nissan Leaf (top) and Tesla Model X (bottom)

Figure 2 - The second iteration of Mitsubishi's popular Outlander PHEV

What are electric vehicles?



An EV is any vehicle that is fully or partially driven by an electric motor and that can be plugged in to charge. EVs can be split into two main types:

- ▶ **Battery electric vehicles (BEVs), and**
- ▶ **Plug-in hybrid electric vehicles (PHEVs).**

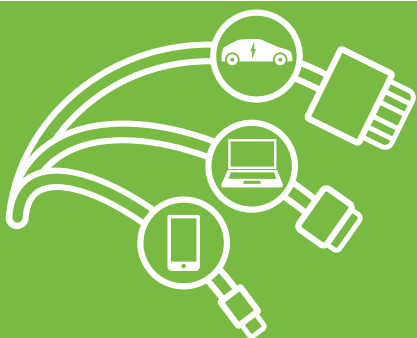
BEVs are only powered by electric motors. The electric motors are powered by a battery which generally ranges in size from 20kWh up to 100kWh. One of the most common BEVs on the market – the Nissan Leaf (Figure 1 - top) – has a driving range of up to 250km (2018 model). Premium BEVs, such as the Tesla Model X (Figure 1 - bottom), currently have driving ranges of up to 500km – comparable to conventional fossil fuel vehicles. More affordable BEVs with driving ranges of over 350km will be available soon. The Chevrolet Bolt (380km) was made available in overseas markets in late 2016, and the much publicised Tesla Model 3 (350km) is expected to be made available in Australia in late 2018/early 2019.

The major difference with a PHEV is that it is powered by electric motors in conjunction with an internal combustion engine (using petrol, diesel or biofuel), but can still be plugged in to charge. The internal combustion engine is primarily used to generate electricity to recharge the battery and/or extend driving range during longer trips. PHEVs have smaller batteries, ranging from 5 to 20 kWh. This in turn means that their “electric-only” range is less at 20-90km, however, the vehicle itself can be driven much further when the combustion engine is engaged. One PHEV model that has proven successful around the globe is the Mitsubishi Outlander PHEV (Figure 2), which has an electric-only driving range of 52km, and a total driving range of 500-600km.

Queensland motorists drive 38km per day on average, meaning that most PHEVs and all BEVs could cover an average motorist's daily drive using only electricity¹. For motorists living in regional Queensland PHEVs will be the best EV option, in the medium-term, given their flexibility to drive longer distances, with the lower fuel consumption and emissions benefit of an electric drivetrain.

Both BEV and PHEV drivetrains are also starting to appear in buses and trucks, as part of the broader electrification of transport systems. It is already possible to purchase both electric bikes and motorbikes in Queensland.

¹ [http://www.abs.gov.au/ausstats/Subscriber.nsf/LookupAttach/9208.oData+Cubes-15.10.151/\\$File/9208oDO001_1231201410.xls](http://www.abs.gov.au/ausstats/Subscriber.nsf/LookupAttach/9208.oData+Cubes-15.10.151/$File/9208oDO001_1231201410.xls)



EVs can be charged at home, at work or at a destination using a charging unit or any standard powerpoint.

The charging process is similar to charging a laptop or phone.

On average, an overnight charge using a household powerpoint will provide 200km range. Faster home units can also be installed, increasing an overnight charge to over 500km range.*

*Currently only the Tesla Model S has a range of over 500km



200km

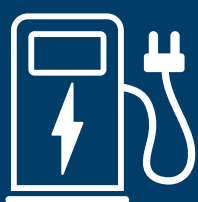


EVs can also be charged at work or at any other destination where a powerpoint is available.

Increasingly, as the market matures, more dedicated EV charging units will become available at destinations. Currently available public charging units can be viewed at www.plugshare.com*

*plugshare website is not a government site and the accuracy of its content is not guaranteed

As charging and battery technology continues to improve, driving ranges will increase and charging times will also continue to decrease.



**~10-40min
charging
time**

For quicker charging times EVs can be charged at fast-charging stations.

Recharging can range from 10 to 40 minutes depending on: the size of the battery, the type of charger and the current level of charge. This type of charging is ideal for longer trips (e.g. over 200km) when a charging stop can be included in a general rest break. By the end of 2017, EV owners will have access to fast-charging units every 200km between the Gold Coast and Cairns.

Electric vehicle benefits

The eight key benefits for Queensland in supporting a transition to EVs are:

1 Reduces greenhouse gas emissions

The transport sector is Queensland's second largest source of greenhouse gas emissions. As EVs can be powered using locally-produced, renewable energy – including rooftop solar – the transport sector has the opportunity to significantly reduce its emissions through the uptake of EVs. Although the manufacturing of EVs currently produces 15% more emissions than that of fossil fuel vehicles, EVs produce far less emissions over the lifetime of the vehicle². Even when charging an EV using Queensland's existing electricity grid mix, the operation of an average EV is responsible for approximately 25% less emissions than an average fossil fuel vehicle³. However, this should not be relied upon as a sole measure, and unless Queensland increases local generation of renewable energy, the full emissions reduction benefits of EVs will not be realised.

2 Supports renewables

In order to support a transition towards renewables, the Queensland Government has established the Queensland Renewable Energy Expert Panel to provide advice on credible pathways to a 50% renewable energy target for Queensland by 2030. In order to significantly increase renewable energy in Queensland, action will need to be taken to better match peak renewable energy production, with peak state-wide electricity demand. EVs provide electricity utilities with a product that can help to flatten out overall electricity grid demand—charging at peak hours of renewable energy production.

3 Improves electricity grid utilisation

As household and business grid electricity demand decreases and solar PV energy production increases,



Figure 1



Figure 1 - Volvo XC90 T8 PHEV

Queensland's per capita grid electricity consumption will continue to fall over the coming decade⁴. Given the significant investment already made in Queensland's electricity network, it is important that the grid is adequately utilised in order to manage the network's impact on electricity prices. EVs can improve grid utilisation as vehicles are usually parked during times when the grid has unused capacity (middle of the day and overnight). In the future, EVs could also potentially discharge electricity into the grid during peak consumption periods to reduce grid demand.

² <http://www.ucsusa.org/sites/default/files/attach/2015/11/Cleaner-Cars-from-Cradle-to-Grave-full-report.pdf>

³ www.curtin.edu.au/research/cusp/local/docs/environmental-attributes-australia.pdf

⁴ <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/-/media/9FABB1C47Fo44BFBB6BCF1oBD8o7C9C2.ashx>

4 Reduces transport costs

Charging costs for an EV are around 60% to 90% cheaper than fuel costs for a fossil fuel vehicle⁵. With Queensland households spending \$5.8 billion on fuel each year,⁶ the fuel savings created by the transition to EVs could be spent elsewhere in the local economy. EVs are also generally cheaper to service when compared to similar fossil fuel vehicles⁷. When the purchase price of EVs equalises with fossil fuel vehicles in the next 5-6 years,⁸ Queensland businesses and households will benefit from reduced transport costs.

5 Creates new green jobs

A sustainable transition towards EVs in Queensland will require investment in new skills and service industries, leading to the creation of new green jobs. The Queensland Government is supporting innovative companies to develop EV technology, such as Brisbane-based Tritium, which now employs over 50 staff to produce and distribute their VeeFill DC Fast-charging systems around the world. The Government has also supported Clenergy Team Arrow in establishing a solar-electric car manufacturing hub in Queensland. EV batteries are also likely to create additional new green jobs through their reuse and recycling.

6 Reduces oil dependency

Australia is highly reliant on imported oil for the majority of its transport needs⁹. This exposes the community to the consequences of global oil pricing. Conversely, Queensland is completely self-reliant in terms of electricity production. EVs provide a pathway to reducing the economy's dependency on oil and imported fuel products, whilst supporting the use of locally-produced energy.

7 Increases climate resilience

Queenslanders regularly experience natural disasters and it is predicted that in the future many of these events will last longer and happen more frequently due to climate change¹⁰. EVs not only reduce tailpipe greenhouse gas emissions – potentially to zero when charged using greenpower and/or solar power – but also provide the possibility to mobilise electricity during disasters. In the near future, EVs could be used to run lighting, signs and sustain communications during emergency events. EVs could also be used to power essential appliances in homes, schools and community halls. Current PHEV batteries store enough energy to power the essential appliances in an average household for a day¹¹.

8 Improves public health and urban amenity

The Organisation for Economic Co-operation and Development (OECD) estimates that 1.75 million premature deaths occur globally each year due to motor vehicle pollution¹². In Australia, another study found that motor vehicle pollution is associated with 3,000 premature deaths annually¹³, and specifically for Queensland, a study conducted by the Bureau of Infrastructure, Transport and Regional Economics found that up to 253 premature deaths and 607 cases of respiratory disease each year could be attributed to motor vehicle pollution¹⁴. Given that EVs produce no tailpipe air pollution, the uptake of this innovative technology can assist in reducing urban pollution, and in turn, improving public health. EVs also produce significantly less noise compared to fossil fuel vehicles – particularly at lower speeds – and therefore the uptake of this technology will also lead to improvements in urban amenity.

⁵ Assuming: EV consumption of 1.8kWh/100km (at the power point) and electricity cost of \$0.06-\$0.28/kWh equals \$1.00-\$5.04/100km; and average passenger vehicle petrol consumption of 10.5L/100km and average petrol price of \$1.25/L equals \$13.25/100km.

⁶ Based on average Queensland Household spending \$63 per week on transport fuel; <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4670.omain+features132012>

⁷ http://www.afdc.energy.gov/vehicles/electric_maintenance.html

⁸ <http://www.bloomberg.com/features/2016-ev-oil-crisis/>

⁹ <http://www.industry.gov.au/Office-of-the-Chief-Economist/Publications/>

<Documents/energy-in-aust/Energy-in-Australia-2015.pdf>

¹⁰ http://www.bom.gov.au/state-of-the-climate/documents/state-of-the-climate-2014_low-res.pdf

¹¹ http://www.mitsubishi-motors.com/publish/pressrelease_en/corporate/2014/news/detail0954.html

¹² <http://www.oecd.org/environment/the-cost-of-air-pollution-9789264210448-en.htm>

¹³ <http://dro.deakin.edu.au/eserv/DU:30046702/stevenson-burdenofdisease-2003.pdf>

¹⁴ https://bitre.gov.au/publications/2005/files/wp_063.pdf



Figure 1

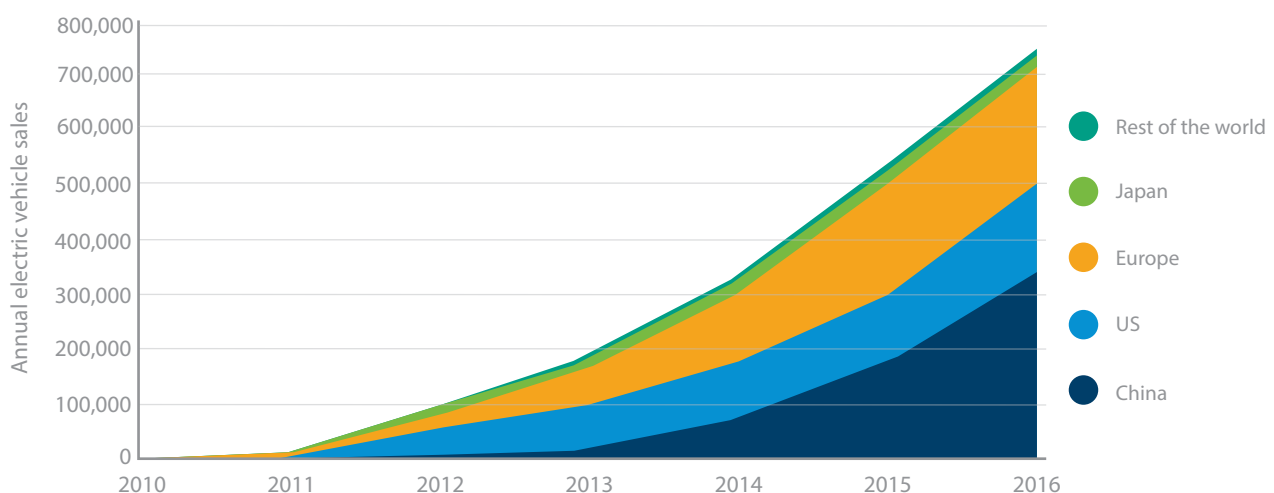
State of the market

As of late 2016, there were over 2 million EVs globally¹⁵, with more than 30 vehicle manufacturers—including 13 of the top 14 manufacturers¹⁶—already producing over 60 different electric models. Yet the majority of these vehicles are not being made available in Australia. This absence of consumer choice is reflected by the fact that Australia's proportion of EV sales is one of the lowest amongst developed nations — 0.1% of new vehicle sales in 2016, with a total stock of approximately 5,000 EVs¹⁷.

The majority of the global EV fleet is concentrated in OECD nations and China, where governments have actively supported improvements in vehicle fuel efficiency and carbon emissions standards. 38 percent of the global EV fleet was sold in 2016 alone (775,000 vehicle sales¹⁵), indicating that sales in advanced nations are rapidly increasing. Leading nations have EV proportions of new vehicle sales as high as 29% in Norway, 9.7% in the Netherlands, 1.1% in the UK, 0.9% in China, and 0.7% in the USA¹⁵.

Predictions of where the global EV market is heading are numerous and varying. Different studies have predicted that the global share of EV sales will rise to between 15% and 60% of all new cars by 2030¹⁸. Similarly, predictions of EV sales in Australia have varied. One of the most recent studies of the Australian EV market, released by Energeia in February 2016, forecast that 7.7% of all new vehicles sales will be EVs by 2022, and that this will increase to 22% by 2030 under business-as-usual conditions¹⁹. This would see an estimated 2.2 million EVs on Australian roads by 2030.

Global EV Sales by Country/Region 2010-2016¹⁵



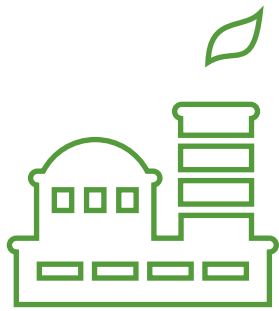
¹⁵ <http://www.hybridcars.com/the-world-just-bought-its-two-millionth-plug-in-car/> and <http://www.ev-volumes.com/>

¹⁶ <http://www.oica.net/wp-content/uploads/Ranking-2014-Q4-Rev.-22-July.pdf>

¹⁷ Electric Vehicles Sales in Australia 2010-2016; estimated using VFACTS and vehicle registration data

¹⁸ http://www.theicct.org/sites/default/files/publications/ICCT_GlobalZEVAlliance_201509.pdf

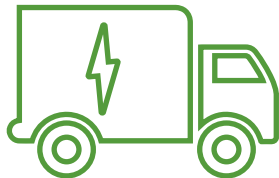
¹⁹ <http://energeia.com.au/wp-content/uploads/2016/02/Shifting-Gears-The-Australian-Electric-Vehicle-Market-to-2030.pdf>



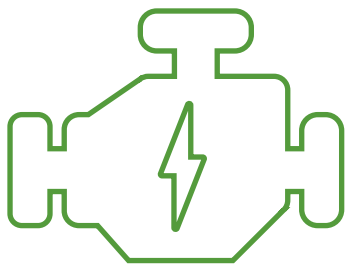
EVs are part of a range of low-emission vehicle technologies. Over the coming decade, conventional fossil fuel vehicles will increasingly be replaced by more carbon-friendly technologies including: battery-electric, biofuels and hydrogen.



Given the efficiency of the electric drivetrain, all vehicles are likely to be electrified to some extent. Biofuels and hydrogen can both be used in hybrid-electric vehicles to generate electricity to power an electric motor. In the future, biofuels could also be used to generate hydrogen for fuel cell-electric vehicles.



Hybrid low-emission vehicle technologies will likely play an important role in both the heavy vehicle and airline industries.



Hybrid vehicles provide further opportunity for greater efficiency gains over fossil fuel vehicles, as the engine can be programmed to run at an optimum speed to generate electricity to charge the battery and/or power the electric motors.

Barriers to uptake of EVs



There are three main barriers that are preventing the widespread uptake of EVs in Queensland:

- a) lack of information and experience**
- b) infrastructure availability, and**
- c) upfront purchase cost.**

Lack of information and experience

‘Range anxiety’ is often seen as one of the major barriers to mainstream EV uptake. There is a common impression that EVs are an impractical option given the driving ranges of most existing models are lower than fossil fuel vehicles. However, on average, Queenslanders travel less than 38km each day. This distance could be achieved using 100% electricity with any BEV and many PHEVs already available on the market. For people living in regional Queensland, or who tend to drive longer distances, a PHEV would be the best option in the medium-term, as these EVs have total driving ranges of 500+ km, but with lower fuel consumption and emissions than fossil fuel equivalents.

Queenslanders need to be provided with opportunities to experience this technology to better understand its current benefits, and how it will continue to evolve and develop over the coming years.

Infrastructure

In conjunction with range anxiety, a lack of public charging infrastructure discourages consumers from making the switch to an EV as consumers are wary of having limited charging opportunities. The widespread adoption of EVs will require a cultural shift in the way we think about our own mobility needs, how we meet these needs, and in turn, how we recharge EVs.

Evidence from overseas markets suggests that the majority of EV charging is carried out at home or at the workplace as users generally do not use the entire vehicle’s charge in a single day. Although this form of charging is slower, it is also relatively easy to install and a consumer then has the opportunity to charge the vehicle using excess solar power or by utilising off-peak tariffs. In many cases, it simply involves the installation of a power point in the garage or car park.

Despite the majority of charging being carried out at home or at work, a lack of public charging infrastructure leads to concerns about: how easy it will be to recharge when away from home; and ultimately whether an EV is a practical option.



Public charging infrastructure can include both fast and slow options. Slower public charging infrastructure is suitable for locations where individuals would be expected to stay for a number of hours e.g. tourist boat terminals, hospitals, schools or public transport hubs. Fast public charging infrastructure is principally required to facilitate inter-city travel i.e. trips greater than 150-250km.

Even though consumers are unlikely to use public charging infrastructure every day - given the majority of their trips will be fulfilled by charging at home or work - the existence of public charging infrastructure is crucial for consumers to overcome the fear that they may become stranded during a trip.

Upfront cost

The low uptake of EVs in Australia is partly due to the limited range of EV models available and the upfront cost. The cost of purchasing non-luxury EVs is currently higher than equivalent fossil fuel vehicles, and this difference in upfront costs is a major barrier to consumers. The upfront cost is driven by the battery cost (up to one-third of the total cost of manufacturing an EV) and smaller manufacturing volumes.

The cost of EV batteries fell considerably between 2010 and 2015; falling by 35% in 2015 alone²⁰. Bloomberg

²⁰ <http://www.bloomberg.com/features/2016-ev-oil-crisis>

New Energy Finance (BNEF) recently predicted that on the basis of these price falls, unsubsidised EVs are likely to cost the same as fossil fuel equivalents in the next 5-6 years .

There is clear evidence that a global transition towards EVs has begun. Over the coming years as battery and EV prices continue to fall this uptake rate is likely to rapidly increase. Given this upcoming change, the Queensland Government is starting to prepare the state for the transition to EVs today.



Figure 1

Figure 1 - Volkswagen I.D. concept EV



Tesla Model S

Future evolution of Electric Vehicles



2025

Volkswagen Group (Volkswagen, Audi, Porsche) to sell 2–3 million EVs each year

Volvo to have sold 1 million EVs

2022

Reduction in lithium-ion battery pack costs and the increased scale of EV production will lead to EVs costing the same as equivalent fossil fuel vehicles

Nissan-Renault to have sold 1.5 million EVs

Daimler (Mercedes-Benz, Smart) to sell 100,000 EVs per year and release EQ electric SUV

Porsche to release Mission E

Volkswagen to release I.D.

Hyundai-Kia to offer 9 EVs, including electric SUV and sell 300,000 EVs annually

Ford to offer 13 EVs

Wireless charging to become more cost effective and support charging autonomous EVs

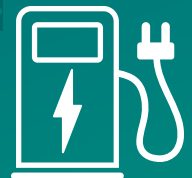
2020

Mitsubishi to release eX electric SUV

Volvo to offer plug-in hybrid electric vehicles (PHEVs) across entire model range

Ford to release Model E

2019



2018

Release of four EVs in Australia:

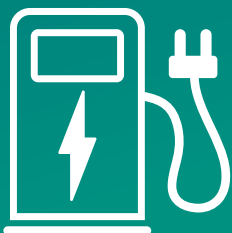
Hyundai Ioniq Electric, **Nissan** Leaf 2.0,

Renault Zoe, and the **Jaguar** I-PACE

Tesla released Model 3

Toyota released Plug-in Prius Prime with integrated roof solar panel option

2017



2016

General Motors released first mass-market long-range EV: Chevrolet Bolt (320km)

Nissan has recently developed a Bio-Ethanol Fuel-Cell EV that converts ethanol into hydrogen (600km)

*As announced by respective manufacturers and experts in 2016/17

Global electric vehicle policy

In the face of increasing greenhouse gas emissions and deteriorating air quality, many regions and countries around the globe have implemented policies to encourage a shift towards cleaner forms of transport. In particular, many national governments have introduced initiatives to promote the uptake of EVs.

Norway leads the world in terms of EV incentive policies, as shown by the fact that 29% of its new vehicle sales and over 3% of its vehicle fleet are EVs. Income, sales and road taxes are much higher in Norway than in most other parts of the world. This provides the nation with the opportunity to support the uptake of EVs using revenue from these taxes. EVs have been made exempt from import tax, sales tax, annual registration tax, public parking fees, toll roads and are able to use bus lanes and vehicle ferries for free. This has resulted in EVs already becoming cost-competitive with fossil fuel vehicles. Norway has also supported the rollout of an extensive network of charging infrastructure, with 7,500 charging points, over 500 of which are fast-chargers.

Many other countries and states have implemented a similar range of incentive policies in order to reduce or offset the upfront cost of EVs. These measures have included: subsidies, tax rebates, vehicle tax discounts, parking discounts and/or toll road discounts. Although these measures have been found to increase the uptake of EVs, some incentives – such as subsidies – tend to favour vehicle manufacturers more than consumers. This may make sense for regions or countries that manufacture EVs, however, this does not make sense for Queensland or Australia.

The Queensland Government currently offers EV owners a discount on vehicle registration duty (stamp duty) and a further discount on annual registration fees. The Queensland Government is also starting the process



Figure 1



Figure 2

Figure 1 - Tesla Model 3 (to be released in 2017/2018)

Figure 2 - Clenergy Solar Car

of investing in the necessary charging infrastructure today, in order to prepare for the upcoming transition to EVs over the coming years.

The Federal and state governments must work together to identify other opportunities that make economic-sense in reducing national vehicle emissions, and encouraging the uptake of EVs. Some potential measures were recently identified in the Federal Government's Vehicle Emissions Discussion Paper, including:

- ▶ Fuel efficiency (CO₂) standards
- ▶ Fleet purchasing policies
- ▶ Information and education campaigns and,
- ▶ Charging infrastructure.

Queensland alone cannot reduce the global price of EVs, however, the state can, in collaboration with the Federal and other state governments, take actions that improve EV pricing in Australia. EV pricing in Australia is negatively impacted by low volume of sales, limited public charging infrastructure and a limited range of EV models available on the market.

The Queensland Government will seek a national discussion on EVs, and work with the Australian and other state governments to encourage national actions to deliver a faster transition to EVs.

The Future is Electric

– preparing Queensland for electric vehicles

The Queensland Government recognises the innovative opportunities and benefits of EVs and is therefore preparing Queensland for a transition to EVs. This Strategy outlines a number of measures that the Government will implement to prepare for the transition to EVs, including the establishment of the Queensland Electric Vehicle Council.

The Queensland Government recognises that it will have to adjust its approach as the EV market continues to develop. The Queensland Electric Vehicle Council will be responsible for providing recommendations as to how Queensland can keep pace with global developments in order to remain internationally competitive.

The sixteen initiatives outlined in this strategy are divided into four categories which aim to:

- ▶ **Empower** the community so they can make informed choices about this new technology
- ▶ **Enable** the transition through the rollout of EV charging infrastructure
- ▶ **Explore** cost-effective programs that make economic-sense for the government to employ in order to further support the uptake of EVs across the state and,
- ▶ **Envisage** what future actions may be required to ensure Queenslanders continue to benefit from this transition.



Empower

Establish Queensland Electric Vehicle Council
.....
Raising EV awareness
.....
Making Queensland's innovation strategies available to support EV technology



Enable

Queensland Electric Super Highway network (Phase 1 by end of 2017)
(Phase 2 by 2020)
.....
Regional EV destination charging rollout from 2017
.....
Workplace EV charging
.....
A national discussion on EVs



Explore

Transitioning the Queensland Government's vehicle fleet
.....
Drive Electric Queensland - EV tourism
.....
Electrical infrastructure analysis of existing buildings
.....
Feasibility of integrating EVs with public transport hubs
.....
Improving Queensland climate resilience using EVs
.....
Feasibility of electric heavy vehicles



Envisage

Reuse and recycling of EV batteries
.....
Future mobility trends - shared/autonomous vehicles
.....
Electric public transport vehicles



Tritium Veefil fast-charger



BMW i3, i8, 740e, x5 xDrive40e, 530e , 330e

Empower



To provide Queenslanders with opportunities to investigate and experience EV technology and other related innovations, the Queensland Government will:

- ▶ facilitate knowledge sharing and community engagement through the establishment of the Queensland Electric Vehicle Council
- ▶ bridge the information gap by providing Queenslanders with information that supports informed technology choices and provide opportunities for the community to experience this innovative technology
- ▶ empower local EV technology innovations.

Queensland Electric Vehicle Council

The Queensland Government will establish the Queensland Electric Vehicle Council, comprised of representatives from industry, government and the community. The Queensland Electric Vehicle Council will help to inform the long-term strategic direction of EV policy in Queensland. Moving forward, this forum will provide advice on how the Queensland Government may need to adjust its approach as the EV market continues to develop, and will assist with the implementation of many of the programs outlined in this strategy.

Raising EV awareness

The Queensland Government, working with the Queensland Electric Vehicle Council, will empower Queenslanders who are exploring EV technology through the deployment of public awareness events, including community show-days and EV test drives. Online resources will also be developed to empower consumers so they can make informed choices about making the switch to an EV.

Making Queensland’s innovation strategies available to support EV technology

The Queensland Government’s Advance Queensland program is focused on diversifying the economy by developing new industries that have global growth

potential, and in turn create the knowledge-based jobs of the future. Clean energy production and storage is identified as an area where Queensland has a competitive advantage.

Queensland has the world's second highest levels of household Solar PV penetration at 24.12% (almost 1 in every 4 households) and is uniquely placed within the global market to take advantage of the numerous potential benefits of an integrated vehicle-battery-solar system, at both the small-scale residential and large-scale community levels.

Queensland has world-leading energy storage research capabilities at its universities that are ready to take on these challenges. James Cook University's Energy Storage Materials Development Group are designing and testing new battery materials prepared from common and plentiful resources (e.g. iron, silicon) that are low cost, have low toxicity and can be customised for different uses. The University of Queensland researchers have developed improved solar PV and storage control and management systems in partnership with AGL, First Solar, MPower and Provecta with their new 3.275MW solar PV array and 600 kW Li-ion battery bank at their Gatton campus. Griffith University has research expertise in the design of battery materials using natural polymers and have developed micro-grid testing facilities on their Nathan Campus in partnership with Energex, Elevare Energy and Ergon. The Queensland University of Technology has capabilities in developing battery

materials, improving battery cell management and analysing energy retail business models and optimising network connections.

Under the Queensland-Chinese Academy of Sciences Collaborative Research (Q-CAS) Fund the Queensland Government provided \$250,000 to a major joint Queensland-Chinese research project developing a more efficient and longer-lasting battery for electric vehicles based on nanotechnology. Researchers from the Queensland University of Technology and China's Suzhou Institute of Nano-Tech and Nano-Bionics are leading the project.

Under the Advance Queensland startup attraction program Hot DesQ, electric motorcycle company OpenRevs was recently attracted to Queensland from New South Wales with a \$75,000 grant and free co-working space to grow their business in Queensland. OpenRevs aims to produce the REV1 electric motorcycle as the most affordable, sustainable and safe transport option for Queenslanders.



Figure 1



Figure 2



Innovative technologies — such as EVs, batteries and renewables — are on the cusp of changing our transport and energy systems.

Under the Advance Queensland Research Fellowship program, \$1.26 million has been committed for projects including developing alternative energy sources and technology, such as a Griffith University project improving solar power through advanced electronics for distributed energy storage.

The Advance Queensland Innovation Partnerships program offers grants of up to \$1.5 million to Queensland research organisations to collaborative with industry on projects addressing science and research priorities including clean energy, such as a Central Queensland University Project making on-site solar PV power production and consumption easy and cost-effective through battery storage management systems.

The Queensland Government recognises that this provides a range of economic opportunities and is exploring opportunities to support EV, renewable and battery innovations locally.

Under the Advance Queensland Business Development Fund, the Queensland Government has already invested \$2.5 million in Brisbane-based EV charging hardware firm Tritium to support the development of innovative EV fast-charging hardware, with the ultimate aim of providing Queensland EV users with faster charging rates.

Solar EV manufacturer Clenergy TeamArrow has also been supported by the Queensland Government in establishing an innovation, design and manufacturing hub in Eagle Farm, Brisbane.

In January 2016, the Queensland Government launched Energex's Battery Storage Trial and inducted 22 new Energex apprentices into the EsiTrain facility at Rocklea. The new recruits are gaining first-hand experience with the latest battery technologies as part of their training at the facility. Energy Queensland is also building a new 300 square metre Innovation battery laboratory facility, within an existing Ergon operations workshop in Cairns.



2018 Nissan Leaf



Examples of local electric vehicle innovation

Tritium

World-class EV Fast-chargers

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Tritium is a specialist designer and manufacturer of power-electronic systems and fast chargers for EVs and battery energy-storage applications. Tritium, produces state-of-the-art electric-motor controllers and battery-management systems for the solar car industry as well as for more traditional automotive applications. The company's world-leading technology is now found on every continent.



Clenergy TeamArrow

World-first Solar EV

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Clenergy TeamArrow is Australia's premier solar racing team. It recently announced the establishment of an innovation, design and manufacturing hub in Brisbane that will see the production of the world's first commercial, road-registered, custom Australian solar electric car. The Arrow STF is a two-seater, solar electric racing car, designed for compliance with road regulations. It uses the latest in solar and battery technology to create a unique vision of what is possible in the pursuit of clean, efficient motoring.

Transit Australia Group

Electric Bus Manufacturer

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In 2015 Transit Australia Group's manufacturing arm, Bustech, launched Australia's first e-bus, 100% designed, engineered and manufactured in Queensland. Since the launch of this prototype, Bustech has continued to develop its e-bus, and in 2017 released Australia's only e-bus fully compliant with Australian Design Rules, National Heavy Vehicle Regulations and public transport specifications.





Enable



To assist in overcoming the barrier of limited EV charging infrastructure, and prepare Queensland for the upcoming transition towards EVs, the Queensland Government will initiate:

- ▶ the Queensland Electric Super Highway network
- ▶ regional EV infrastructure
- ▶ workplace EV charging trial
- ▶ a national discussion on EVs.

Queensland Electric Super Highway network

The Queensland Government and Energy Queensland, in collaboration with local councils and other partners, is rolling out the Queensland Electric Super Highway network – the world’s longest EV superhighway within a single state. The network of fast EV charging stations will initially span from the Cairns region down to South-East Queensland (SEQ), with expansion to other regions in possible future phases. The network will provide EV owners with the ability to drive between

major regional centres and eco-tourists the opportunity to travel to many of Queensland’s tourist destinations in a low or zero emissions vehicle. The Queensland Electric Super Highway network has also been identified as an opportunity for development of tourism and transport in Queensland through encouraging low-emission road-touring to the State’s natural wonders.

Regional EV infrastructure

The Queensland Government, working with local governments and regional tourism groups, will develop a series of regional local implementation strategies, to help support the uptake of EVs and associated destination charging infrastructure. EV tourism and a transition to EVs in regional Queensland can be supported through the rollout of regional EV charging infrastructure. The government will start the process of installing EV charging infrastructure at tourist destinations and other regional locations during 2017.

Workplace EV charging trial

In collaboration with local governments, the Queensland Government will pilot EV workplace charging infrastructure projects within workplaces and regional city commuting car parks. This could potentially lower the cost of commuting to effectively zero for some Queenslanders.



Mitsubishi Outlander PHEV

A national discussion on EVs

The scale and imminent roll out of the Queensland Electric Super Highway network presents a unique opportunity to influence future charging standards for Australia. The installation of EV charging infrastructure throughout Australia should utilise the benefits of three-phase power within the existing electricity network to enable the fastest possible charging times.

The charging stations installed along the Queensland Electric Super Highway network will adopt the European Mennekes Type 2 connector for single and three-phase AC charging, and a dual approach of European Combined Charging System (CCS) Type 2 and Japanese CHAdeMO connectors for fast DC charging. This has been identified as the best solution to support long distance travel with fast AC and DC charging, utilising three-phase power that is prevalent throughout the state's electricity grid.

The Queensland Government will start a discussion with other state governments and the Federal government as to how these standards can be mandated for future charging infrastructure across the nation.

There are many other opportunities for the Federal and state governments to work collaboratively to support a transition to EVs.

The Queensland Government intends to actively participate in the national discussion on EVs, firstly through implementing the initiatives outlined in this strategy, and secondly through encouraging broader collaboration amongst state and Federal governments to address the existing barriers to EV uptake.



Queensland Electric Super Highway Network

**The world's longest
electric vehicle
super highway***

Legend

0 50 100 250km



- Queensland Electric Super Highway Fast Charging Station - Phase 1
- Queensland Electric Super Highway Fast Charging Station - Proposed future site

For more information go to: www.qld.gov.au/electricvehicles

Other existing fast charging station locations can be viewed at www.plugshare.com#

Final site selection is ongoing and some locations are subject to review

Supporting Partners



*in a single state or region

#plugshare website is not a government site and the accuracy of its content is not guaranteed



2018 Jaguar I-PACE

Explore



The Queensland Government has developed six programs to investigate and explore further ways in which it can support a transition to EVs, including:

- ▶ transitioning government vehicle fleets
- ▶ Drive Electric Queensland
- ▶ integrating EVs with public transport hubs
- ▶ improving Queensland climate resilience using EVs
- ▶ electrical infrastructure analysis of government buildings
- ▶ feasibility of electric heavy vehicles.

Transitioning government vehicle fleets

A cost-effective way of increasing the uptake of EVs in the Australian market is for local, state and Federal governments to engage in volume purchase

agreements with EV manufacturers for their own vehicle fleets.

QFleet – a commercialised business unit in the Department of Housing and Public Works that manages the Queensland Government motor vehicle fleet – is making EVs available to departments for leasing and evaluation purposes to encourage their inclusion in the fleet mix. QFleet will determine a practical and sustainable way to increase EVs in the fleet by taking into consideration the evaluation results and factors, such as:

- ▶ total cost of ownership
- ▶ fit-for-purpose suitability
- ▶ recharging infrastructure implementation
- ▶ the range of suitable EVs currently on the market
- ▶ manufacturers' plans for future EV releases.

The Queensland Government will establish a Fleet Transition working group, comprised of fleet managers from across government – including the Queensland Police Service and Queensland Public Safety Business Agency, who will work in conjunction with QFleet to investigate opportunities for transitioning Queensland Government vehicle fleets to include a greater number of EVs as a fit-for-purpose alternative where appropriate.



Additionally, the Queensland Government, through the on-selling of EVs to the general public after 3-4 years, can increase the number of EVs in the community, and improve the overall emissions profile of the general public vehicle fleet.

Drive Electric Queensland - EV Tourism

Queensland's touring market contributes approximately \$2 billion per annum to the local economy and is likely to be significantly impacted by a strong national uptake of EVs if regional charging infrastructure is not provided. Road-based tourists tend to take longer trips and visit more locations. A recent study commissioned by the Queensland Government, and independently verified, found that EV-based domestic tourism in Queensland could be worth up to \$234 million over the next decade (not including international visitors). There

is an inherent risk that if Queensland does not support the rollout of charging infrastructure, as interstate and SEQ motorists transition to EVs, they may choose not to travel to Queensland.

Queensland's tourism industry is strongly tied to our amazing natural wonders and environment. In order for our regional tourism industry to continue to thrive it is important that Queensland is recognised as an environmentally-sustainable destination. The Queensland Government will work with local governments and tourism bodies to develop strategies to encourage and support EV-tourism across the state.

Feasibility of integrating EVs with public transport hubs

Encouraging greater use of public transport is one strategy for reducing vehicle emissions. However, many people rely on private vehicles to access public transport services.

The Queensland Government will investigate ways to encourage the use of public and active transport modes by integrating EVs and electric bicycles with public transport hubs.



Mercedes-Benz S 500e (left), GLE 500e (middle), C 350e (right)

Improving Queensland climate resilience using EVs

The Queensland Government will investigate opportunities to incorporate additional EV technologies, such as vehicle-to-home (V2H) systems, focusing on regional Queensland.

The incorporation of such innovations would lead to an increase in both the energy independence and climate resilience of communities across Queensland by making the electricity stored in EV batteries available for household and community usage.

V2H systems would also allow schools, community halls and other buildings to remain open during emergency events or periods of sustained power loss.

Electrical infrastructure analysis of existing buildings

In order to encourage the uptake of EVs by commercial fleet operators, it will be critical to ensure that the infrastructure necessary to charge EVs can be retro-fitted into existing buildings in a cost-effective manner. The Queensland Government will undertake an analysis of different buildings, in order to understand the

opportunities and barriers to installing EV charging infrastructure. The lessons learnt from this study are not only intended to be used to support the rollout of EV charging infrastructure in government owned buildings for government EVs, but will also inform building guidelines and regulations to ensure the installation of EV charging infrastructure can become a straightforward task.

Feasibility of electric heavy vehicles

As one of the principal transport contributors towards urban air pollution, the electrification of small-to-medium heavy vehicles not only has the potential to improve urban air quality, but can also significantly reduce the operating costs of local transport and logistics services. In order to facilitate a transition to heavy vehicles, adequate public heavy-vehicle charging infrastructure will be required in order to allow heavy vehicle operators to better utilise these vehicles. The Queensland Government will investigate the feasibility of electric heavy vehicle charging in SEQ that would encourage industry to shift to electric freight vehicles.



Electrification of Commercial Vehicles

Whilst electric passenger vehicles can produce a number of social, environmental and economic benefits for Queensland, the potential benefits from the electrification of commercial vehicles are equally significant. Commercial vehicles produce the majority of pollutant emissions in Australia. These emissions have been linked to causing respiratory illnesses and premature deaths²¹. Greenhouse gas emissions from heavy duty trucks, buses and light commercial vehicles also make up 39.3% of Queensland's transport emissions²². This is compared to cars which contribute 43.6% of Queensland's transport emissions²². In addition to the environmental and public health benefits, the electrification of commercial vehicles also has the potential to significantly reduce the cost of freight in Australia, and over the longer-term, decrease the cost of everyday goods.

Several companies around the world are trialling battery-electric and plug-in hybrid electric commercial vehicles. Daimler Trucks and Mitsubishi Fuso Trucks have both deployed a number of pilot vehicles for testing in Europe, including the Mercedes-Benz 26-tonne Urban eTruck (Figure 1) and the Mitsubishi Fuso 6-tonne Canter E-CELL (Figure 2). Through these trials it has been established that electric commercial vehicles could reduce costs by 60 – 70%, and that they are well-suited to daily freight movements within urban areas. A number of manufacturers are already producing battery electric vans. One example is the Nissan e-NV200 (Figure 3). John Deere has also recently announced a battery-electric tractor prototype.

Given the significant potential benefits from the electrification of commercial vehicles, the Queensland Government is exploring the infrastructure required to support this transition.

²¹ https://bitre.gov.au/publications/2005/files/wp_063.pdf

²² <https://www.ehp.qld.gov.au/state-of-the-environment/finding/?id=3.4.0.3>



Figure 2



Figure 3

Figure 1



RACQ

Promoting an electric vehicle future

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RACQ believes that the electrification of the vehicle fleet is both necessary and desirable. RACQ first purchased a Mitsubishi iMiEV in October 2010 and added it to its vehicle fleet as a demonstrator of future technology. Following the lease expiry of the iMiEV, RACQ purchased a Holden Volt — the first locally-available plug-in hybrid electric vehicle (PHEV). Today the Volt is a part of the RACQ fleet as a pool car and is used in training activities.

The technical training team at RACQ have an ongoing role in training RACQ Road Service staff and contracted service providers across Queensland in future technology, including the opportunities provided by EVs. RACQ also seeks to educate the public on the EV future through events such as Motorfest, sustainability events and through its publication The Road Ahead.





Mercedes-Benz F 015 Luxury-in-Motion self-driving concept EV

Envisage



The Queensland Government has developed three exploratory projects to envisage what future government actions may be required to ensure Queenslanders gain the maximum benefit from EVs.

Reuse and recycling of EV Batteries

In the long-term, the transition to EVs – in addition to the uptake of stationary battery storage – will generate demand for the reuse and recycling of EV and other related battery products. After EVs are retired, the batteries can be removed, with a significant proportion then able to be reused as stationary storage (e.g. home batteries). The elements from these batteries that cannot be reused can be recycled and used to manufacture brand new batteries for both EVs and other battery products. The Queensland Government is investigating the future economic opportunities that could be generated due to the need for reusing and recycling EV batteries.

Future mobility trends - shared/autonomous vehicles

The changing nature of mobility over the coming years has the potential to dramatically increase accessibility for many Queenslanders that previously may have had limited transport options – including the elderly, disabled, children and individuals without a licence.

As a result of the rise of shared/autonomous EVs, overall transport costs are likely to fall, with other implications in terms of licensing, registration, stamp duty and fuel taxation. The Queensland Government will investigate how these future mobility trends will shape Queensland's future transport system, and is also examining what actions may be required to encourage more productive forms of mobility, whilst ensuring that the transport system is adequately maintained and financed.

Electric public transport vehicles

The Queensland Government is investigating the potential to trial electric buses in South East Queensland. These trials would be used to assess the feasibility of deploying electric buses in coming years.

The feasibility of trialling autonomous electric buses to shuttle commuters between their homes and public transport hubs is also being investigated.

The life-cycle of EV batteries



Raw materials (e.g. lithium, cobalt, nickel) are mined for batteries and used to manufacture individual battery cells



Individual battery cells are assembled into battery packs that can be used in EVs



Battery packs are installed into EVs. After 10 years these batteries are expected to hold 70-80% of their original capacity



Even after batteries have passed their useful life in an EV they are still a valuable resource. Individual battery cells can be removed from EV battery packs and reused as home batteries or commercial stationary storage. It is expected that these repurposed batteries would have another 10–15 years of useful life for these applications



Once battery cells have passed their useful life in stationary storage, battery materials can then be recycled in the manufacturing process to create new battery cells



Tesla Model X

What is next?

The Queensland Government has developed this EV strategy in order to kickstart a conversation with Queenslanders about how we can successfully navigate the transition to EVs to reap the benefits of this innovative technology.

The programs outlined in this document will be initiated over the coming 12 months. The Queensland Electric Vehicle Council will be involved with the implementation of many of these programs, and will be consulting with industry partners and local communities to ensure Queensland keeps pace with global developments in the EV market.

The Queensland Government will work with the Queensland Electric Vehicle Council to continue to explore other initiatives to support a transition towards EVs.

For more information go to:
www.qld.gov.au/electricvehicles



Figure 1



Figure 2

Figure 1 -Jaguar I-PACE Concept EV
Figure 2 - Tritium Veefil RT Fast-charger

Photo credits

Adam Harper

Audi

BMW

Hyundai Motor Company

Integral (Clenergy TeamArrow)

Jaguar Australia

Jessica Tillotson

Marc Talloen

Mercedes-Benz

Mitsubishi Motors Australia

Nissan Motor Company

OpenRevs

RACQ

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