Electric Vehicles:
Driving EVolution

November 2014

Executive Summary

Electric Vehicles (EVs) have the potential to provide a significant benefit to consumers and utilities, however as demonstrated in Ergon Energy's trials, if EVs are not charged in a grid friendly manner they have the potential to increase peak demand, drive the need for increased infrastructure and put increased pressure on electricity prices.

As has been demonstrated through many trials and established EV operations around the world, EVs can be adopted in a manner that provides not only consumer choice and benefit, but also has limited impacts on electrical infrastructure.

Ergon Energy wishes to provide an EV friendly network and encourage EV uptake in a manner that does not increase peak demand, therefore Ergon Energy recommend the following two options for recharging EVs:

1. Time of Use tariffs, as demonstrated in our trials, provide consumers with choice about charging at low cost times or charging when the EV needs a charge. These tariffs offer consumers the most flexibility concerning the EV charging needs.
2. T33 or controlled load tariffs, these tariffs offer customers a set and forget method of charging their EVs. The T33 control options reduces the cost of charging for customers in return they enable Ergon Energy to manage the times for when the EV can be charged. The main down side of T33 charging is the inflexibility of choice of charging time and the need to have a dedicated EV connection in line with Ergon's connection standards.

While the choice is limited at this stage Ergon Energy expects to increase consumer choices as EVs grow in popularity, in line with our strategy of being an EV friendly network. Ergon Energy will work with regulators to deliver an open access platform and customer choice.

Background

Electric Vehicles (EVs) present an opportunity for low cost, low carbon transport; and also provide the opportunity for energy diversity and security in transportation. EVs can be used for passenger, fleet and non-road (e.g. material handling equipment) transportation, with the "plug-in" varieties - which can be recharged from an external source of electricity – divided into two types:

- Battery Electric Vehicles (BEV) – vehicle contains a built in battery pack, which is draws electricity from the grid to charge, and has no other engine or fuel tank.
- Plug-in Hybrid Electric Vehicles (PHEV) – vehicle is driven by an electric drive train and fitted with an internal combustion engine (ICE), allowing the battery to be charged via either the grid or the ICE (Energy Supply Association of Australia, 2013).

To date, EV uptake in Australia has been slow, however in other countries EVs are starting to grow in popularity. By September 2014 there were over 600,000 EVs worldwide, with at least 22 models available, with countries such as USA, Japan, China, and the European member states leading adoption (Cobb, 2014). It is anticipated that by September 2015 the total number of EVs worldwide will surpass 1 million, with a 60/40 split between BEV and PHEV.

However there exist a number of barriers that have stalled the uptake of EVs. Customers have highlighted that the barriers to EV ownership include higher upfront cost of vehicles compared to conventional vehicles, availability of charging infrastructure, and other overheads.

Ergon Energy's own EV trials have demonstrated that if EV charging were left unmanaged, consumers would charge at periods of peak demand on the electricity distribution network, by plugging in when they returned home from work. This behaviour would exacerbate network peaks, putting increased strain on the network and limiting the number of EVs that could be connected, compared to if they were otherwise charged outside of peak demand periods.

It is therefore imperative that Ergon Energy provides its customers choices with their EV charging, to enable both flexibility and incentives to charge outside of peak times.

Fast Facts - Electric Vehicles

- In California alone, there are now upwards of 100,000 EVs on the road and the state's goal is for 1.5 million by 2020 (Vorrath, 2014)
- There were zero PHEV models available 3 years ago with more than 16 models available now in the US. (Edison Electric Institute, 2014)
- U.S. Department of Energy data show that battery costs fell by roughly 50% in the last four years alone (Edison Electric Institute, 2014)
- In September 2014, seasonally adjusted there were 18,800 new vehicles sold in Queensland alone (Australian Bureau of Statistics, 2014), and 94,285 sold across Australia.
- Tesla S have received numerous automotive awards including the Motor Trend Car of the Year 2013 and Automobile Magazine 2013 Automobile of the Year
- Running costs of EVs are approximately $0.03 per km versus $0.10 per km for ICE vehicles, and even less if charged from a consumer's own renewable generation - such as solar photovoltaic (PV).

All this points to BEVs and PHEVs reducing in price, increasing in availability and gaining popularity over the coming years within Australia.

Townsville Electric Vehicle Trial

Over a period of 18 months between 2012 and 2013, Ergon Energy ran trials in Townsville to understand customer acceptance of EVs, and the eco system that supports them, including chargers, electricity tariffs, and the EVs themselves. The trial sought to gain some real world understanding of customer EV driving and charging behaviour, and involved:

- 10 households at two different locations - Townsville inner city (Mysterton) and Townsville city fringe (Mt Low)

- Four charging regimes / electricity tariffs – uncontrolled (T11), controlled (T33), Time of Use (ToU), and modified ToU
- Mitsubishi i-Miev BEVs.

Key insights gained from the trial included:

- The further out from the CBD the higher the energy consumption with the vast majority of the charging happening at night.
- Customers did not charge every day, but rather charged when they thought they needed a charge which was triggered at about 60% state of charge.
- As the distance from the city increased so too did the likely impact on peak demand.
- Customers generally preferred the TOU trial as it gave them flexibility over charging and enabled the customers to get a top up if needed during peak time.
- EVs were well accepted by the customers with most of the customers stating they would own one if the price was appropriate.
- Generally customers have substantial capacity in the EV at the start of network peak time and that most of the EVs are at home. This presents an opportunity to unlock this potential to support the network and their own energy needs through developing technologies such as Vehicle-to-Grid (V2G) or Vehicle-to-Building (V2B).

Benefits of Electric Vehicles

EVs offer a number of benefits to both consumers and the electricity utility alike, however a number of them require consumers and utilities to work together in order for many of them to be realised to their full extent.

Consumer Benefits

EVs ownership and usage can have significant benefits for consumers, such as:

- Lower cost transportation - ESAA estimate running cost of EVs to be approximately $0.03 per km vs ICE at $0.10 per km (2013).
- Low CO2 emission transport if changed from renewable energy.
- If combined with consumer's own renewable generation – such as solar photovoltaics (PV) - EV running costs can be reduced even further with low CO2 emissions.
- Enabling an energy storage opportunity for households via new technologies - such as V2B - could enable consumers to reduce peak demand and potentially reduce bills, or even supply power to the house in the event of a natural disaster. While these concepts are new, they are developing and it is important for Ergon Energy to remove as many barriers as possible enabling the choice for our customers.

Electricity Utility Benefits

If consumers, organisations and electricity utilities work proactively together there are considerable benefits for utilities that that will ultimately flow onto consumers from EV owner ship, such as:

- Management of renewable energy, EVs can be used to help manage renewable generation into the grid by:
    - Charging when solar PV output is high, thus soaking up extra generation

    - Dynamically changing charging regimes to account for the intermittent nature of renewable energy generation
- Support grid stability - most EVs are only driving about 4 per cent of the time, and charging 10 per cent of the time. For the remaining 86 per cent, they are effectively untapped energy storage on wheels, utilities, with consumer permission, may be able to use this energy as a demand response mechanism. (Vorrath, 2014).
- Increased usage of the grid - there is a large investment in electricity networks and increasing the utilisation of this asset benefits all Queenslanders, customers charging EVs from the grid would help support this large investment in electricity infrastructure.
- The potential of utilising EV batteries as energy storage for the house either to reduce peak demand or as support in disaster events. These potential uses of EVs may be enabled with developing technologies such as V2G or V2B.

Barriers to Uptake

EVs like any new technologies have a range of consumer barriers to overcome. The main barriers to EV uptake to date have included:

- The large upfront costs of purchasing an EV.
- Concerns over the driving range of the vehicles.
- Lack of knowledge and understanding of the technology.
- Lack of standards and charging infrastructure.

The automotive industry is quickly tackling some of the vehicle barriers to EV ownership such as the upfront costs and limited range. For instance, US-based BEV manufacturer Tesla have been leading the charge on consumer acceptance and the Tesla S has won several automotive awards, indicating that the EVs are fast removing barriers to ownership.

Over the coming years Ergon Energy are expecting to see an increase in PHEVs, these EVs contain smaller batteries and an internal combustion engine (ICE). PHEVs have the ability to be charged from the grid and run on batteries for the start of the journey, while offering the ability to switch to using the ICE if the batteries get low on charge, allowing for greater total vehicle range. These vehicles are expected to be more popular in the next few years due to their increased range and reduced costs over BEV, while still providing access to a low cost and low CO2 fuel source. As these vehicles have an ICE the needs for public charging infrastructure are significantly reduced removing one more barrier for consumer uptake.

It would come as no surprise that over 90% of commuter trips in Townsville are made by car, what may come as a surprise is that around 67% of these trips are less than 10km, well inside the electric range of most PHEVs (Transport and Main Roads, 2011).

Removing Barriers

In order to support our customers and their desire to own EVs, Ergon Energy is actively working to become an EV friendly grid. Due to the significant benefits and risks associated with EVs, Ergon Energy wishes to remove as many barriers to EV ownership as possible to ensure that consumers connect and charge their EV in a grid friendly manner.

In order to enable the significant benefits of EVs for our customers we are actively working to develop a range of opportunities and strategies to enable customer choices for connecting and charging their EVs. The Ergon Energy EV trials, along with knowledge from other trials that have taken place throughout the world have helped inform Ergon Energy's strategic direction for EVs.

A key insight from the Ergon Energy trials was that consumer driving behaviours have significant impacts on the charging options that are suitable to them. Rather than a one-size-fits-all Ergon Energy wants our customers to have access to economical charging at a time that matches their lifestyle.

Ergon Energy's EV Strategy

To achieve Ergon Energy's goal of becoming an EV friendly grid, Ergon Energy has developed a strategy to help facilitate the removal of barriers, provide impartial information to customers and stakeholders, and ensure the safety of customers, staff and the network. Figure 1 provides a snapshot of Ergon Energy's EV strategic objectives.

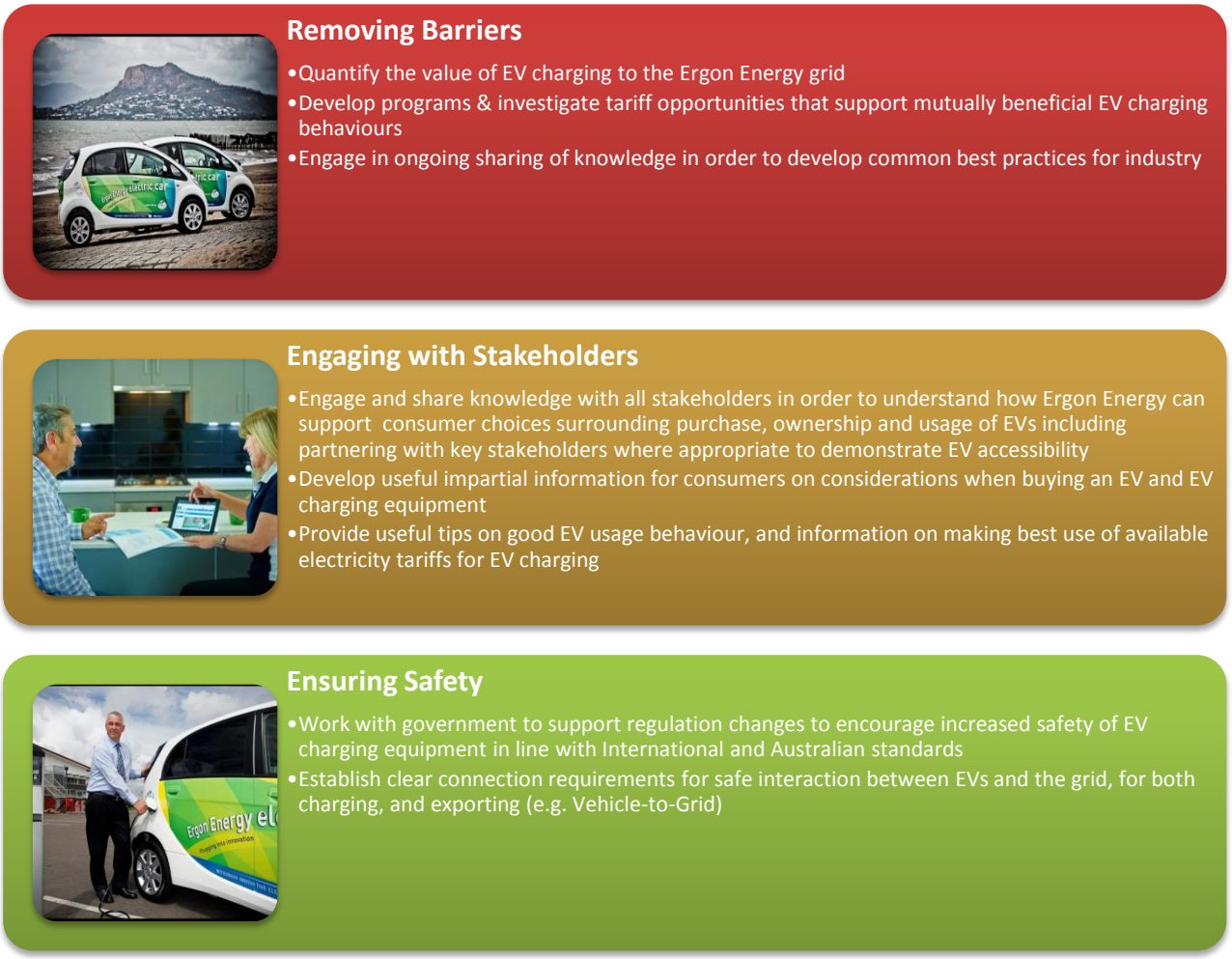

Figure 1 – Snapshot of Ergon Energy's EV strategic objectives

Current Options for Customers

While the option for EV charging is limited at present, as part of our strategy Ergon Energy are working to enable more consumer options with EVs and to develop these options as EVs gain in popularity.

Currently there are two recommended options for EV charging within Ergon Energy's territory - Time of Use Charging or Controlled Tariff Charging (T33).

- **Time of Use (ToU) charging** is actively encouraged by Ergon Energy for customers to investigate for their EV charging by utilising the ToU tariffs that are already available. ToU presents some significant benefits over controlled charging, as was discovered in Ergon Energy's trials. The trials clearly showed that under increased EV use customers preferred the flexibility of being able to charge whenever they needed to, even if the cost was a little higher. This flexibility enabled customers to grab a quick top up charge if they needed, however most of the charging was done at night in the low cost "off-peak" energy times. ToU charging was also found to be more broadly accepted from the customers that drove higher distances each day.

- **T33 or controlled tariff charging** is a much stricter charging mechanisms with the EV only being able to be charged in off peak times. In Ergon Energy's trials customers who drove longer distances that required a quick top up charge were unable to do so and found that controlled charging impacted their ability to use the EV. However customers that have smaller trip distances found there was generally enough charge to enable them to use the EV when they needed to and having a time where charging was not available had very little impact on their lifestyle. In order to access T33 charging customers must get their local electrician to ensure that:
    1. Their switchboard and controlled tariff connection has the capacity to safely provide charging.
    2. That a dedicated EV charging connection is installed in line with Ergon Energy recommendations and conditions.

Where available, Ergon Energy also encourages consumers to make use of functionality in the EV charging equipment or the EV itself to set an "end charge time" rather than a "start charge time". By setting an "end charge time" for charging to be complete, customers help support the grid by increasing diversity in the charging patterns of EVs in the neighbourhood. This helps to avoid spikes in load that could affect the grid, and ultimately allows for a greater number of EVs to be supported by the existing grid infrastructure.

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