Electric Vehicles in Australia

an Owners Perspective

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Sustainability Expo, Dubbo, Sept.2013 –Author with his i-MiEV and Dubbo Mayors Volt.

ABSTRACT

Australia has a growing population of electric vehicles (EV), with a number of new models due to be released in 2014. In this paper the author (an EV owner for over 12 months) will examine:

1. the current numbers and models of EVs available in Australia
2. the various electric vehicle trials conducted in Australia
3. the synergies between Solar PV and EVs
4. the consequential issues of EVs for Distribution Network Service Providers (DNSP's).
5. The 'myths' and 'truths' about owning an EV.

Some of the network issues to be explored in the presentation are :

- The likely impacts on network load (good or bad ?) of growing numbers of EVs.
- Level 1, Level 2 and Level 3 charger characteristics explained.
- Controlling EV Charging – DRED's and/or Controlled load channels (1 or 3 ?)
- Metering challenges
- Will 2017 be 'the year of the EV' as the NSW Solar Bonus Scheme closes ?
- Vehicle to Grid (VTG) and Vehicle to Appliance (VTA) developments.

What EVs are available in Australia ?

At the time of preparing this paper, the production vehicles pictured on the next page were available for purchase, or had been announced for coming availability in Australia. In addition, various individuals and commercial workshops have for many years converted internal combustion models to electric, popular choices being the Diahatsu Charade and Ford Focus. Only Ross Blade has full ADR compliance approval for converting the Hyundai Getz.

How many EVs are there in Australia ?

The following numbers are estimates only, gathered from various sources:

- 252 Mitsubishi i-MiEV's (15 sales 2013)
- 284 Nissan Leafs (188 sales 2013)
- 181 Holden Volt's (101 sales 2013)
- 40 Blade Electrons
- 23 Tesla Roadsters (no longer produced)
- 11 Ford Focus conversions (WA Trial)
- 7 Electric Commodore conversions (Vic Trial)
- 6 'Plug in' Toyota Prius's
- 2 Renault Fluence ZE
- Various 'one-off' conversions including a Delorean, Lotus and MX-5.

Nissan LEAF(RRP k$39 on road)

Mitsubishi i-MiEV (from k$25 for Dealer demonstrator)

Blade Electron (from k$27)

Holden Volt (RRP k$59)

Mitsubishi Outlander (from k$49 on road)

Tesla Model ‘S’ (coming mid 2014)

BMWi3 (Nov.14 RRP k$64 + ORC)

Porshe Panamera Hybrid (coming)

Electric Vehicle Trials in Australia

A number of EV trials have been conducted in Australia, with the assistance of Federal and State Government grants (from former Labour Governments).

- Western Australian REV Trial
    - 11 Ford Focus conversions – all placed with fleet owners
- AusGrid (Sydney-Newcastle) Smart Grid-Smart City trial
    - 20 Mitsubishi MiEV's – 7 placed with fleet owners, 13 with private drivers
- Ergon (Townsville) EV trial
    - 5 Mitsubishi MiEV's – placed with 2 groups of private drivers
- Victorian EV Trial
    - 54 vehicles consisting of 16 leaf's, 17 MiEV's, 8 Blade Electrons, 7 Electric Commodores and 6 plug-in Prius's.
    - Placed with both fleet and private drivers in batches.

Synergies between Solar PV and EV ownership

The owner of a solar PV system is likely to be:

- An innovator or 'early adopter'
- Environmentally aware and motivated
- Understand electricity tariffs
- Understand how an up-front investment will be recovered over time (NPV)

Charging an EV from your Solar panels :

- A 1.5kW system will produce enough energy to run a MiEV 17500km/year.
- A 3.0kW system running at 80% capacity will yield 10amps to charge a car.
- Removes the 'tailpipe to smokestack' criticism of EVs and quickly recovers any 'embodied energy premium' in the manufacture of an EV and its battery –see Figure 1
- Ignoring any feed-in-tariff, means fuelling an EV is effectively free.

A number of Solar Suppliers and Installers have purchased EV's to promote their solar business, and many have indicated purchase (once available) of the Mitsubishi Outlander as a 'work vehicle'..	

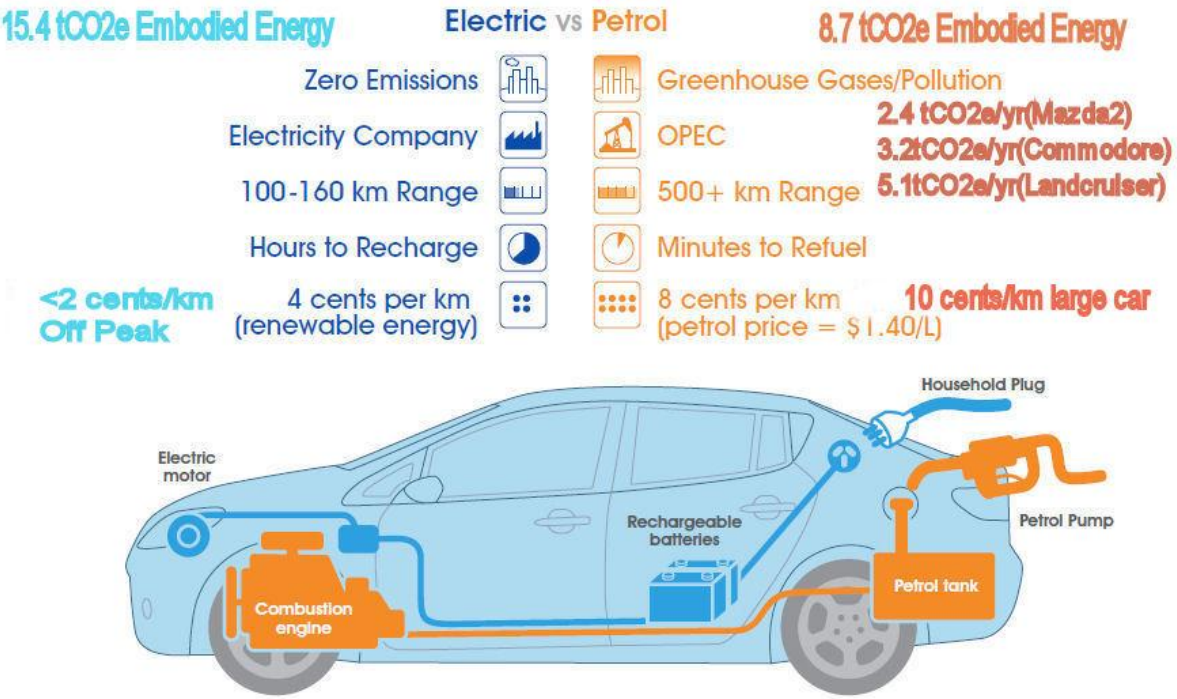

Figure 1. Environmental footprint of an EV – adapted from the Victorian EV Trial report.

EV's and the NSW Solar Bonus Scheme (SBS)

Secondary systems are allowed from 3 June 2013. This means:

- SBS customers with a GROSS solar can add a second separate NET system without losing their FiT (60c or 20c)
- There are 160,000 SBS customers, most with a GROSS system
- This is an ideal opportunity to make them EV ready

The NSW SBS will conclude in December 2016, meaning:

- Most GROSS customers will convert to NET and look for a 'sink' for their excess generation – perhaps an EV at zero running cost?
- Some customers will 'break-up' larger systems into smaller ones, spreading them over additional sites or selling them
- Will 2017 be 'The year of the EV', particularly for NSW ?

Solar Installers are uniquely placed to advise customers because they:

- Are licensed electricians and often Accredited Service Providers for metering
- Understand electricity tariffs and metering requirements
- Inverters and panels are often on or near garages and carports where a charge point may be logically added.
- They are likely to have an EV themselves or be familiar with them.

EV Charging

EV Charger	Current/Voltage	Power Supply (kW)	Min. Cable Size
Level 1	15 amps / 230 Volts	3.6kW Single phase	2.5mm
Level 2	32 amps / 230 Volts	7.7kW Single phase	6.0 mm
Level 3	125 amps / 400-600 Volts DC	>50kW Three phase	16.0 mm
Notes :			
1.	Refer to AS/NZS 3008 for additional guidance on cable sizes		
2.	Although level 1 plugs and sockets are generally 15amps, charge current is often limited to 10amps		
3.	Installers of a Level 1 circuit should consider using 6.0mm cable to allow for a future upgrade to a Level 2 charge point.		

Controlling EV Charging

1. As a Controlled Load – generally Off Peak 1 (10pm to 7am)
   - DNSP's generally agree that EVs should have access to controlled load tariffs
   - Start times may need to be 'staggered' to avoid a 10pm spike
2. DRED – Demand Response Enabled Devices
   - Recent 'Smart appliance' RIS sought comment on including EV Chargers
   - No 'cost/benefit' included re EVs and the discussion was very one-sided on the potential (negative) impacts on networks
3. Time of Use Tariffs
   - Trials to date indicate this is the most popular option with EV drivers, with maximum flexibility
   - EV charging is responsive to price signals.

The Impact of EV Charging on Load Profiles

1. West Australian REV trial

   "Despite initial concerns….that EV charging will create a new demand peak in the early evening hours…this appears to be highly unlikely"

2. Ausgrid 'Smart Grid-Smart City' trial

   "…the majority (79%) of charging was performed overnight…to exploit the off-peak rate." (13 home users)

   "…fleet charging occurs during business hours with a peak at 10:00am." (7 fleet vehicles)

3. Ergon trial

   "…if the charging of EVs is well managed, they have the potential to flatten the load duration curve thus leading to better network utilisation and lower electricity costs."

4. University of Melbourne simulations

   "Using centralised load control we are able to give every single household an EV. Uncontrolled charging can introduce issues at 10-15% penetration." Dr Julian de Hoog

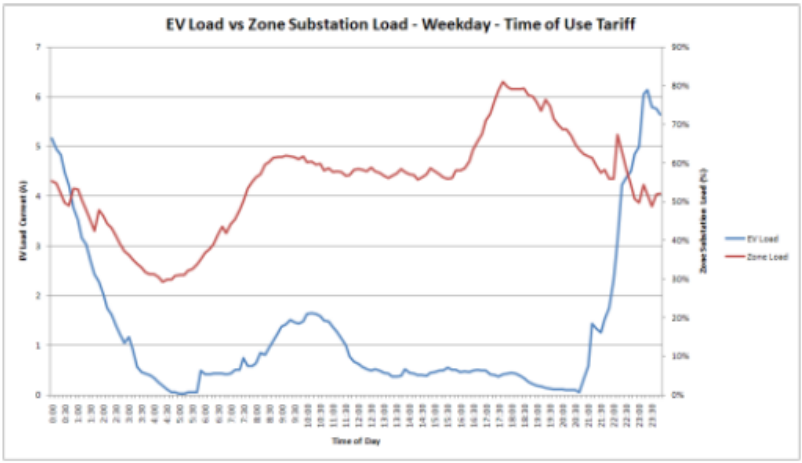

Figure 40: EV Electrical Load vs. Typical Zone Substation Load Weekday Time of Use Tariff

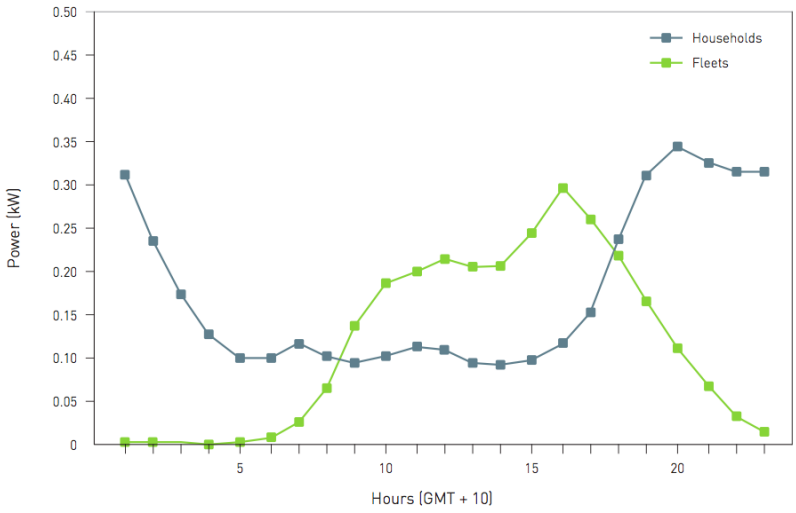

Figure 41. Electric vehicle charging demand profiles for fleet and household trial participants (n = 41 and 83 respectively).

Potential impact of EVs on Power Quality

1. LV impacts in particular phase imbalance
    - "PV voltage rise issues and EV voltage drop have a similar set of root causes." (i.e. weak LV networks) – Ergon trial
    - "based on a real distribution network of 114 houses, charging an EV at the 'weakest' bus had 21 times the impact of charging an EV near the distribution transformer." – Dr Julian de Hoog – Uni. of Melbourne.
2. Harmonics
    - "THD (voltage)….5 EVs charging (on one transformer)…there is very little difference (to no EVs charging) and well below the 8% maximum (<1.8% on all phases) – Ergon trial
    - Malaysian paper indicates harmonics do not simply summate and concerns may be unfounded (Jan 2013)
    - UK simulation suggest penetration levels up to 30% OK before third harmonic may become an issue (not THD)
    - To minimise harmonics, it is preferable to charge at peak load times rather than off-peak.

Metering of EV Charging

- Some EV owners will want a Controlled Load meter and relay, and may not be already set up for this
- Some EV Owners will want access to TOU tariffs and may not currently have an electronic TOU meter installed
- Some EV owners may want a 'private' meter on their EV charge point for personal or commercial reasons (e.g. claiming travel expenses, taxation reasons etc)
- Charge Points in public spaces will incorporate their own metering and NMI, probably with communications and be DRED enabled
- Charge Points in 'communal' areas (e.g. apartment blocks) may utilise PAYG metering technologies.

Vehicle to Grid (VTG) and Vehicle to Appliance (VTA) technologies

Vehicle to Grid (VTG) is often cited as part of the 'smart grid' of the future. However, because of low wholesale prices in the Australian market, and few 'high price' events, it is unlikely to be economically justified. A UWA paper (2012) concludes"…at first glance it is compelling, however…the economics and practical complexities ….make conventional generation or alternative storage options better…with lower infrastructure costs." Low utilisation (hence modest capacity payments) and battery wear are seen as the main barriers.

Vehicle to Appliance (VTA) was most recently topical with the i-MiEV "Powerbox" developed by Mitsubishi in response to the Fukushima Nuclear emergency. This device plugs in to the 'high current' charge socket (330V DC) on the vehicle and produces 1500 watts AC (e.g. to power a rice cooker or similar).

Dispelling some Myths about EVs

1. Range Anxiety
    - A temporary ‘ailment’ that lasts about two weeks….just carry your leads.
    - No different from understanding the range of a petrol tank
2. EV’s are Slow
    - All the production EV’s will comfortably do 110kph
    - EVs have excellent torque-speed characteristics
    - A Tesla roadster will do 0-100kph in 3.7secs (and with no gear changes required)
3. EV’s are ‘ugly’, ‘not cool’, ‘nerdish’ etc.
    - This has been largely dispelled by the Tesla roadster (based on a Lotus) and the Tesla ‘S’ type – already the No 1 selling vehicle in Norway (for Mar 2014).
4. EV’s are unsafe
    - The Tesla ‘S’ is the ‘safest car ever tested by the US authorities and had to be ‘assisted’ for the rollover test. There is no liquid fuel to catch fire in an accident.
5. EV’s will be charged at peak times
    - Owners want to minimise their charging costs or use their Solar panels. This is one of the weaknesses of the EV trials, where vehicles were ‘loaned’ and hence drivers did not invest in TOU or Off-peak charging circuits.

References and Acknowledgements

The information in this paper, including a number of the figures, is drawn largely from the various EV trial reports that are freely available on the internet, augmented by the author’s personal experiences from owning and driving an EV.

Special thanks to Dr Julian de Hoog from the University of Melbourne for providing some specific comments on their EV simulation studies currently underway.