Submission: Energy Market Arrangements for Electric and Natural Gas Vehicles (EMO0022)

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Here are comments on Approach Paper EMO0022. I have commented on the content of each electricity section, as well as provided answers to the electricity questions. I have not commented on natural gas vehicles.

Section 2.1

Section 2.1 says:

> The vehicle driving range for BEVs is around 100–150 km for most passenger cars and for PHEVs it is slightly higher.

This is perhaps misleading. The electric-only driving range for most PHEVs will be much lower than the range of BEVs, but the combined battery and fuel range will be much higher.

A typical residential charger will operate from a 15 A circuit, and so deliver about 3 kW. Charging duration will depend on the distance travelled since the last charge, but will average between two and three hours.

Question 1

Key drivers for the uptake of EVs in Australia are likely to include:

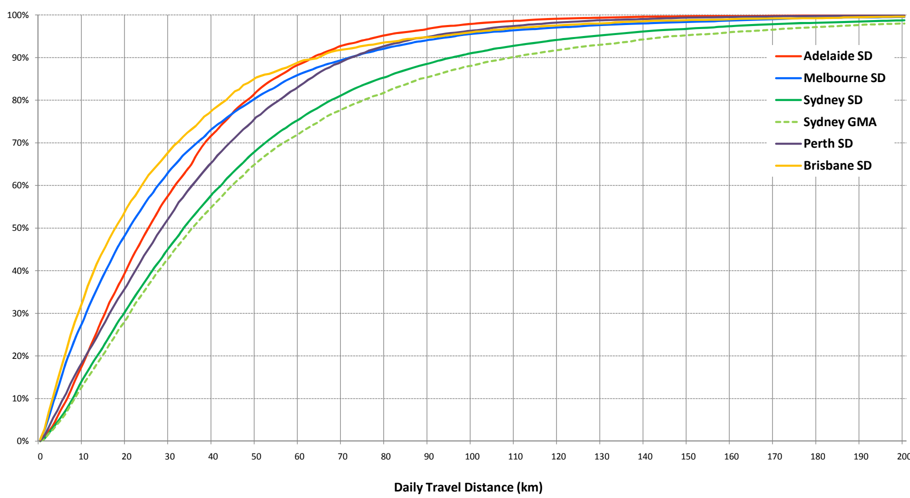
- the rising cost of oil, driven by reducing global availablilty of cheap oil and increasing global demand for oil products
- an increasing cost of CO_2 (although a carbon price on passenger car and light commercial vehicle fuels in Australia has been ruled out for now)

- the introduction of mandatory CO_2 emissions standards to apply to new light vehicles from 2015 (the level has not yet been decided).

On the other hand, availability of EVs for the next few years is likely to be limited by supply constraints. Manufacturers including Mitsubishi and Nissan have stated that they are aiming to have 20 per cent of their production to be plug-in vehicles (BEVs and PHEVs) by 2020, but this is perhaps an ambitious target.

These factors are not likely to differ significantly between NEM and WA.

The proportion of passenger vehicles travelling less than 100 km per day in Perth is more than 95%, which is similar to the proportion in Melbourne and Brisbane, and greater than the proportion of short trips in Sydney. Travel distances should not cause a significant difference in the uptake of EVs between Perth and Melbourne or Brisbane.

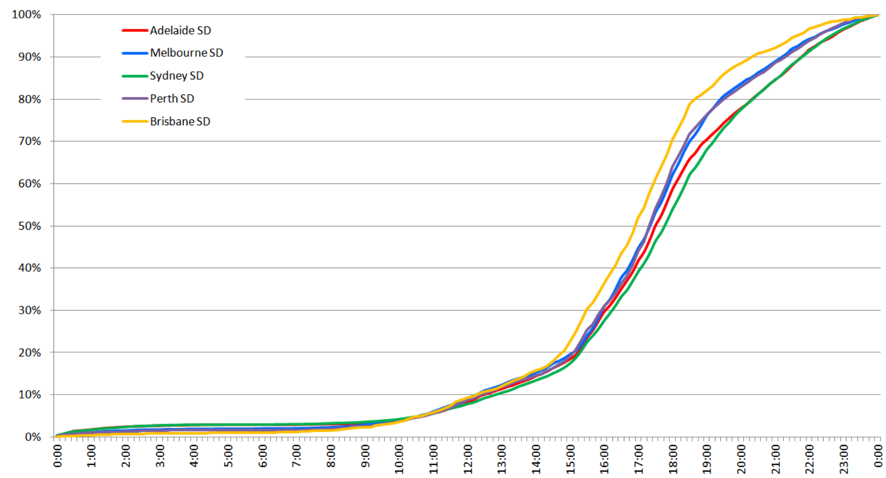


UniSA has detailed travel information for statistical divisions within each capital city.

Section 2.3

An EV designed for home charging in Australia will draw less than 15 A (3.4 kW). The 2011 model i-MiEV, for example, draws about 13 A (3.0 kW). The 2012 model i-MiEV draws less than 10 A (2.3 kW) from domestic circuits, but can draw more from EV charging stations.

UniSA has data on the distribution of times at which cars return home. The graph below shows that there is a considerable spread of arrival times; about 20 per cent arrive home before 15:00, and about 20 per cent arrive home after 20:00.



The estimate of each vehicle using 3.5 MWh per annum is perhaps high. The Nissan Leaf has a consumption of about 175 Wh/km. With an annual distance travelled of 15000 km, the annual energy use will be 2.6 MWh. For an i-MiEV, with 135 Wh/km, the annual energy will be 2.0 MWh. (Reported energy consumption is based on Australian Design Rules drive cycles; consumption in practice could be up to 30 per cent higher. UniSA is currently logging EVs in South Australia to determing real-world performance.)

The term 'V2G' often refers to all grid services, not just those involving power transfer from the car.

PHEVs are unlikely to have enough battery capacity to export power to the grid. They could potentially use their engines to generate power for export, but this would be less efficient than dedicated generators.

Question 2

One of the key benefits of EVs for the grid is that they can be a controlled load, typically requiring only a few hours of charging overnight. Furthemore, the rate of charging could be finely controlled without adversely affecting the battery.

Initially, control could be done using:

- time-of-day pricing or price that increases with load, and simple charge timers either built into the car controls or external

- Demand Response Enabling Devices (AS 4755) responding to commands to pause charging, charge at half power, or start charging early.

Eventually, however, more sophisticated charging systems could respond to dynamic pricing information and dynamic information on the availability of renewable energy, work with other household load management systems such as Smart Energy and OpenADR, and transfer energy from the vehicle when required. Both the Society of Automotive Engineers (North America) and the International Electrotechnical Commission (Europe) are developing standards for communication between vehicles and the grid. The relevant standards include:

- SAE J2836, J2847/1: Communication Between Plug-in Vehicles and the Utility Grid
- SAE J2836, J2847/2: Communication between Plug-in Vehicles and the Supply Equipment (EVSE)
- SAE J2836, J2847/3: Communication between Plug-in Vehicles and the Utility Grid for Reverse Power Flow
- SAE J2836, J2847/4: Diagnostic Communication for Plug-in Vehicles
- SAE J2836, J2847/5: Communication between Plug-in Vehicles and their customers
- SAE J2931: Communication for plug-in electric vehicles
- IEC 15118: Vehicle to grid communication interface
- AS 4755: Demand response capabilities and supporting technologies for electrical products
- ZigBee, HomePlug: Smart Energy 2.0
- OpenADR: Automated Demand Response

Section 2.4

Early experience in Japan and in the UK has shown that some public charging infrastructure is required to give people the confidence to use EVs, but that most charging is done at home. It is important not to over-invest in public infrastructure.

Question 3

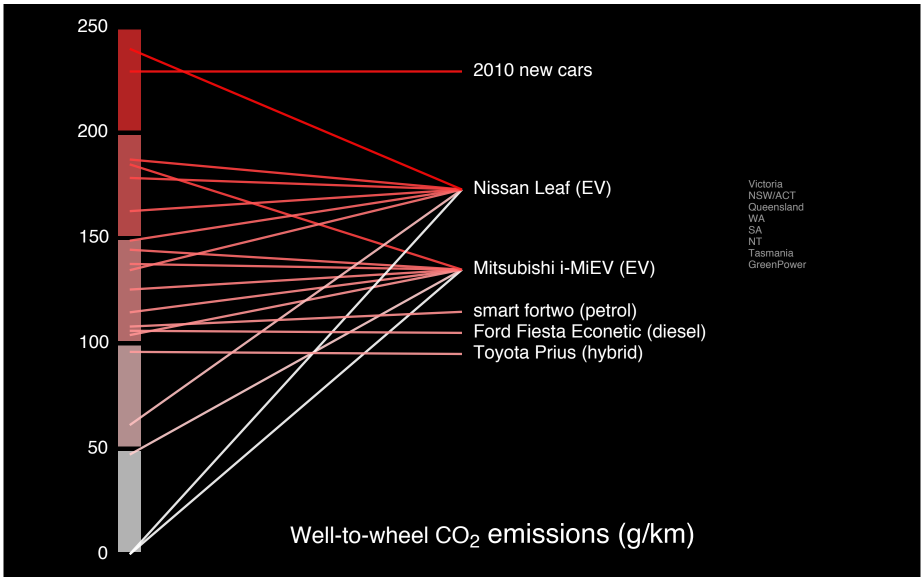
The ultimate goal should be to move from the current electricity system where supply is varied to meet the (largely uncontrolled) demand, towards a system where demand can be varied to meet the available supply of renewable energy (also taking into account transmission and distribution constraints). Mechanisms for controlling demand could include:

- time-of-day pricing
- price-per-watt that increases with power use, to encourage energy efficiency and load levelling
- dynamic pricing that responds to fluctuations in the cost of generation
- other dynamic signals, such as the availability of renewable power or capacity constraints (household, street transformer, substation)
- mechanisms for dynamic, ad hoc aggregation of demand (or supply from EV batteries) on sub-networks
- mechanisms for trading power and energy quotas.

(I am particularly interested in the design of mechanisms for controlling demand and sharing the available supply of electricity, and will continue to do research in this area.)

Ultimately, the distribution network will need to support communication with load control systems, and support distributed generation and storage.

It is crucial that the uptake of renewable generation exceeds the increase in demand for electricity due to EVs, since EVs powered from coal have about the same CO_2 emissions as comparable conventional cars. In fact, low emission conventional cars have significantly lower CO_2 emissions than EVs recharged from coal. But EVs recharged from renewable energy have effectively zero CO_2 emissions.



The cost of charging an EV using GreenPower is about one third the cost of refuelling a conventional car.

If all passenger car travel in the NEM region was electric, the extra energy required would be about 11 per cent of the current NEM demand. Coping with a gradual uptake of EVs should not be difficult.

There is considerable scope for integrating EVs with renewable generation through load control mechanisms, and ultimately for controlling the supply of electricity from renewable sources using EV storage.

Question 4

I am not familiar enough with the National Electricity Rules to give a detailed answer to this question. However, the National Electricity Objective does not appear to include 'sustainability'. It should.

Question 4 does not address *why* you would change the regulatory arrangements to facilitate the uptake of EVs. The answer is that there are benefits for both transport and electricity supply:

- controlled charging of electric vehicles can improve the load factor of the grid
- controlled charging and discharging of electric vehicles can be used to absorb fluctuations in the supply of renewable energy
- electric vehicles recharged from renewable energy produce no air-toxic emissions or CO_2.

Natural Gas Vehicles

I do not have sufficient knowlege of Natural Gas Vehicles or of the natural gas market to make detailed comments. I will, however, pose two questions (for which I do not know the answers):

- Australia has plenty of natural gas, but is there enough natural gas in the world for global automotive companies to consider developing engines optimised for natural gas, and to ensure the development of refuelling infrastructure?
- Which is the lower-emission energy pathway: natural gas - tank - combustion engine - wheels, or natural gas - electricity - battery - electric motor - wheels?

More information

Reports from the Auto CRC project *Planning for electric vehicles in Australia* are availble from:

`http://scg.ml.unisa.edu.au/autocrc/ev_planning/final_reports/`

UniSA and the Auto CRC are currently completing projects which assess the applicability of EVs in Australia, and smart charging.