Electric Vehicle integration in the NEM: implications for passenger vehicle emissions

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Low Carbon Living CRC
Low Carbon Transport Research Workshop
Adelaide, October 2013
A low carbon challenge for petroleum transport

**FIGURE 5** (Pitt and Sherry, CEDEX, 2013)

**FIGURE 6**

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EV integration in the grid - implications for policy
...and possible opportunity

Changes in electricity generation emissions

(Pitt and Sherry, CEDEX, 2013)

Changes in electricity generation fuel type

EV integration in the NEM: emissions implications
Still a long way to go to decarbonise electricity

EV integration in the NEM - emissions implications

but promising progress

<table>
<thead>
<tr>
<th>Energy source</th>
<th>South Australia registered generation capacity</th>
<th>Electricity generated in 2012–13 by energy source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Megawatts (MW)</td>
<td>Percentage of total</td>
</tr>
<tr>
<td>Gas</td>
<td>2,672</td>
<td>50%</td>
</tr>
<tr>
<td>Wind</td>
<td>1,203</td>
<td>23%</td>
</tr>
<tr>
<td>Coal</td>
<td>770</td>
<td>14%</td>
</tr>
<tr>
<td>Rooftop Pvi</td>
<td>400</td>
<td>7%</td>
</tr>
<tr>
<td>Diesel</td>
<td>270</td>
<td>5%</td>
</tr>
<tr>
<td>Landfill methane/</td>
<td>16</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>landfill gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydro</td>
<td>3</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Total</td>
<td>5,334</td>
<td>100%</td>
</tr>
</tbody>
</table>

Solar PV Capacity in Australia
(ESAA, 2013)

SA Wind Power vs SA Demand
..and potential eg. AEMO 100% Renewables Study, 2013

(AEMO, 2013)
A range of Australian studies – deployment potential, economics, integration
... and potential emissions implications
UNSW CEEM Project on EV integration

- Maximising the economic value of EV integration into the Australian National Electricity Market
  - Residential, distribution and system level
  - Unmanaged, scheduled, ‘smarter’ managed

- Related work on
  - High renewable penetrations in NEM
  - Distributed storage: potential value, institutional challenges
  - Distributed energy infrastructure, markets policy, regulatory frameworks

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Electric car network 'ahead of schedule'

Barry Park
July 26, 2011 - 4:56PM

Better Place says its Canberra recharging strategy is now ready to roll out.

Electric car infrastructure company Better Place says it will soon start out recharging points across Canberra — months ahead of its original schedule.

According to Better Place chief executive Evan Thomley, seven existing recharging points around Australia’s national capital will soon expand to “quite a lot more” after the company signed on 12 new members to its Canberra network.

The company said today that the 12 foundation members of the network — the ACT Government, the ACT Electric Vehicle Council, ActewAGL, Canberra Airport, Capital Hotel Group, CIT Australia, Crowne Plaza, Hindmarsh, Lend Lease, the National Convention Centre, Rock Development Group, and TransACT — will support the electric car network, with Better Place’s public recharging stations installed at member sites.

“Today’s announcement is the next step in the installation of Better Place’s full charge network in the region,” Thomley says.

“It is the next step towards zero-emissions driving in our nation’s capital, and the introduction of mainstream electric cars that will be affordable and convenient for Canberra drivers.”
EV Charge/Battery SOC Modelling

- EV charging depends on: underlying transport requirements/charging infrastructure availability/charging control approach;
- Vehicle trip behaviour was obtained from the NSW Household Transport Survey;
- A Plug in Hybrid (similar to a Volt) was used in modelling;
- Control state logic was applied to model charge control/different approaches to EV integration;
- Vehicle charging and battery SOC was then simulated across the survey day for each vehicle (weekday-weekend).
Model Tool

Disclaimer(s)

- We used trip data for existing ICE Sydney vehicle fleet;
- Assumes that EV transport mirrors that of ICE transport;
- Model doesn’t include informed decision making w.r.t. charging (yet)
Scenario Space

- **Charging Infrastructure:**
  - Residential only;
  - Residential + Commuter off-street;
  - Universal off-street;

- **Charging Rate:**
  - Slow - 10A;
  - Medium – 15;
  - Fast - 32A;

- **Charging Control:**
  - Un-managed;
  - Time of Use;
  - Overnight valley filling.
Temporal Characteristics of EV Charging

Residential Infrastructure – Impact of charge control approach

Un-managed Charging – Effect of charging infrastructure availability
Modelling EV Emissions

- Electricity emissions are a function of when EV charging occurs;
- Electricity emissions can be assessed on either a marginal basis, or an average basis;
- Renewable generation is almost never marginal so average and marginal emissions can differ significantly (SA as an example);
- The marginal emitter was identified from the generator setting the price in the SA and NSW NEM pools in 2011;
NEM/NSW and SA – Annual Average
EV Emissions (2011)

Average

Marginal

EV integration in the NEM - emissions implications
Looking Forward

- The future electricity industry will look different from today’s;
- EVs could be beneficial in allowing higher RE penetrations than otherwise possible;
- But… there needs to be adequate flexibility in charging to respond to RE generation;
- Charging infrastructure availability is important to provide the flexibility to charge according to wind/solar availability.
EV Charge Control – Solar
(impact of charging infrastructure availability)

![Graph showing the impact of charging infrastructure availability on EVs](image)

EV integration in the NEM - emissions implications
Conclusions

- Charging infrastructure availability is a key variable which effects:
  - Marginal and Average emissions from charging;
  - Flexibility to move charging load to correlate with RE.
- A trade off is observed between the economic interests of the Electricity Industry and Emissions – Challenge for policy makers
- Lots of more work could be done in this space
Thank you… *questions and discussion*

*Many of our publications are available at:*

www.ceem.unsw.edu.au