





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

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School of Electrical Engineering and Telecommunications Centre for Energy and Environmental Markets (CEEM) Low Carbon Living CRC Low Carbon Transport Research Workshop Adelaide, October 2013



A low carbon challenge for petroleum transport



Centre for Energy and Environmental Markets













EV integration i

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Still a long way to go to decarbonise electricity



EV integration in the NEM - emissions implic

Centre for Energy and Environmental Markets	Energy source	South Australia registered generation capacity		Electricity generated in 2012–13 by energy source		
		Megawatts (MW)	Percentage of total	Gigawatt hours (GWh)	Percentage of total	
	Gas	2,672	50%	6,786	52%	
but promising	Wind	1,203	23%	3,483	27%	
but promising	Coal	770	14%	2,238	17%	
prograss	Rooftop PV ^a	400	7%	497	4%	
progress	Diesel	270	5%	12	<1%	
	Landfill methane/ landfill gas	16	<1%	55	<1%	
	Hydro	3	<1%	6	<1%	
	Total	5,334	100%	13,077	100%	
Solar PV Capacity in Australia		(AEMO, SA Report, 2013)				
3,000	۲ ۵	5				
(ESAA, 2013) 2,500 2,000 1,500 1,000 End of Solar Bonus Scheme, April 2011 Credits Multiplier,	(LOAA, 2013) - 4 - 3 - 3 - 3 - 3 - 3 - 3 - 4 - 3 - 3 - 3 - 3 - 4 - 3 - 3 - 4 - 3 - 3 - 4 - 3 - 4 - 3 - 2.1 June 2012 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -		5 (Joshi, <u>www.reneweconomy.com.au</u> , August 2013) 5 (Joshi, <u>Joshi</u> , <u>J</u>			
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AICH_UNIT_SC 5-Minute Resolution using DUID expressing initial generation at beginning of Dispatch Interval Summarised using AEMO Registration/Exemption listing Ketan Joshi - Research/Communications, Infigen Energy. Twitter :@ArghJoshI or @Infigen

EV integration in the NEM - emissions implications





..and potential eg. AEMO 100% Renewables Study, 2013



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A range of Australian studies – deployment potential, economics, integration



Economic Viability of Electric Vehicles

Department of Environment and Climate Change 4 September 2009

AECOM

Australian Energy Market Commissior

FINAL ADVICE

Energy market arrangements for electric and natural gas vehicles

Commissioners Pierce Henderson Spalding

11 December 2012

REVIEW



Building the Electric Vehicle Market in Victoria: **Policy & Technology Scenarios**

June 2012



Reference: EMO0022 Final Advice



EV integration in the NEM - emissions in place



... and potential emissions implications



RENEWABLE TRANSPORT:

How Renewable Energy and Electric Vehicles using Vehicle to Grid technology can make Carbon Free Urban Development.

By Andrew Went, Peter Newman and Wal James



Centre for Energy and Environmental Markets



(Melbourne Energy Institute, 2012)







UNSW CEEM Project on EV integration

 Maximising the economic value of EV integration into the Australian National Electricity Market

> Barry Park July 26, 2011 - 4:56PM

- 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



Electric car network 'ahead of schedule'

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 Thornley, 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, CIC 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

"Today's announcement is the next step in the installation of Better Place's full charge network in the region," Thornley 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."

Comments 6

recharging stations installed at member sites.



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

Weekend

Hours of the Day









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









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)







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

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