Will electric vehicles break the network?

Matthew Stocks
Research School of Engineering
http://re100.anu.edu.au
Emissions Reductions - Electrify everything

Australian GHG emissions

- 35% Electricity
- 13% Land transport
- 7% Low temperature heat
- 11% High temperature heat
- 4% Aviation & shipping
- 4% Industrial processes
- 8% Fugitive emissions
- 18% Land sector & other

55% of emissions:
- PV + wind
- Electric vehicles
- Electric heat pumps

Gigawatts from 2016 to 2018:
- PV + wind
- Everything else
- Fossil + nuclear + hydro + others
EVs are gaining traction

Global Sales of Electric Vehicles and Plug-in Hybrids

EVs - 50% year on year growth

Running costs

• Petrol
  – 7l/100km @ $1.40/l => 10c/km

• Electric
  – 6km/kWh @ 28.7c/kWh => 5c/km (peak)
  – 6km/kWh @ 16.6c/kWh => 3c/km (off-peak)

1 kW PV panel on your house roof
• Produces 1,500 kWh per year
• Lasts 25 years (= 2 cars)
• Drives an electric car 9,000 km/year
• Costs <$2,000

=> PV energy costs 1 cent per km
Price parity in the late 2020s?

Getting Competitive
Battery prices seen reaching key level of $100 per kilowatt hour by 2026

- Actual lithium-ion prices
- BNEF projections

Source: Bloomberg New Energy Finance
Electricity demand for EV’s

- Based on ABS fuel use data
- Assume 4x better energy efficiency i.e. 7l/100km ~ 6km/kWh

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage of current electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger vehicles</td>
<td>19%</td>
</tr>
<tr>
<td>Motor cycles</td>
<td>0%</td>
</tr>
<tr>
<td>Light commercial vehicles</td>
<td>6%</td>
</tr>
<tr>
<td>Rigid trucks</td>
<td>3%</td>
</tr>
<tr>
<td>Articulated trucks</td>
<td>5%</td>
</tr>
<tr>
<td>Non-freight carrying trucks</td>
<td>0%</td>
</tr>
<tr>
<td>Buses</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>34% more electricity required</td>
</tr>
</tbody>
</table>
Time of day matters

Persons travelling on motorised modes by time of day, average weekday and weekend, 2012/13

From Sydney Greater Metropolitan Region Travel Survey
Most drivers don’t drive far

Three quarter of all drivers cover only half the total distance travelled
The really big battery

- Light vehicle capacity around 50kWh (~300km range)
- ~17 million light vehicles
  - 850GWh of battery capacity
  - South Australia’s Tesla 0.1GW/0.13GWh
  - Snowy 2.0 2GW/350GWh
  - Our work on 100% renewables needs ~20GW/500GWh

- Average journey 35km
  - 85% of total battery capacity idle each day
  - Huge opportunity for flexible charging decisions
Fixed (or dumb) charging

Simulate SA electricity network
• Include expected rooftop PV
• Add sufficient announced wind and solar farms to meet annual demand
• Simulate five years of supply/demand
Fixed (or dumb) charging

Ok, we broke it!!!
Fixed (or dumb) charging
• Parking Garage example from Power Flex Systems
Electric car ferry

- 2 Li-polymer batteries = 520 kWh each
- Each pier has 260 kWh battery, to recharge ferry, doesn’t draw on local grid.
  - Avoided costly network augmentation
- Quiet operation, saves 1 ML diesel per year
- Specially designed to be lightweight
- 150 kWh per trip
Planning uncertainty

• This work assumed current vehicle usage patterns
  – Future: autonomous service, shared, individual ownership?
  – Each has different energy use and charging expectations

• Huge opportunity to manage vehicle charging
  – What model will influence behaviour sufficiently (and fairly?)
  – Petrol demand very inelastic with price
  – Social science problem – what incentives provide right outcomes?

• Vehicle to grid???
Summary

• High penetration EVs significant addition to electric demand
• Tremendous spare capacity – flexibility in charging
• Simple daytime charging (PV alignment) lower cost
• Smart charging to help manage networks
  – Technically doable
  – Lots of uncertainty around usage patterns and incentives