100% Renewables for Australia?

Challenges and Opportunities

Dr Jenny Riesz
Solar Supercharge, QUT, 14th February 2016
Who am I?
Renewable technologies

Variable & non-synchronous
Optimising generation mix

System cost

0% variable
Least cost mix
100% variable

Proportion of variable renewables

Generation capital cost

Integration cost
(Voltage/Frequency management)
J. Riesz, J. Gilmore, (2014) “Does wind need “back-up” capacity – Modelling the system integration costs of “back-up” capacity for variable generation”. International Energy Workshop (Beijing)

Wind displaces baseload generation

A new power system paradigm
## Engineering challenges

<table>
<thead>
<tr>
<th>Frequency control - seconds (inertia)</th>
<th>Frequency control - minutes (regulation)</th>
<th>Frequency control - hours (ramping)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Displacement of synchronous generation</td>
<td>• Increasing variability and uncertainty → increase in regulation reserves</td>
<td>• Managing long wind &amp; PV ramps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fault level in-feed</th>
<th>Grid code performance standards</th>
<th>Reliability and Resource Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Non-synchronous technologies don’t provide sufficient fault feed-in</td>
<td>• New reactive power and voltage support capabilities required during disturbances</td>
<td>• Need to assess differently to present</td>
</tr>
<tr>
<td>• Protection systems may no longer be able to determine when and where a fault has occurred</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessment by Australian Energy Market Operator (AEMO)

- Responsible for operating the grid
- Study on 100% renewables in 2013:
  - Reliability standard maintained
  - Operational issues “appear manageable” (high level review, based upon international research)

“High penetrations of semi-scheduled and non-synchronous generation would constitute a system that may be at or beyond the limits of known capability and experience anywhere in the world to date…”

but...

“There are no fundamental technical limitations to operating the given 100 per cent renewable NEM power system generation portfolios that have been identified.”
<table>
<thead>
<tr>
<th>Cost for 100% renewables (AEMO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total capital cost including transmission</td>
</tr>
<tr>
<td>Wholesale cost including opex</td>
</tr>
</tbody>
</table>

- 20% increase in total bill
Costs are going up anyway...

Summary

- 100% renewables is technically feasible
- Some technical challenges remain
  - But high confidence they will be solved as we progress
- Costs are similar to those we’ll probably be paying anyway
  - 20% increase in electricity bills from present?
  - And bills are likely to go up regardless
Thank you
jenny.riesz.com.au
ceem.unsw.edu.au