The impact of technology availability on the costs of 100% RE scenarios

*Australian Case Study*

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Background

- Several studies now modelled scenarios with 100% RE modelled for Australian National Electricity Market (NEM)
  - UNSW, BZE, Australian Energy Market Operator

But significant uncertainty over technology costs and availability
- What if bioenergy is further limited?
- What if geothermal doesn’t eventuate?
- What if there are NIMBY constraints on wind development?

How might scenario costs change if technology availability changes?
Modelling - NEMO

- Evolutionary program to optimise the mix of generating technologies
  - Meet hourly demand profiles over a year, to meet the Reliability Standard, at least cost
- Costs based upon the Australian Energy Technology Assessment (AETA)
  - Published annually by Australian Government
  - Projected for 2030
- Hourly solar and wind profiles for range of locations (smoothing)
  - Based upon 2010 weather variability
- Constraints:
  - Hydro limited to existing 12 TWh pa
  - Bioenergy limited to 20 TWh pa
  - Maximum synchronous generation of 85%
  - NEM Reliability Standard met in all case (0.002% USE pa)

Scenarios

- Removed technologies one by one, and in groups
  - EGS and HSA Geothermal
  - CST
  - Wind, PV
- Progressively reduced bioenergy availability
- Modelled least cost generating portfolio
  - Calculated scenario costs
Technology availability - energy

- All meet reliability standard
  - Robust ability to achieve 100% RE
- Costs $65 - $87 /MWh
  - Most expensive scenarios don’t have wind
  - Costs vary by only 10% in all scenarios with wind
  - Wind typically provides ~70% of energy
Technology availability - capacity

- Significantly less capacity installed in no-wind scenarios
  - But costs are much higher
- Bioenergy operation depends upon the mix
  - Higher capacity factors in scenarios with limited other synchronous generation options (meeting synchronous generation constraints)
  - Much lower capacity factors in no-wind scenarios (peakers only)
Bioenergy availability

- Some opposition to using bioenergy for electricity
  - Native forests, competition with food production
  - How do costs change if bioenergy is constrained to lower levels?

- Reducing bioenergy availability increases costs significantly
  - +$20 - $30/MWh

- Even having 0.1 TWh of bioenergy available per year reduces average costs by $3 - $4 /MWh

- Strongest effect when geothermal isn’t available
  - Need to include more expensive concentrating solar thermal to compensate

Synchronous generation constraint increases costs, but isn’t the main driver of cost escalation with reducing bioenergy availability (more related to bioenergy peaking capacity role)
Bioenergy availability

- Reducing bioenergy causes more geothermal to be installed
  - And less wind
  - Wind and geothermal are interchangeable on a portfolio basis
  - Wind is like baseload
- Still a significant capacity of bioenergy installed even when only 0.1TWh available
  - Peaking role (avoids installation of geothermal for rare peak periods)
Without geothermal:

- As bioenergy availability reduces, more CST is installed
- CST has progressively lower capacity factors as bioenergy is removed
  - CST is moving into more of a peaking role
  - Less economically optimal
  - Even when only 0.1TWh of bioenergy is available, a significant capacity is installed (for peaking)
Without synchronous generation constraint:

- Costs are reduced because CST operates less
  - Less surplus, use wind in more periods
- Install less CST when bioenergy is available
- CST still required if bioenergy not available
  - Being used in a peaking role
Conclusions

- Wide range of possible portfolios of 100% RE
  - Costs vary by less than 10% if wind is available
  - Robust to changing technology cost and availability assumptions
- Wind is the most important technology
  - ~70% of energy in all lowest cost portfolios
  - Costs escalate significantly without wind (20-30%)
- Presence of even a small amount of peaking renewable capacity can significantly reduce costs
  - “Baseload” renewables aren’t the problem!
  - Development of viable peaking renewables (low capital, high SRMC) is extremely important
  - Demand-side participation may be an alternative here (future work)
Thank-you

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