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

Australian Case Study

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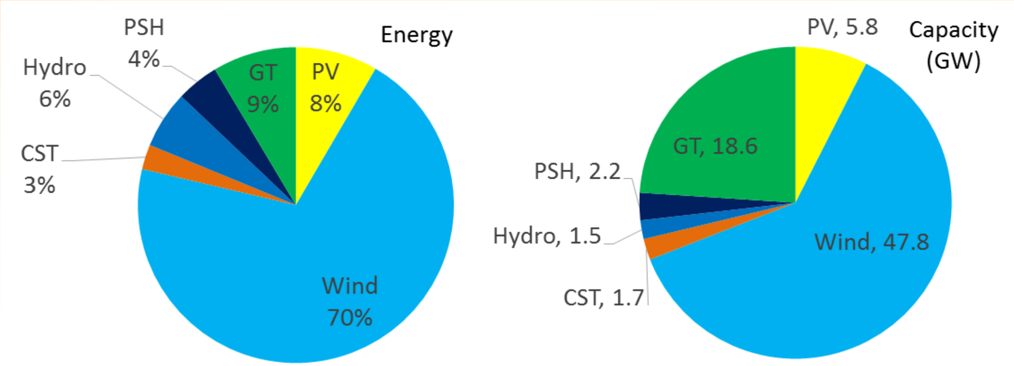
Background

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

Least cost 100% RE mix (UNSW modelling)



- 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)

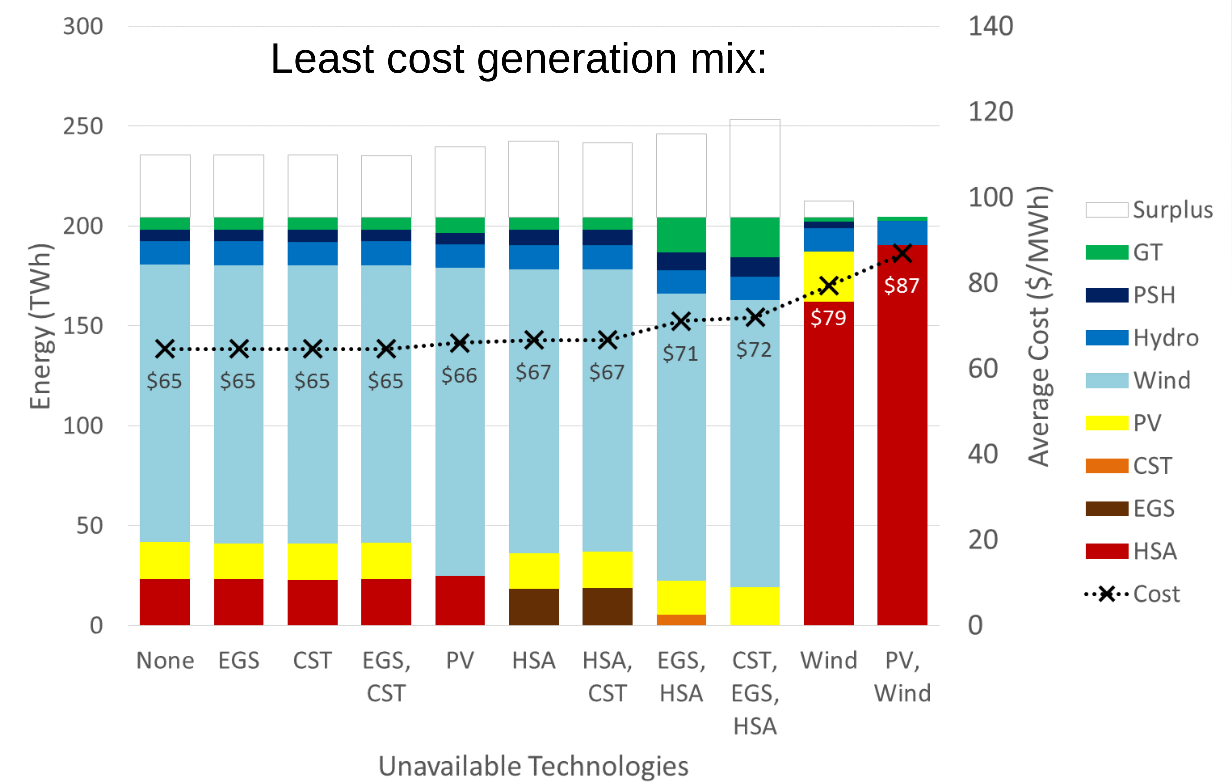
B. Elliston, M. Diesendorf and I. MacGill, "Simulations of scenarios with 100% renewable electricity in the Australian National Electricity Market," Energy Policy, vol. 45, pp. 606-613, 2012.

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

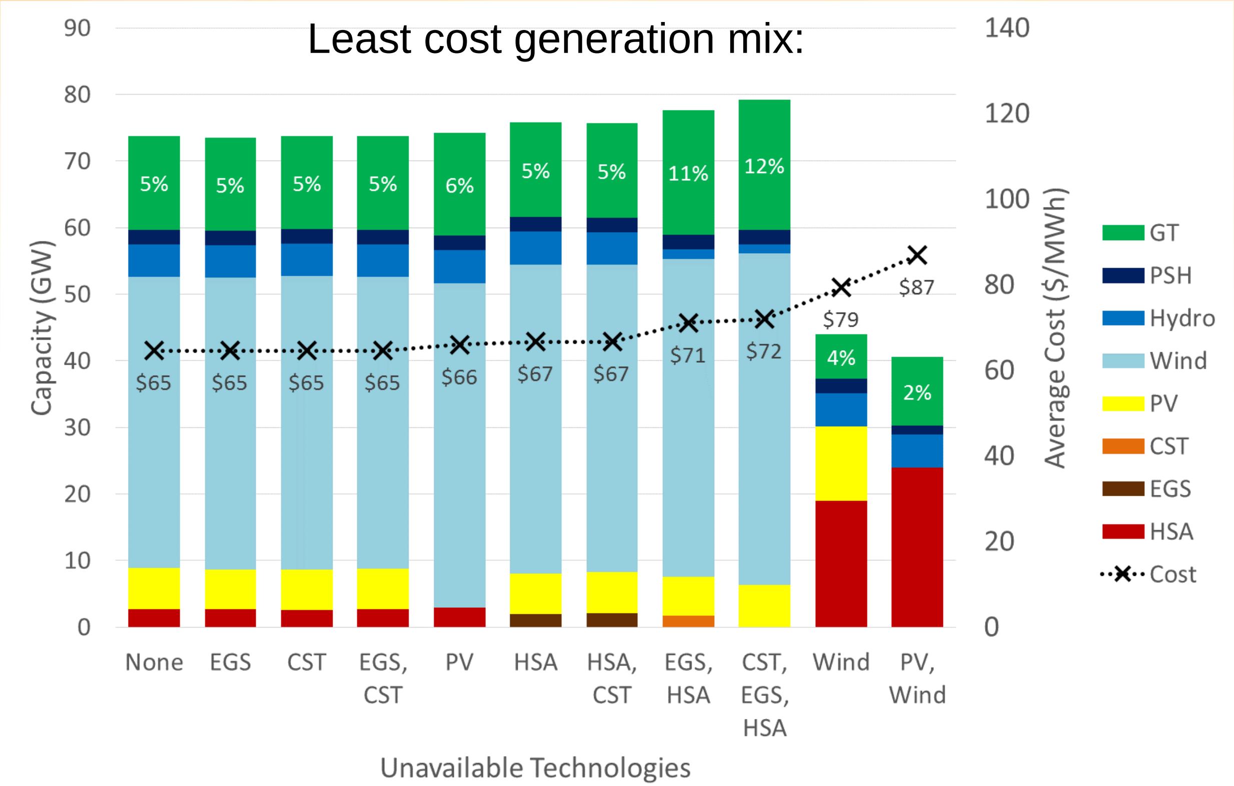
Technology availability - energy

- 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

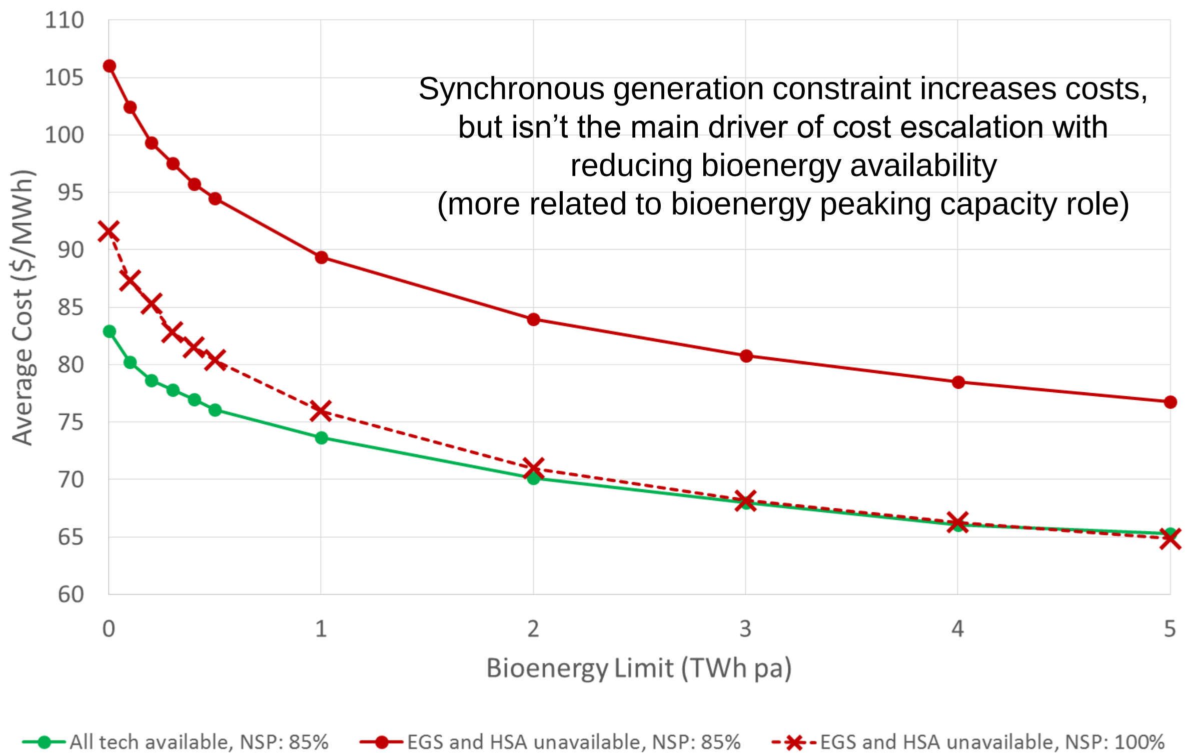
- Significantly less capacity installed in no-wind scenarios
  - But costs are much higher
- Bioenergy operation depends upon the mix
  - Higher capacity factors in scenarios with limited other synchronous generation options (meeting synchronous generation constraints)
  - Much lower capacity factors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

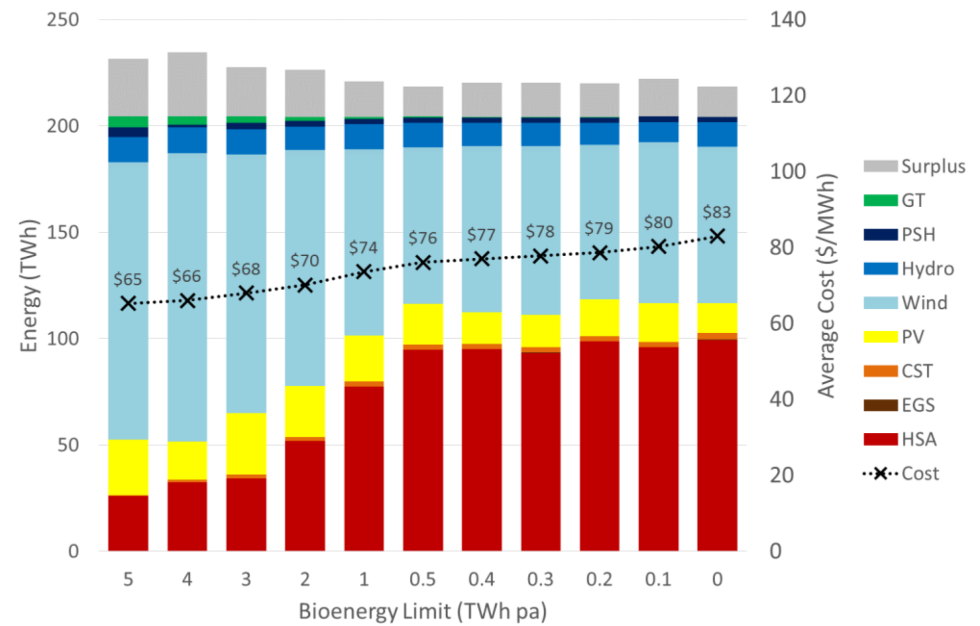
- Reducing bioenergy availability increases costs significantly
  - +$20 - $30/MWh
- Even having 0.1TWh of bioenergy available per year reduces average costs by $3 - $4 /MWh
- Strongest effect when geothermal isn't available
  - Need to include more expensive concentrating solar thermal to compensate

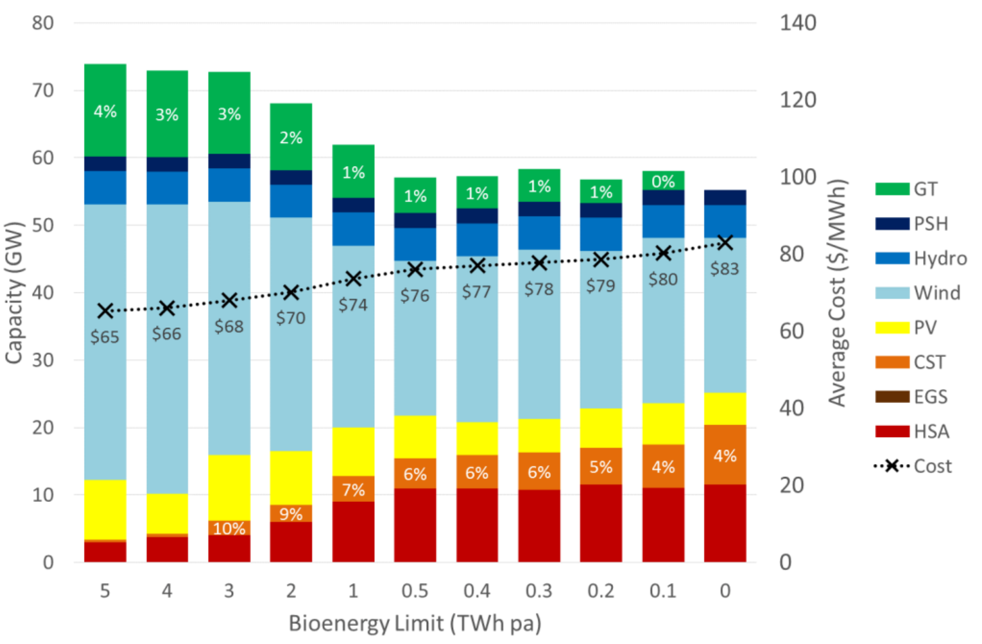


Bioenergy availability

- 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)

All technologies available, NSP: 85%





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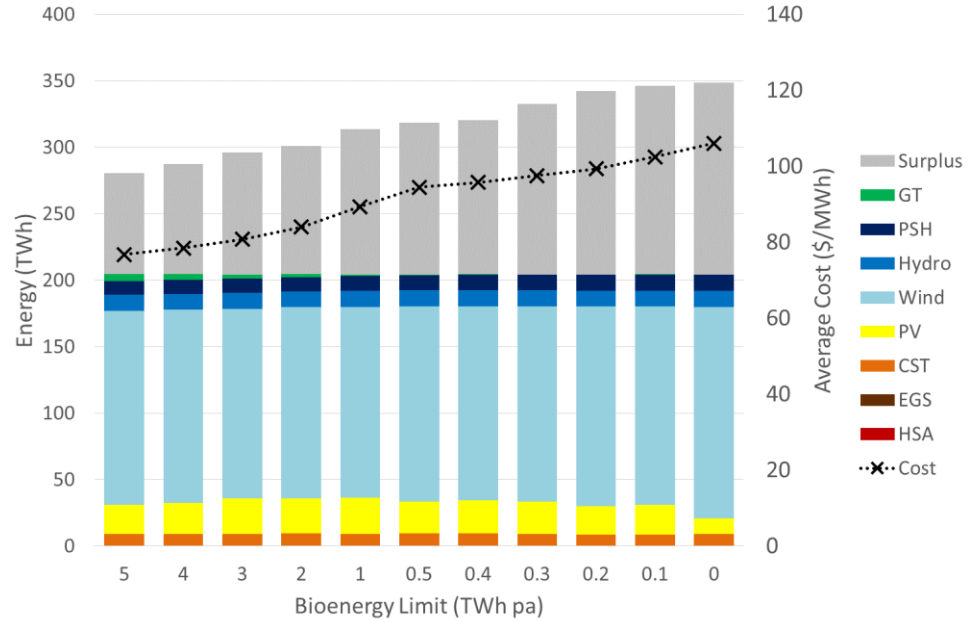
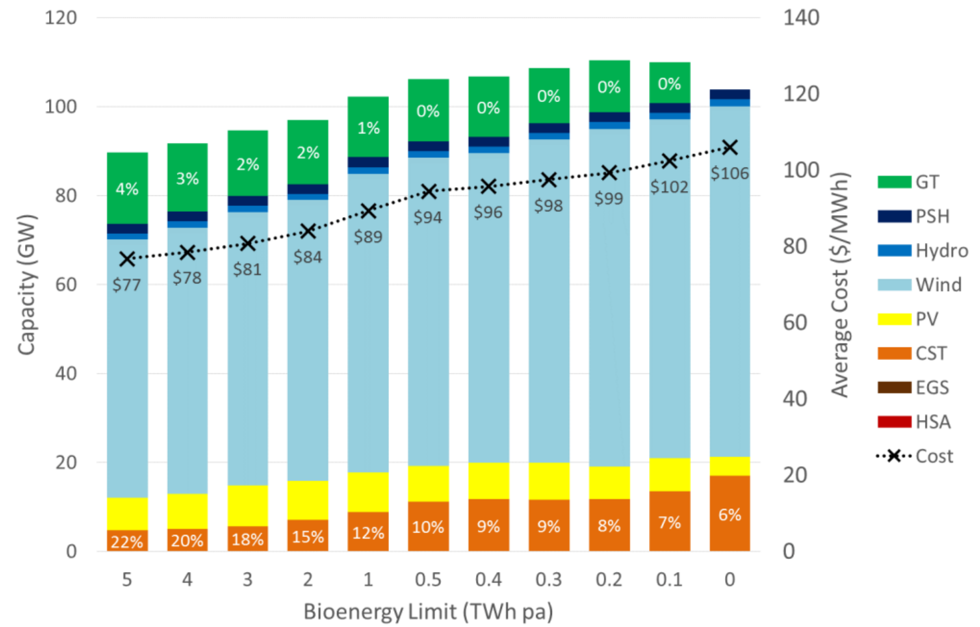
Geothermal unavailable, NSP: 85%

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)





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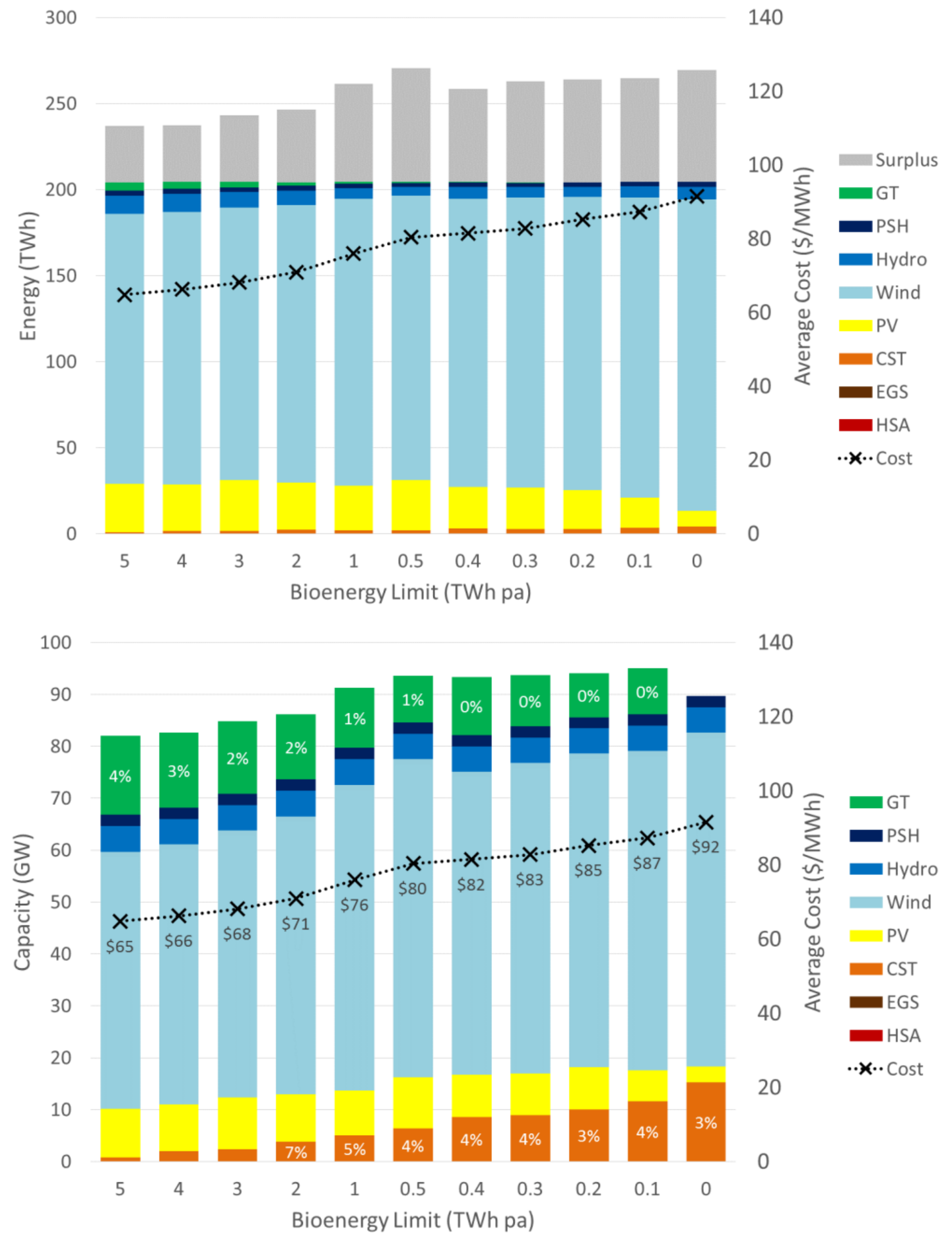
Without synchronous generation constraint:

- 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

Geothermal unavailable, NSP: 100%



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)

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Thank-you

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