Impact of Wind Farm Dispersion Across the Australian NEM on Wind Penetrations in Least-cost 100% Renewable Electricity Scenarios

Never Stand Still | Engineering

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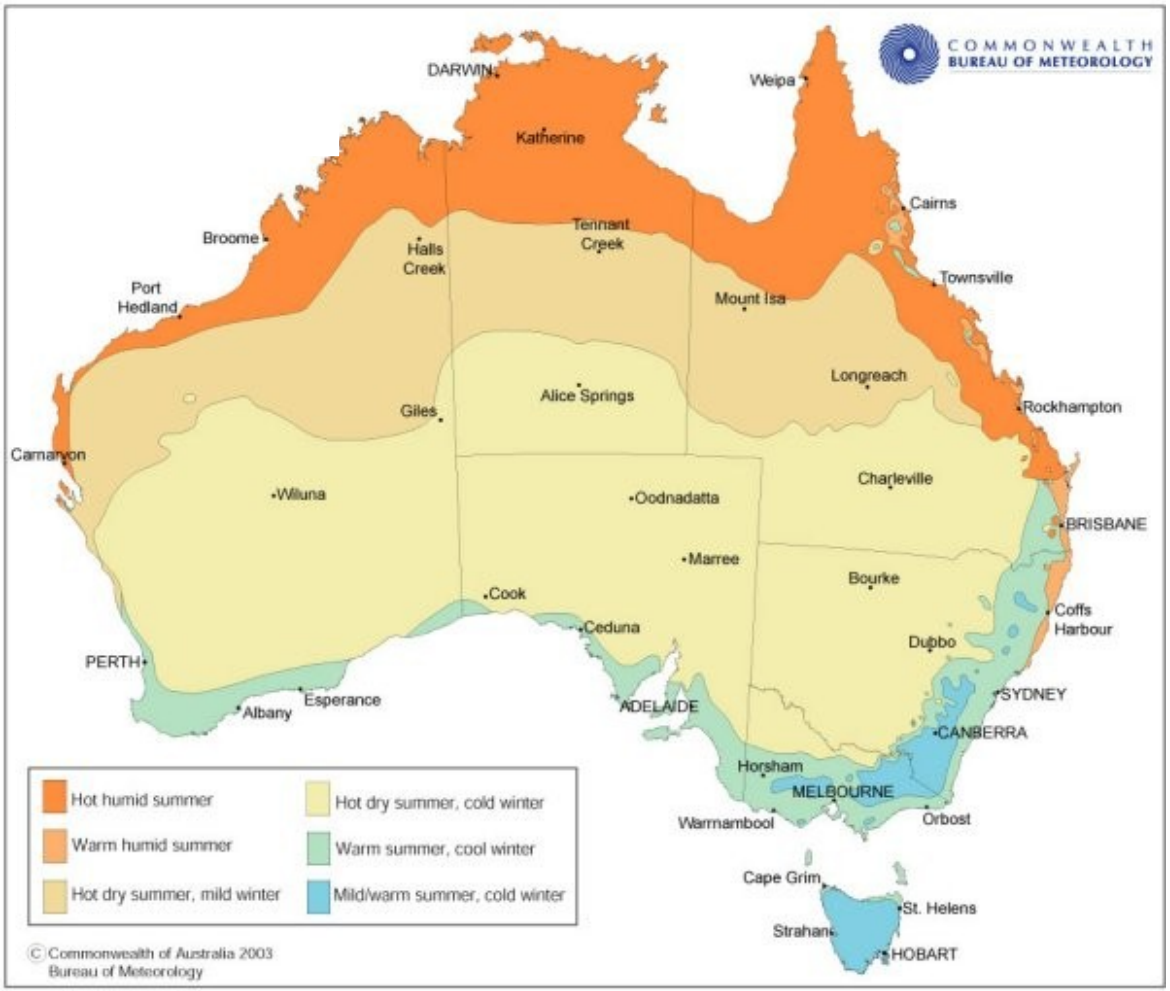
Outline

- Introduction to 100% RE simulations in NEM
- Our previous work on relocating wind
- Application of a new (ROAM) wind data set
- Results
- Conclusions

Australian climate zones



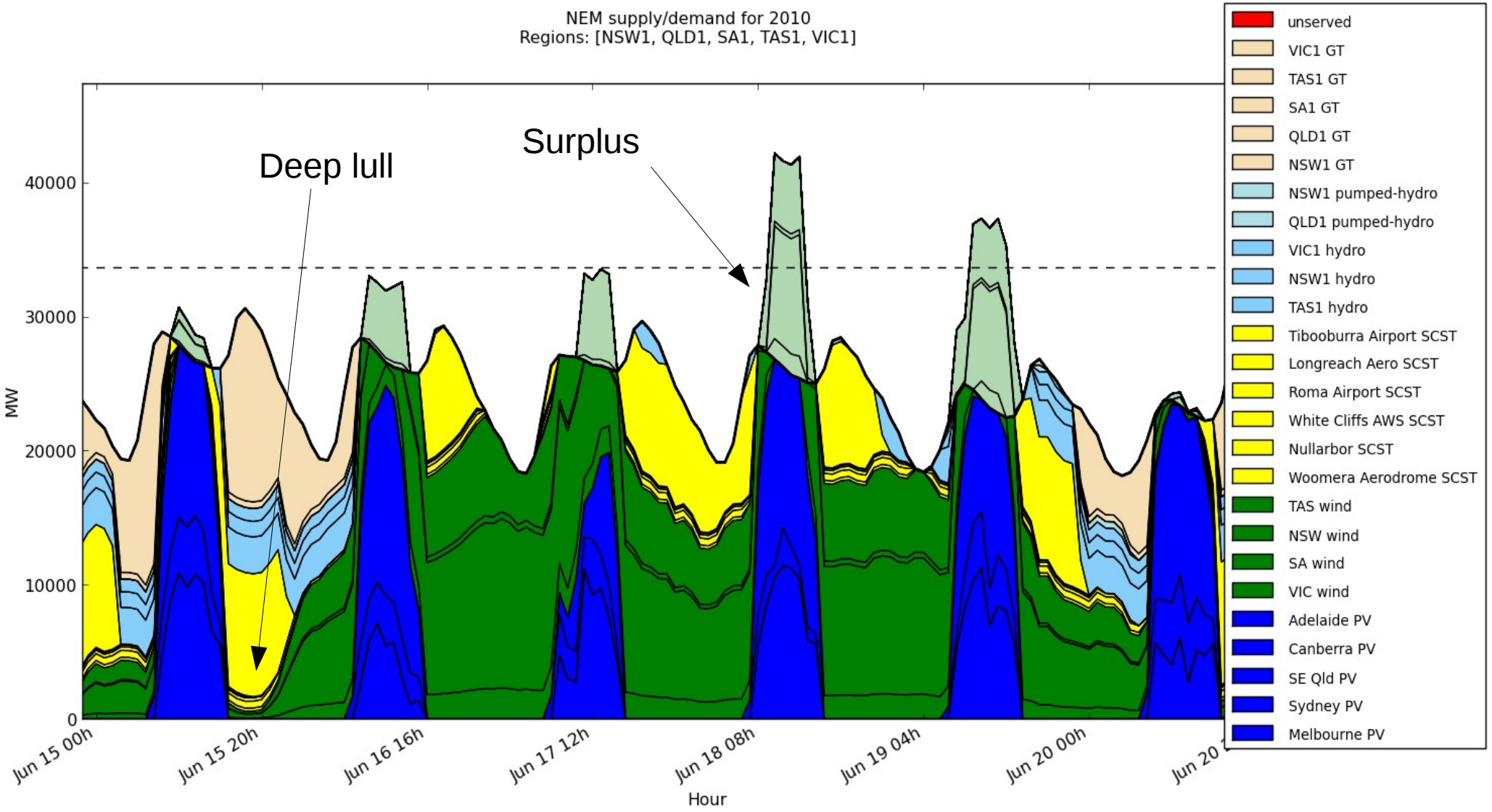
30 degrees of latitude

The NEM

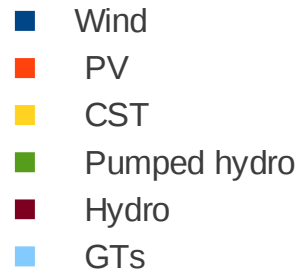
Introduction to 100% RE scenarios in the NEM

- UNSW research going since 2010
- Several phases
  - Technical feasibility
  - Economic least cost optimisation
  - Comparisons with other “reference” scenarios
    - Complete replacement of the current system (“BAU”)
    - All gas
    - Fossil fuels with CCS
- Now, how can we further reduce costs?

Optimisation with original wind data



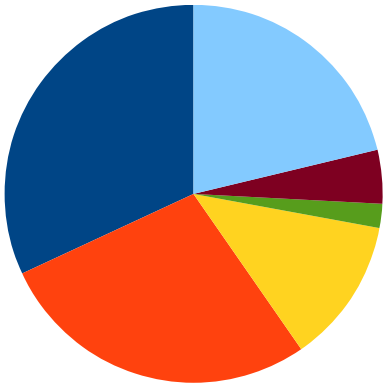
Previously optimised mix with original wind data

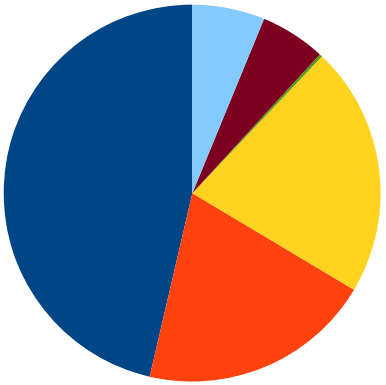


By capacity

By energy

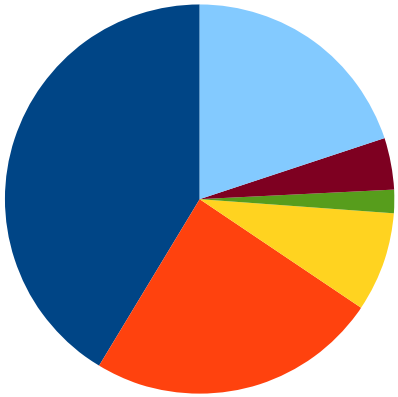
Low cost

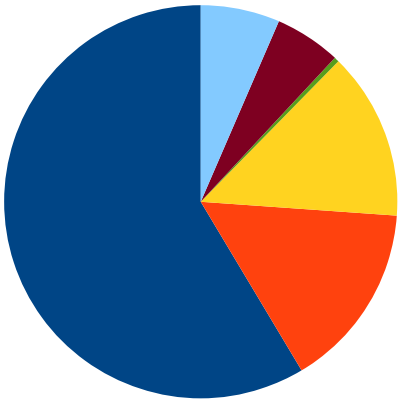




+ 8.8 TWh spilled (~4%)

High cost



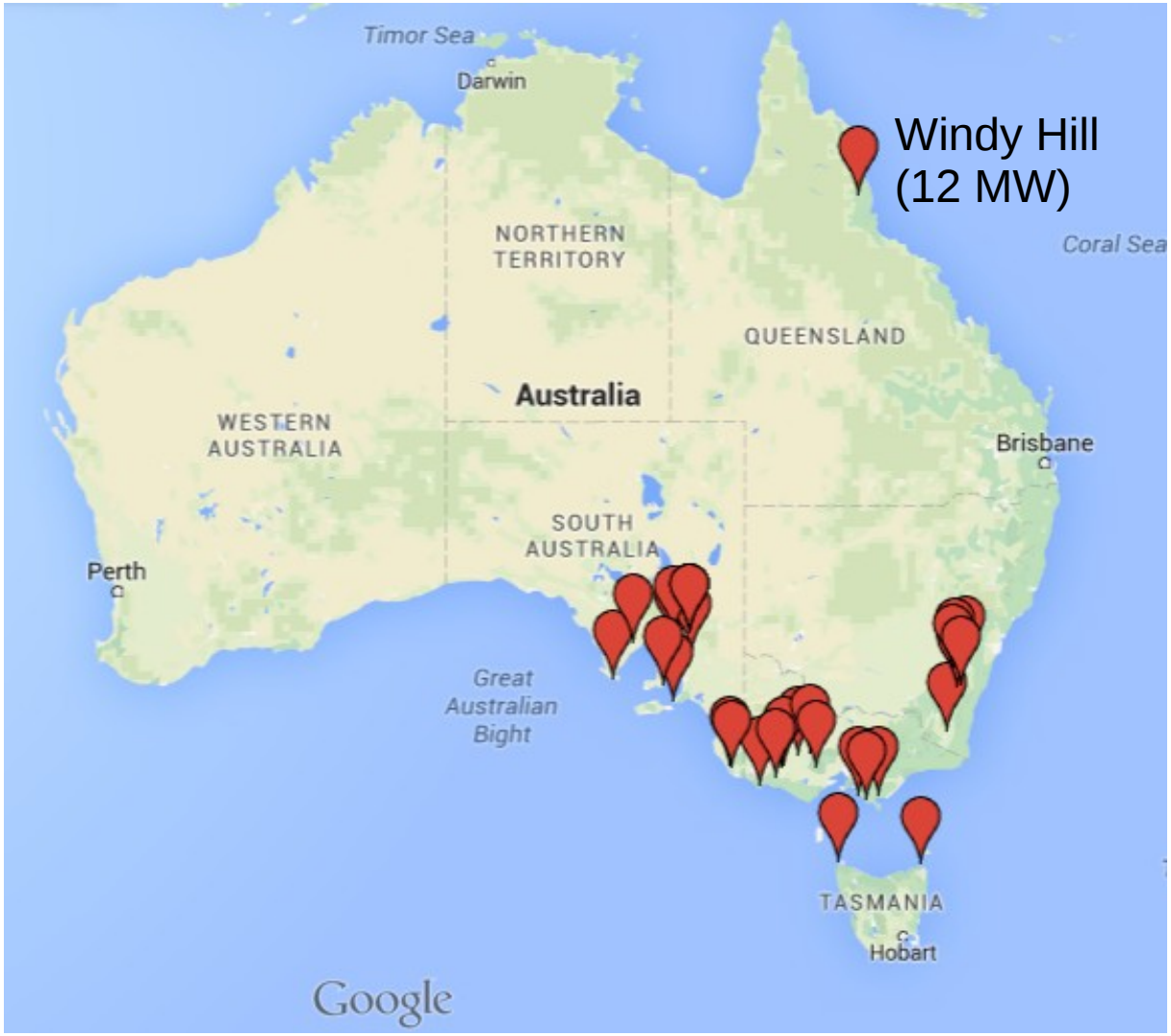


+ 24.9 TWh spilled (~12%)

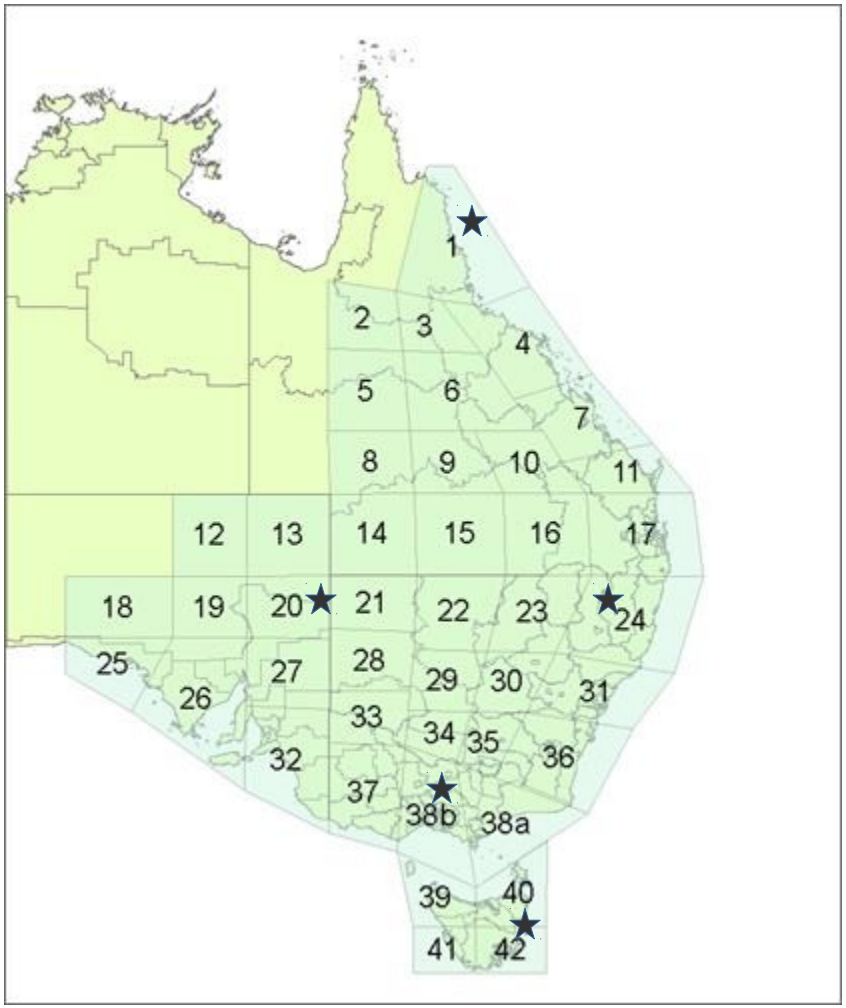
Previous work on wind relocation

- Current NEM wind farms are mainly in one regime
- Earlier research question: “Could relocating some of the wind capacity to another location increase the share of wind?”
  - Elliston, Diesendorf, MacGill (2012), “Reliability of 100% renewable electricity in the Australian National Electricity Market”, IRENEC 2012, Istanbul
- Results with a single additional Queensland site using synthetic wind data were promising

Current NEM wind farms



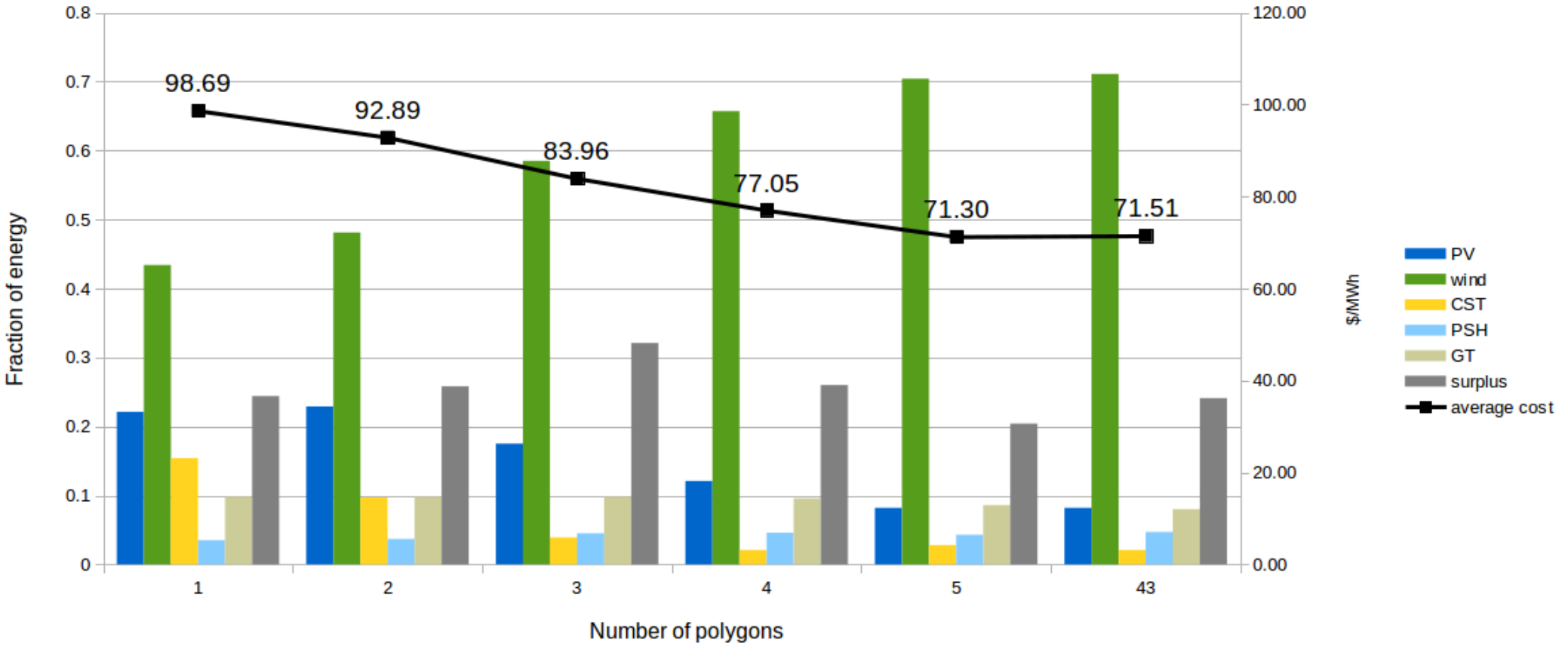
ROAM wind power data set



43 polygons around the NEM, 5 (starred) chosen

- Hourly wind generation traces 2003-2011
- ACCESS-A wind speed data into ROAM's WEST model
- Wind power curve function applied to several sites in each polygon
- Each site normalised to 1 MW
- Weighted average calculated for each polygon
- Capacity limits (GW) given

Results



With more polygons, wind share grows at the expense of PV and CST, costs fall
No major additional improvement seen with 43 polygons

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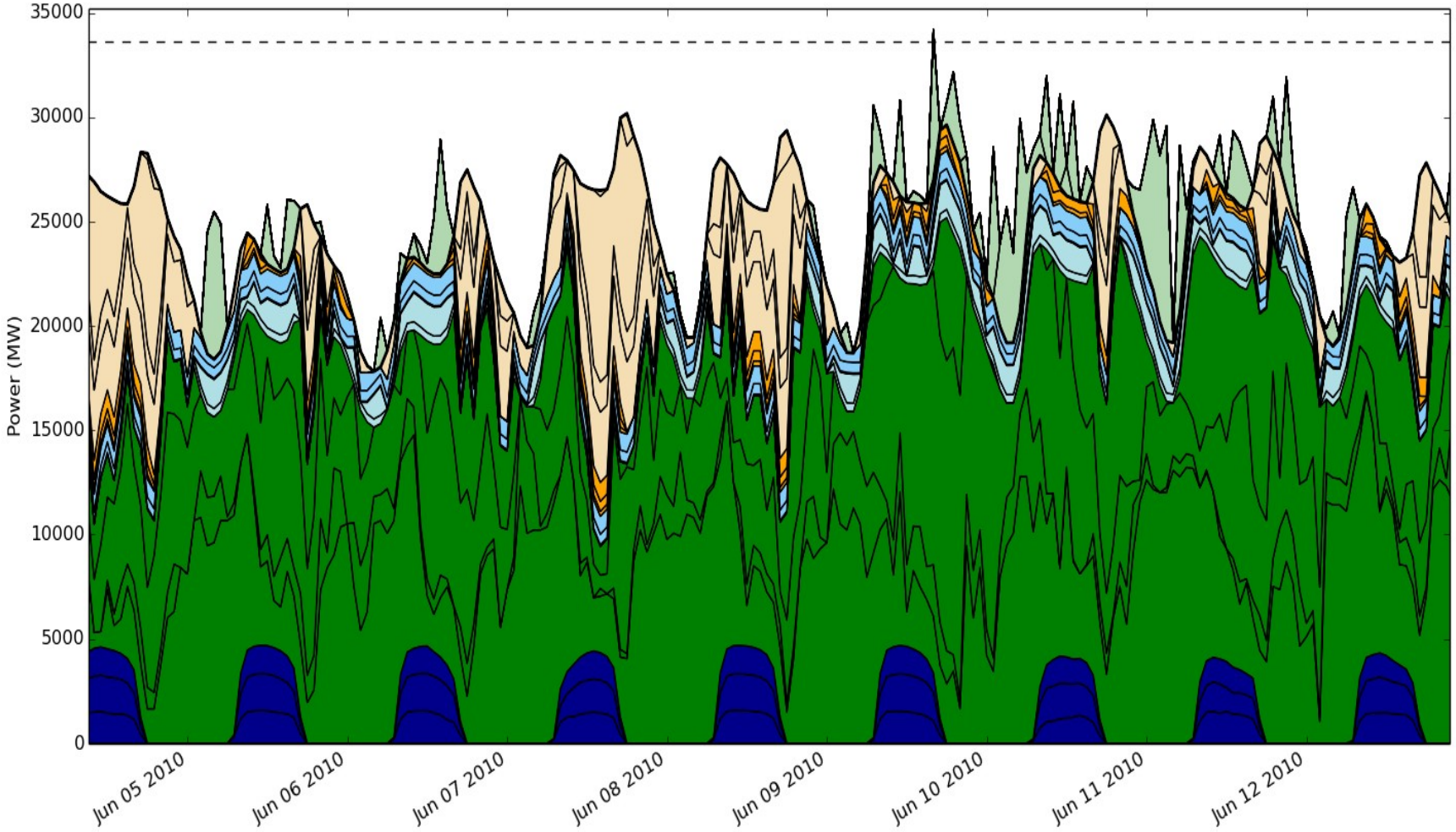
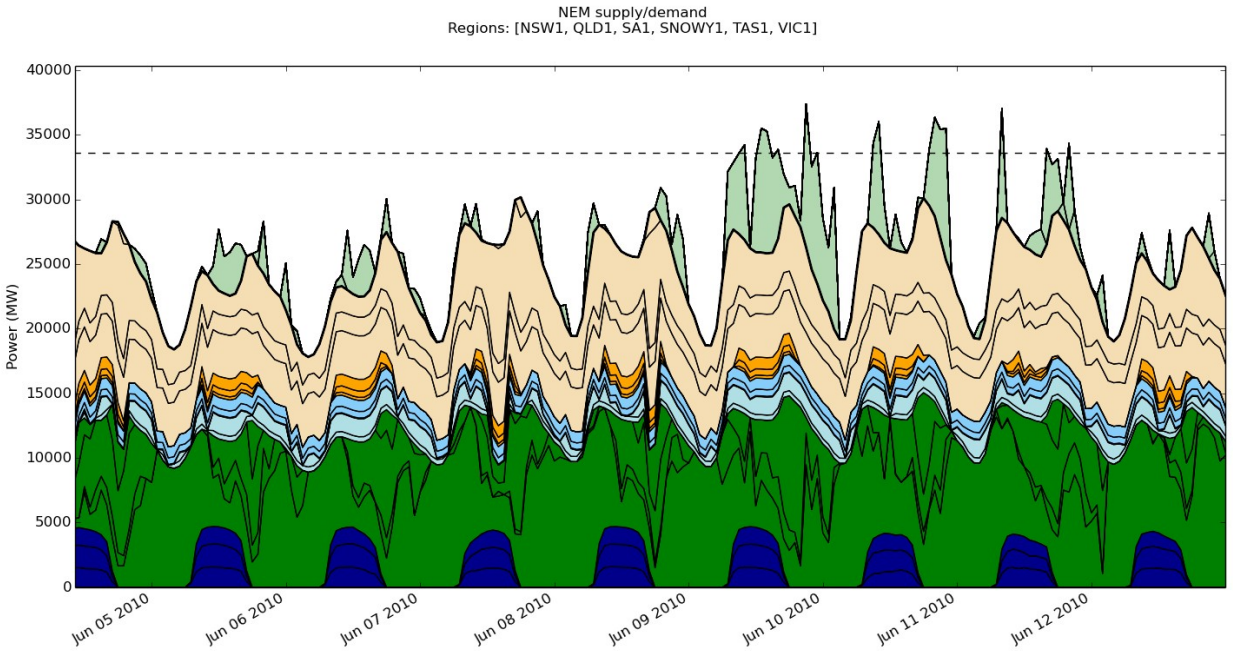
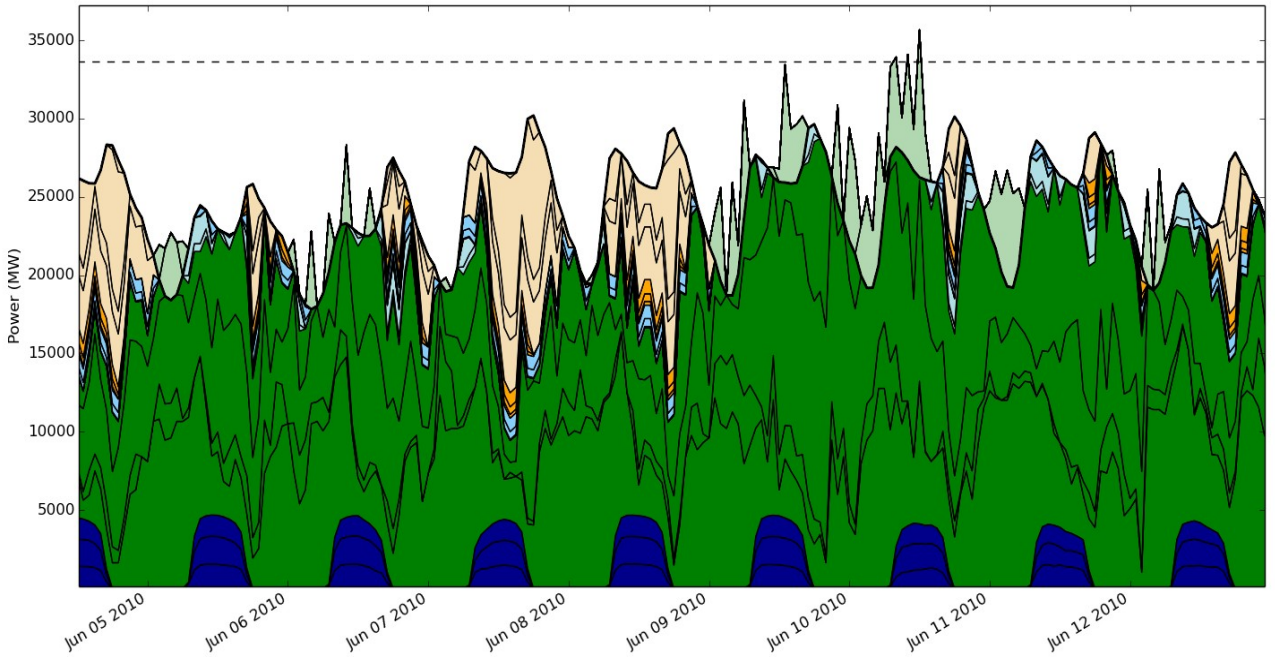
New system dispatch
(85% NSP limit)





50% NSP limit

100% NSP limit



Effect of modifying non-synchronous limit on wind penetration

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Conclusions

- Conventional wisdom: need contribution from an ensemble of RE technologies
- Not necessarily: geographic diversity allows for some technology substitution
- Wind power dominates in this work due to low capital cost and capacity factors
- Limited dispersion can dramatically reduce costs and increase wind share