Least cost 100% renewable electricity scenarios in the Australian National Electricity Market

Never Stand Still | Engineering

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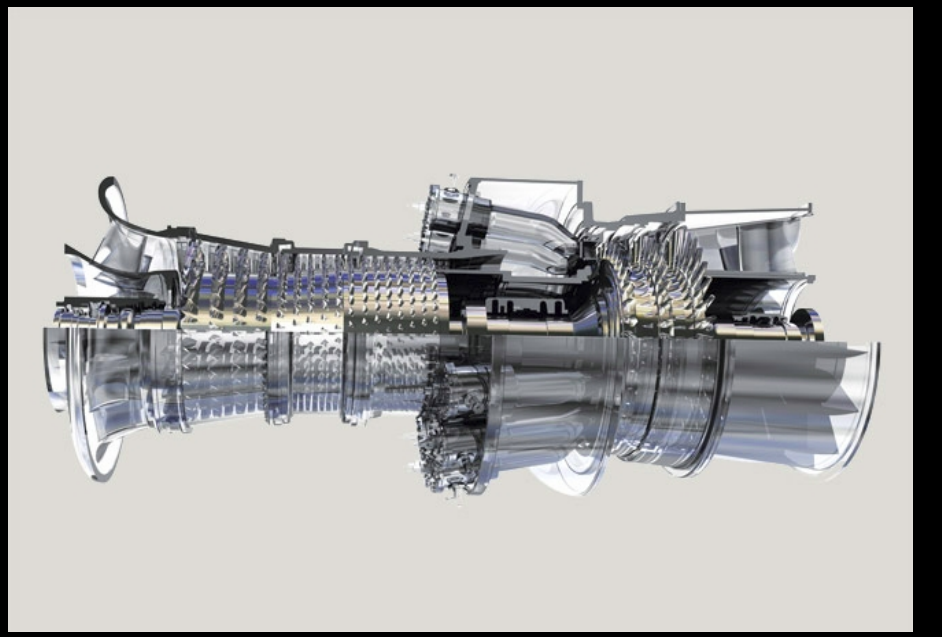
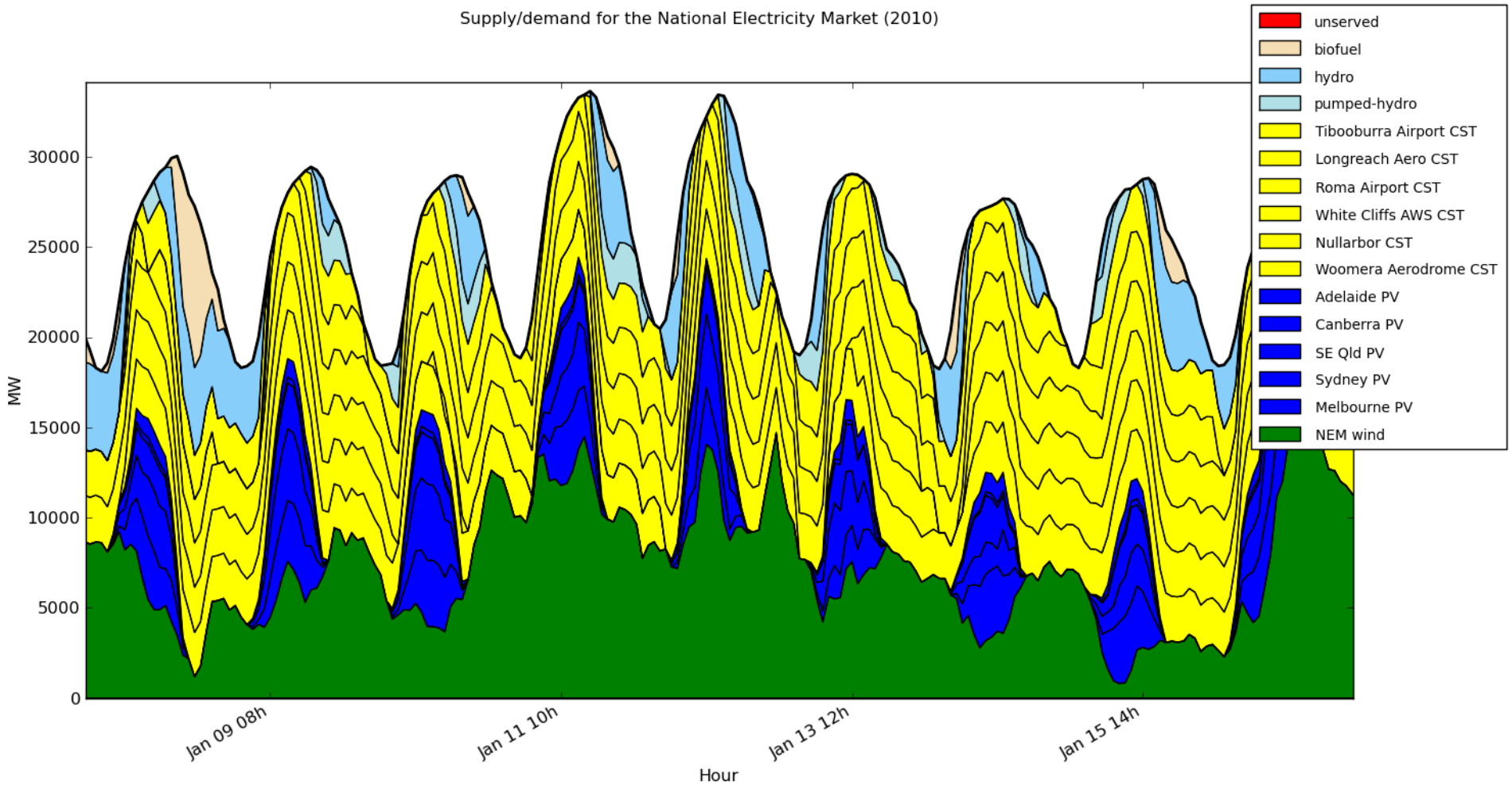
Simulation background

- *Simulations of Scenarios with 100% Renewable Electricity in the Australian National Electricity Market*, Energy Policy 45, 606-613.
- Hourly simulations using **commercially available technologies**
- Always meet reliability standard
- Generation mix: guided exploration

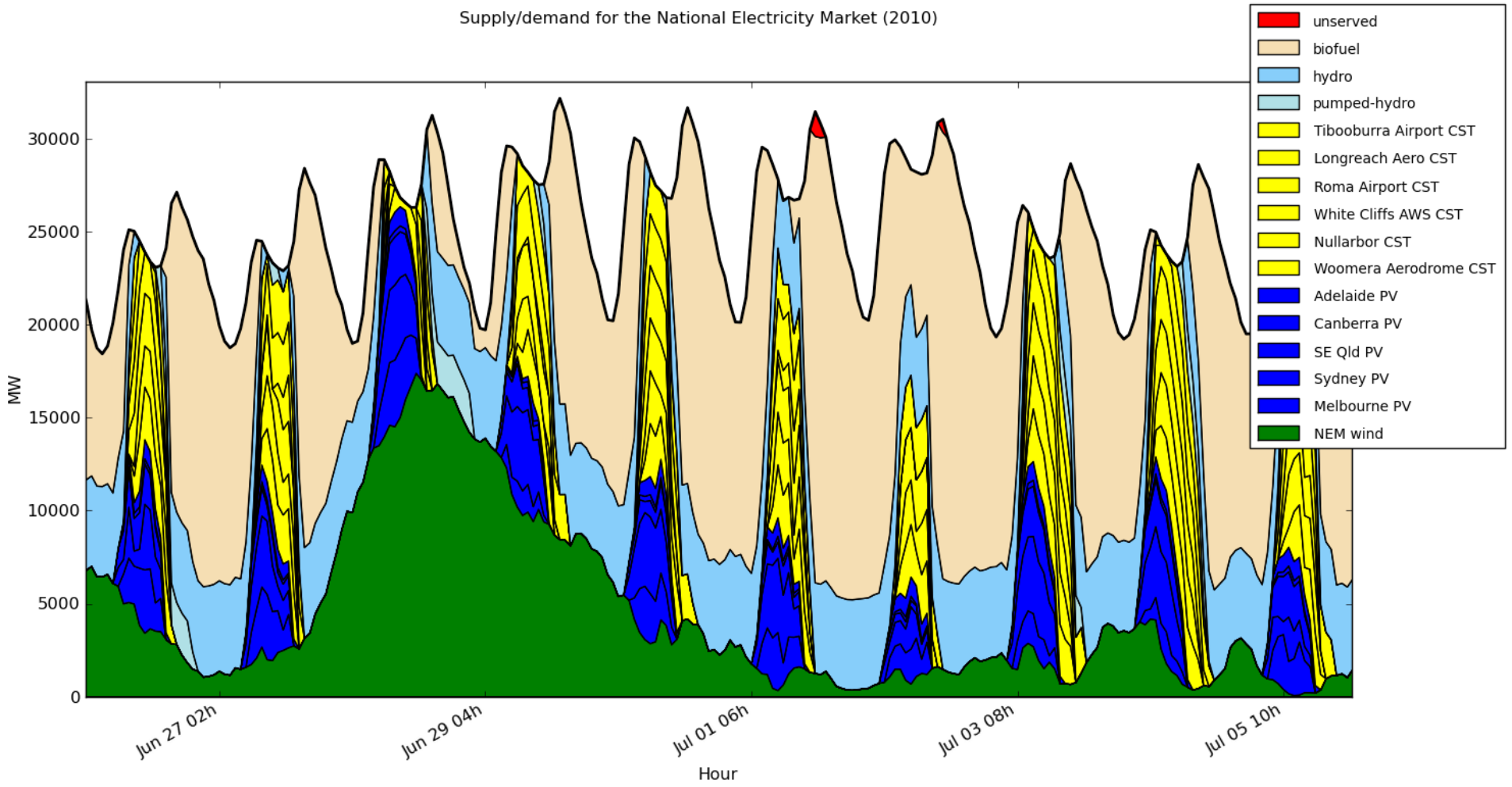


Simulation background



Hour-by-hour plot from a week in January 2010

Simulation background



Hour-by-hour plot from a week in June/July 2010

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Combining simulation and search

- Drive simulations with a genetic algorithm
- GA representation
  - 25 generators in simulation
    - Some location-specific (eg, Sydney PV)
    - Some abstract (eg, VIC gas turbines)
    - Hydro generators are excluded (5 total)
- Goal – minimise annual cost

Combining simulation and search

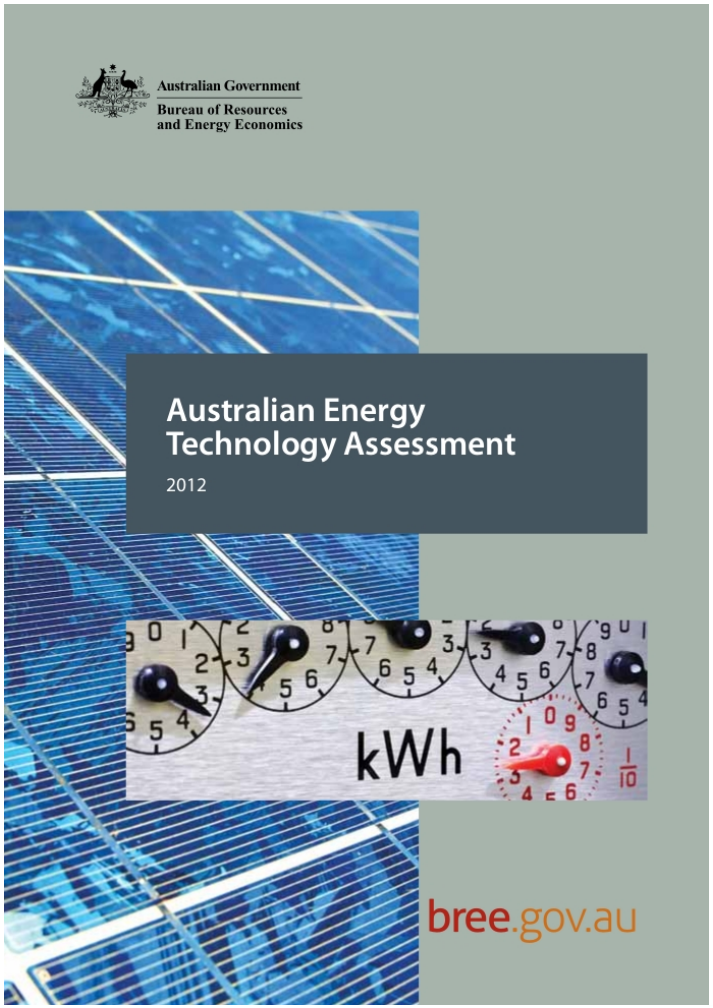
- Objective function: sum of
  - Annualised capital cost ∀ generators
  - Fixed O&M costs ∀ generators
  - Variable O&M costs ∀ generators
  - Penalty functions

$f(x) = \max(0, x - D/50000)^3$ (< 0.002% unserved energy)

$g(x) = \max(0, x - 20\ \text{TWh})^3$ (limit bioenergy)

$h(x) = \max(0, x - 12\ \text{TWh})^3$ (limit hydro)

Technology cost data for 2030



Source: Bureau of Resource and Energy Economics (2012)

What are the likely costs?

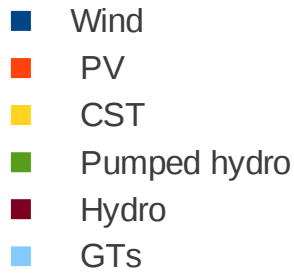
	Generation only		Including transmission	
Discount rate	Low cost	High cost	Low cost	High cost
5%	$96	$108	$104	$119
10%	$135	$154	$153	$173

Average cost of energy (2012 $ per MWh)

Hinkley Point C strike price: ~ $155 per MWh (2012 £)

Generation mix

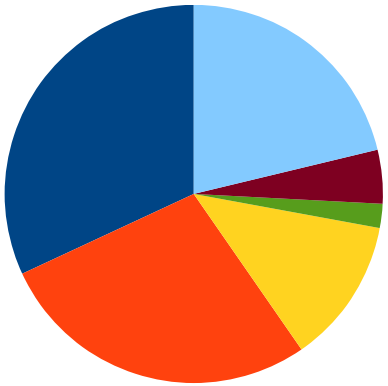
5% discount rate

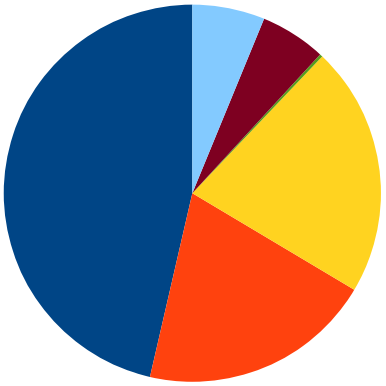


By capacity

By energy

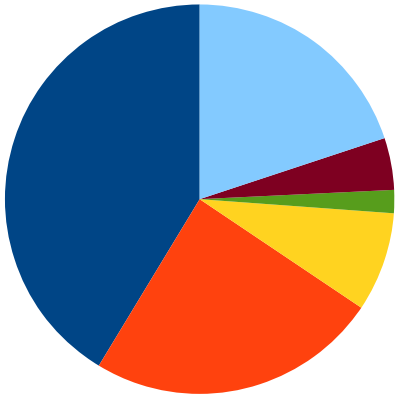
Low cost

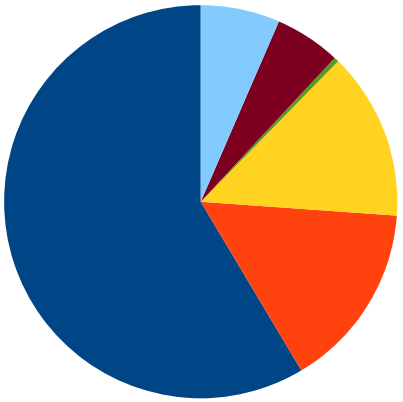




+ 8.8 TWh spilled (~4%)

High cost





+ 24.9 TWh spilled (~12%)

CST 13.3 GW, PV 29.6 GW (< Germany)

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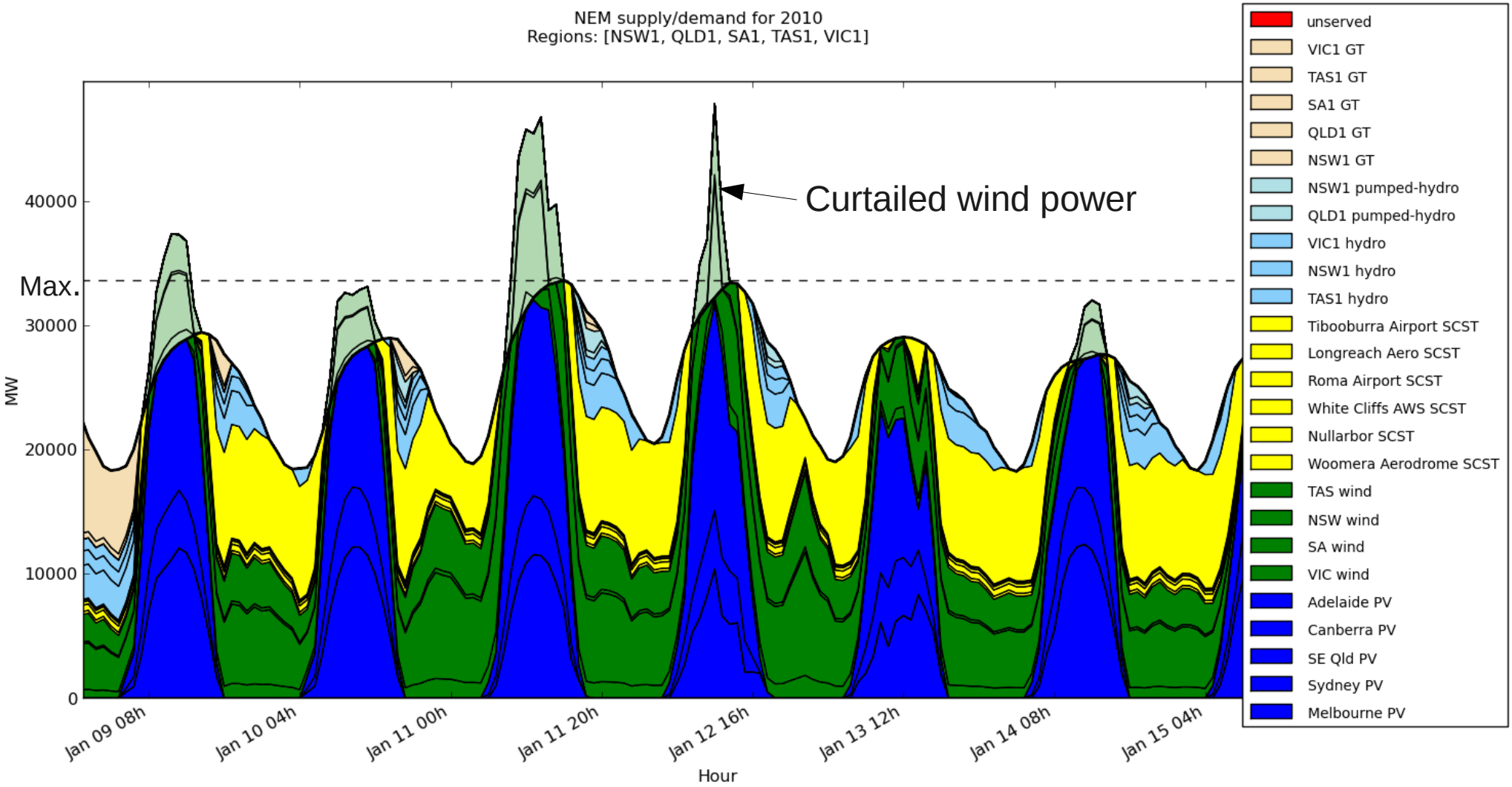
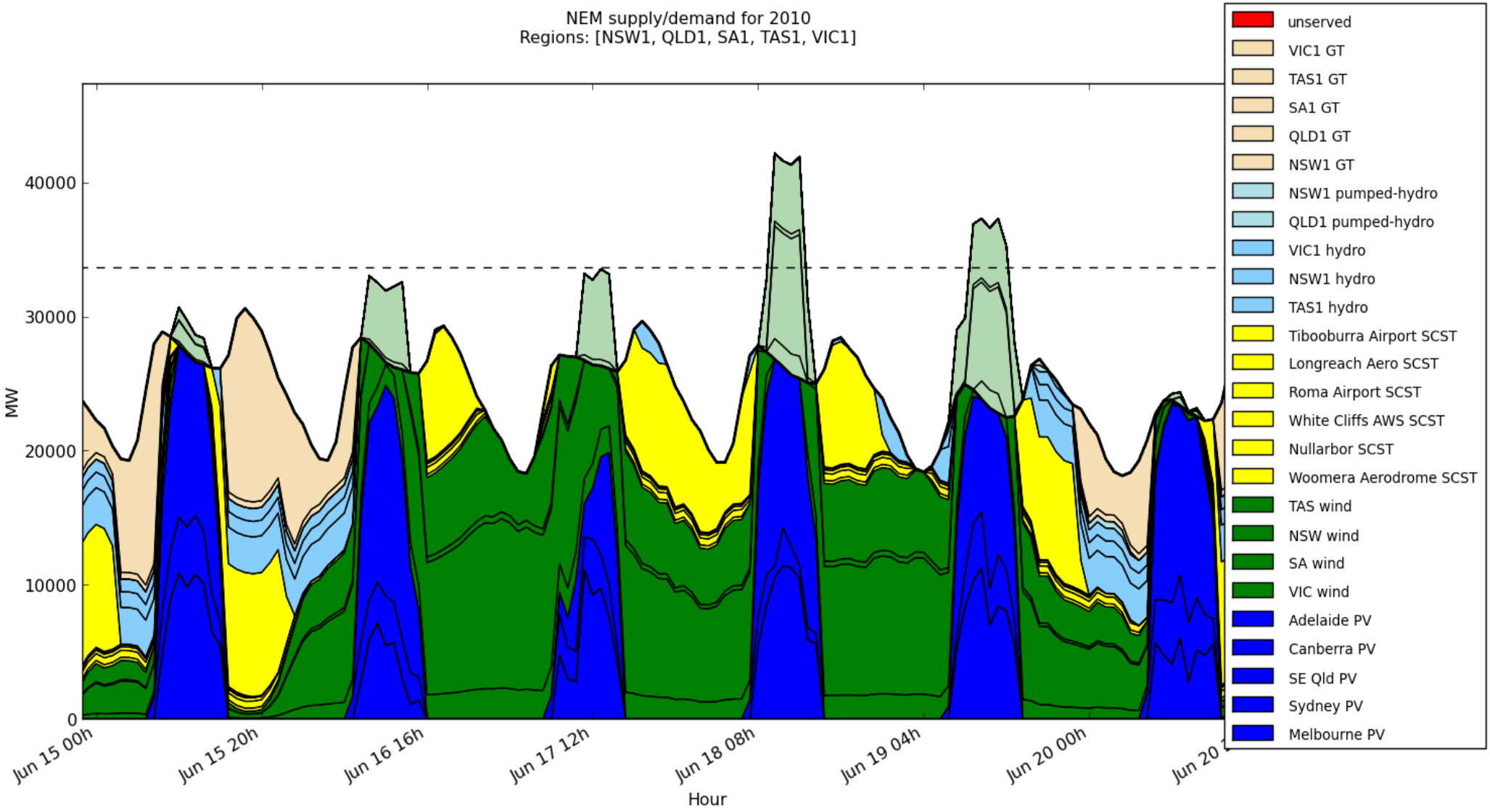
Hourly balancing mid-Jan 2010



Hourly balancing mid-June 2010



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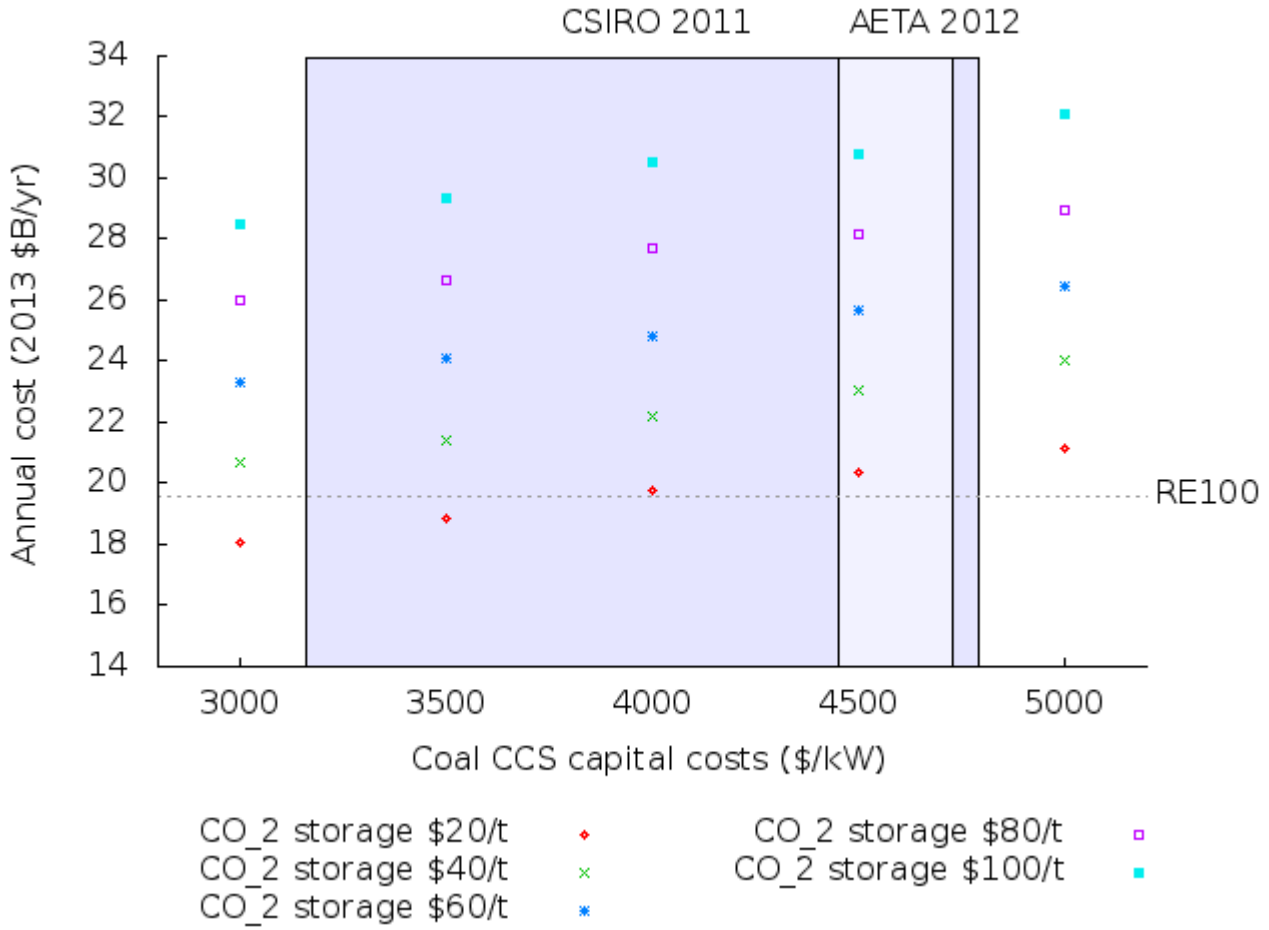
Alternative future scenarios

Saskpower Boundary Dam CCS plant under construction (Canada)

Coal CCS scenario



Baseline coal cost $1.86/GJ, baseline carbon price $56 per tonne CO_2

Conclusions

- Least cost scenarios dominated by wind
- CST value demonstrated in helping to meet demand, despite higher capital cost
- System security: flexible generators with high capacity, low annual energy
- 100% RE looking like a low risk pathway!