The role of bioenergy in a 100% renewable electricity system

Never Stand Still | Engineering

Dr Ben Elliston
Centre for Energy and Environmental Markets
University of New South Wales

b.elliston@unsw.edu.au

Outline

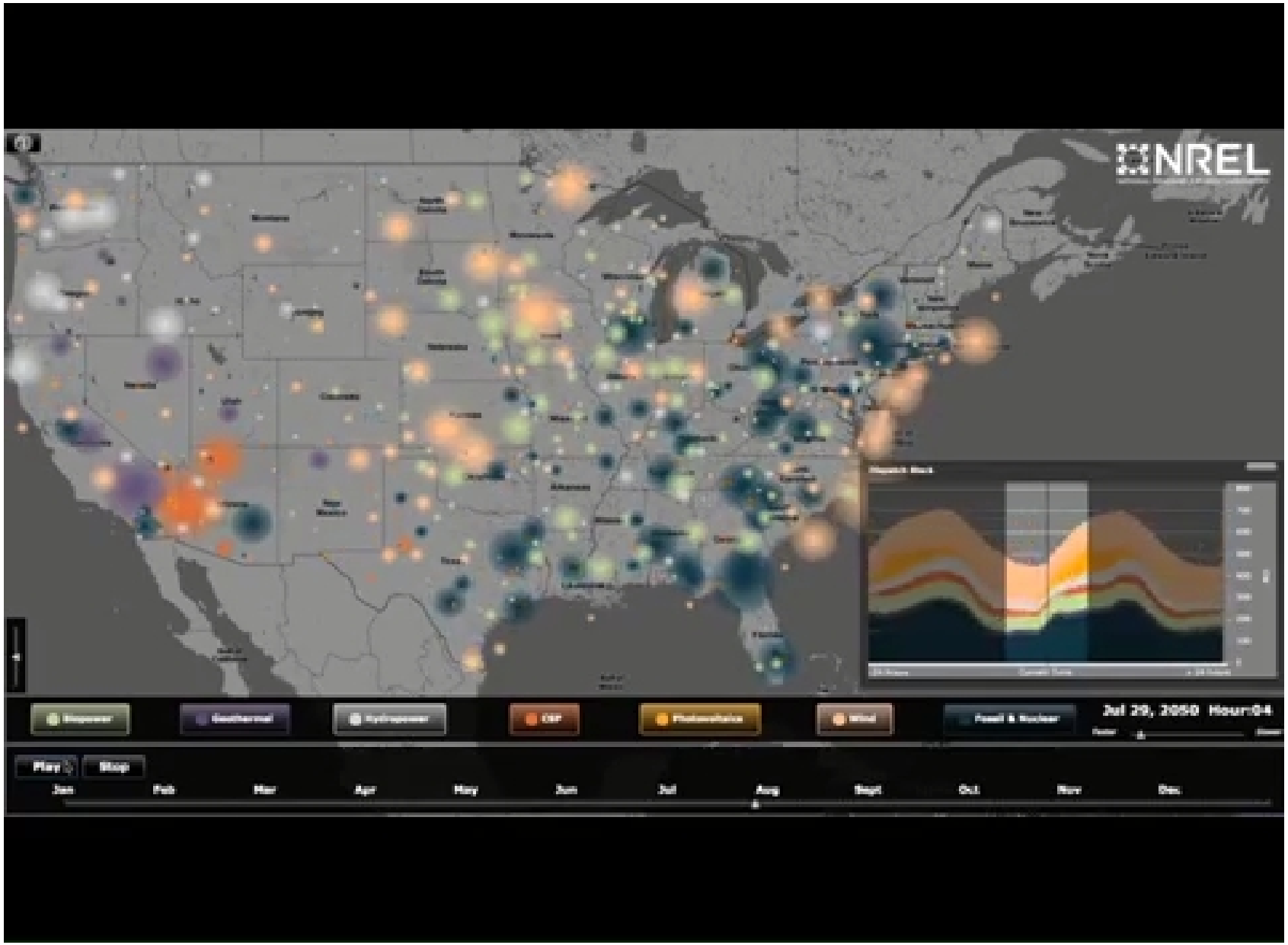
- Motivation
- Previous work on 100% RE in Australia
- 100% RE work at University of NSW
  - Reliability, system composition, costs
- Implications for bioenergy industry
- Summary

Motivation

- Long-lived electricity assets, uncertainty in policies, costs & technology
- Carbon budget vanishing quickly
  - ~26 years to 450 ppm
- Electricity is a big emitter in Australia
  - Electricity produces around 1/3rd of emissions
  - Many low carbon generation options
  - Some options not yet commercially available
    - eg. hot dry rock geothermal, wave power, CCS
  - The easiest sector to decarbonise?

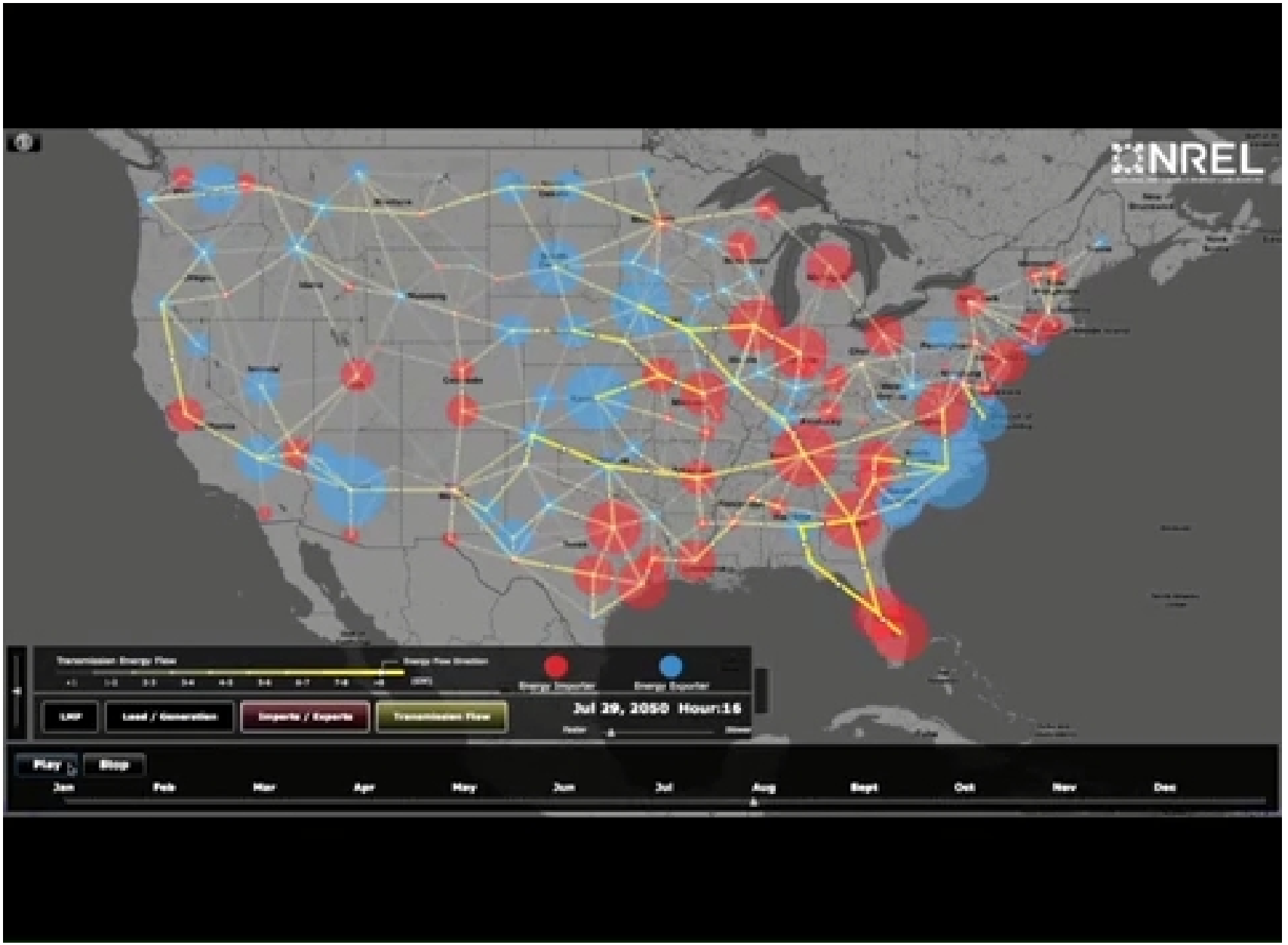
100% RE studies

- Beyond Zero Emissions (2010)
  - *Zero Carbon Australia Stationary Energy Plan*
- UNSW (2010 – present)
- AEMO 100% Renewables Study (2012)
  - No reference scenario
- NREL RE Futures Study for USA (2012)
  - Many scenarios
  - Focus on 80% RE, 20% existing fossil/nuclear



Hourly dispatch in 2050. Source: *http://www.nrel.gov/analysis/re_futures/*

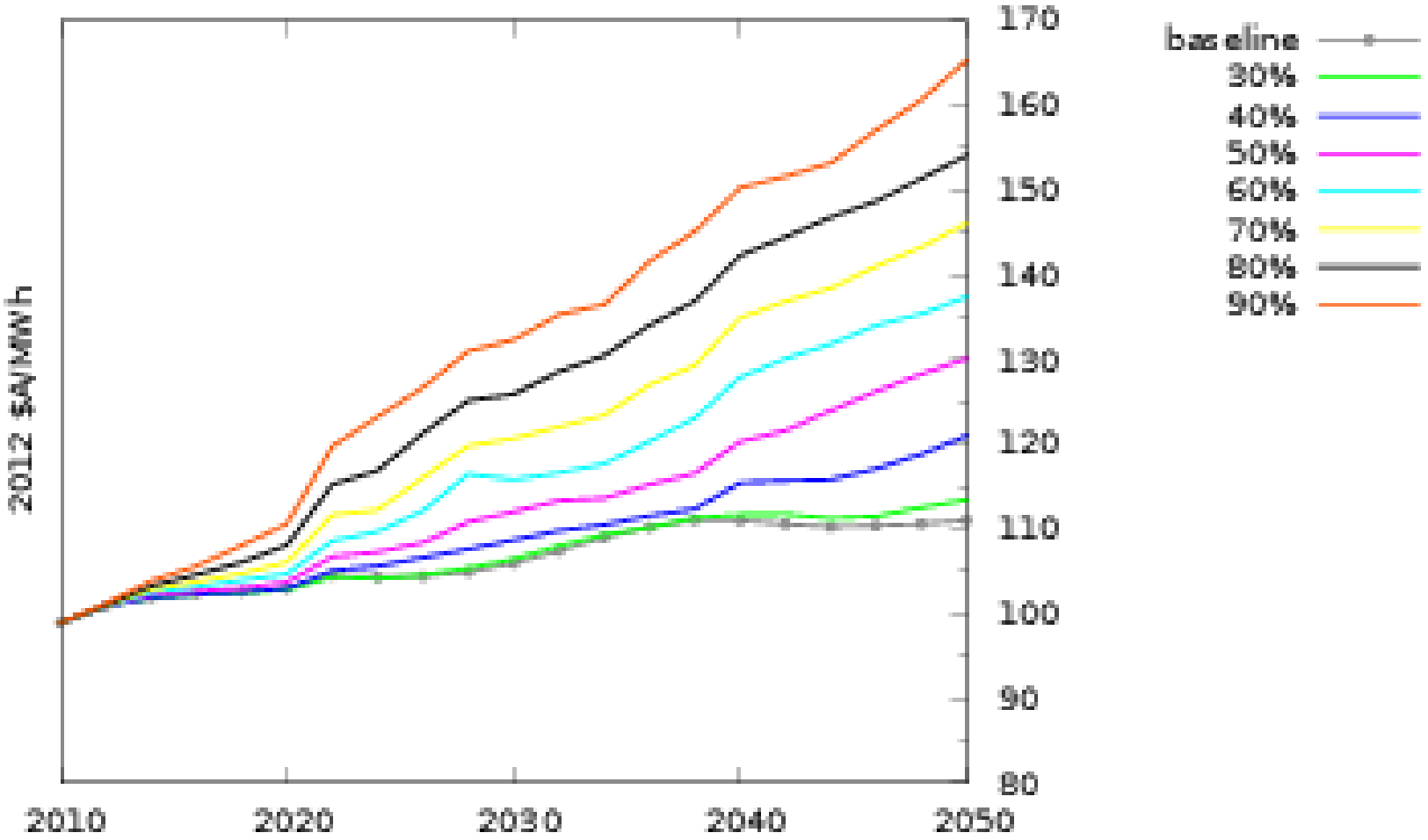
UNSW AUSTRALIA



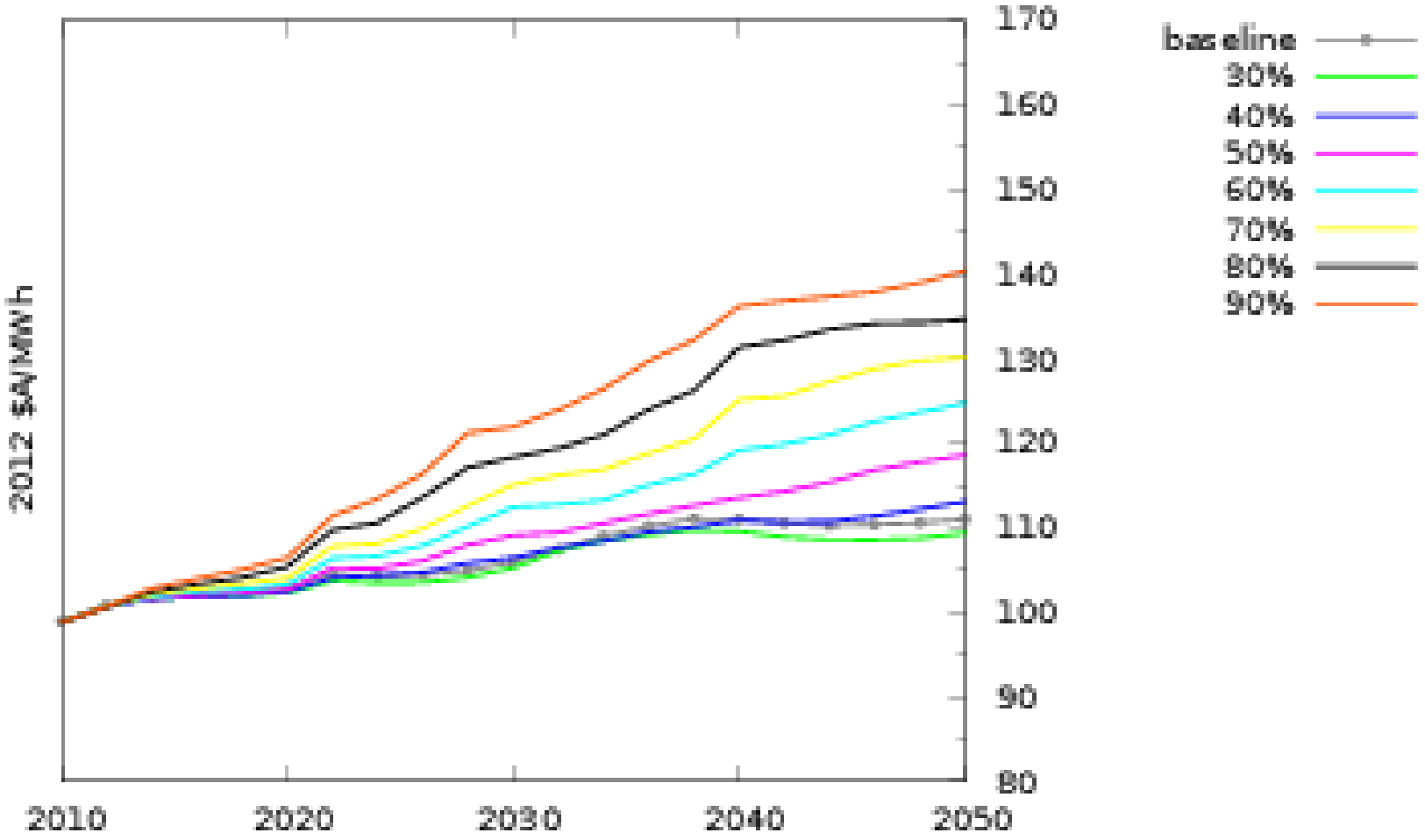
Transmission flows in 2050. Source: *http://www.nrel.gov/analysis/re_futures/*

UNSW AUSTRALIA

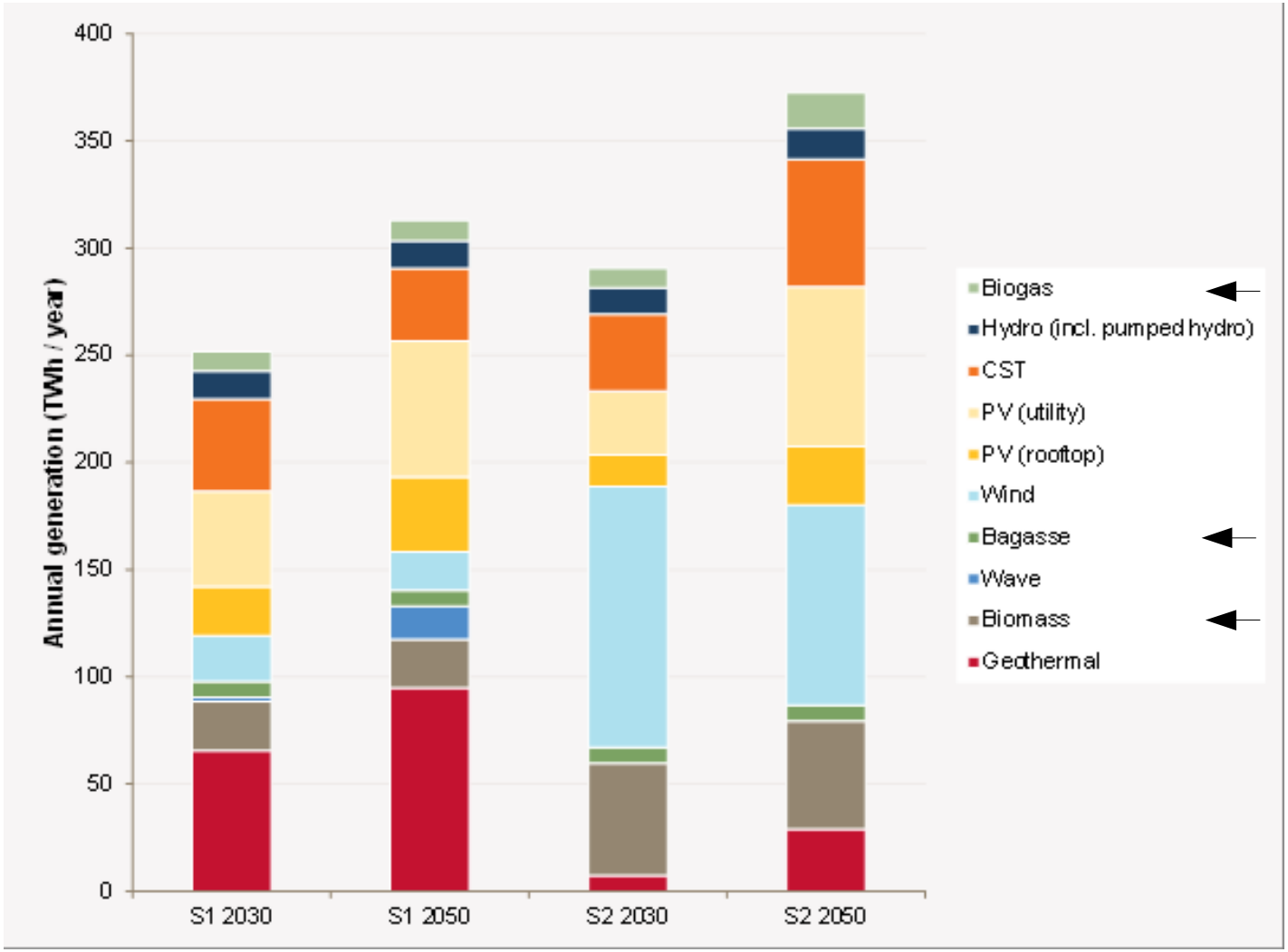
RE Futures: Average retail electricity price trajectory to 2050 under different penetration levels (`incremental' scenarios)



RE Futures: Average retail electricity price trajectory to 2050 under different penetration levels (`evolutionary' scenarios)



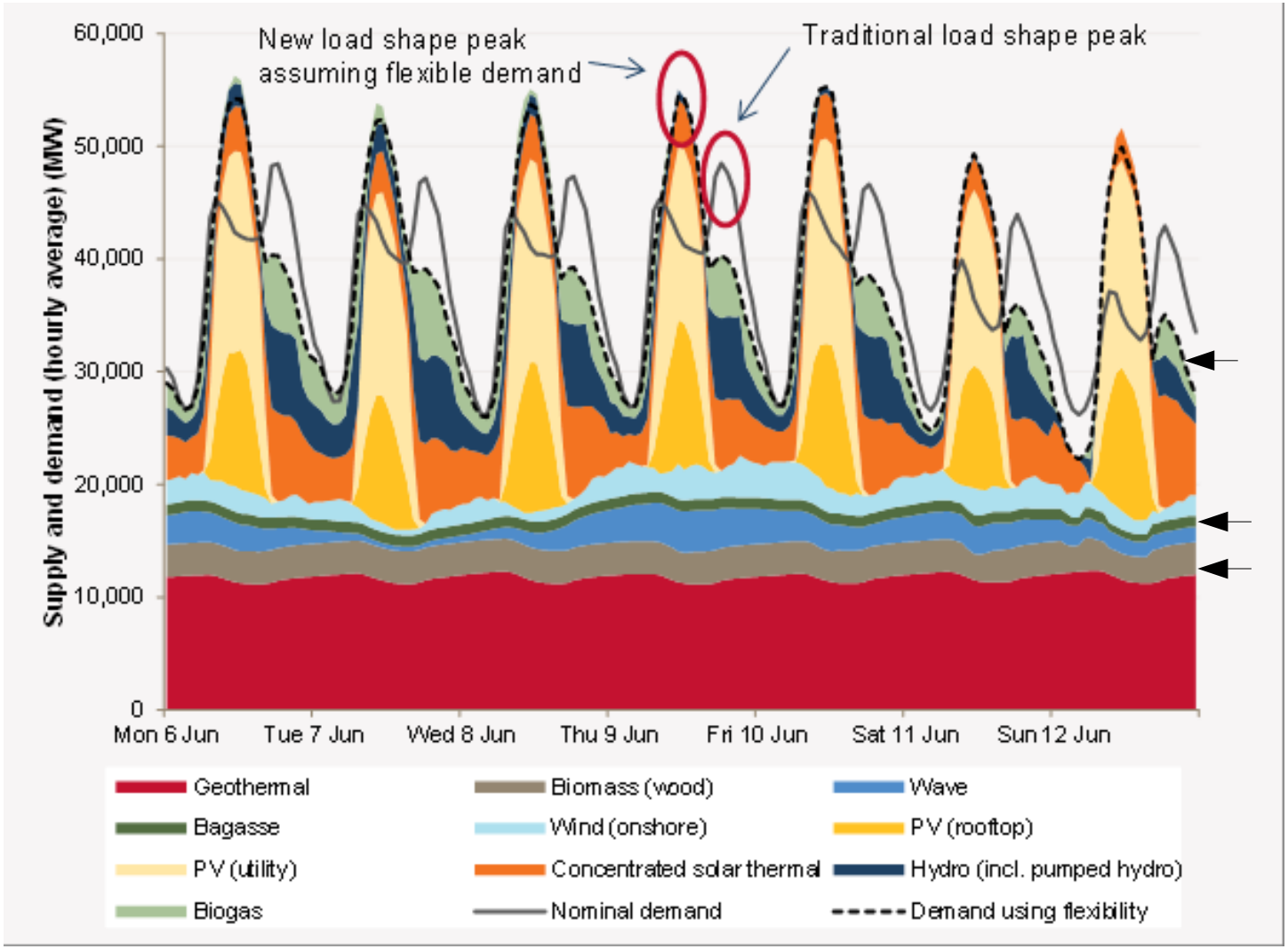
AEMO 100% Renewables Study



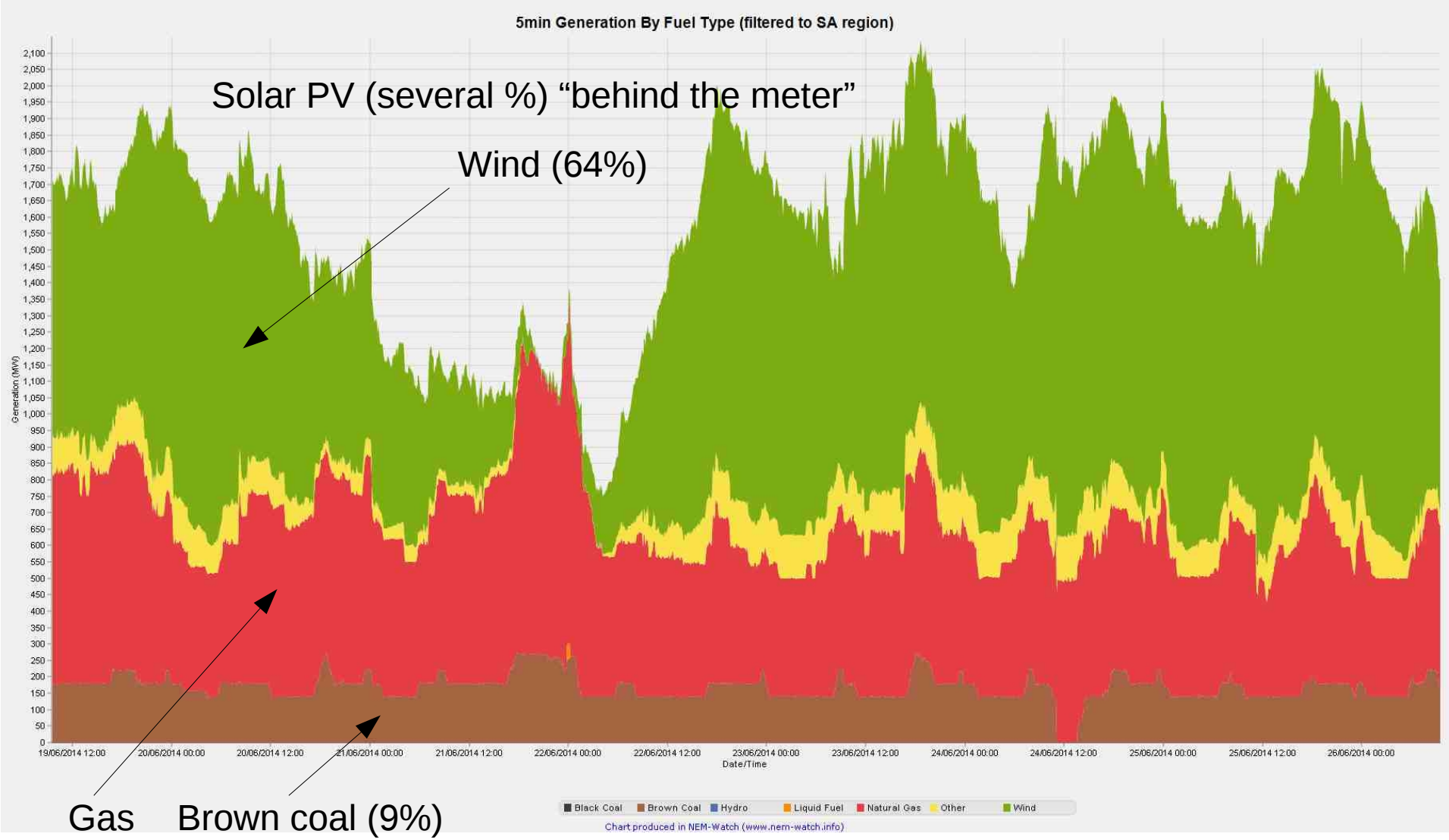
Generation by technology

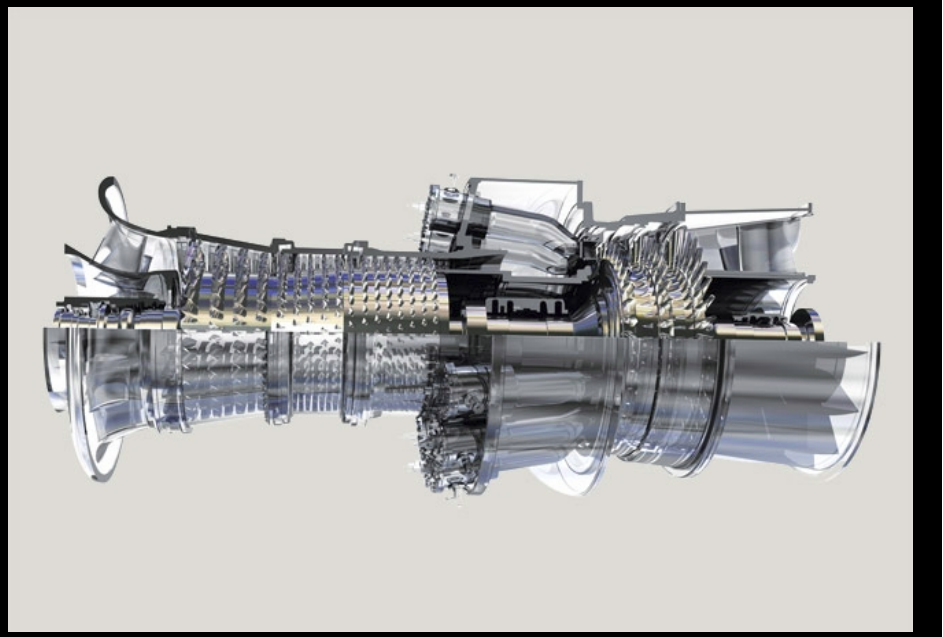
UNSW AUSTRALIA

AEMO 100% Renewables Study

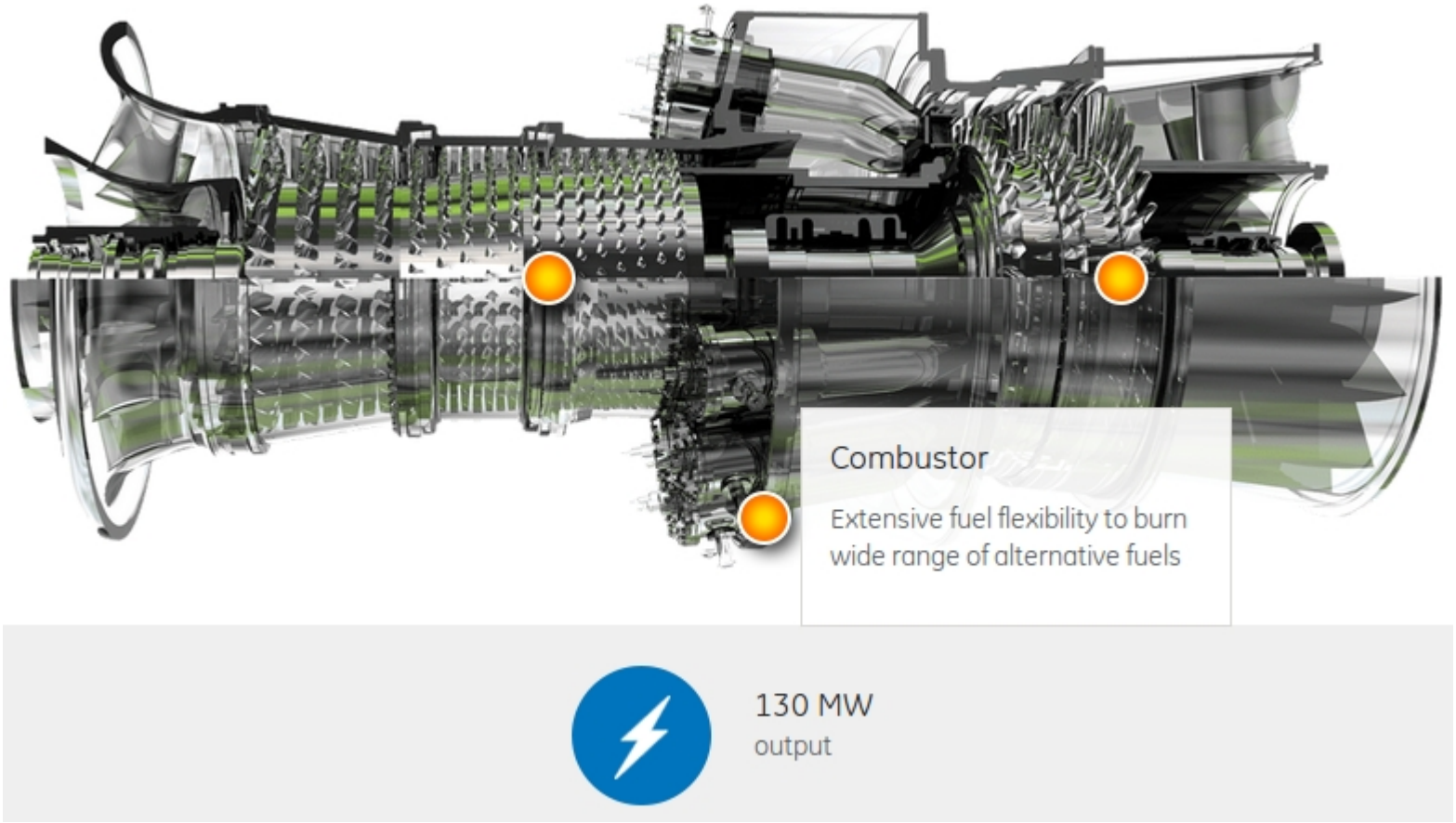


South Australia (actual)



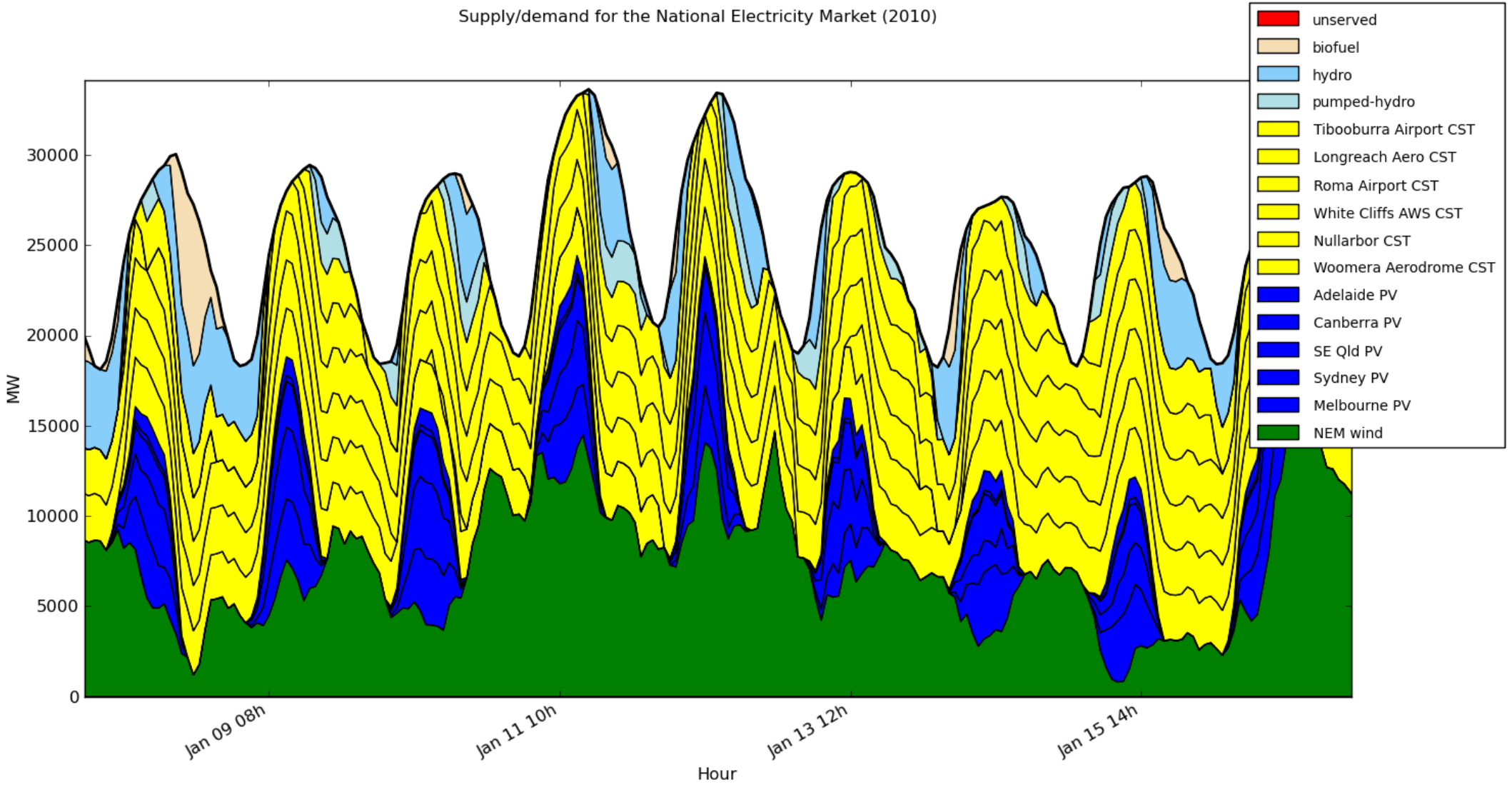


Open cycle gas turbines



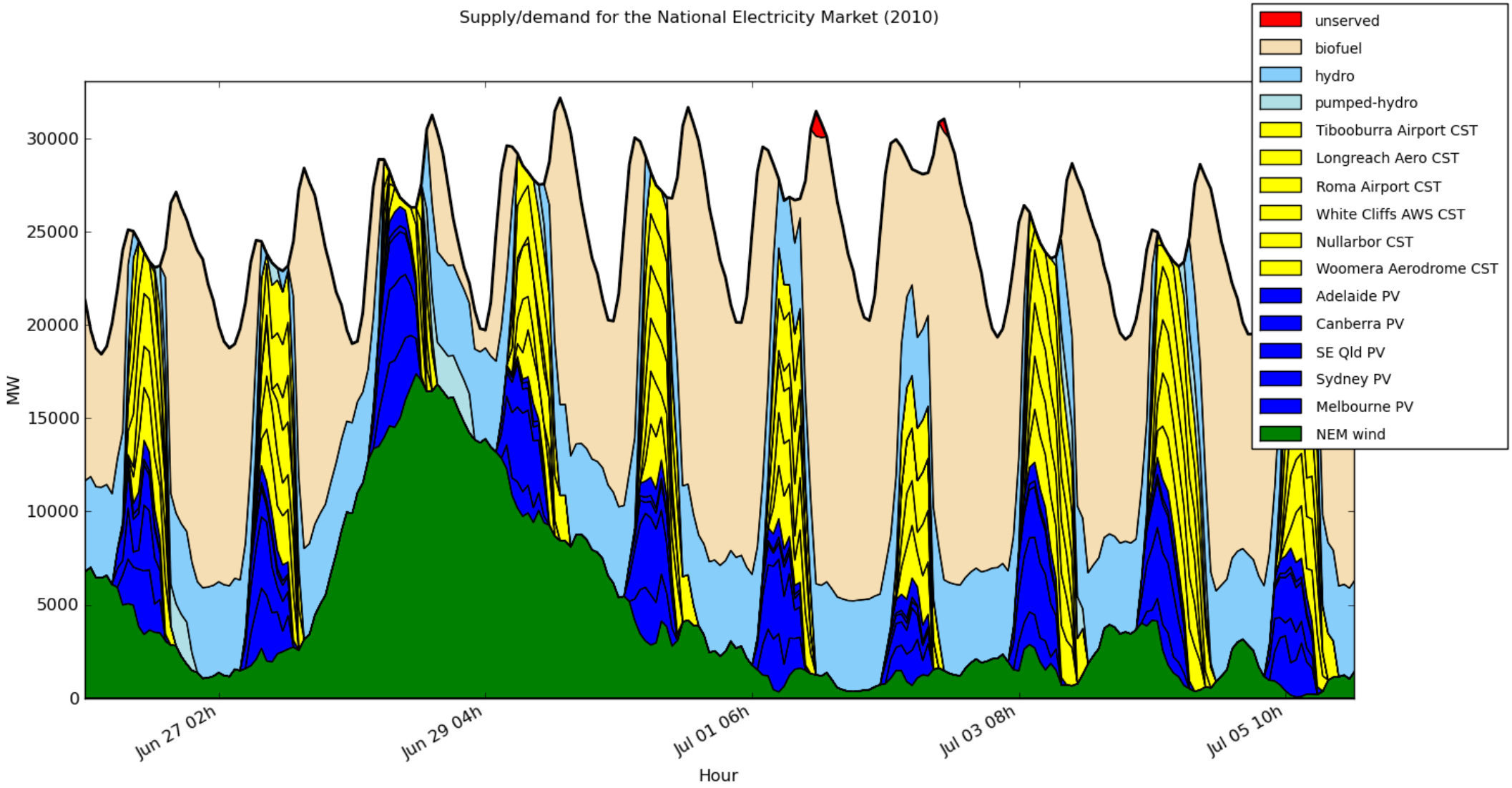
GE 9E: burns 50 gaseous or liquid fuels, 34% efficiency

First simulations (summer 2010)



Bioenergy: 28 TWh-e for the year (13.7% of energy)

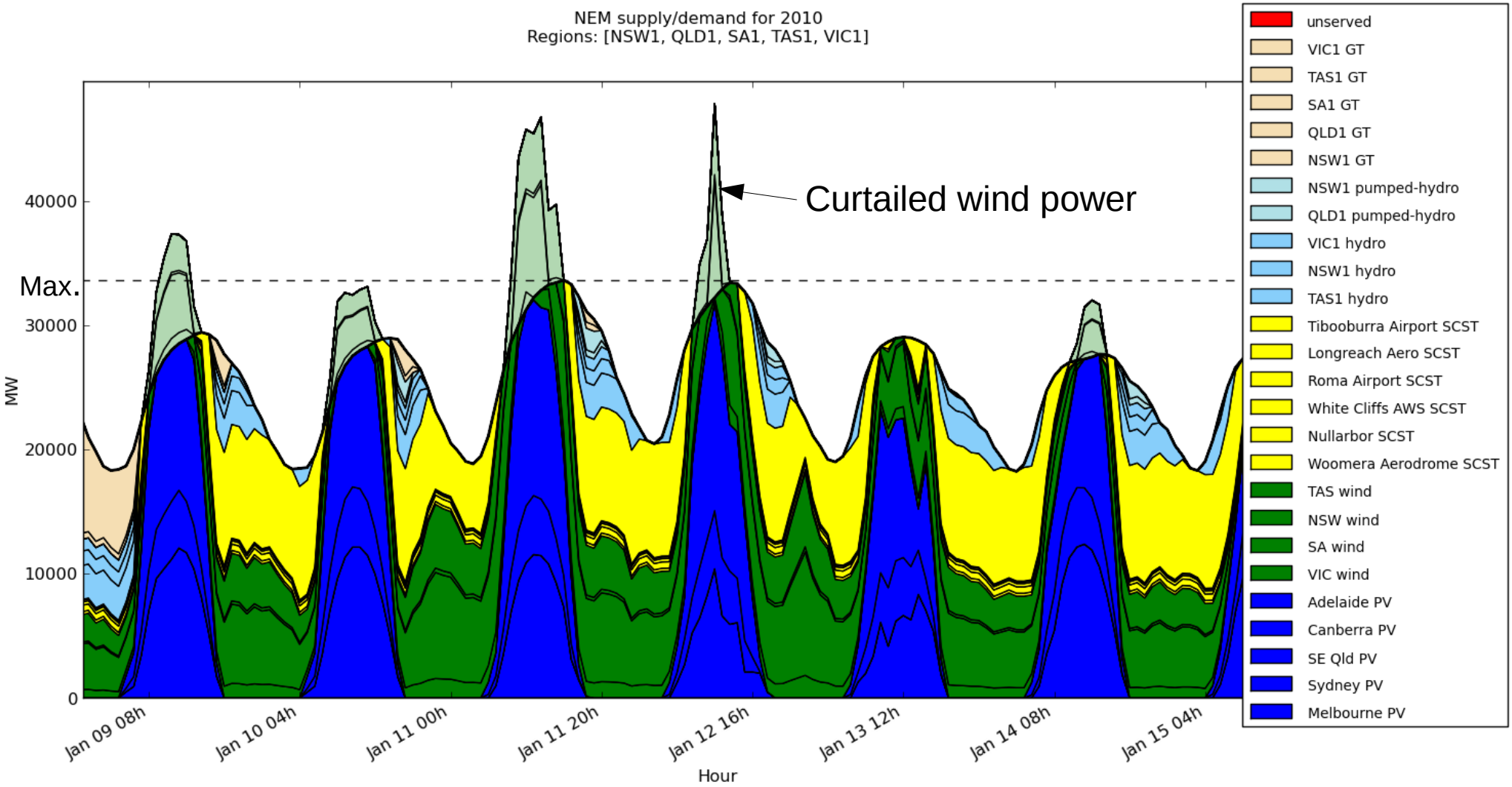
First simulations (winter 2010)



Bioenergy: 28 TWh-e for the year (13.7% of energy)

UNSW AUSTRALIA

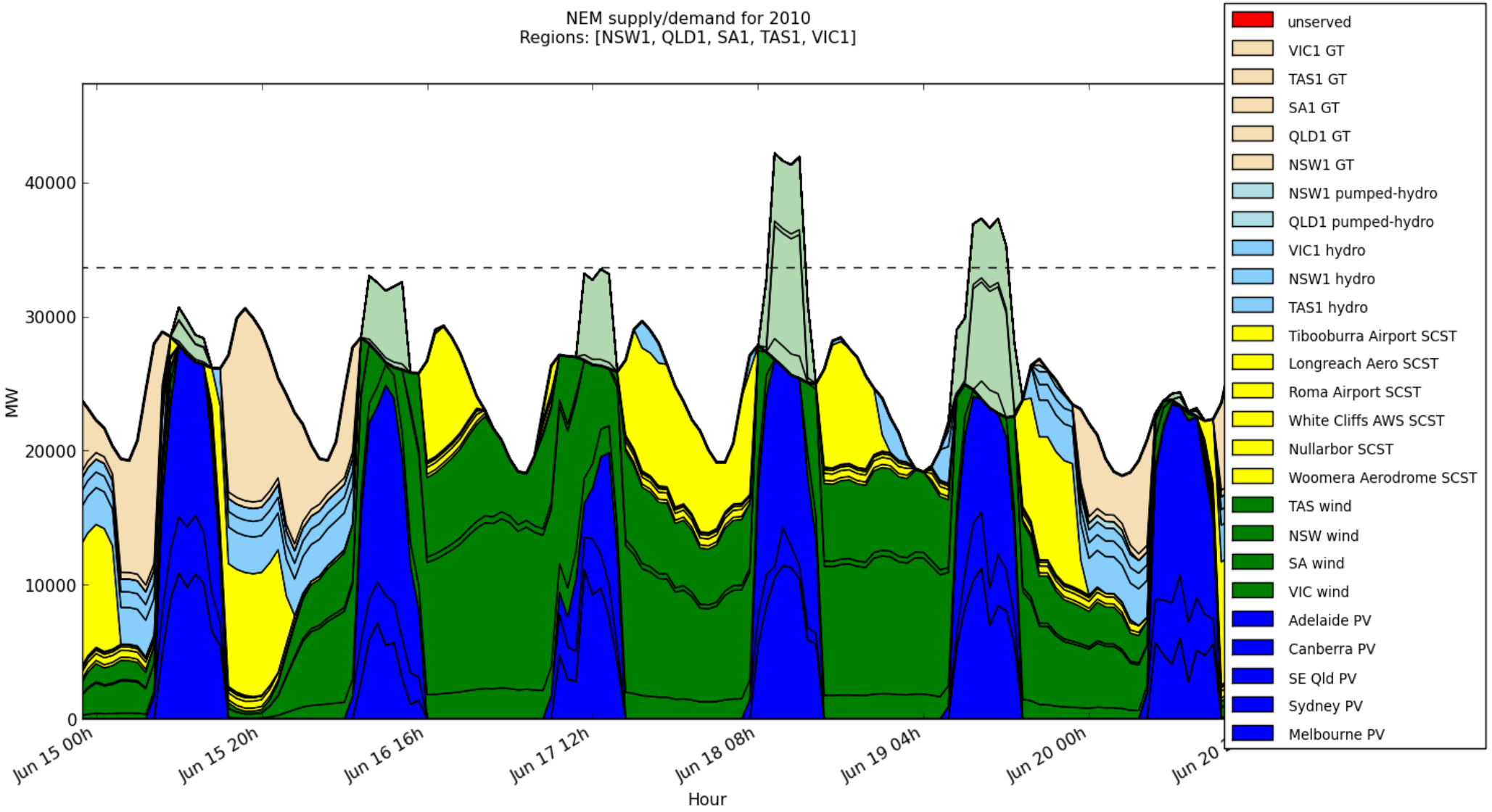
Hourly balancing mid-Jan 2010



Bioenergy: 12.7 TWh-e for the year (6.2% of energy)

UNSW AUSTRALIA

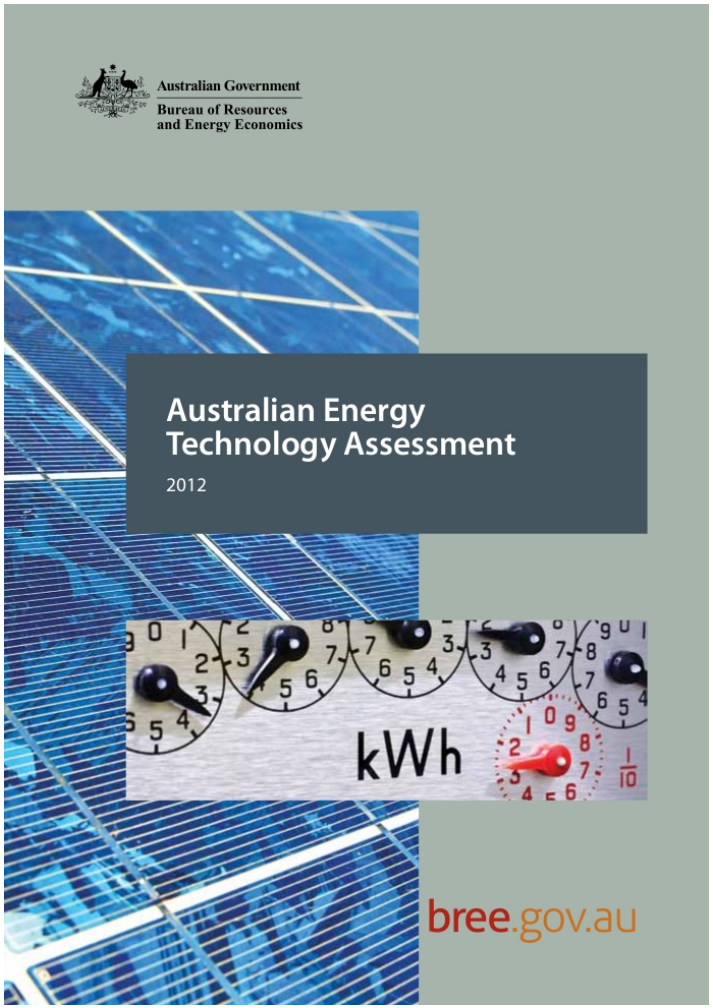
Hourly balancing mid-June 2010



Bioenergy: 12.7 TWh-e for the year (6.2% of energy)

UNSW AUSTRALIA

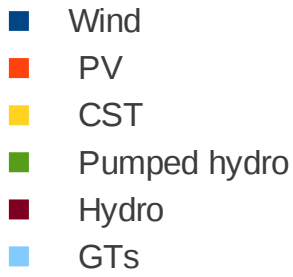
Technology cost data



Source: Bureau of Resource and Energy Economics (2012)

Generation mix

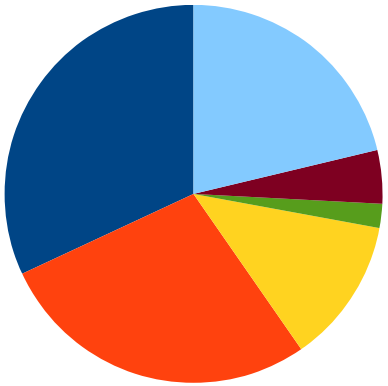
5% discount rate, low end capital costs

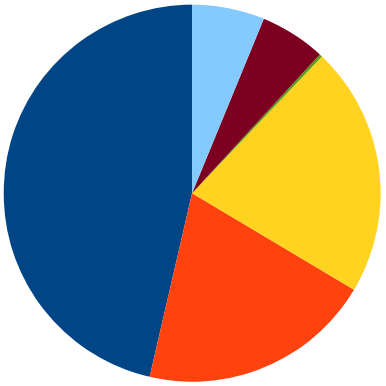


By capacity

By energy

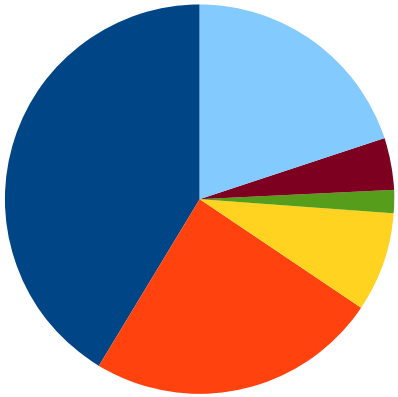
Low cost

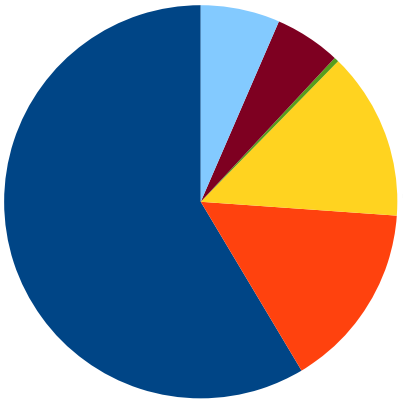




+ 8.8 TWh surplus (~4%)

High cost





+ 24.9 TWh surplus (~12%)

CST 13.3 GW, PV 29.6 GW (less than installed in Germany)

UNSW AUSTRALIA

What are the likely costs?
(they're a bit lower now)

	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)

Implications for bioenergy

- Flexible, dispatchable generators crucial to reliability
  - Adds to system inertia for AC frequency response
  - Fast start-up & ramping to balance variable renewables
  - Low minimum operating level
  - Small units (100-200 MW) may be sited close to fuel supply
- Flex-fuelled gas turbines could run on:
  - Numerous gaseous or liquid biofuels
  - Hydrogen or renewable methane (power-to-gas)
  - Renewable liquid fuels (power-to-liquids)
- Balancing energy is likely to be high value (MPC events)
- Supply and distribution will need to scale up

Summary

- Work to date suggests 100% RE technically and economically feasible
- Bioenergy crucial for reliability in our scenarios
- “Baseload” not required for 100% RE
  - Biomass *could* play a part, but will need low cost
  - Biomass more likely to compete with CST (mid-merit)
- Faces possible distant competition from e.g. power-to-gas or off-river pumped hydro

Thank you

Ben Elliston

b.elliston@unsw.edu.au