THE UNIVERSITY OF MELBOURNE

ENERGY Research Institute

Melbourne University Renewable Integration Lab (MUREIL)

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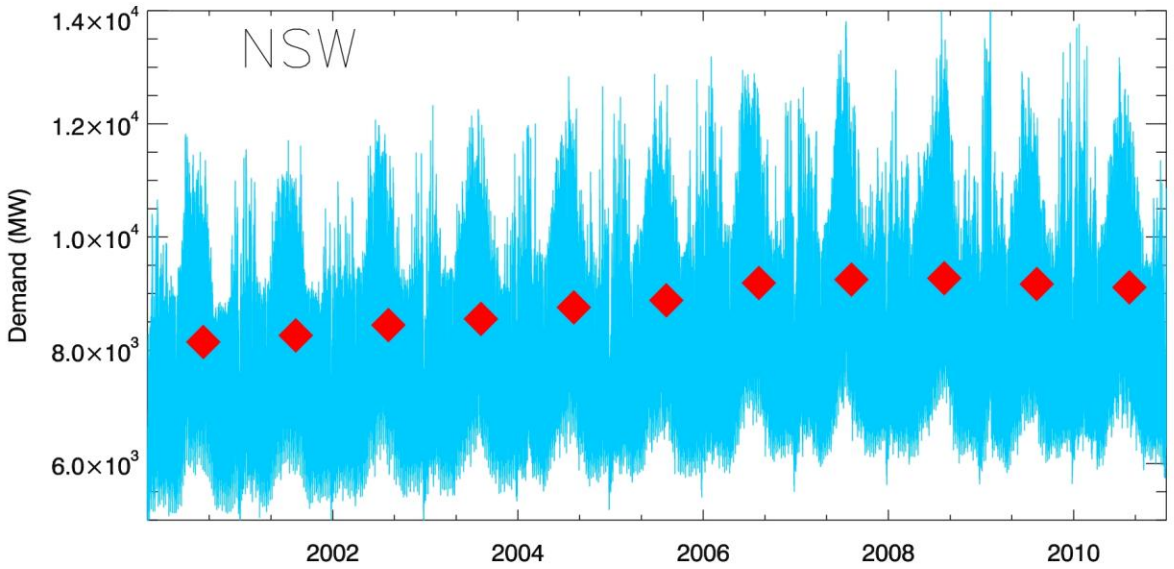
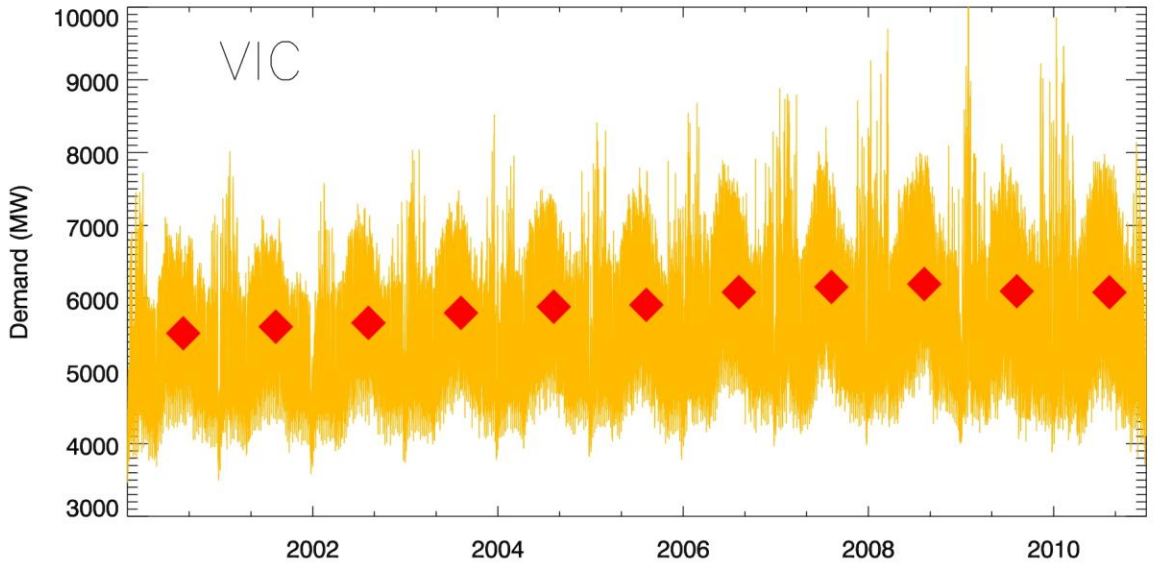
Demand

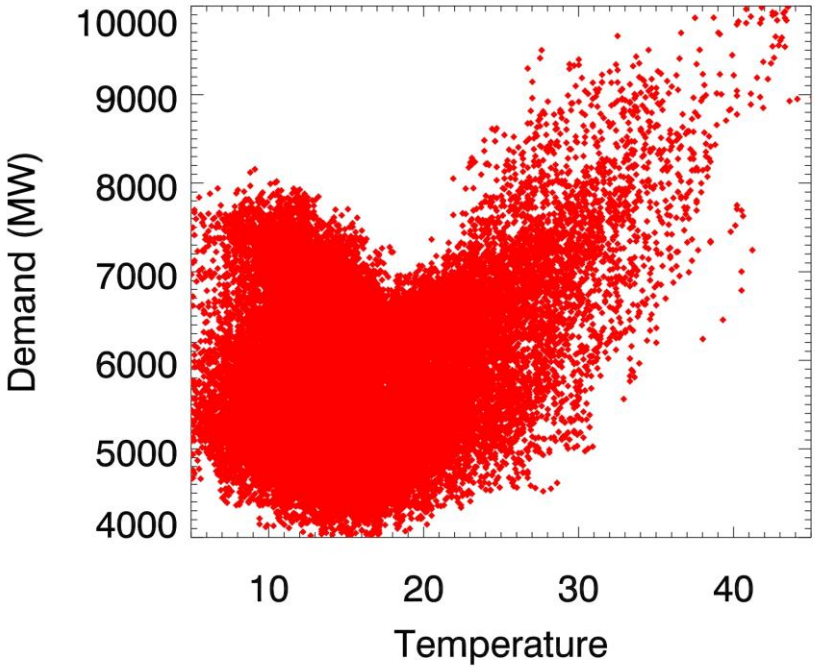
Peak demand increasing faster than the average

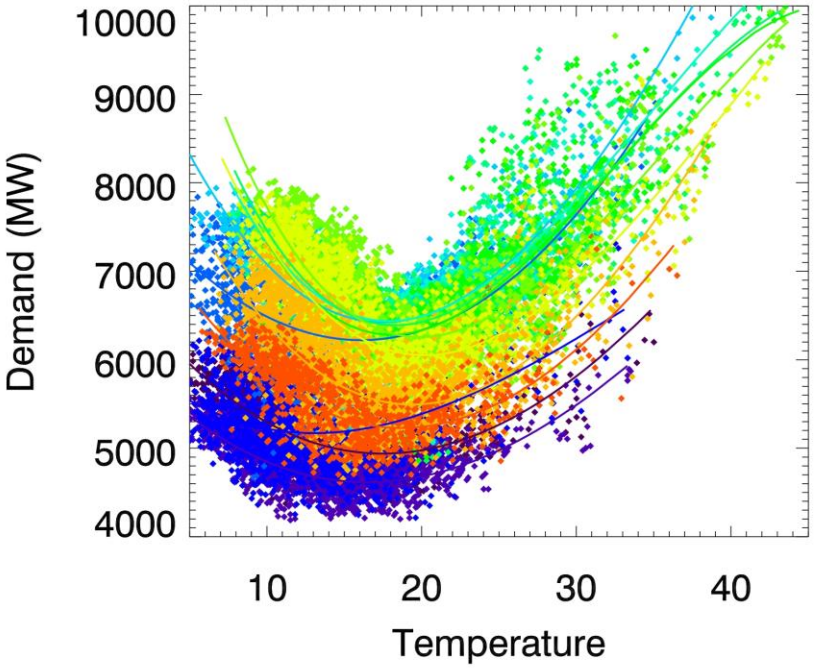
Annual average demand stopped increasing in 2009





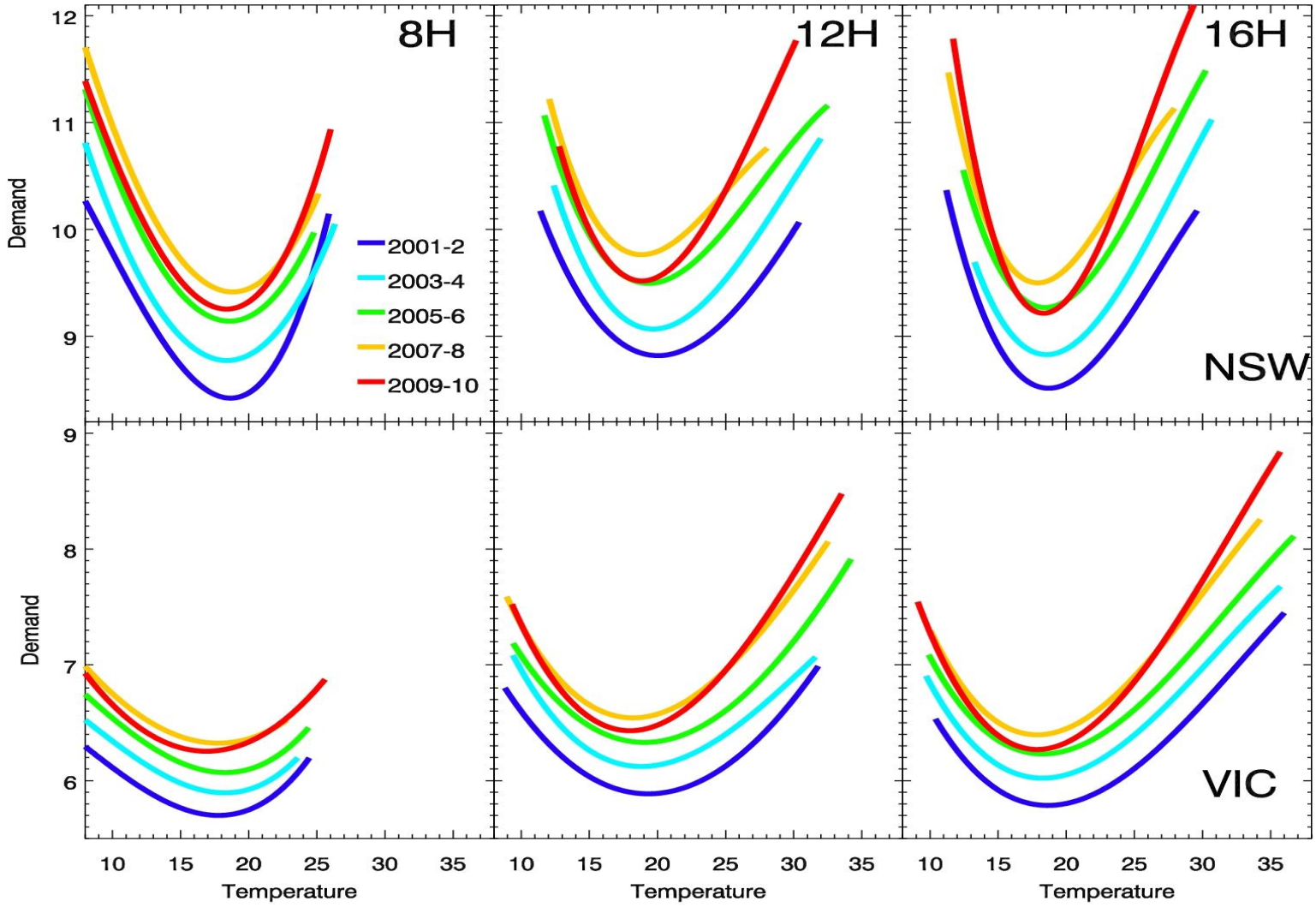
Demand Model



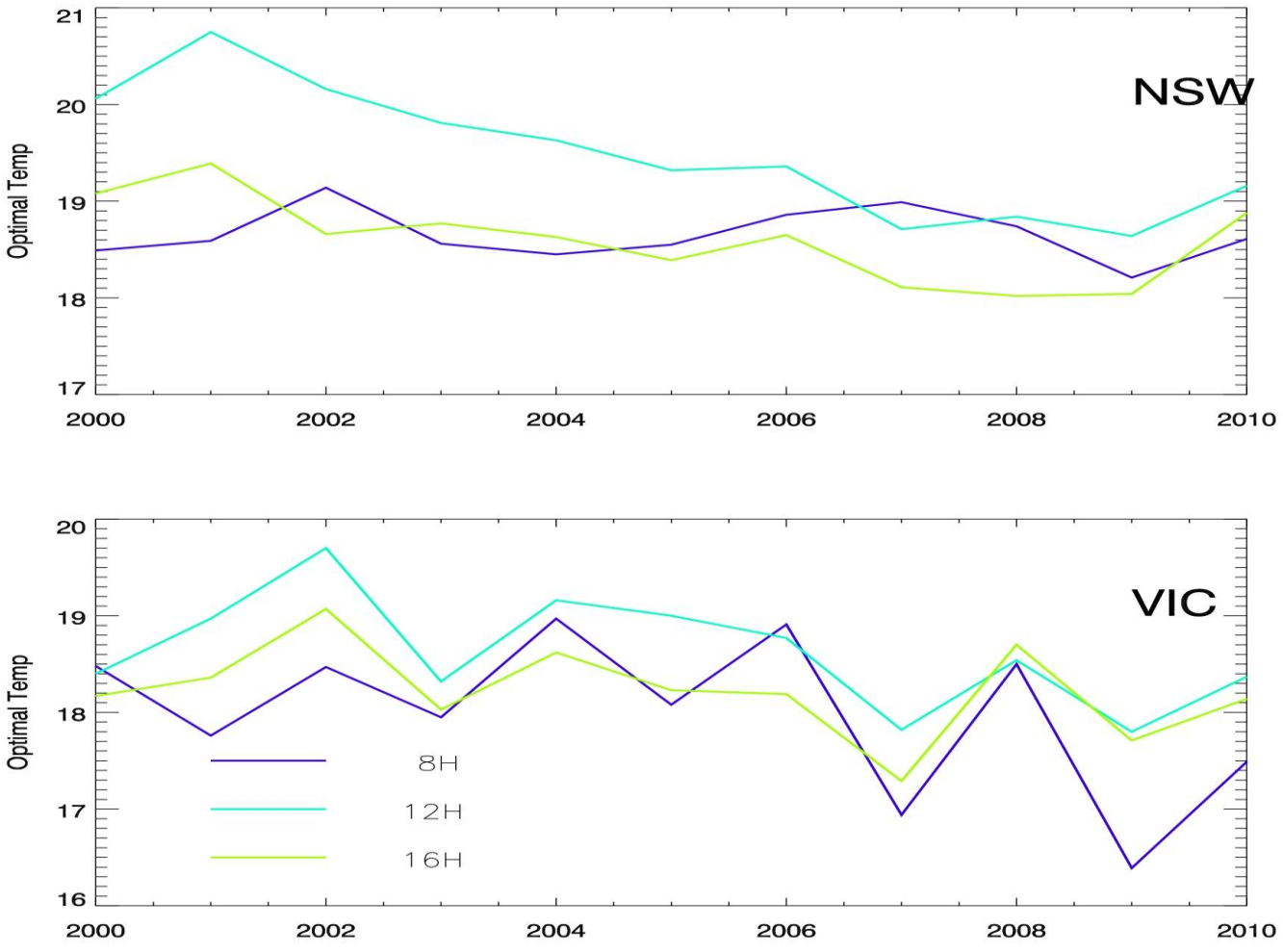


Statistical model trained with 2009-2010 data

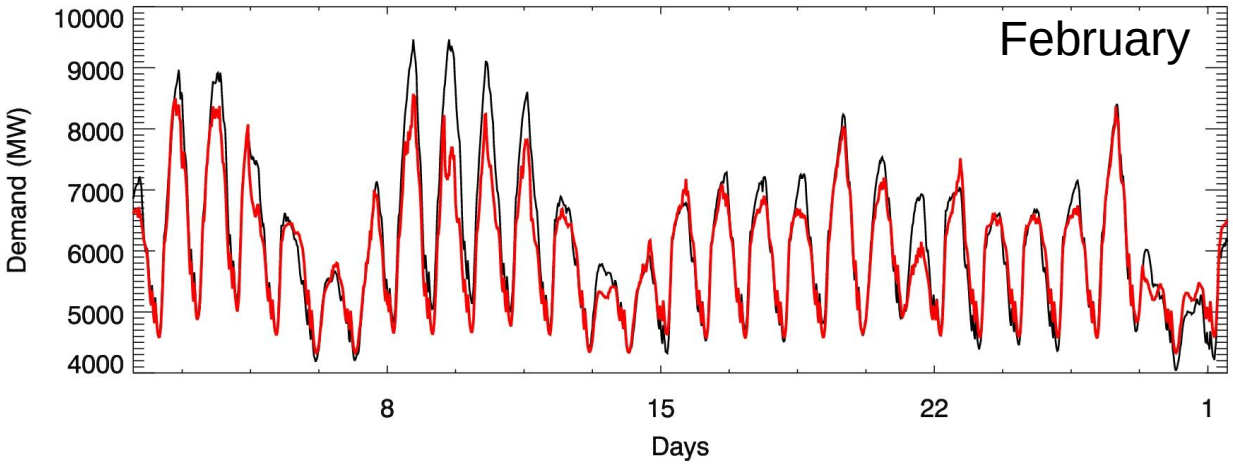
Demand model

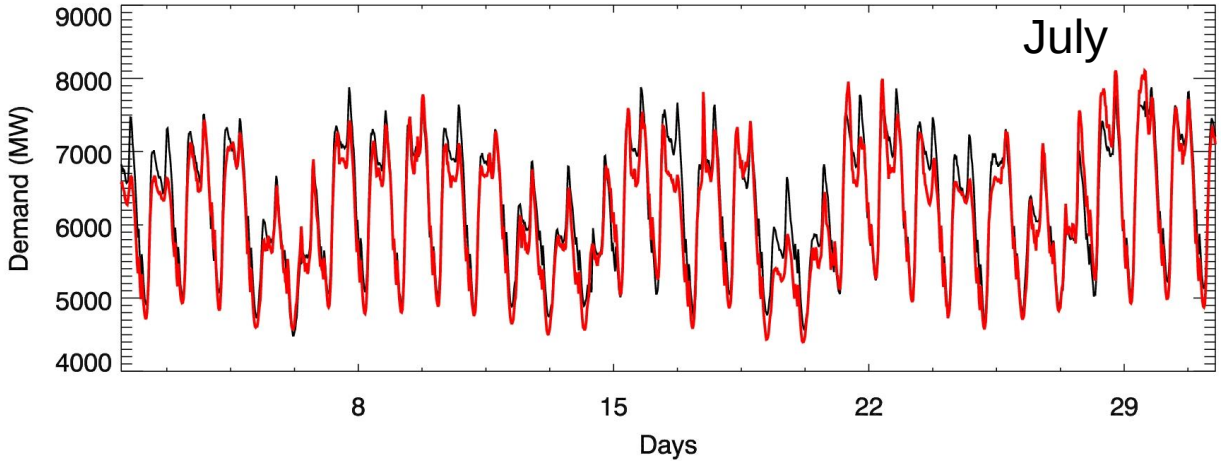


Trend in optimal temperatures

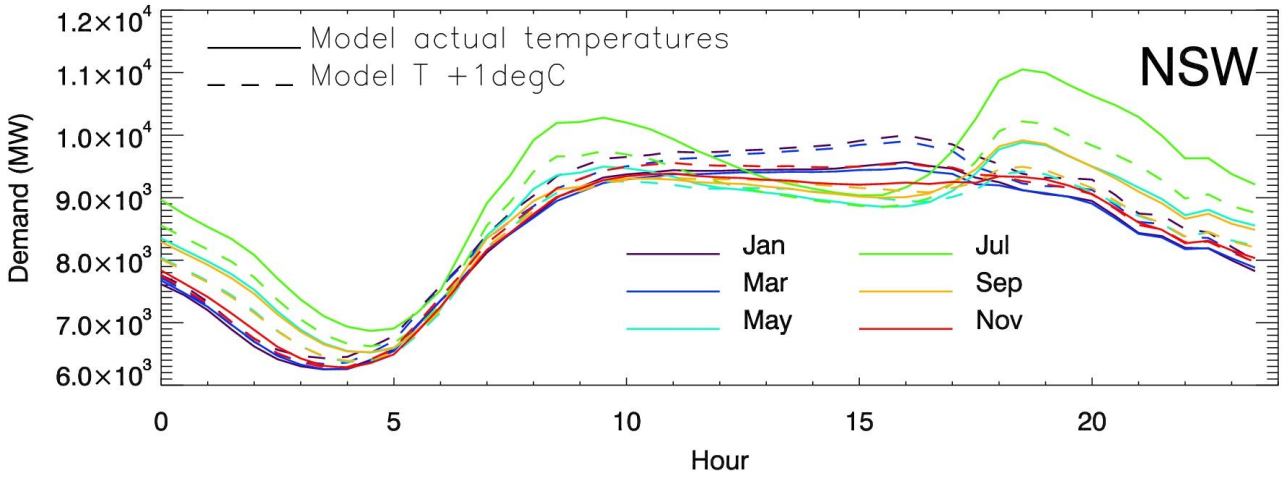


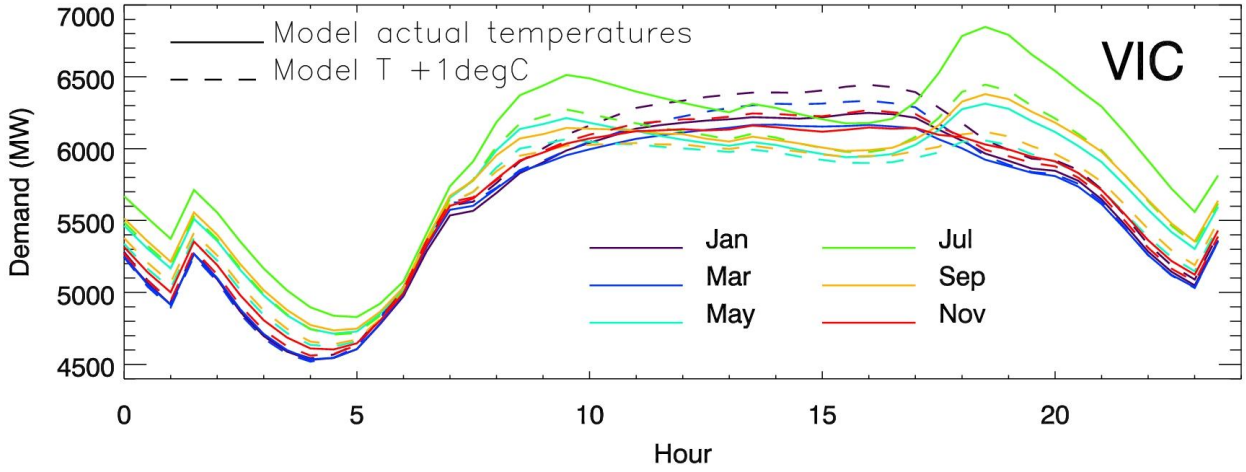
Model performance: Victoria





Global warming impact on demand



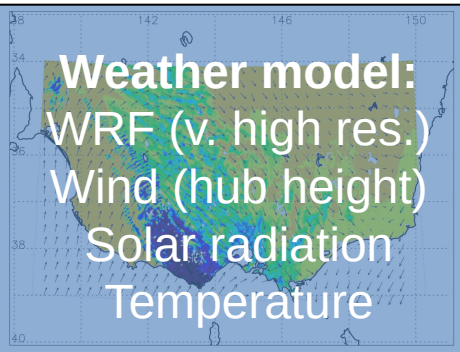


MUREIL Overview

- Managing the short-term natural variability in renewables is a key challenge
- This variability can be reduced by intelligent design
- Different technologies have different characteristics in terms of reliability, cost and carbon footprints.
- MUREIL is a modelling system to find this optimal mix

MUREIL concept

- Scalable
- Modular
- Computationally expensive



Potential electricity production

Site selection

Wind and solar power

Electrical system model

Conventional power
Hydro
Storage

Demand

Optimisation algorithm

Transmission network

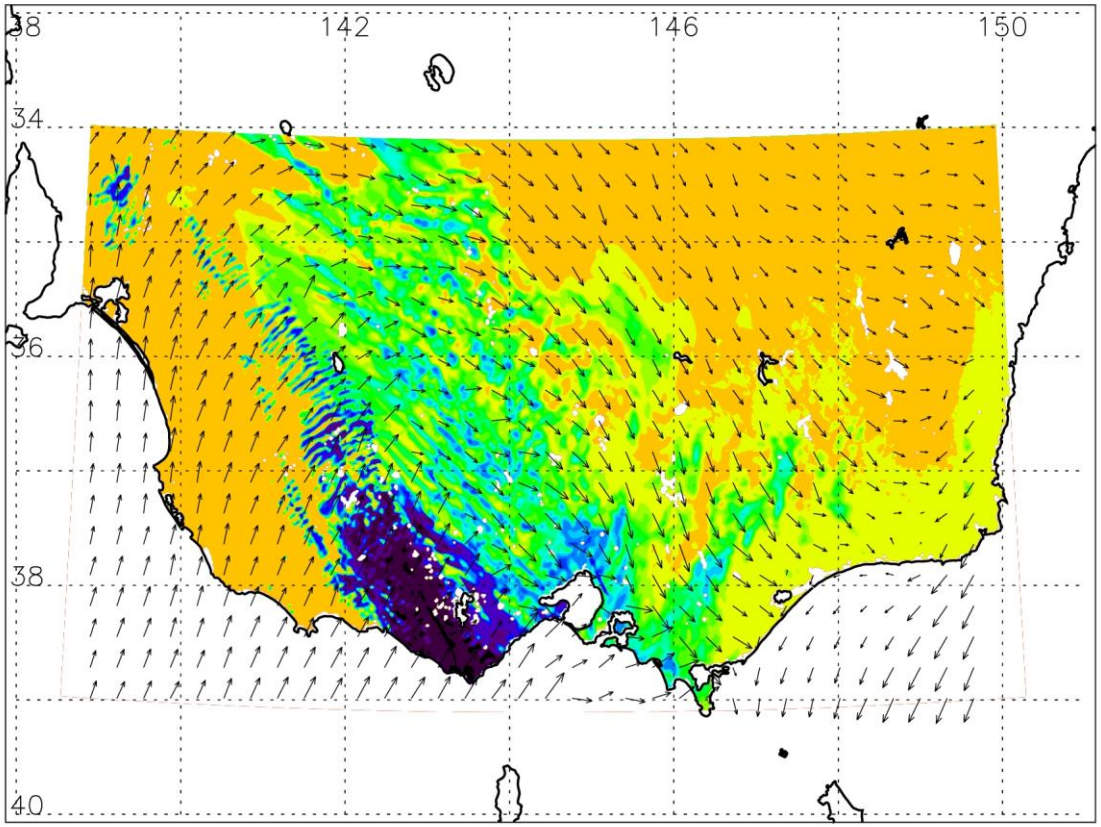
Cost
Carbon price/ regulatory levers

Spot Market

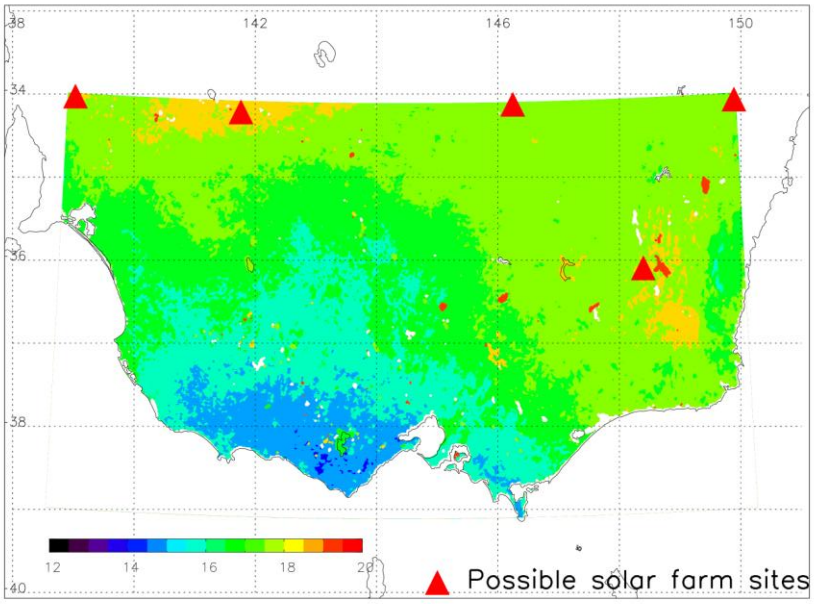
Optimisation Loop

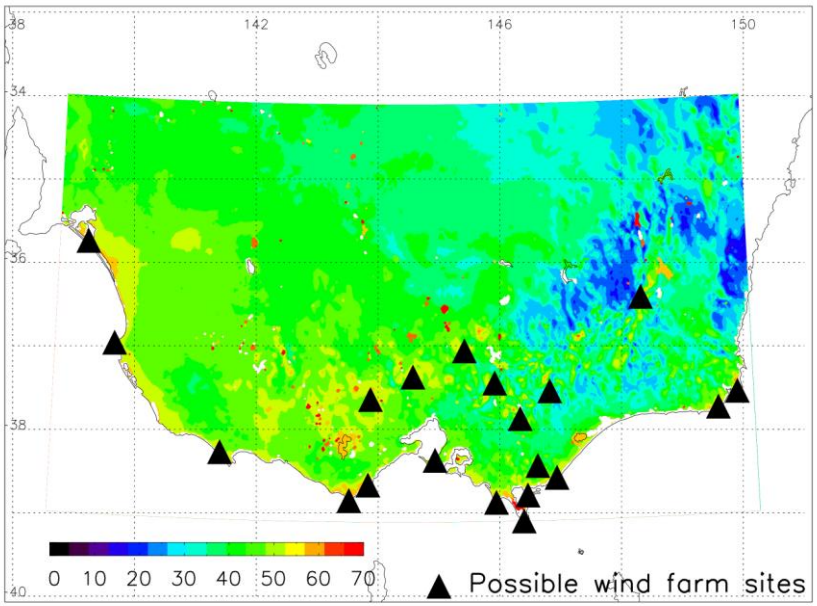
WRF model setup

- 1.5x1.5 km resolution
- Nested in global reanalysis
- Surface short-wave radiation and wind speed at 30 minute increments



Site selection



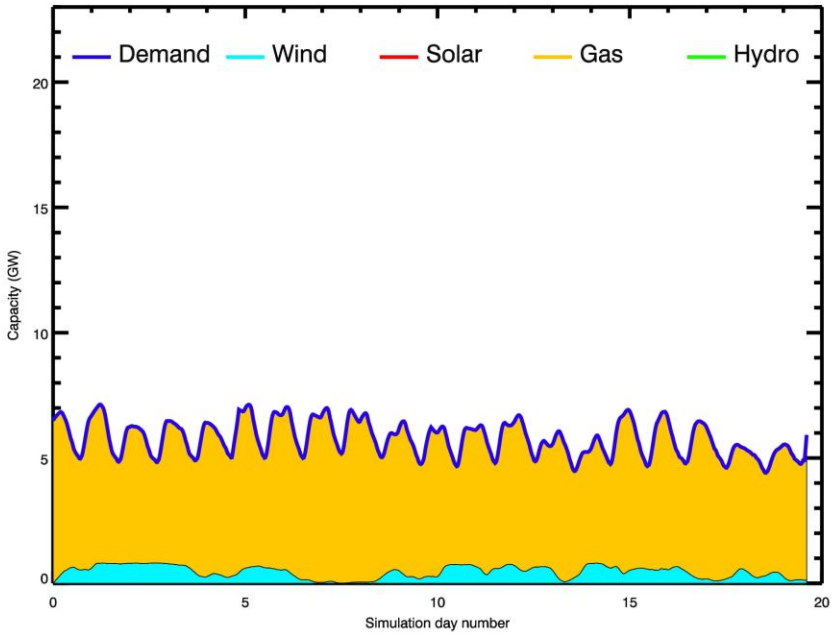


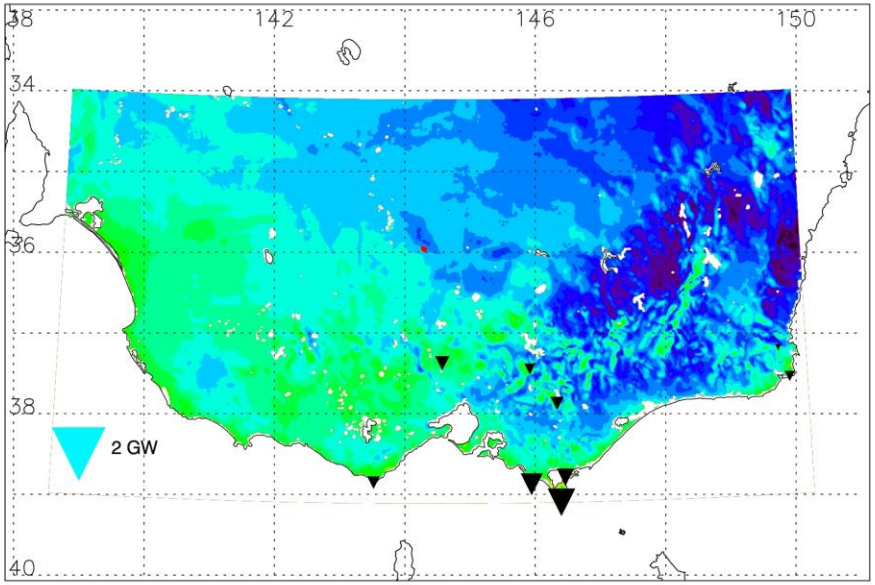
Best sites for wind and solar farms - based on WRF output and producing a geographical spread

*note that actual best sites will change with longer simulation
**National Parks etc not masked in this scenario

Business as usual scenario

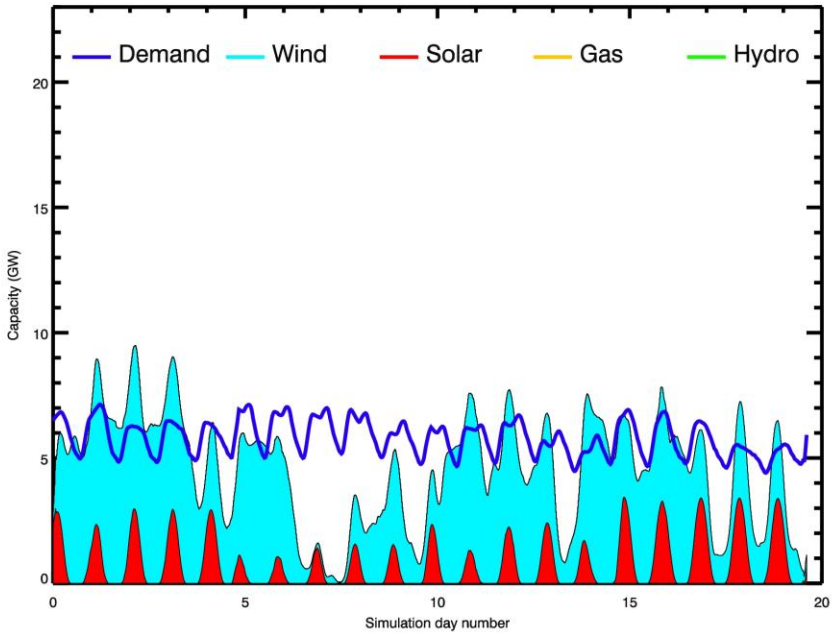
- No carbon price, high gas price
-
- Model selects a few good quality wind farms, but meeting demand with gas poses no variability issues

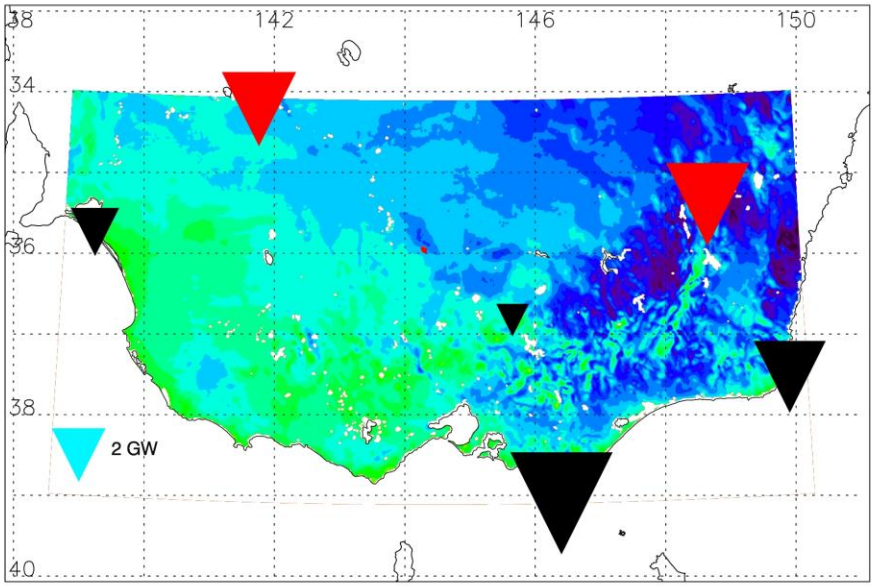




Scenario 0

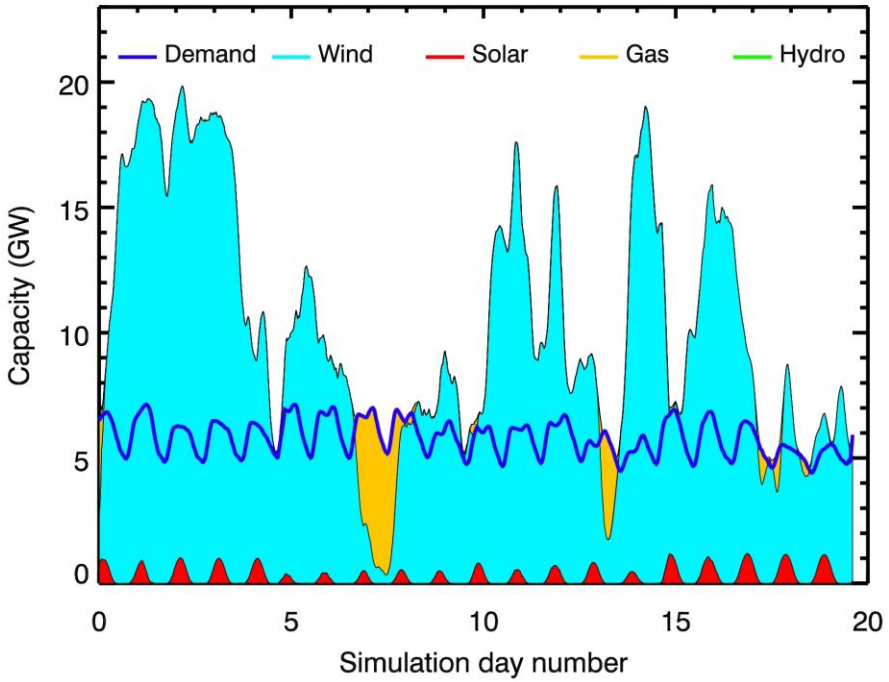
- Just wind and solar
- No requirement to always meet demand – just do the best possible

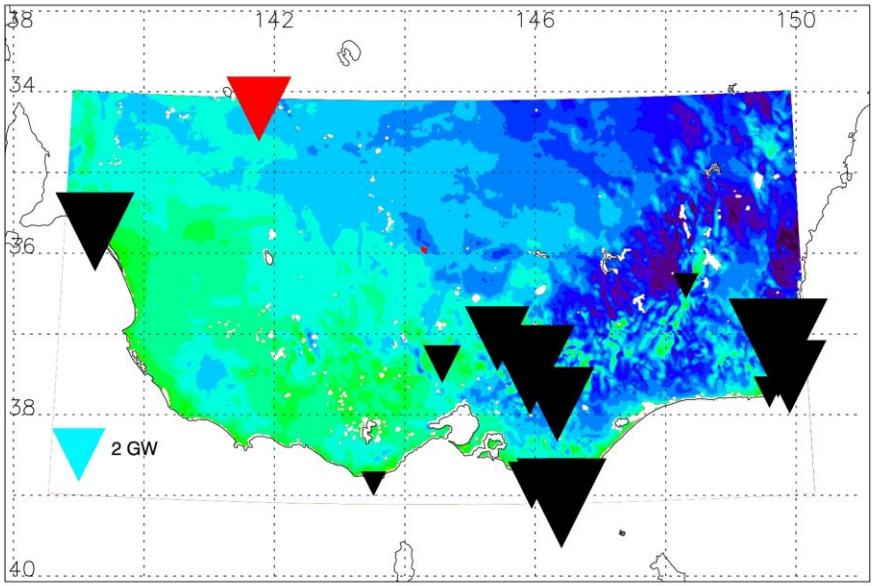




Scenario 1

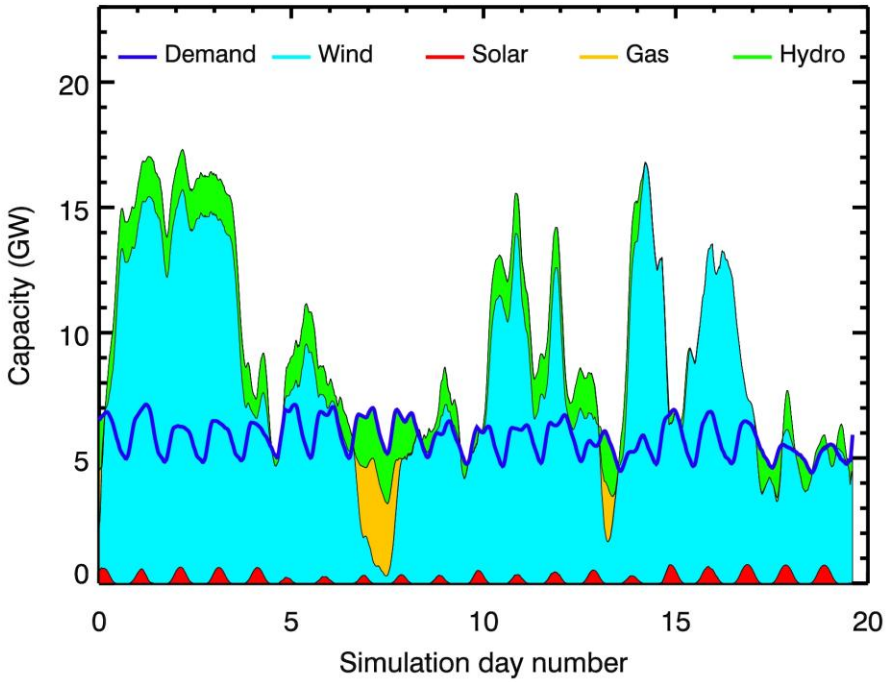
- Optimal mix of wind and solar to meet demand
- Gas fills in the gaps
- Wind dominates solar due to solar's higher expense and lack of supply at night
- Geographic distribution shows fairly even spread of wind stations

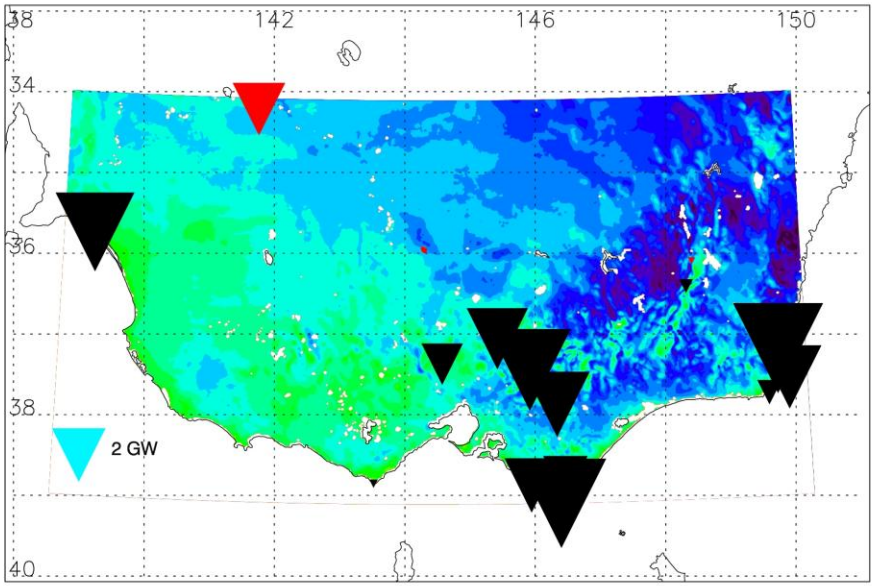




Scenario 2

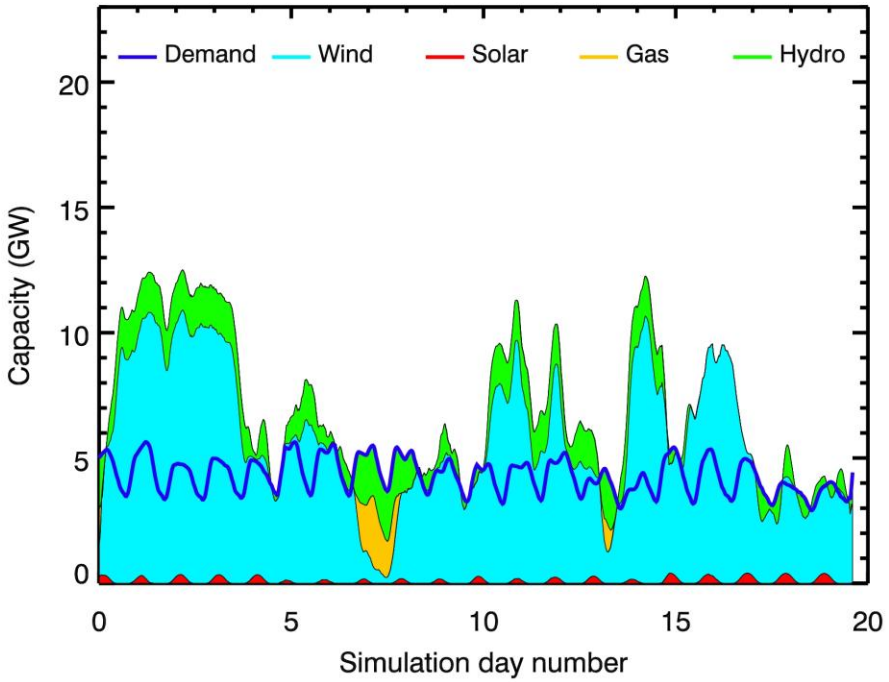
- 2 GW of pumped hydro available
- Results in 4.5 GW reduction in required generating capacity
- Solar becomes even less important

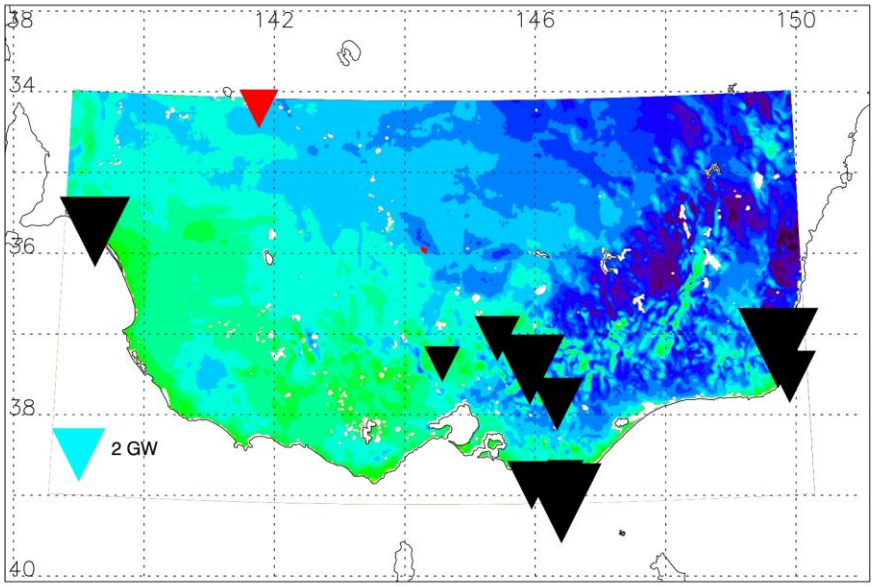




Scenario 3

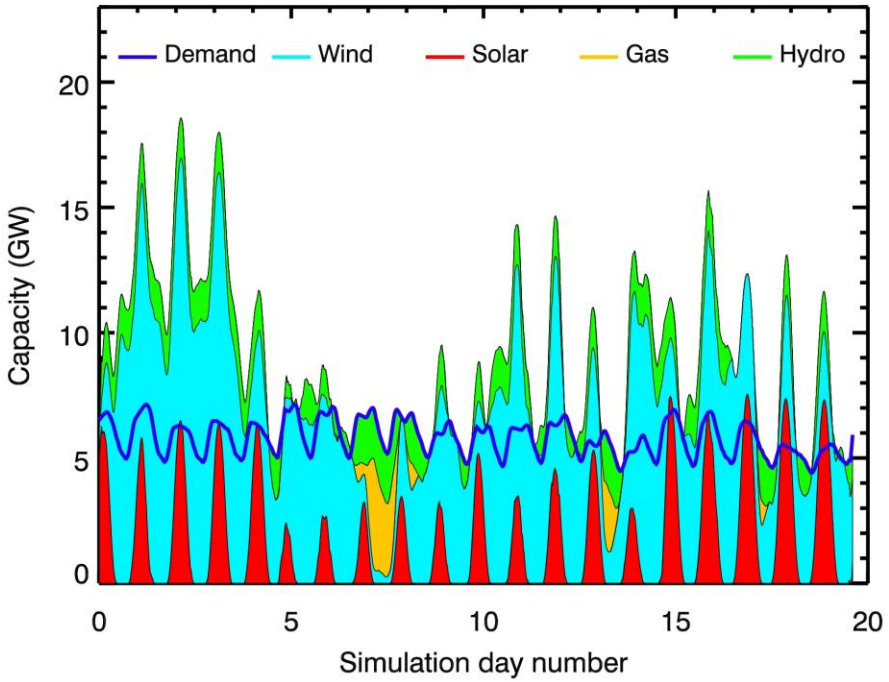
- Same scenario 2 but 1.5 GW shaved of demand
- 6 GW reduction in required capacity
- Wind still dominates

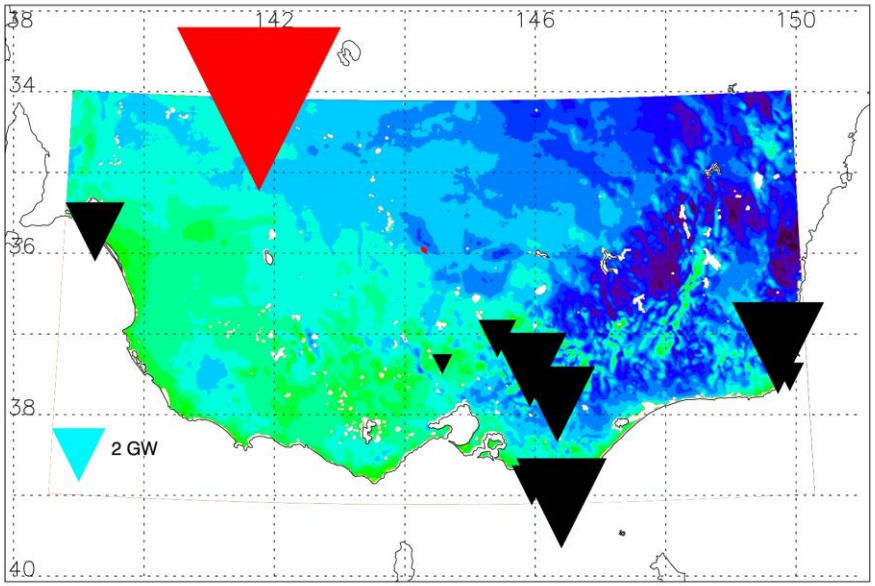




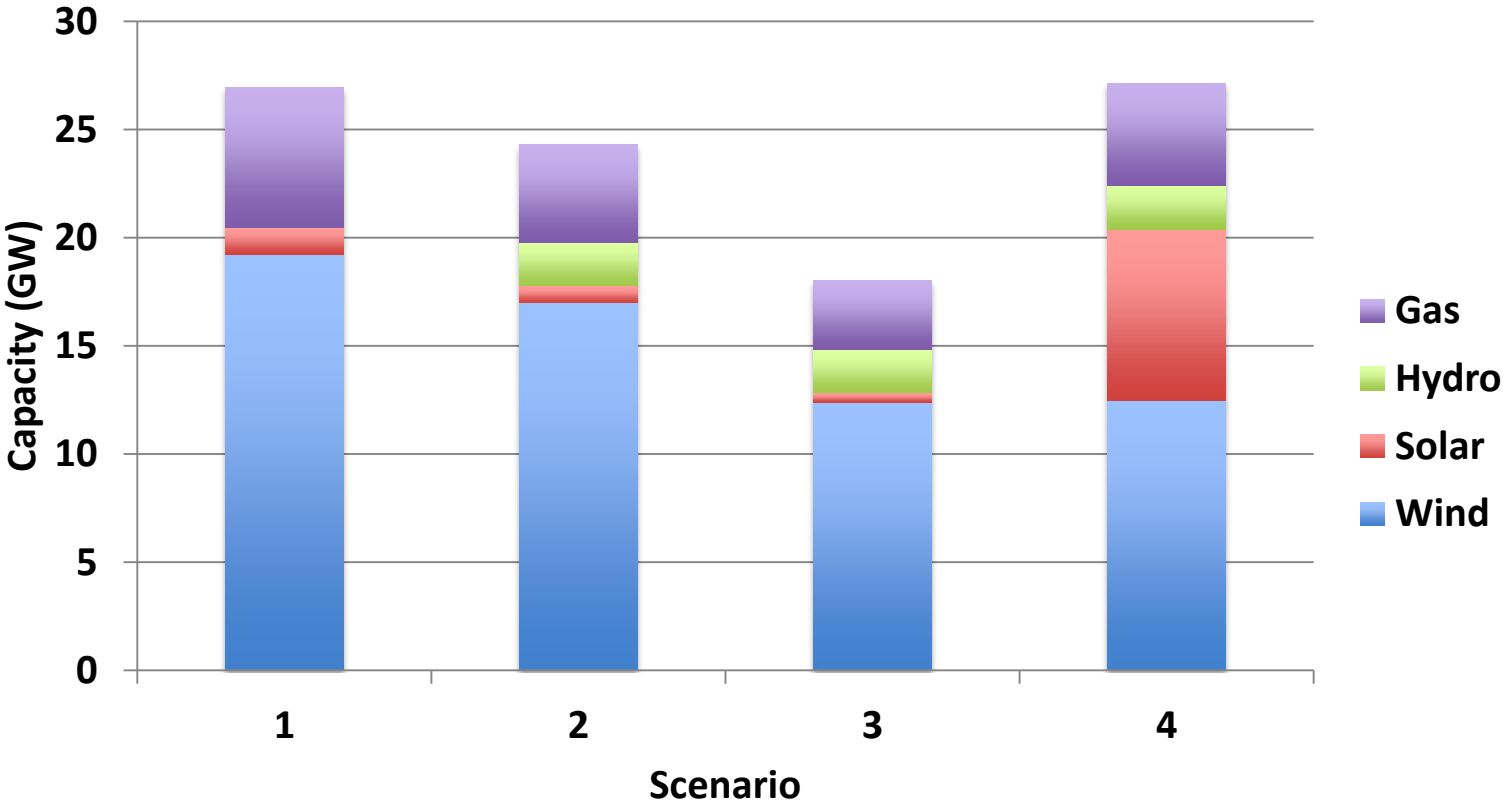
Scenario 4

- Solar costs dramatically reduced (5 fold)
- Wind still dominates
- => it can't provide power after sun set for system with larger overnight demand





Summary


30
25
20
15
10
5
0
Capacity (GW)
1
2
3
4
Scenario
Gas
Hydro
Solar
Wind

Conclusions

- MUREIL is currently at the prototype stage
- Additional functionality/features need to be added
  - National scale, annual scale, site masking
  - Additional technologies, i.e. wave, tidal, solar with storage, geothermal, biomass
  - Transmission network
  - Spot Market
  - Regulatory aspects
  - Water constraints
  - New optimisation algorithm
- Can also consider demand side response; time day pricing, energy efficiencies, electric vehicle fleet impact, DG impact