Wind integration – the long view

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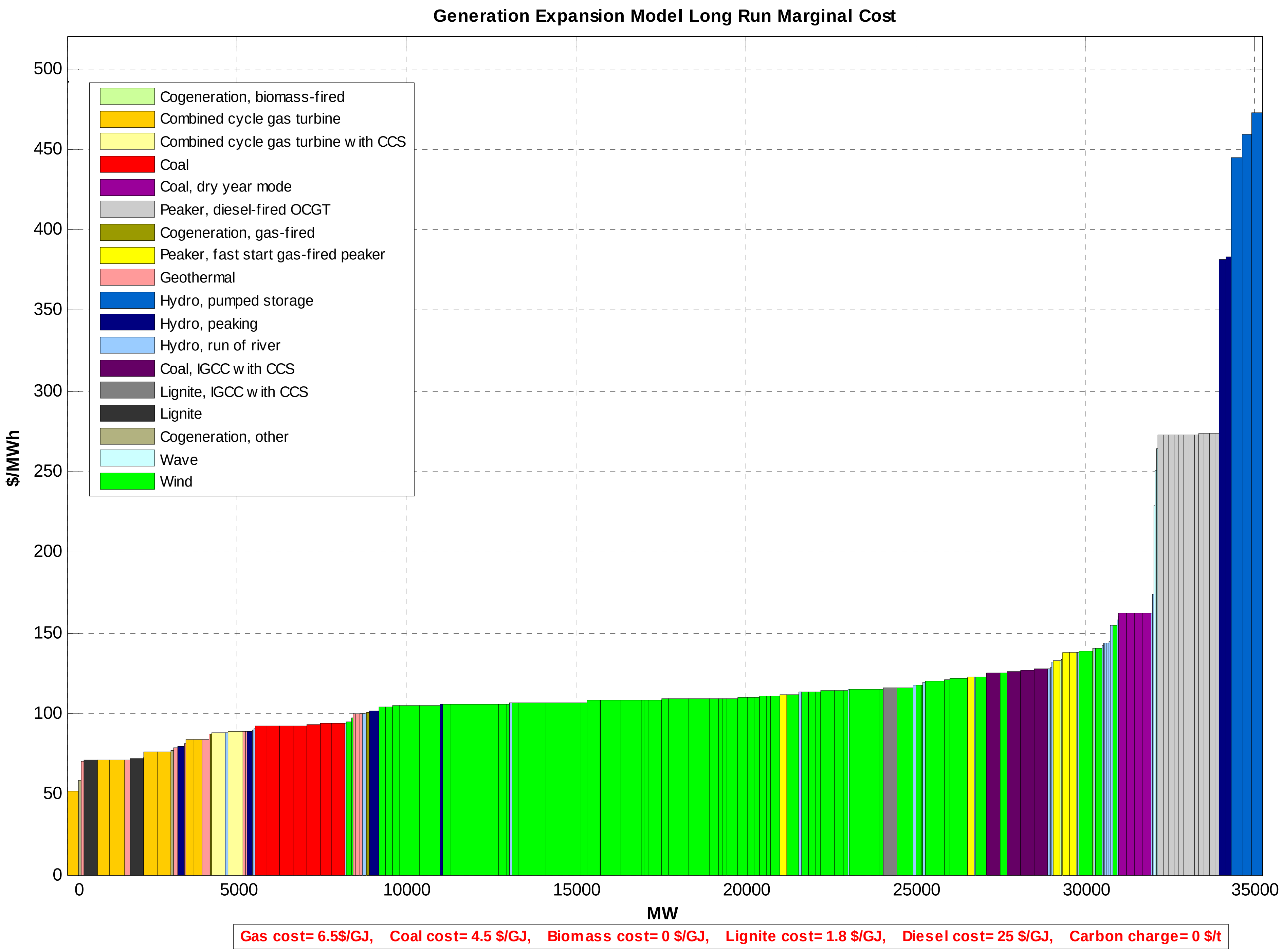
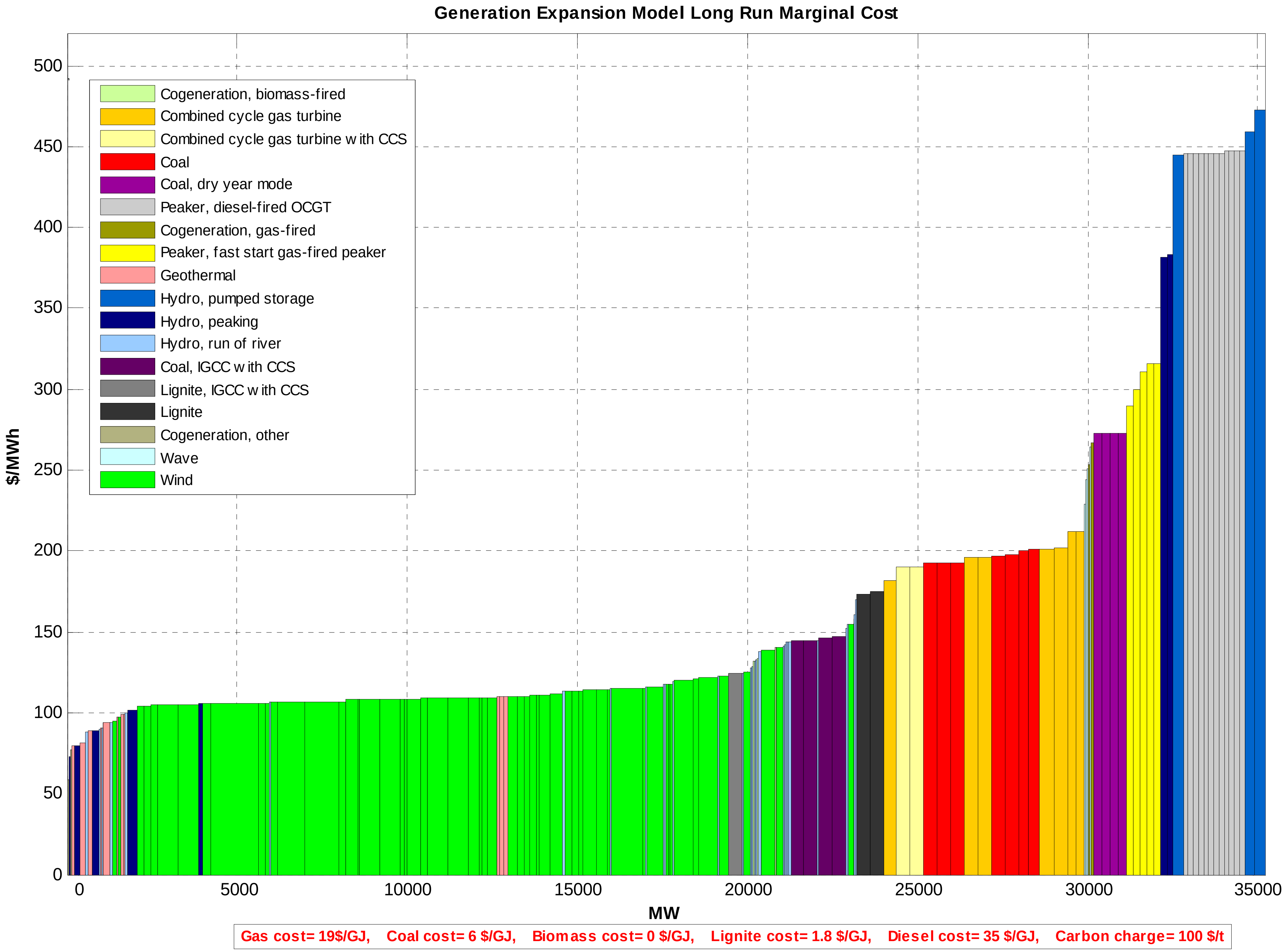
Wind Integration

- Long run perspective
- Economics of wind integration
  - Carbon price
  - Barriers to penetration
- Modelling of physical quantities
  - Frequency Keeping
  - Scheduling Reserve
  - Risk
- Modelling Approach and Synthetic Dataset

Generation expansion

- Generally least cost
- Relative ranking, not absolute cost most important
- Risk averse investors
  - Carbon price 2012-2032?
  - Gas supply and cost?
  - Consents for hydro, coal plant?


Generation Expansion Model Long Run Marginal Cost
Cogeneration, biomass-fired
Combined cycle gas turbine
Combined cycle gas turbine w ith CCS
Coal
Coal, dry year mode
Peaker, diesel-fired OCGT
Cogeneration, gas-fired
Peaker, fast start gas-fired peaker
Geothermal
Hydro, pumped storage
Hydro, peaking
Hydro, run of river
Coal, IGCC w ith CCS
Lignite, IGCC w ith CCS
Lignite
Cogeneration, other
Wave
Wind
$/MWh
0
50
100
150
200
250
300
350
400
450
500
0
5000
10000
15000
20000
25000
30000
35000
MW
Gas cost= 6.5$/GJ, Coal cost= 4.5 $/GJ, Biomass cost= 0 $/GJ, Lignite cost= 1.8 $/GJ, Diesel cost= 25 $/GJ, Carbon charge= 0 $/t



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MW
Gas cost= 19$/GJ, Coal cost= 6 $/GJ, Biomass cost= 0 $/GJ, Lignite cost= 1.8 $/GJ, Diesel cost= 35 $/GJ, Carbon charge= 100 $/t

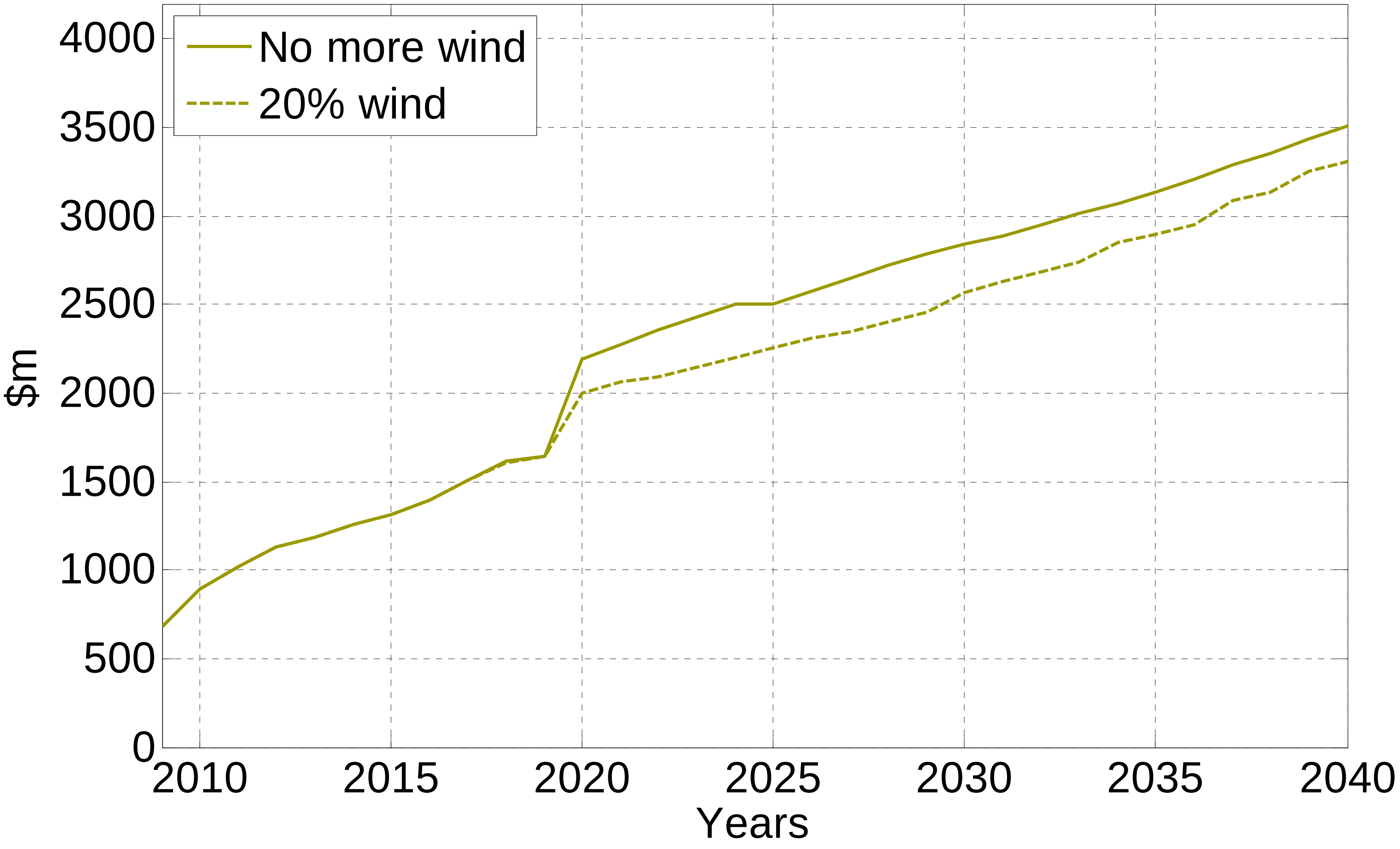
Currently investing in…

- Wind generation (1100 MW, 2074 MW applied)   (31st Mar)
- Geothermal generation (222 MW, 35MW applied)
- Hydro (28MW, 354 MW applied)
- Gas thermal (609 MW, 240 applied) 400 OTC, 200 peaker
- Gas peaking

‘Optimal’ expansion outcome

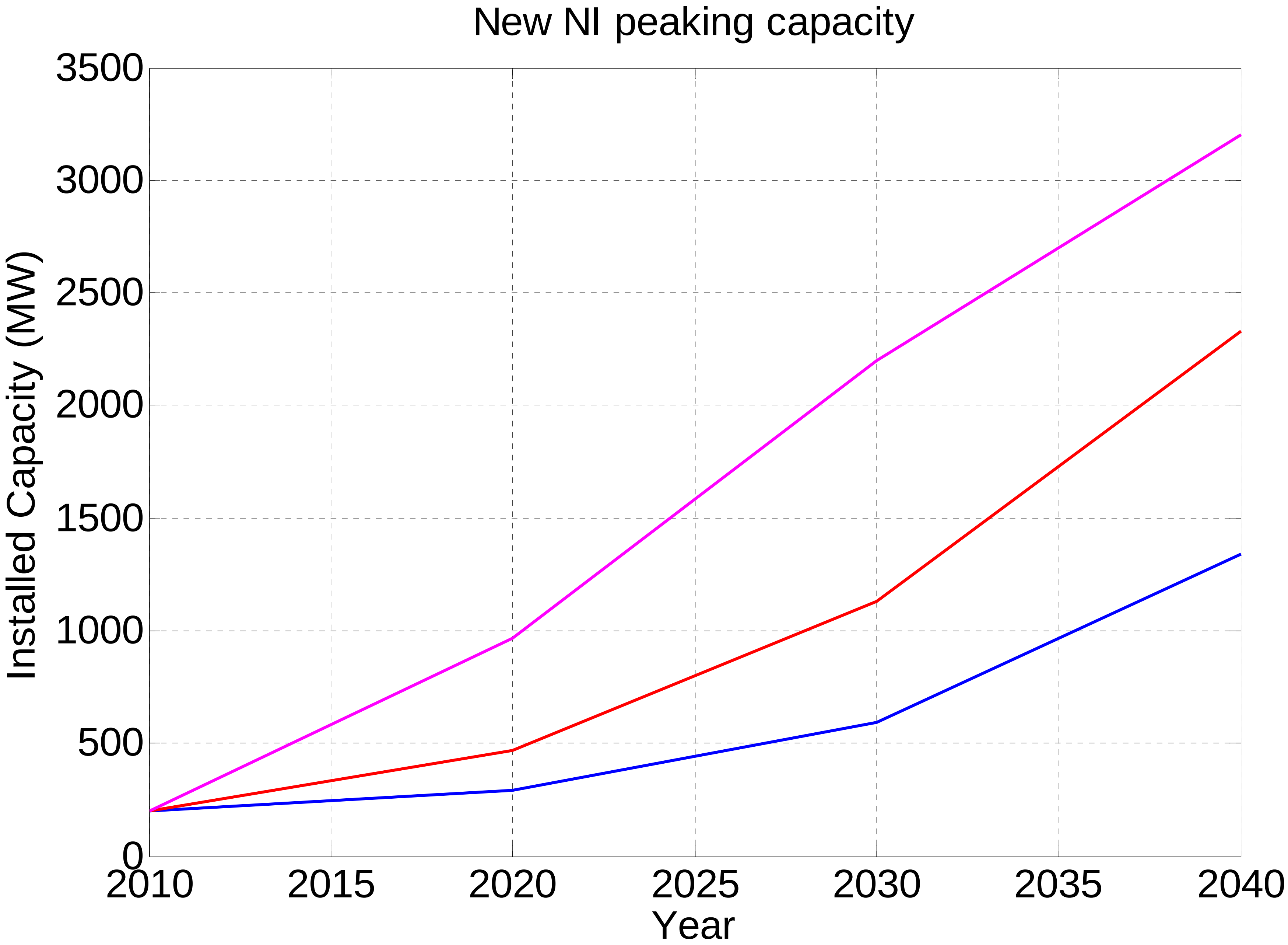
- Gas restricted by LNG price or export parity or supply
- At moderate carbon price
  - 20% of energy from wind
- ‘Rule of thumb’ wind limit
- Significant economic benefit in integrating wind generation
- Compare cost of total restriction on wind development
  - Wind up to 20%, Carbon =$100
  - Wind up to 0%, Carbon =$100

Annualised supply-side costs ($100C)



‘Barriers’ to entry

- Peaking contribution
- Frequency Keeping/ Load Following
- Scheduling Reserve
- Off-peak over-generation



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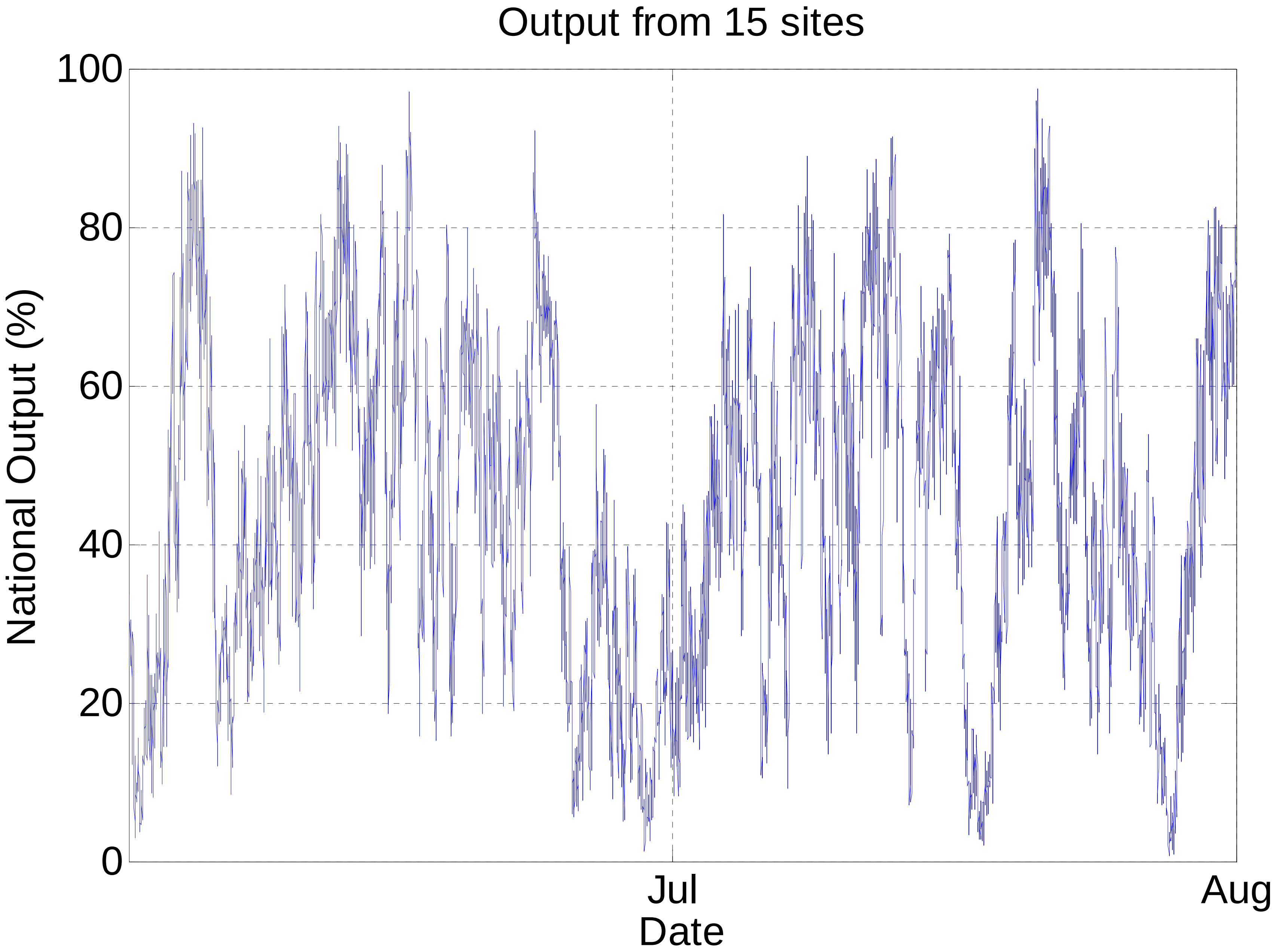
Wind & Peaking

- Contributes in a stochastic sense
- ‘Fills-in’ when firm plant unavailable
- Roughly 20-30% capacity – site correlation
- Firm plant ‘fills-in’ for wind
- Need enough firm generation and DSR for zero wind
- So a dual stochastic and deterministic requirement



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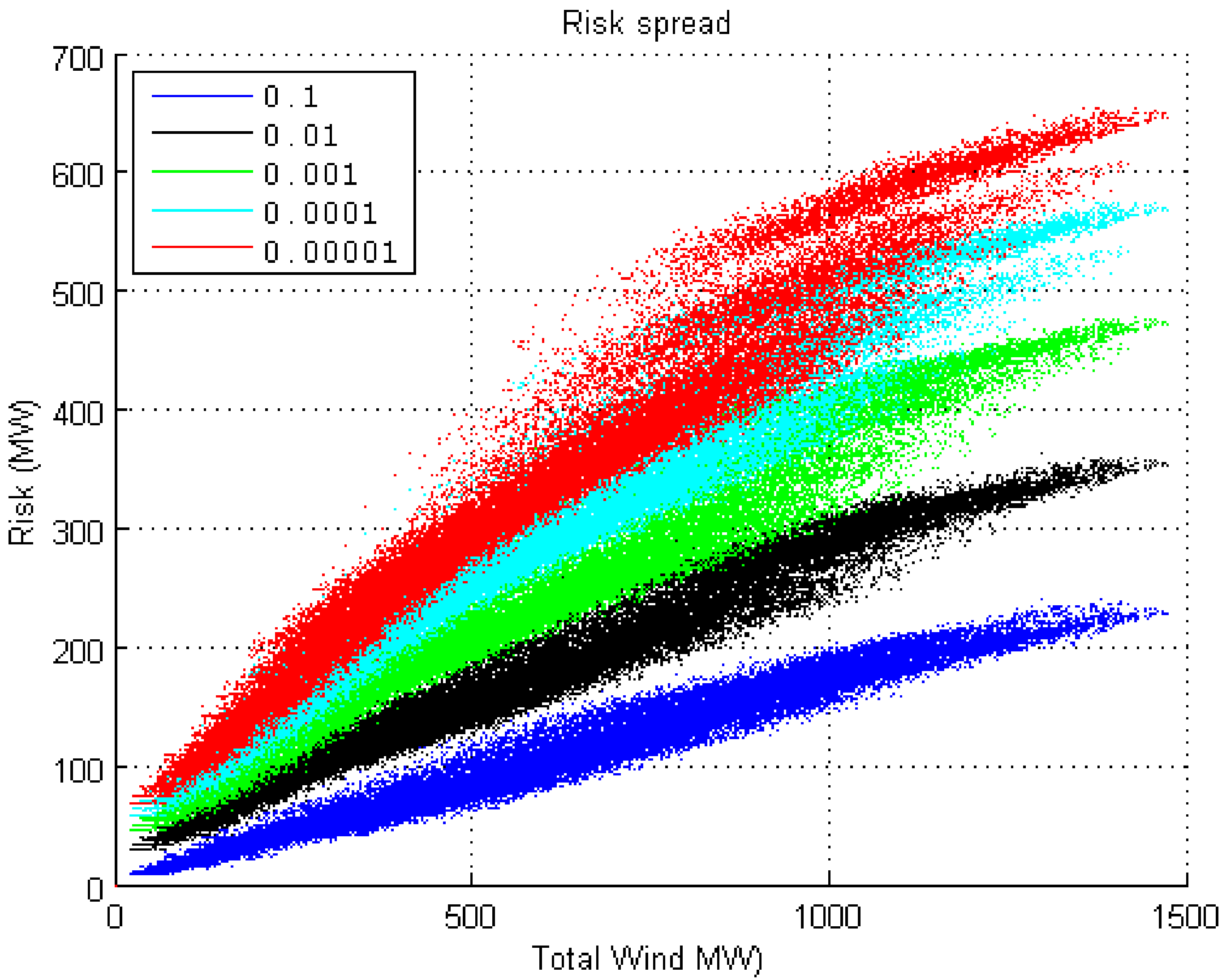
Frequency Keeping

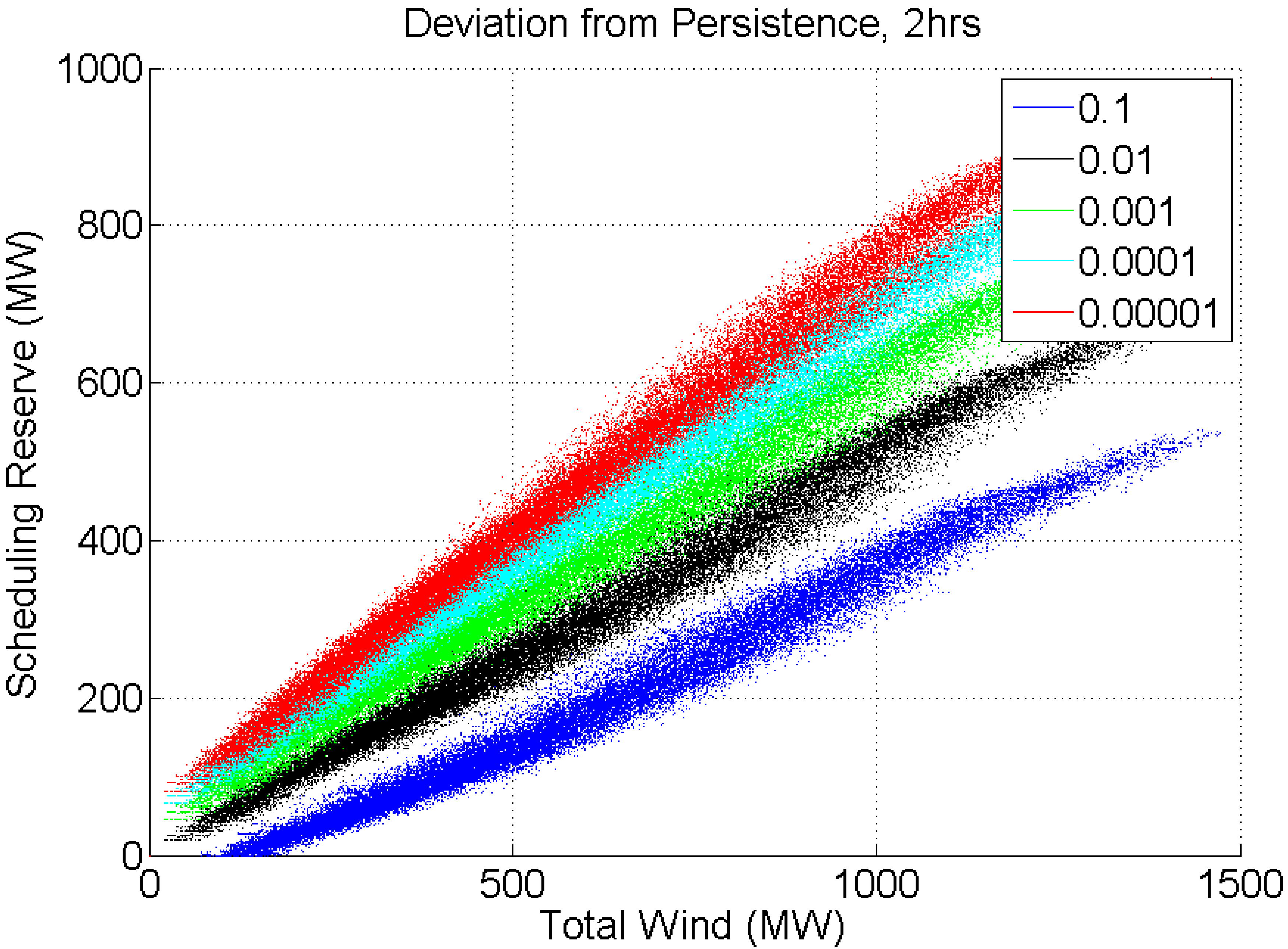
- To cover normal variations over the dispatch period…
- Currently 50MW, but would need to increase
- Amount of cover required depends on risk level
- Best to convolve all sources of uncertainty

Frequency Keeping vs risk, MW level



Scheduling Reserve

- Adequate overhead in the offer-stack to cover forecasting error
- Needs to physically exist and be offered
- Likely role for demand-side participation



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Off-peak

- Could be too-much generation off-peak
- Conflict with base-load plant, dynamic characteristics of connected plant
- Need flexible demand, storage up to 6-12 hours
  - Pumped hydro
  - Electric vehicles
  - Water heating
- Possibly most significant barrier

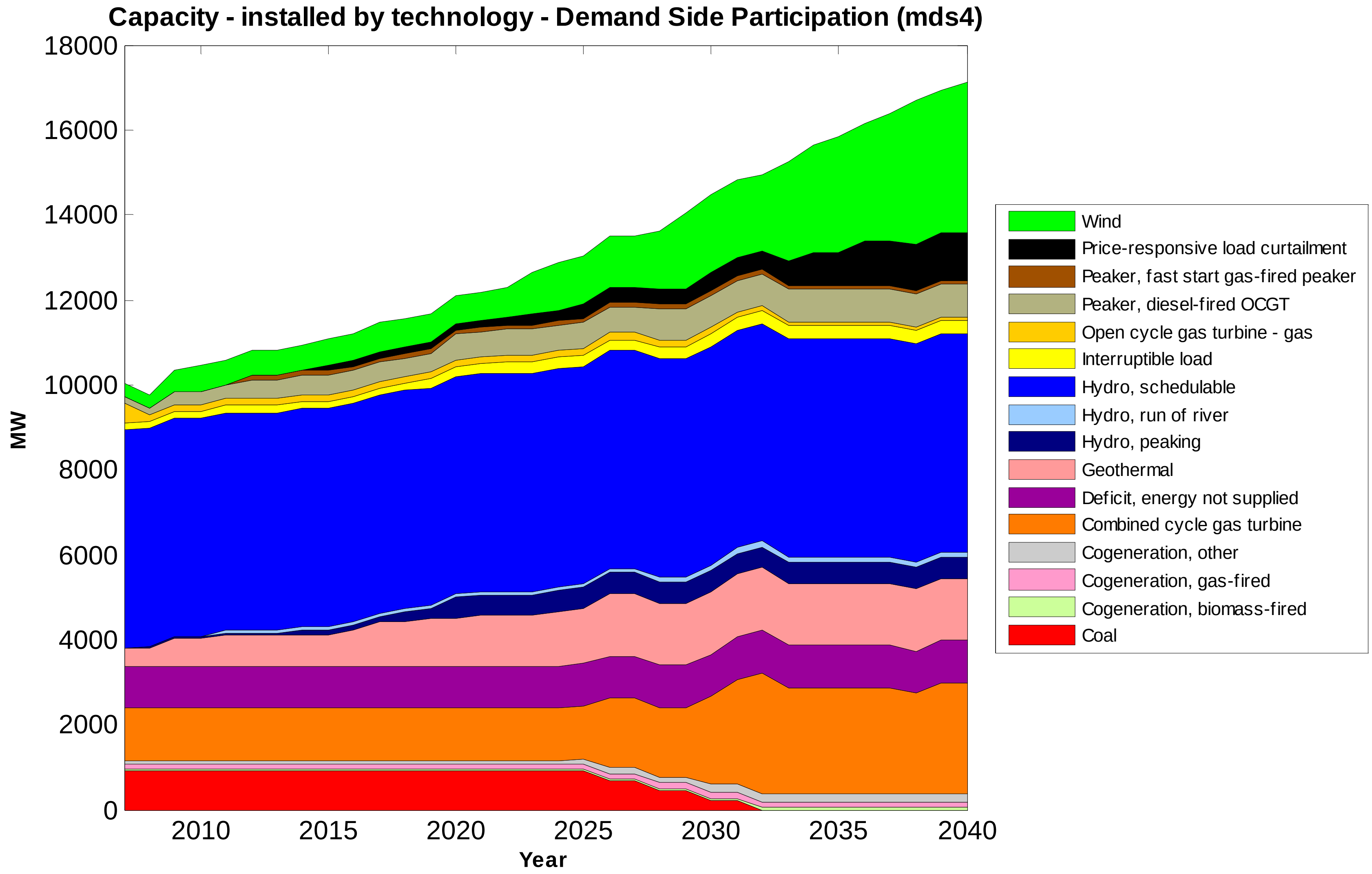
Modelling these issues

- Least cost generation expansion
- Co-optimise with constraints reflecting integration issues
  - Contribution to peak
  - Maximum penetration
  - Scheduling and frequency keeping
  - Low wind states
  - Off-peak over-generation
- Calculate benefit of 'relaxing' modeled constraints
  - Eg more DSR, pumped hydro, dc link capacity etc

Modelling Framework

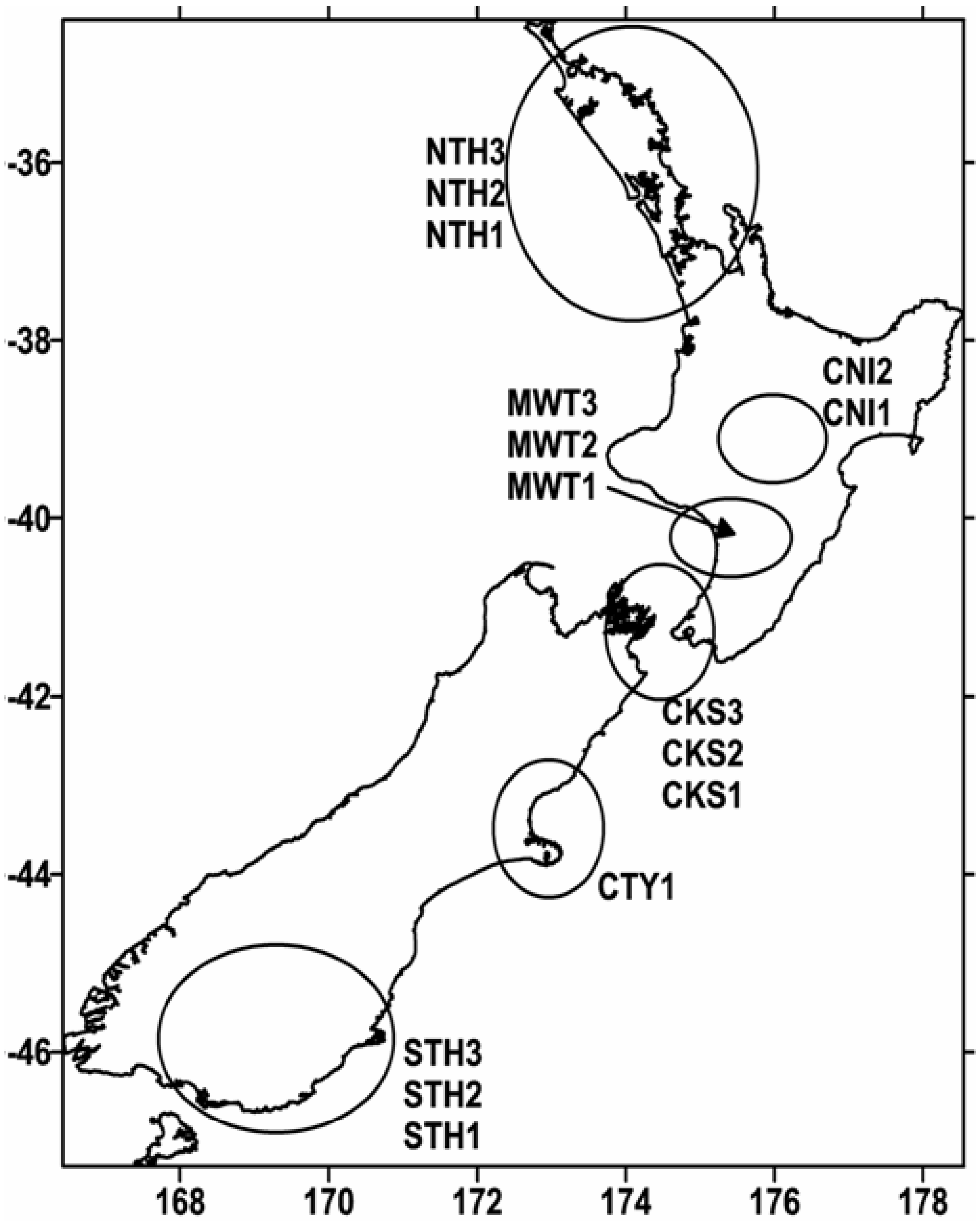
- Wind data
  - 10 minutely, many sites, five years
  - Wind variability, site correlation, seasonal and daily patterns
  - Contribution to peak, FK and scheduling reserves
- Market Dispatch Model
  - Stochastic dispatch
  - Unit commitment
- Generation Expansion Model
  - Least cost generation to meet demand growth
  - Hydro variability, peak, wind variability etc

Example expansion plan



Synthetic Wind Dataset

- NIWA & MetService project for EC
- Synthetic dataset, but tested against data provided by
  - Meridian, Contact, Trustpower, Unison, MainPower
- Two different models used – two datasets
- Will be made publicly available in the near future
- Will be used to derive constraint equations for GEM
- All models available on request, or published


NTH3
NTH2
NTH1
CNI2
CNI1
MWT3
MWT2
MWT1
CKS3
CKS2
CKS1
CTY1
STH3
STH2
STH1
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Questions?

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