

Correlation between wind and hydro

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EFNZ

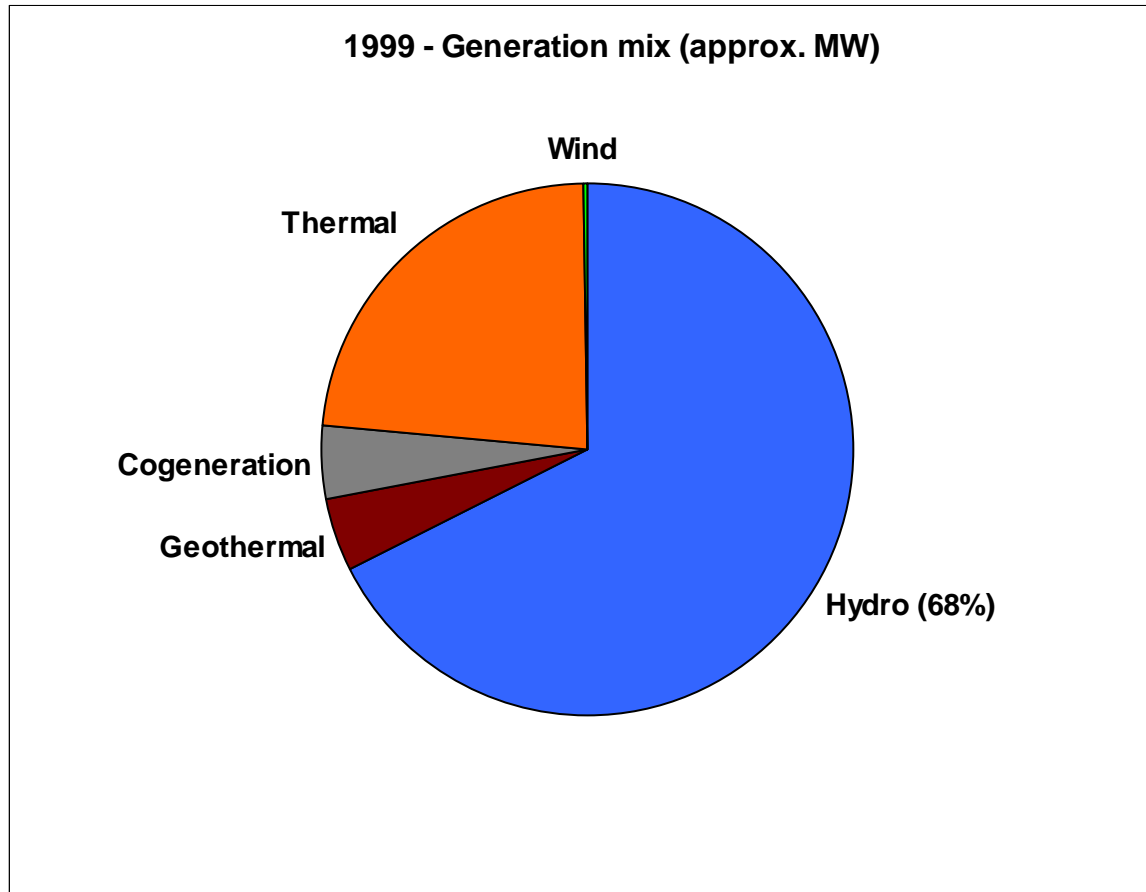
18 August 2010

Obligatory picture of wind turbine

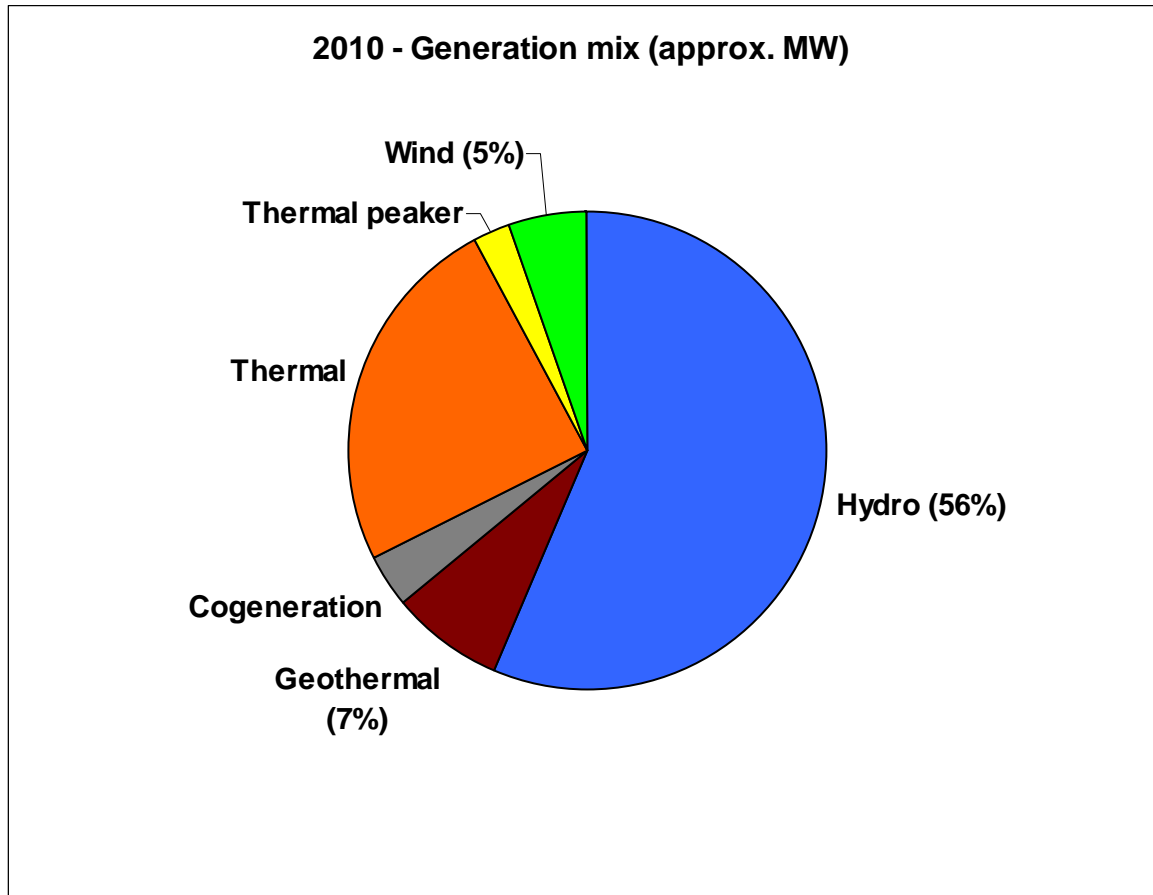


Windpower's "Aerogenerator X" design (10 MW)

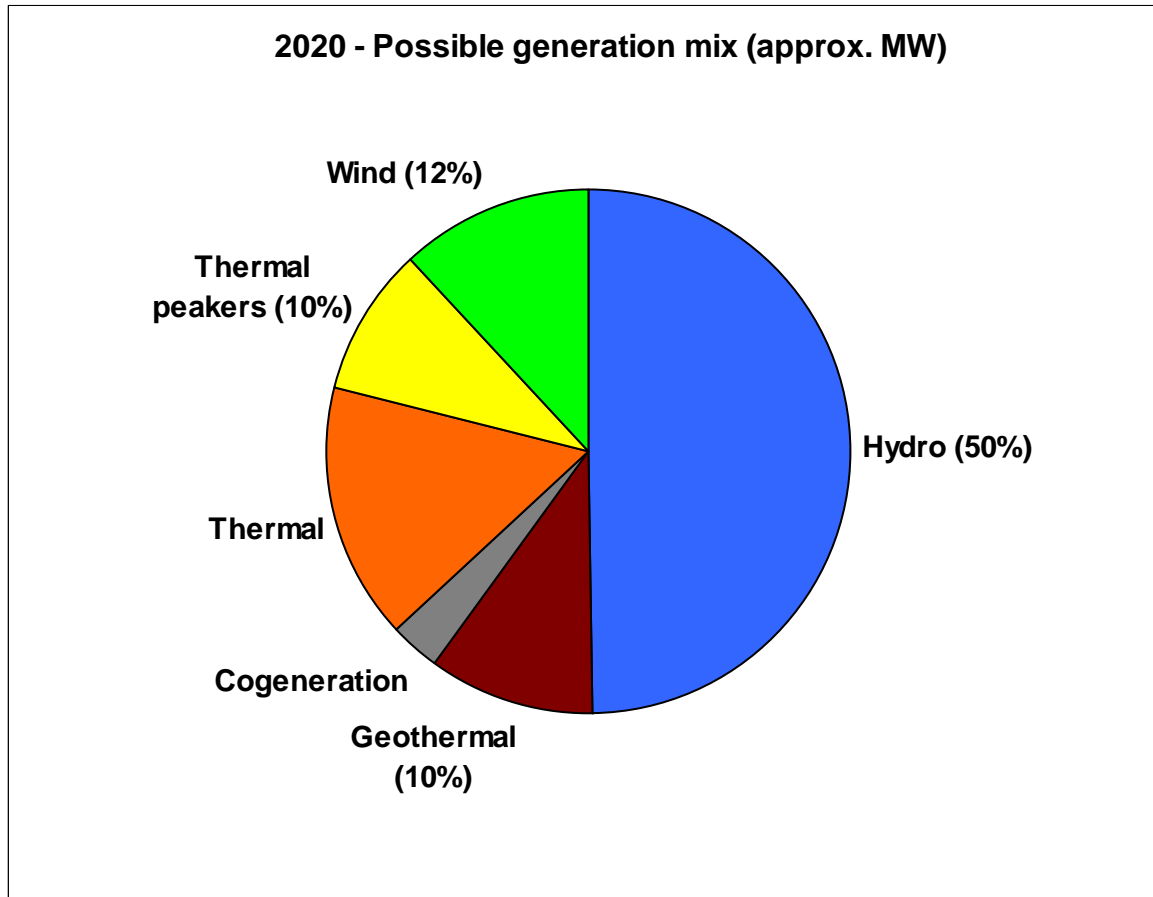
Changing generation mix - 1999



Changing generation mix - 2010



Changing generation mix – 2020?



Wind integration

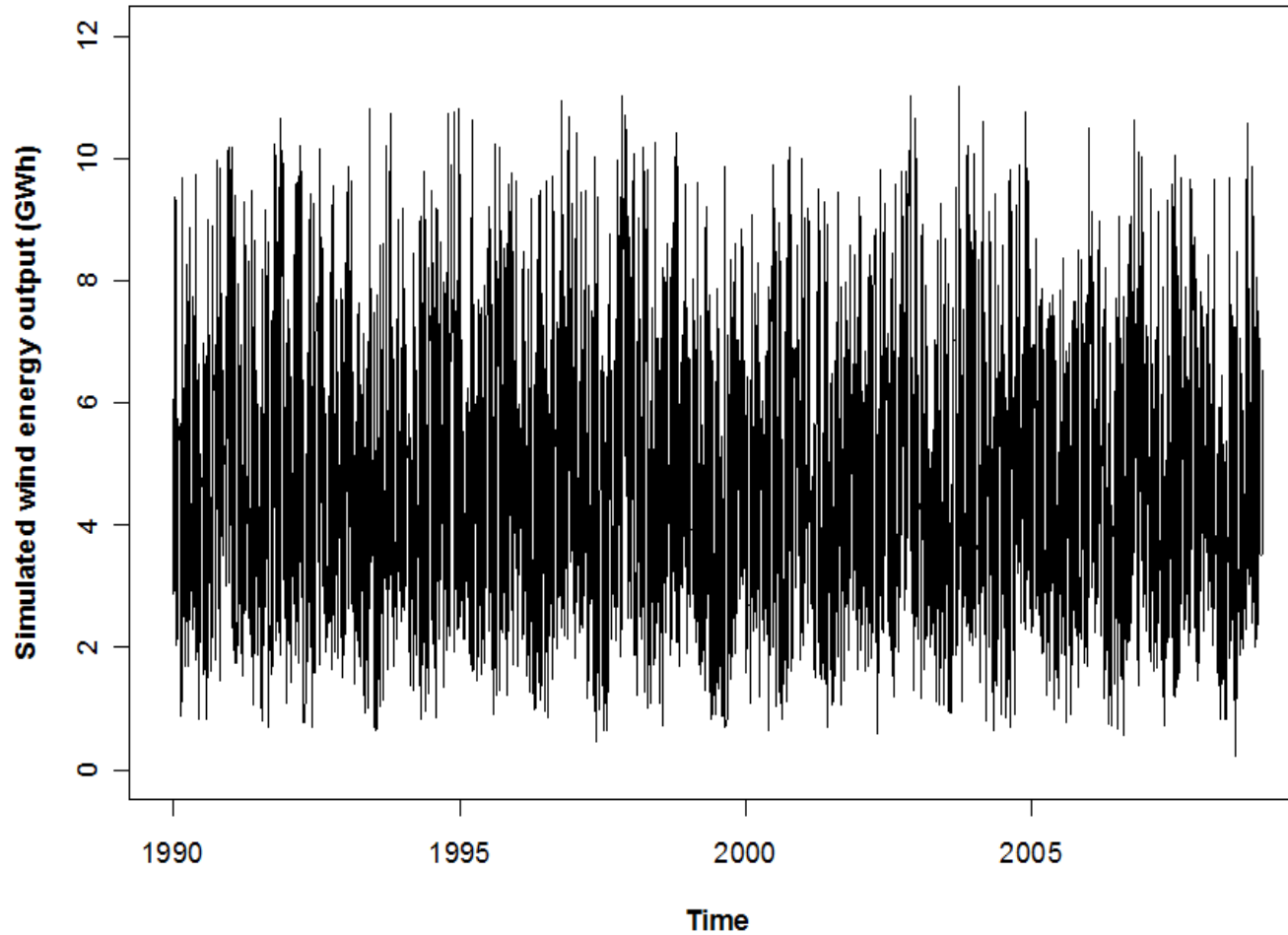
- Wind generation brings both challenges and benefits
- Some areas of concern:
 - Hour-to-hour variation and uncertainty
 - Frequency management
 - Voltage management
 - Power system stability
 - Seasonal and year-to-year variation

Commission work programme

- Common Quality
 - Multiple frequency keepers (MFK)
 - Frequency keeping cost allocation
 - Asset owner obligations & technical standards
 - Fault ride through
 - Wholesale
 - Forecasting
 - Market integration
 - Modelling
 - GEM modelling of long-term wind integration
 - Publication of synthetic wind data
 - Correlation between wind and hydro
- } *Consultations recently closed*

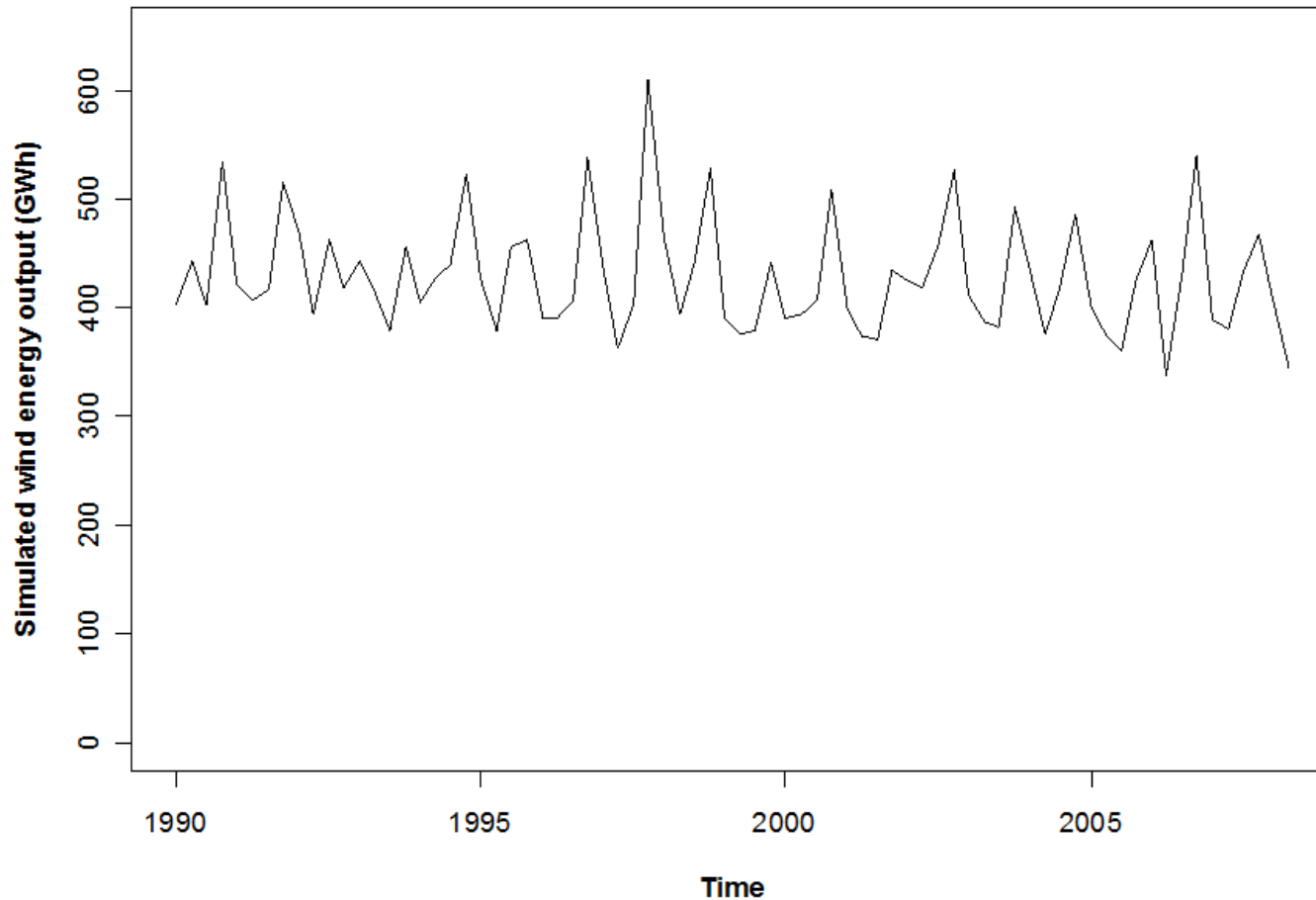
Wind varies on short time scales

Figure 5: Daily synthetic wind generation output for the 'near-future portfolio'



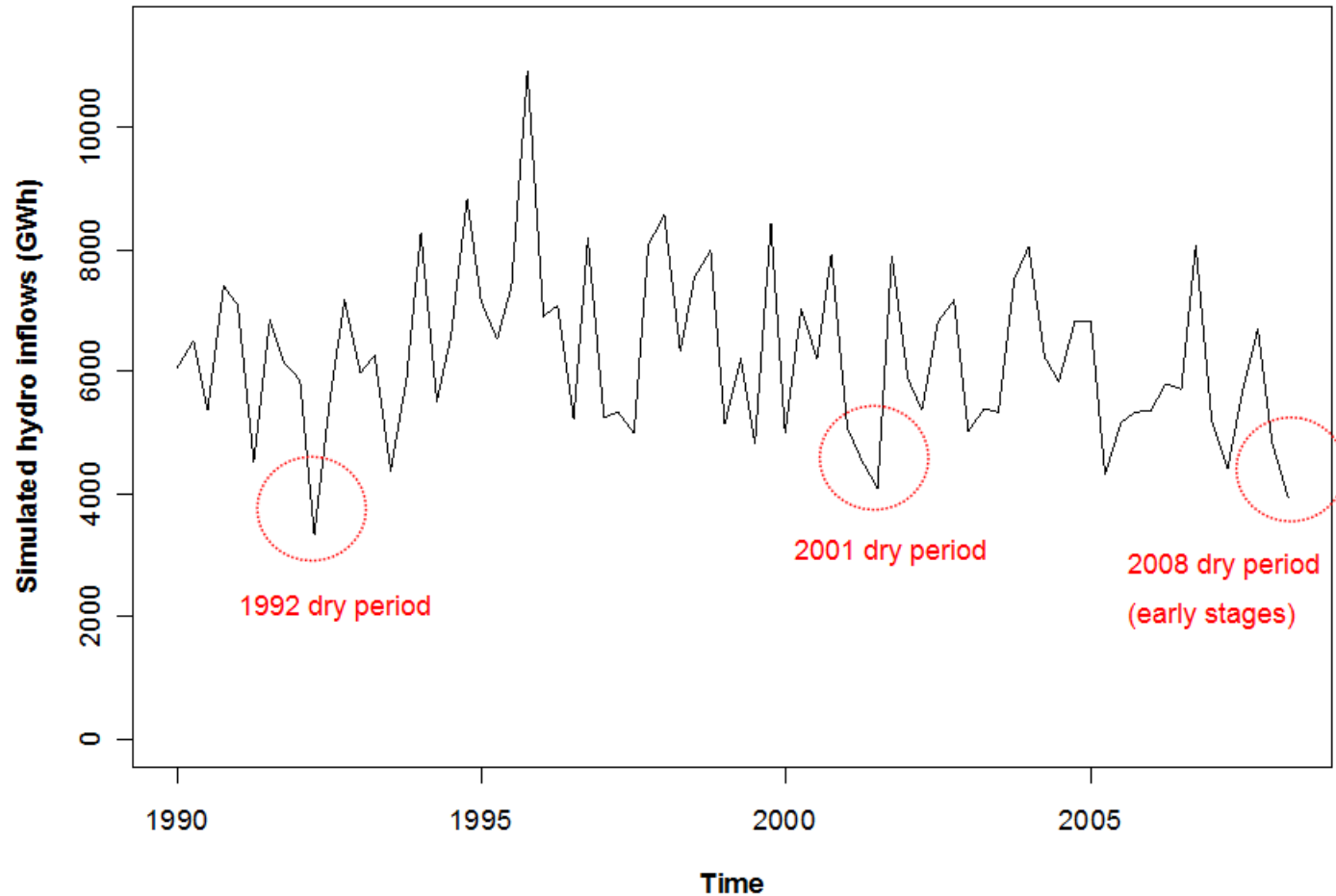
Not so much on long time scales

Figure 4: Monthly synthetic wind generation output for the 'near-future portfolio'



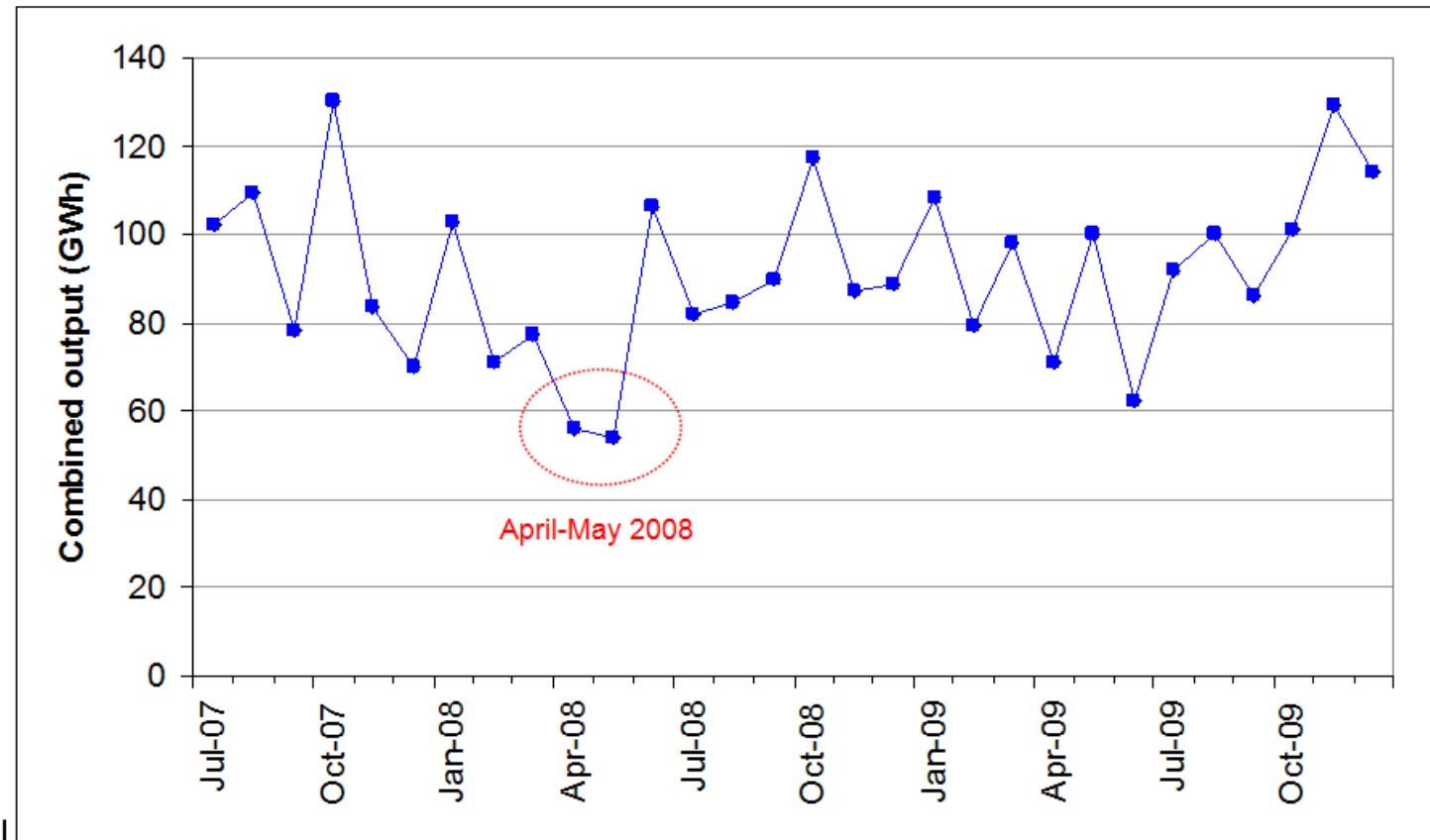
Hydro has more annual variability

Figure 2: Total monthly hydro inflows for listed catchments, 1990-2008



Correlation between wind and hydro??

Figure 1: Combined output from White Hill, Tararua and Te Apiti wind farms



Concerns

- Is a *dry year* more likely to be a *calm year*?
- If so, there are implications for:
 - economics of wind generation
 - dry-year security assessment

*C.f. peak capacity security assessment –
already takes variability of wind into account*

Approach

- Synthetic dataset of inflows to major hydro systems (cumecs)
- Convert to energy yields (GWh)
- Synthetic dataset of wind speeds (m/s) at actual and potential wind sites;
- Convert to energy that would have been produced (GWh) by various possible wind generation portfolios
- Assess seasonality of wind generation output
- Investigate correlations between wind and hydro datasets

Synthetic dataset of wind speeds

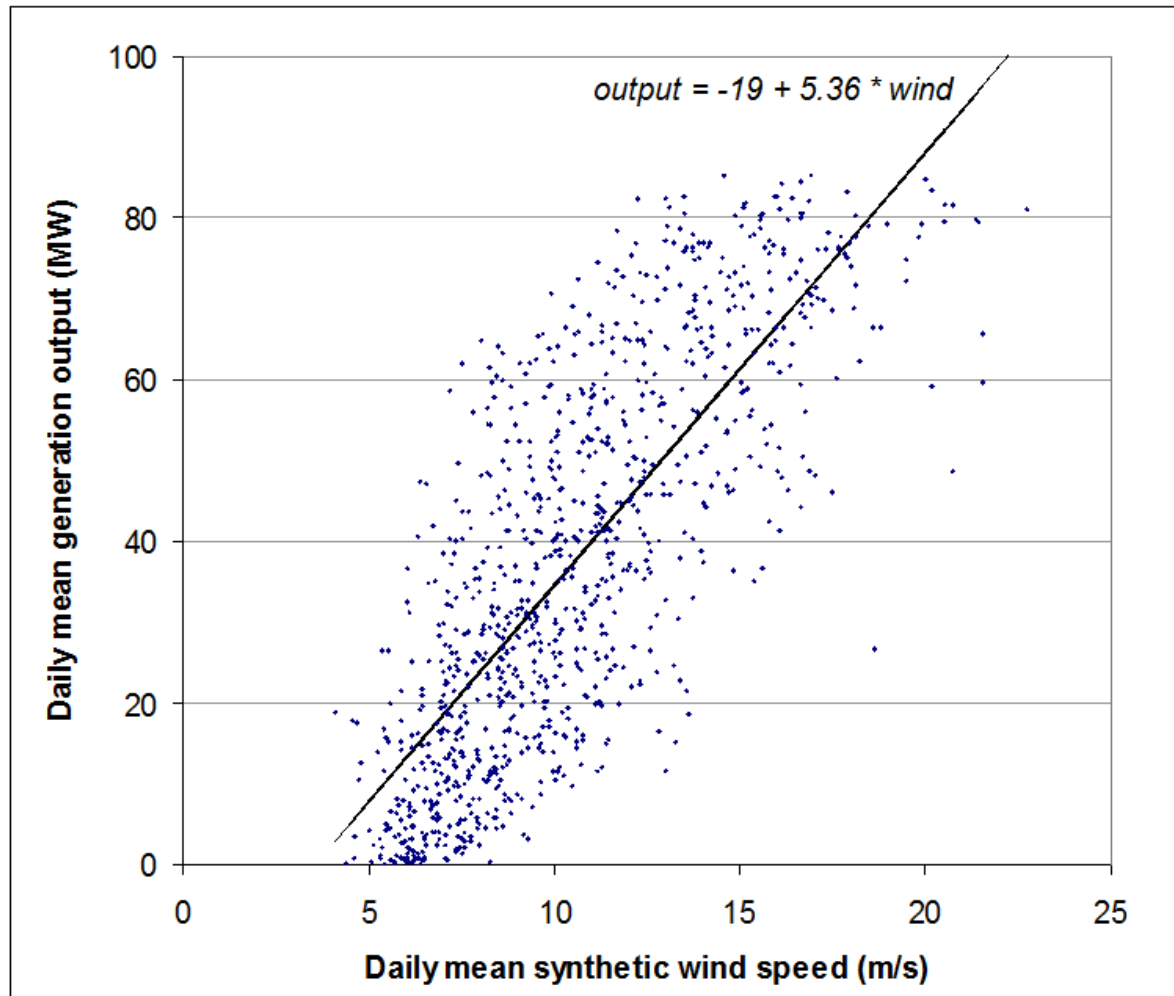
- Provided by Meridian
- Published on EC website
- Daily mean wind speeds
 - 12 sites distributed throughout NZ
 - 19-year span (1990-2008)
- Not real wind data, but produced by combining:
 - Meridian wind monitoring mast data
 - NIWA station data from National Climate Database
- Sites rescaled to protect confidentiality

Four potential wind portfolios

- Near-future
- Diversified
- Tararua-based
- Southern

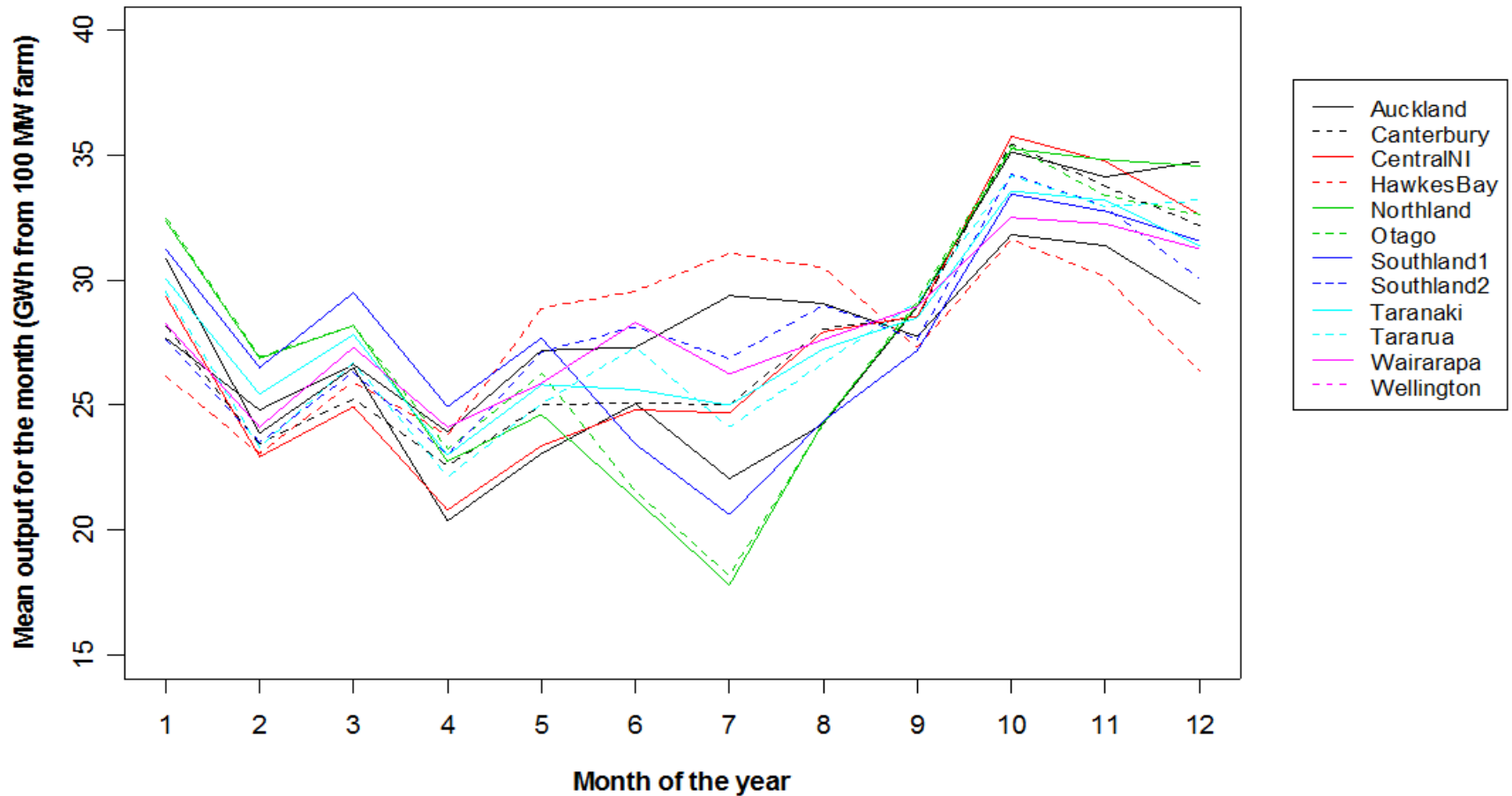
Convert wind speed to power

Figure 3: Relationship between wind speed and generation at Te Apiti, 2004-08



Wind generation is seasonal

Figure 6: Seasonal patterns in synthetic wind generation output



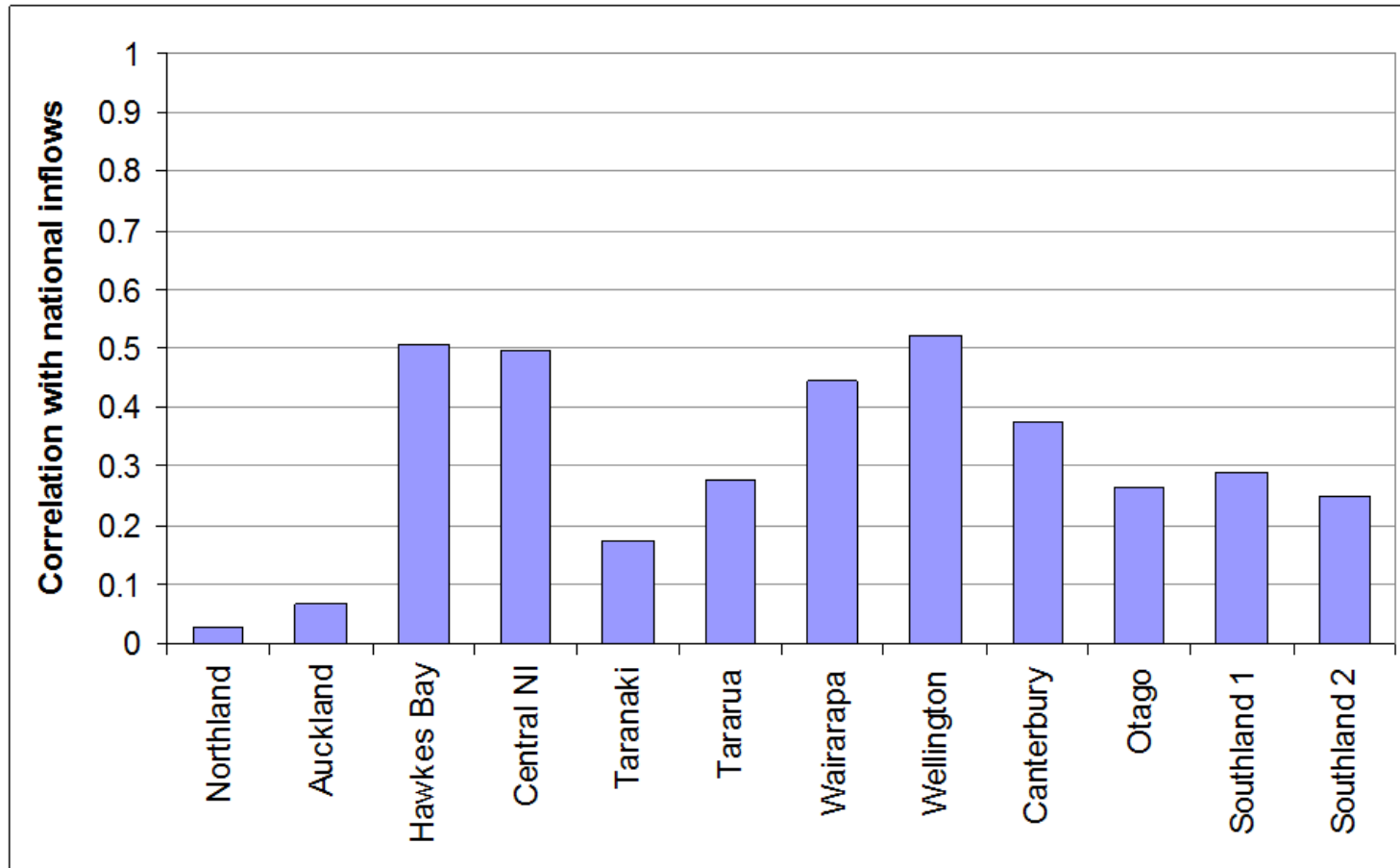
Wind generation is seasonal

Table 2: Seasonality of synthetic wind generation output

Portfolio	Ratio of mean winter output (Apr-Sep) to year-round mean output	Apr-Jun only	Jul-Sep only
Near-future	0.94	0.91	0.97
Diversified	0.91	0.88	0.94
<u>Tararua-based</u>	0.93	0.90	0.97
Southern	0.89	0.87	0.91

Wind and hydro are correlated

Figure 11: Correlations between inflows and wind



(Rank correlations between deseasonalised quarterly datasets)

Wind and hydro are correlated

Table 3: Correlations between inflows and wind

Portfolio	Correlation	95% CI
Near-future	0.38	(0.17, 0.56)
Diversified	0.42	(0.21, 0.59)
<u>Tararua-based</u>	0.44	(0.23, 0.60)
Southern	0.33	(0.11, 0.52)

(Rank correlations between deseasonalised quarterly datasets)

But is the correlation important?

Table 4: Model predictions of expected wind energy output, given hydro inflow

Portfolio	Expected output (GWh) in Apr-Jun quarter			
	Dry conditions	Average conditions	Wet conditions	% difference between dry and average
Near-future	376	388	400	3.0%
Diversified	851	888	926	4.2%
<u>Tararua-based</u>	697	725	752	3.9%
Southern	770	793	833	2.9%

- *Less important than the seasonality of wind*
- *Much less important than year-to-year variation in hydro*
- *But still worth considering*

Conclusions

- New Zealand wind generation is seasonal
 - Low period is April – July (*but varies between regions*)
- Wind generation is mildly correlated with hydro inflows
 - except Auckland, Northland, Taranaki
- Should be taken into account in security assessment
 - Derate wind output by 10% in calculation of winter energy margins?
(*Consider also effect on 1 April position*)
 - Effect on assessment is **minor** for 2011-15
- This assumes climate over the next few years will be similar to the last 20 years

Acknowledgements

- Many thanks to Meridian for providing the synthetic wind dataset used in this work
 - NIWA weather station data was sourced from National Climate Database (cliflo.niwa.co.nz)
- Thanks also to reviewers (NIWA, EECA)

Resources

- Report on Web –
<http://www.electricitycommission.govt.nz/opdev/modelling/wind-hydro>
- Synthetic wind datasets –
<http://www.electricitycommission.govt.nz/opdev/modelling/synthetic-wind>,
<http://www.electricitycommission.govt.nz/opdev/modelling/long-term-synthetic-wind>
- Synthetic hydro inflow datasets –
<http://www.electricitycommission.govt.nz/opdev/modelling/centraliseddata/inflows>
(update coming soon)
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