Department of Meteorology
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University of Reading

ENERGY METEOROLOGY

at the University of Reading

CLIMATE & RENEWABLES INTEGRATION

THE EXAMPLE OF WIND POWER OVER GREAT BRITAIN

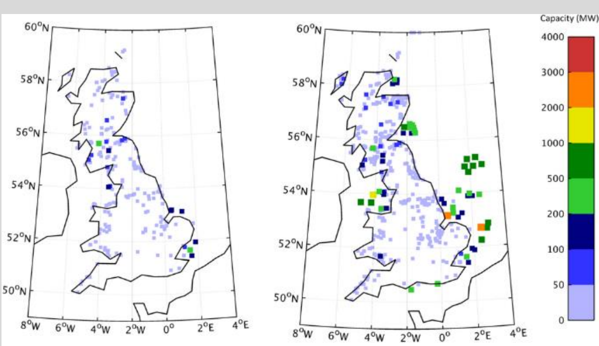
Researchers: HC Bloomfield, DJ Brayshaw, LC Shaffrey, PJ Coker, HE Thornton

Further info: Bloomfield et al., ERL (in press, 2017)

Motivation

Weather has long been known to impact the energy system through changes in *demand*. Rapid increases in renewable power generation (e.g., solar and wind), however, are also leading to weather-sensitivity in *supply*. European power systems are therefore becoming strongly susceptible to interannual-to-decadal climate fluctuations.

Previous assessments of renewables integration into power systems have typically used short climate records (just a few years) which cannot account for the full impact of inter-annual climate variability. This study estimates the uncertainty that long-term climate variability introduces to power-system planning and operation, demonstrating climate records of at least 10 years are essential.



Current (2012) and projected wind farm distribution and capacity.
From Drew et al. 2015.

Summary

Hourly meteorological data for 1980-2015 are combined with an idealized representation of the British power system to explore the impacts of year-to-year climate variability on the system as whole (including coal, gas and nuclear generation). Four wind power installation capacity scenarios are considered (from 0GW in the "NO-WIND" scenario to 45GW in "HIGH"; see table).

Climate variations are found to impact all aspects of the power system, and this impact grows as wind power capacity is increased. Baseload generation, such as nuclear, is more affected than peaking plant (e.g., gas), with a 10-fold increase in the inter-annual range of baseload-type generation between the NO-WIND (0GW) and MED (30GW) wind power capacity scenarios.

Scenario	WP capacity	Distribution	Interpretation
NOWIND	0 GW		No use of wind power
LOW	15 GW	2012	Present day (2015)
MED	30 GW	2012	National Grid GG 2025
HIGH	45 GW	Future (Rd3)	National Grid GG 2035

Wind power generation scenarios.

METHODOLOGY

- Idealised hourly reconstructions of GB aggregated **demand and wind-power** were created from weather data (the MERRA reanalysis) for the period 1980-2015.
- **4 wind-power capacity scenarios** were considered corresponding to the present-day and plausible near-future (see table).

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RESULTS

All types of generation plant (peaking, baseload and mid-merit) are shown to be affected by year-to-year variability, and baseload generation more significantly so.

The table below shows the mean and interannual range of energy from peaking and baseload type plants under each wind capacity scenario. Installing wind capacity preferentially reduces the opportunity for baseload plant generation and the year-to-year variability of both peaking and baseload increases rapidly. For 15GW of wind capacity (LOW scenario), there is an opportunity for 190 TWh of baseload generation with an inter-annual range of 11.8 TWh. This decreases, however, to 128 TWh with an internannual range of 45.9 TWh if the wind capacity is doubled to 30GW.

	Peaking plant (TWh)		Baseload plant (TWh)	
	Mean	Range	Mean	Range
NO-WIND	1.3	0.7(54%)	227	3.8(2%)
LOW	1.7	0.9(69%)	190	11.8(5%)
MED	1.9	1.0(77%)	128	45.9(20%)
HIGH	2.0	1.2(92%)	18	55.0(24%)

Interannual range as percentage of the mean production for each wind scenario. Range is the difference between ‘best’ and ‘worst’ years.

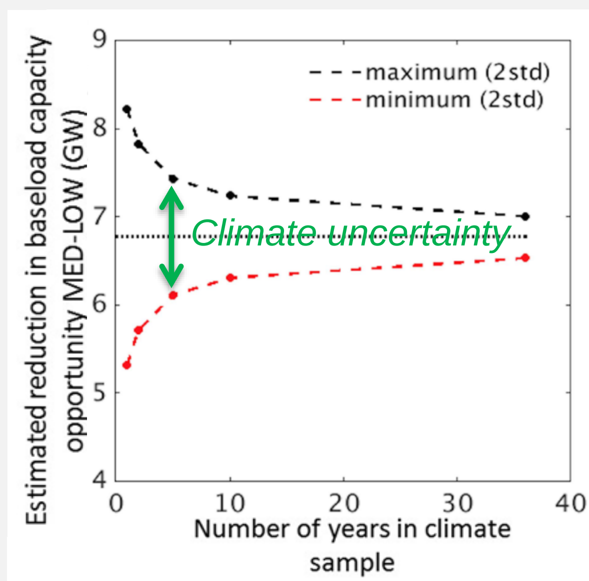
Please refer to Bloomfield et al (ERL, in press 2017) for detailed discussion.

Key Conclusions

- As installed wind capacity increases, energy required from other sources decreases.
- Reduction is most pronounced for baseload-type plant (e.g., nuclear).
- Existing wind power installation has already likely effected the climate sensitivity of the entire GB power system (including coal, gas, nuclear).
- Further integration of wind power will likely continue to increases the impact of inter-annual climate variability on the operation of other power plant (e.g. nuclear, gas, coal).
- The impact of increased wind power capacity depends on its location (off-shore vs. on-shore).
- Climate variability has significant implications for power systems operations. Future research efforts are seeking to explore this in more detail using climate-model simulations (long baselines, future climate, predictability at seasonal-to-decadal timescales) and more sophisticated power system representations.

Length of weather records

The use periods shorter than 10 years introduces significant uncertainties into the estimations of the key features of the power system (such as baseload capacity).



Even a period of 36 years may prove to be too short to represent climate extremes, decadal variability and climate change.

CONTACT

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