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Quantifying the increasing sensitivity of power systems to climate variability

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The amount of renewable energy generation within power systems is rapidly increasing in order to meet climate mitigation policy targets. An increased proportion of weather-dependent generation requires an increased understanding of the impacts of climate variability on power systems. While previous research has focussed on the impact of climate variability on individual power system components, this study focuses on the GB power system as an integrated whole.

Multi-decadal time series of meteorological re-analysis data are combined with a simplistic representation of the GB power system, of which the weather-dependent components are hourly electricity demand and hourly wind power production. Multiple GB power system scenarios are analysed, including 0GW, 15GW, 30GW, and 45GW of installed wind power generation. Load duration curves (LDC's) are the chosen tool for power system analysis as they offer a tractable means to examine the implications of high resolution variability in power systems. In order to analyse the LDC's a series of power system metrics have been identified.

This study characterises the impact of inter-annual climate variability on multiple aspects of the GB power system (including peaking plant, mid-merit plant and baseload generation). In a power system with no wind power generation, climate variability predominantly influences the operation of peaking plant, and causes large variability in peak demand. Including present day levels of wind power generation causes all aspects of the system to be impacted by inter-annual climate variability, with an overall doubling of the impact of inter-annual variability compared to a system with no wind power production. As the amount of wind power generation present on the system is increased from 15GW to 45GW the impacts of inter-annual variability become most pronounced for baseload generation. Sensitivity analysis has shown that the results found in this study are extremely sensitive to the length of data period used. Using only a few years of data for analysis leads to a large uncertainty ranges in how increasing the amount of installed wind power may impact conventional plant operation. This study builds on previous work, suggesting that a more robust approach to weather and climate data is needed within the power system modelling community.