EMS Annual Meeting Abstracts
Vol. 15, EMS2018-689-1, 2018

Renewables.Ninja - A model for the global output of weather-dependent renewable energy sources

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Objective & Background
Accommodating high shares of variable wind and solar power is essential for decarbonising the world's electricity systems, but their weather-dependent generation patterns are challenging for operations and modelling. Energy system models rely critically on the ability to model time series of energy production and understand their complex spatial and temporal correlation.
Reanalysis data allows the energy community to build a consistent global picture of wind and solar generation. Whilst solid data has been established for Europe by several research groups, the rest of the world is limited to individual ad-hoc studies (individual countries, varying methodologies), which do not transparently provide their underlying data and/or are not validated against reality.
The Renewables.ninja model is a validated, open-access platform which uses NASA's MERRA-2 reanalysis to simulate wind and solar farm outputs anywhere in the world. In the 18 months since launch, this service has delivered >400,000 simulations to researchers from >70 countries worldwide.

Method
We use Renewables.ninja to simulate the hourly output from 1980–2016 for every wind farm currently in operation ($\sim$21,000 farms worldwide). Similarly, we simulate $\sim$154,000 solar panels, with locations assigned based on population density, and orientation randomly assigned based on the known distribution of tilt and azimuth from observed panels. These outputs (56.7 billion observations) are then aggregated to country and state/province level to deliver the first hourly global renewables dataset covering multiple decades.
To account for the inherent bias in MERRA-2, we demonstrate a new, globally applicable bias correction technique, using high-resolution wind and solar atlas data to adjust the hourly MERRA-2 data. We demonstrate this method's ability to refine the resulting capacity factors.

Principal Findings
This talk will summarise recent research using this data, covering systems integration, geographical smoothing and future outputs. Bias correction in 23 European countries has shown that accurate simulation of national wind and solar generation can be achieved, with hourly R^2 exceeding 0.95.

Discussion and Conclusion
We use our generation profiles to show that a more detailed meteorological understanding of renewable generation's variability can lead to vastly improved siting decisions for new capacity. We then discuss how establishing deeper links between meteorology, wind/solar engineering and electricity market modelling. This will allow more insights into feasible designs for energy systems with high shares of variable renewables. The talk concludes with a discussion of how the open availability of simulated PV and wind data is useful to a range of stakeholders globally.