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Impact of climate change on renewable power resources and consequently on a future highly renewable European power system

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Renewable power is on the rise world wide to mitigate climate change and allow for sustainable economic development. However, renewable resources are effected by climate change and their variability makes their system integration already a challenging task requiring sufficient balancing infrastructure. Power system studies (e.g., [1]) often rely on historical weather data and therefore neglect effects of climate change.

In this work, we use EURO-CORDEX ([2]) data on wind speed, temperature and solar irradiation with a spatial resolution of approximately 12 km and a temporal resolution of 3 hours under emission pathway rcp 8.5 until 2100 to investigate the impact of climate change on wind and solar resources and consequently on a highly renewable European power system. We transform this data into power densities and investigate different aspects of resource and power data such as capacity factors, variability, spatial smoothing, correlation lengths as well as wind speed statistics using information-geometric methods to quantify their changes due to climate change and discuss the resulting implications for the European power system. Lastly, we compare a power system investment optimisation via a 30-node model for Europe ([3]) using historical (1970-2000), climate-effected mid-term (2030-2060) and long-term future data (2070-2100) data and the power system modelling toolbox PyPSA (pypsa.org). In this model, we optimise investments in generation, transmission and storage facilities for a pan-European power system with 95% reduction of CO 2 compared to 1990 levels.

We show how capacity factors and correlation lengths develop throughout the century and how they impact optimal transmission grid expansion. Then we discuss the results with regard to the investment optimisation model and how robust investment optimisation can be performed to cope with uncertainty resulting from climate change.

References

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