Geophysical Research Abstracts
Vol. 20, EGU2018-15965, 2018
EGU General Assembly 2018

Investigation of the Effects of Climate Change on a European Energy System

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Renewable generation capacities are growing fast and accounted for roughly two thirds of all new generation capacities worldwide in terms of installed capacity in 2016. A central objective of decarbonising energy systems is the mitigation of climate change. However, renewable resources are directly affected by climate change, whereas power system studies often rely on historical weather data and therefore neglect effects of the interplay of renewable power systems and climate change.

In this work, we use EURO-CORDEX data on wind speed, surface runoff, temperature and solar irradiation with a spatial resolution of approximately 12 km and a temporal resolution of 3 hours under emission pathway RCP (representative concentration pathway) 8.5 (associated with a temperature increase of 2.6 to 4.8 degrees Celsius until the end of the century) until 2100 to investigate the impact of climate change on a future European power system.

We start by studying effects on the statistical patterns of weather data by information-geometrical methods and derive direct implications for the design of energy systems, which are robust against climate change. In addition, we transform this data into power output via state-of-the-art methods to perform a long-term optimisation of a future renewable European power system under various scenarios, which share a 95% reduction of CO_2 emissions compared to 1990 levels.

The optimisation shows that changes in renewable resources due to climate change directly lead to changes of more than 10% in the requirements for transmission grid extensions in Northern Europe and storage capabilities in Southern Europe, which can partly be overcome by the inclusion of climate change effects in a robust optimisation approach.