Climatological Analysis of the Potential of Solar and Wind Energy in Germany

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Renewable energies, like solar and wind energy, play an important role in current and future energy supply in Germany and Europe. The renewable energy production highly depends on weather, which leads to an increasing impact of the meteorological fluctuations on energy production.

Here, climatological datasets with high spatial and temporal resolution are used to simulate the electrical energy production from photovoltaic (PV) installations and wind turbines. For the solar radiation the CM SAF SARAH 2.1 dataset is used, which includes global and direct radiation with a temporal resolution of 30 minutes and a grid spacing of 0.05°. The data is available from 1983 to 2017. The regional reanalysis COSMO-REA6 provides hourly wind speed data from 1995 to 2015 with a spatial resolution of 6km. Based on these datasets capacity factors are calculated for PV and wind energy for Germany. Using the spatial distribution of solar panels and wind turbines as well as electrical power generation data from 2015 the simulated capacity factors were converted into (potential) hourly power generation in Germany from 1995 to 2015.

The main aim of this study is to identify weather regimes where renewable energy production from solar and wind was comparable low. Due to high power production from solar radiation, which exhibits a comparable low variability and high predictability, in summer, all low production events occur in winter. During winter, wind power is the main contributor to renewable energy production. On the basis of the hourly time series of simulated power production the weather regimes that are associated with multiple days of low renewable energy production are identified and analysed. European regions are identified that exhibit comparably high potential renewable power production for those weather regimes with low energy production in Germany.