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The Cost-Optimal Distribution of Wind and Solar Generation Facilities in a Simplified Highly Renewable European Power System

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The transition of the European power system from fossil generation towards renewable sources is driven by different reasons like decarbonisation and sustainability.
Renewable power sources like wind and solar have, due to their weather dependency, fluctuating feed-in profiles, which make their system integration a difficult task.
To overcome this issue, several solutions have been investigated in the past like the optimal mix of wind and PV [1], the extension of the transmission grid or storages [2].

In this work, the optimal distribution of wind turbines and solar modules in Europe is investigated.
For this purpose, feed-in data with an hourly temporal resolution and a spatial resolution of 7 km covering Europe for the renewable sources wind, photovoltaics and hydro was used.
Together with historical load data and a transmission model , a simplified pan-European power power system was simulated.
Under cost assumptions of [3] the levelized cost of electricity (LCOE) for this simplified system consisting of generation, consumption, transmission and backup units is calculated.
With respect to the LCOE, the optimal distribution of generation facilities in Europe is derived.

It is shown, that by optimal placement of renewable generation facilities the LCOE can be reduced by more than 10% compared to a meta study scenario [4] and a self-sufficient scenario (every country produces on average as much from renewable sources as it consumes).
This is mainly caused by a shift of generation facilities towards highly suitable locations, reduced backup and increased transmission need.
The results of the optimization will be shown and implications for the extension of renewable shares in the European power mix will be discussed.

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