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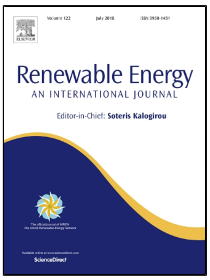

Geographical comparison between wind power, solar power and demand for the German regions and data filling concepts

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Geographical comparison between wind power, solar power and demand for the German regions and data filling concepts

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Abstract. The rising penetration of renewable energies became an important issue in the German electricity sector within the past years. In order to plan the required infrastructure for the energy distribution, a detailed knowledge about the complete geographical and temporal power generation compared to the demand is crucial. However, the available data for the renewable power generation in Germany is insufficient due to the complexity of the energy system. For this reason, a comparison between the renewable power generation and the electricity demand is presented for 95 German zip code regions based on real input data with a sample time of 15 minutes from renewable energy generators. For enhancing the incomplete data, different model-based data filling methods using the data of neighboured regions or additional meteorological data are introduced and compared. As a result, a number of modelling methods, based either on a heuristic model, a wind speed model or a combination of both, has been investigated, leading to similar correlation coefficients of above 80 %. Finally, the obtained data set is applied for an analysis with a high spatiotemporal resolution. For three use cases the resulting optimal flow of the inter-regional power transfers is calculated.

Keywords: renewable energy, geographical distribution, solar, wind, data-based analysis, model-based data filling

1. Introduction

The share of renewable energy for electricity supply within Germany has reached a value of 32 % in 2015 [1]. For some regions the renewable power generation is much higher than the power demand which leads to transfer needs in the electrical transmission and distribution system. Due to the decentralised nature of more than 1 million renewable energy generators, the German grid, originally designed for central power production, has to undergo a drastic change that might need additional infrastructure.

There are still open questions regarding the expansion of the renewable energy capacities towards a 100% renewable energy system. Such a system needs additional infrastructure in the form of power lines, storage systems or load flexibility. In order to be able to assess these central questions, a complete data set with high spatial and temporal resolution is required. The temporal as well as the geographical compensation effects between the fluctuating energy inputs of wind and solar power on the one side and between the renewable energy input and the demand on the other side shall be investigated. Topical investigations are based on differences for the whole German energy sector on a federal state level. An investigation of central and decentral approaches regarding the addition of renewable energy towards a 100% renewable energy input in the year 2040 has been conducted by the Reiner Lemoine Institut [2]. Therefore, Germany is distributed in 14 regions of the larger federal states including the offshore wind energy regions. Both, central and decentral scenarios lead to similar economic cost factors that do not differ from today's energy costs. A sum of 60 GW residual thermal capacities will be needed and should be exchanged by bio mass and storage