Weather data‘s spatial aggregation in power system models with high shares of hydropower

Energiesystem- und Klimamodellierungen - Robustheit, Aussagekraft und Grenzen von Energiesystemmodellen unter (disruptiven) Ereignissen und Technologieportfolios der Zukunft

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Motivation und zentrale Fragestellung

Low cost, low carbon emission generation from sources like wind and solar energy is expected to play a major role in future systems. To model those, it is common to optimise over a year, with a temporal resolution of hours and over all of Europe with a spatial resolution of countries. Yet, the weather conditions can vary spatially profoundly within countries. We therefore study the effect of increasing the spatial resolution for weather data in such models and compare two countries based on hydropower generation share.

Methodische Vorgangsweise

The spatial resolution of these models is bounded by the spatial resolution of the weather data that serves as an input. Furthermore, the higher the resolution, the more complex the computation, which increases the need for computational time and resources. Currently, the state-of-the-art on globally available weather data for long historic time spans is the ERA5 dataset[1]. It comes at a 30 by 30 km resolution. To investigate the impact of hydropower, we choose two countries:

- one whose generation mix is dominated by hydropower (Norway)
- one with only small amounts of hydropower (UK)

and run the weather component of the model (highRES[2]) on a 30 by 30 km resolution for the selected country, while keeping the rest of Europe at country level resolution. We compare our results to model outputs where all of Europe is aggregated to countries. We assess, in particular,

- the impact of spatial aggregation on system designs
- the influence of hydropower on a potential impact of the former

Ergebnisse und Schlussfolgerungen

Previous runs, which did not differentiate by hydropower share, showed:

- a reduction in system costs in the highly spatially resolved model version
- a shift in installed technologies, namely from offshore wind to onshore wind

We expect to see less pronounced effects for hydropower dominated systems, as the hydro reservoirs can provide balancing for the variability of the wind and solar generation and therefore reduce the impact of higher spatial resolution in these countries. The study based on hydropower share, will produce results that can be highly applicable to countries with a large hydropower generation mix in particular.

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Literatur

1. Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G., Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., … Thépaut, J.-N. (2020). The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*, *146*(730), 1999–2049. https://doi.org/10.1002/qj.3803
2. Price, J., & Zeyringer, M. (2022). highRES-Europe: The high spatial and temporal Resolution Electricity System model for Europe. *SoftwareX*, *17*, 101003. https://doi.org/10.1016/j.softx.2022.101003