EMS Annual Meeting Abstracts
Vol. 20, EMS2023-490, 2023, updated on 20 May 2024
https://doi.org/10.5194/ems2023-490
EMS Annual Meeting 2023

Integrating meteorological dependent variability of wind and solar power for resilient power systems

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To mitigate and adapt to the ongoing climate change, the decarbonization of the economy requires a radical change in our energy production and consumption patterns. A robust finding of existing studies is that renewable energy sources - and more specifically wind and solar power generation - are expected to represent a major share of the power mix in the future. Due to their higher dependency on meteorological variable a better understanding of the variability of VRE outputs across different temporal and geographical scales thus becomes critical. Of particular interest is the study of tight grid conditions with periods of coincidence between low wind and solar output because they will condition flexibility requirements.

Our work addresses these research questions based on an analysis of the variability of solar PV and wind power generation capacity factors provided by the Copernicus service C3S energy. The Copernicus C3S energy service deals with the transformation of climate variables (reanalysis, seasonal forecast and climate projection) into energy variables (wind, PV, hydro and energy demand principally). To take into consideration the dependance between the solar and wind resource the combined variability has been evaluated for different wind to PV share. In addition, the coupling of different kind of storage technologies has been anticipated by evaluating the variability on different time scales ranging from hour to month. Finally, focusing on extreme conditions, the results of the variability analysis was synthesized in a couple of boundary conditions that capture the impact of the meteorological variability on estimated joint wind and solar power output. The added value of the proposed methodology will be illustrated for a simple case in France.