**Variable renewable energy droughts in the power sector – a model-based analysis and implications in the European context**

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**Objective & Background**

The continuous integration of variable renewable energy sources (VRE) in the power sector is required for decarbonizing the European economy. Power sectors become increasingly exposed to weather variability, as the availability of VRE, i.e., mainly wind and solar photovoltaic, is not persistent. Extreme events, e.g., long-lasting periods of scarce VRE availability (*VRE droughts* or *Dunkelflauten*), challenge the reliability of supply. Properly accounting for the severity of VRE droughts is crucial for designing a resilient renewable European power sector. Energy system modeling is used to identify such a design. Our analysis reveals the sensitivity of the optimal design of the European power sector to VRE droughts.

**Method**

We analyze how VRE droughts impact optimal power sector investments, especially in generation and flexibility capacity. We draw upon work by Kittel & Schill (work in progress, separate abstract submitted), which systematically identifies VRE drought patterns in Europe in terms of frequency, duration, and seasonality as well as cross-regional and cross-technological spatio-temporal correlation of most extreme drought periods. Based on their analysis, the authors provide a selection of relevant historical weather years representing different grades of VRE drought severity. These weather years will serve as input for the capacity expansion model for the European power sector used in this analysis (DIETER, see [1, 2]). We additionally conduct robustness checks varying policy-relevant assumptions on capacity expansion limits, interconnections, and level of sector coupling.

**Principal Findings**

Preliminary results illustrate how an imprudent selection of weather years may cause underestimating the severity of VRE droughts, flawing modeling insights concerning the need for flexibility. Sub-optimal European power sector designs vulnerable to extreme weather can result. Using relevant weather years that appropriately represent extreme weather events, our analysis identifies a resilient design of the European power sector. Although the scope of this work is limited to the European power sector, we are confident that our insights apply to other regions of the world with similar weather patterns.

**Conclusion**

Many energy system studies still rely on one or a limited number of sometimes arbitrarily chosen weather years. We argue that the deliberate selection of relevant weather years is imperative for robust modeling results.

**References**

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[2] Gaete-Morales, Carlos, Martin Kittel, Alexander Roth, und Wolf-Peter Schill. “DIETERpy: A Python Framework for the Dispatch and Investment Evaluation Tool with Endogenous Renewables”. SoftwareX 15 (1 July 2021): 100784. https://doi.org/10.1016/j.softx.2021.100784.