Severity of variable renewably energy droughts in Europe

Martin Kittel[1], Wolf-Peter Schill[1]

1. German Institute for Economic Research (DIW Berlin), Berlin

Objective & Background

Renewable energy is a cornerstone to the decarbonization of the European energy system. As firm renewable energy is limited in many European regions, the continuous expansion of variable renewable energy sources (VRE) is key. As a consequence of this transition, the European energy system becomes increasingly weather-dependent and exposed to extreme events. Persistent periods of scarce VRE availability (*VRE droughts* or *Dunkelflauten*) challenge the reliability of supply. Due to the variable spatio-temporal extent of weather events, VRE droughts are not limited to a specific region or country but vary largely across time and space. We analyze VRE drought patterns for relevant VRE technologies for all European regions.

Method

We investigate VRE droughts in Europe in terms of frequency, duration, return period, and seasonality as well as the cross-regional and cross-technological spatio-temporal correlation of most extreme drought periods. Initially, we investigate VRE droughts patterns for each relevant VRE technology separately for each European region, followed by an analysis of all relevant VRE technologies combined.

Principal Findings

Our results illustrate how European regions are differently affected by VRE droughts and that VRE drought patterns vary tremendously across technologies and seasons. Based on our findings, we identify regions that may and may not cooperate to deal with extreme VRE droughts.

Conclusion

Energy system models are used to guide the transition toward a renewable European energy system. Many energy system studies still rely on one or a limited number of sometimes arbitrarily chosen weather years. If imprudently chosen, the identified need for flexibility options may be flawed and the optimized system design vulnerable to extreme VRE droughts. Based on our analysis, we argue that the deliberate selection of relevant weather years is imperative for robust energy system modeling. Thus, we derive a selection of relevant historical weather years that appropriately reflect crucial VRE patterns. We aim to support the input selection of future energy system planning activities to pave the way for a resilient future European energy system.