Assessing blackout risk in scenarios of high penetration of variable renewable energies

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We propose a method to analyze the risk of blackouts with high penetration of variable renewable energy sources (VRESs). We consider a model for the self-organized critical dynamics describing the long-term evolution of the power grid including propagation of cascading failures, day-to-day fluctuations of renewable generation and moderate use of storage. We analyze grid resilience and stress as VRESs are progressively incorporated. We also evaluate the VRES performance as the average fraction of daily demand covered by renewables. We find that in general, VRES intrinsic variability increases the grid stress and the blackout risk. However, if VRESs are implemented in a distributed way, the spatial spreading of the generation may have a positive effect on grid resilience. As a case study, we analyze the replacement of conventional power plants by solar photovoltaic generation combined with storage in the power grid of the Balearic Islands. We also consider the use of source redundancy and briefly discuss the potential of wind energy.

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