Escape routes, weak links, and desynchronization in fluctuation-driven networks

Shifting our electricity generation from fossil fuel to renewable energy sources introduces large fluctuations to the power system. Here, we demonstrate how increased fluctuations, reduced damping, and reduced intertia may undermine the dynamical robustness of power grid networks. Focusing on fundamental noise models, we derive analytic insights into which factors limit the dynamic robustness and how fluctuations may induce a system escape from an operating state. Moreover, we identify weak links in the grid that make it particularly vulnerable to fluctuations. These results thereby not only contribute to a theoretical understanding of how fluctuations act on distributed network dynamics, they may also help designing future renewable energy systems to be more robust.

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