Effects of demand control on the complex dynamics of electric power system blackouts

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The propagation of failures and blackouts in electric networks is a complex problem. Typical models, such as the ORNL-PSerc-Alaska (OPA), are based on a combination of fast and slow dynamics. The first describes the cascading failures while the second describes the grid evolution through line and generation upgrades as well as demand growth, all taking place in time scales from days to years. The growing integration of renewable energy sources, whose power fluctuates in time scales from seconds to hours, together with the increase in demand, which also presents fast fluctuations, requires the incorporation of distributed methods of control in the demand side to avoid the high cost of ordinary control in conventional power plants. In this work, we extend the OPA model to include fluctuations in the demand at time scales of the order of minutes, intraday demand variations, and the effect of demand control. We find that demand control effectively reduces the number of blackouts without increasing the probability of large-scale events.

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[1] B.A. Carreras, E.B. Tchawou Tchuisseu, J.M. Reynolds-Barredo, D. Gomila, and P. Colet, Chaos **30**, 113121 (2020).