Comparing the Effects of Failures in Power Grids under the AC and DC Power Flow Models

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We compare the effects of failures in power grids under the nonlinear AC and linearized DC power flow models. First, we numerically demonstrate that when there are no failures and the assumptions underlying the DC model are valid, the DC model approximates the AC model well in four considered test networks. Then, to evaluate the validity of the DC approximation upon failures, we numerically compare the effects of single line failures and the evolution of cascades under the AC and DC flow models using different metrics, such as yield (the ratio of the demand supplied at the end of the cascade to the initial demand). We demonstrate that the effects of a single line failure on the distribution of the flows on other lines are similar under the AC and DC models. However, the cascade simulations demonstrate that the assumptions underlying the DC model (e.g., ignoring power losses, reactive power flows, and voltage magnitude variations) can lead to inaccurate and overly optimistic cascade predictions. Particularly, in large networks the DC model tends to overestimate the yield. Hence, using the DC model for cascade prediction may result in a misrepresentation of the gravity of a cascade.