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Analysis of transmission-power-grid topology and scalability, the European case study

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Abstract— Topological analyses are crucial when assessing network robustness or generating synthetic power grids. In the case of synthetic power grids, topological considerations may be included during the generation process or they may be used as validation criteria once synthetic networks are generated. These synthetic grids can be used as case studies only if their topology is statistically consistent with real power networks. With a view to looking into power-network topology, we analyze the topology of fifteen European transmission networks by using complex-network metrics. The study includes two voltage levels: 400 kV and 200 kV. We study these levels both independently and as a single combined grid. Degree distribution, characteristic path length, network diameter, betweenness centrality and global clustering coefficient are explored in order to understand network topology and to explain observed differences among countries. We analyze empirically whether those metrics scale or not with network size as well as the characterization of power grids as small-world networks. Our conclusions improve the current understanding of power network topology, which is essential for generating synthetic power grids and in the assessment of network robustness.

Index Terms— Power grid; Complex network analysis; Graph theory; Topology; Critical infrastructure

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