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Capricious Cables: Understanding the Limitations and Context of Transmission Expansion Planning Models

Six examples of transmission planning scenarios in which simplifications impact the modeling results can provide useful insights to non-technical participants in transmission planning. Because of modeling simplifications and future uncertainties, no single model can capture all aspects of transmission expansion planning. Instead, sensitivities and trends should be compared across multiple models and the results combined with broader contextual information.

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I. Introduction

The extra-high-voltage transmission network is the bulk transport network of the power system. The design of this network determines which generation resources—whether hydropower, natural gas, wind, solar, coal, or geothermal—can be brought to market. Solving the major issues facing the power system will require more integrated and wide-area coordinated planning of the transmission network. These challenges include more load participating in operations, both as managed load and distributed

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production; rapid technology, cost, and customer changes; markets that could better reflect state policy objectives and long-term capacity and flexibility requirements; droughts and climate change; and costs, risks, and liabilities of natural gas as the default generation option. Transmission plans support decisions about what transmission is needed and where and when to build new transmission. Plans send investment and location signals to generators. They enable options that ensure low-cost, reliable grid operations. The complex economic and physical relationships in the power system, however, make it difficult to predict how the transmission planning decisions of today will impact the power system of the future. To understand how the power system may react to planning decisions today, wide-area transmission models are increasingly used to aid decision-makers and stakeholders.

In the United States, which consists of the Western Interconnection, Eastern Interconnection, and Electric Reliability Council of Texas (ERCOT) Interconnection, various stakeholders provide policy and technical input into a collaborative transmission planning process. In the Western Interconnection, the Regional Transmission Expansion Planning (RTEP) process is overseen by the Western Electricity Coordinating Council's (WECC) Transmission Expansion Planning Policy Committee. RTEP produces 10-year and 20-year regional-level plans. The Technical Advisory Subcommittee conducts the transmission planning study, including managing all data and modeling needs. Additional input and strategic guidance are provided by WECC's Scenario Planning Steering Group and the Western Interstate Energy Board. In the Eastern Interconnection, technical and policy input from the Eastern Interconnection States' Planning Council helps to form scenarios that are evaluated by the Eastern Interconnection Planning Collaborative (EIPC). The EIPC conducts interregional macroeconomic analyses to complement local transmission planning efforts. In ERCOT, the independent system operator works with transmission service providers, market participants, and other stakeholders through the Regional Planning Group to fulfill transmission planning and construction needs.

The models used in these planning processes capture the interplay between transmission and capacity expansion.

The models used in these planning processes capture the interplay between transmission and capacity expansion. Building new lines allows multiple areas to share generator resources, thereby reducing the total required generating capacity among all constituent regions. These tradeoffs are shown in the *Comparing Resource Adequacy Metrics* study of the Western Interconnection in the United States (Ibanez and Milligan, 2012). They analyzed alternative wind/solar build-out cases from the *Western Wind and Solar Integration Study Phase 2* (Lew et al., 2013): the reference case had 8 percent annual energy from wind and 3 percent from solar, and alternative cases had 33 percent of annual demand supplied by wind and solar, split evenly, and high-wind/low-solar and high-solar/low-wind combinations. The objective of the *Comparing Resource Adequacy Metrics* study was to determine how much effective installed generator capacity could be replaced by transmission based on an assessment of resource adequacy. Key results are presented in **Figure 1**. The figure shows the reduction in effective capacity made possible by perfect transmission (copper sheet) within each subregion and by perfect transmission across the interconnection. Although copper sheet transmission is unlikely to

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