Electric Power Systems Research, vol.174, pp.105852-1-105852-13, September, 2019.

# Impact of decision-making models in Transmission Expansion Planning considering large shares of renewable energy sources

P. Vilaça Gomes; J.P. Tomé Saraiva; L. Carvalho; B. Dias; L.W. de Oliveira

**Abstract-**

**Transmission Expansion Planning (TEP) is traditionally carried out based on long-term forecasts for the peak load, which is viewed as the worst-case scenario. However, with the increasing renewable penetration, the peak load may not be longer the only worst-case to quantify new investment requirements. In fact, high off-peak load scenarios combined with low renewable generation can originate unforeseen bottlenecks. Besides, as TEP is a time-consuming problem, relaxed decision-making processes are often proposed in the literature to address the problem, however there is no guarantee that optimal planning has been achieved when some costs in the decision-making process are neglected. In this sense, this paper proposes a novel methodological framework to ensure that the system is sufficiently robust to overcome conditions with high electricity demand and low renewable energy, furthermore, this paper also presents a broad comparison between the common decision-making processes adopted in the TEP literature aiming at providing a more insightful understanding of its impact on the total system cost. The optimization model, which is based on a multi-stage planning strategy, considers an AC-OPF model to enforce operational constrains, including the N-1 contingency criterion. The proposed model is tested through an evolutionary algorithm on a large test system with 118 bus. The uncertainties inherent to wind-solar-hydrothermal systems, demand and the life cycle of generation and transmission equipment are duly considered in the simulations. The results demonstrate the effectiveness of the proposed methodology in providing solution plans able to meet the demand even in scenarios with high off-peak load and low renewable generation, unlike the planning carried out considering only the peak load. Besides, the results also demonstrate that relaxed decision-making models may generate insufficient expansion plans.**

**Index Terms- AC Optimal Power Flow; Monte Carlo Simulation; N-1 contingency criterion; Stochastic Transmission Expansion Planning; Uncertainties**

**Citation:**
*Vilaça, P.; Tomé Saraiva, J.P.; Carvalho, L.; Dias, B.; de Oliveira, L.W. "Impact of decision-making models in Transmission Expansion Planning considering large shares of renewable energy sources", Electric Power Systems Research, vol.174, pp.105852-1-105852-13, September, 2019.*