Long-Term Management of Grid Resilience under a Changing Climate: A Stochastic Optimization Framework

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Global climate change poses a long-term challenge to the built environment across the world. The increase in frequency and intensity of extreme weather and climate events is anticipated under climate change, which subsequently will expose critical infrastructure systems to failure risks beyond those that are deemed acceptable at present. The increased frequency and extent of failures, especially in the power grid, will have dire consequences for communities and businesses and can endanger national security. Enhancing grid resilience in the face of such risks is therefore of paramount importance. Resilience enhancement strategies are currently based on historical climate data and do not account for potential impacts of the changing climate nor address significant uncertainties associated with such effects.

This work presents a new approach to addressing climate change in long-term resilience decisions of the power grid. Acknowledging that resilience is a dynamic attribute with a multi-temporal nature, we propose a decision framework that is built on long-term resilience quantification of power systems. The multitude of uncertainties present in planning under a changing climate are captured through stochastic simulations across multiple climate change scenarios. The methodology is capable of exploring an array of solutions to provide system owners and operators a spectrum of options based on their specific objectives.

The proposed method is applied to a benchmark power system in the southern region of the United States. Results of the investigation point to the capabilities of the methodology in capturing the temporal nature of resilience under climate change and offering cost-effective solutions for enhancing long-term resilience of the power grid.