ID de Contribution: **39**

Type: **Invited talk**

Dynamic Transmission Line switching amidst decision-dependent wildfire-prone conditions

lundi 28 juillet 2025 17:00 (30 minutes)

During dry and windy seasons, environmental conditions significantly increase the risk of wildfires, exposing power grids to disruptions caused by transmission line failures. Wildfire propagation exacerbates grid vulnerability, potentially leading to prolonged power outages. To address this challenge, we propose a multi-stage stochastic optimization model that dynamically adjusts transmission grid topology in response to wildfire propagation. By accounting for decision-dependent uncertainty, where line survival probabilities depend on usage, we employ distributionally robust optimization to model uncertainty in line survival distributions, aiming to develop an optimal response policy. We adapt the stochastic nested decomposition algorithm and derive a deterministic upper bound for its finite convergence. Using realistic data from the California transmission grid, we demonstrate the superior performance of the dynamic response policies against two-stage alternatives through a comprehensive case study. In addition, we construct easy-to-implement policies that significantly reduce computational burden while maintaining good performance in real-time deployment.

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Classification de Session: Application in energy, finance or logistics

Classification de thématique: Applications in energy, finance or logistics