Hualong Liu and Wenyuan Tang, 2024, Multi-objective bi-level programs for optimal microgrid planning considering actual BESS lifetime based on WGAN-GP and info-gap decision theory, *Journal of Energy Storage*, 89 (2024) art. no. 111510.

Abstract With the rapid development of society and economy, random and intermittent renewable energy such as wind and photovoltaic (PV) generation is connected to the grid on a large scale. At the same time, forecasts of renewable energy output and loads are imprecise. These factors together lead to the uncertainty of power systems increasingly showing the characteristics of Knightian uncertainty, which makes the optimal microgrid planning and operation very challenging. Firstly, to overcome the shortcoming of the Monte Carlo method and the Latin hypercube method that require prior knowledge of the probability distributions of renewables and loads, this paper proposes a typical scenario generation methodology for renewables and loads based on Wasserstein generative adversarial networks with gradient penalty (WGAN-GP) and K-medoids. Secondly, optimal multi-objective bi-level microgrid planning models considering the actual battery energy storage system (BESS) lifetime based on WGAN-GP and info-gap decision theory under opportuneness and robustness strategies are established in this paper to effectively resolve the Knightian uncertainty of optimal microgrid planning and operation caused by the uncertain nature of wind, PV generation, and loads. Then, the multi-objective bi-level models are converted into multi-objective single level models. The Pareto-optimal front of these multi-objective problems are obtained by the ϵ-constraint method, and the compromised solution of the Pareto-optimal set is determined by fuzzy decision making. Finally, the proposed models are analyzed on the Banshee microgrid and verified by the Monte Carlo simulation. A bunch of results based on cases studies are obtained. For example, under the opportuneness strategy, when the opportunistic level factor equals 0.20 and the radii of the uncertainties of wind, PV generation, and loads are 0.0625, 0, and 0.2298, respectively, the planning cost of the microgrid does not exceed \$2048k. This case reduces the cost by 20% compared to deterministic planning. All results of case studies prove the reliability, feasibility, and effectiveness of the proposed models.

Keywords Distributed energy resources (DERs); Energy storage; Info-gap decision theory; Microgrid; Multi-objective; Optimal planning and operation; Renewable energy; Uncertainty; Wasserstein generative adversarial networks with gradient penalty (WGAN-GP).

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