

Improving robustness in strategic energy planning: a novel decision support method to deal with epistemic uncertainties

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Abstract-

This paper addresses the challenge of dealing with epistemic, i.e. non-probabilistic, uncertainties in strategic energy planning modelling. Current models have limited consideration of this type of uncertainty compared to probabilistic uncertainty, and also typically lead to overly conservative results. To address this issue, the contribution of the paper is to propose a novel decision support method which combines two decision-making methodologies into a single, internally consistent algorithm, and to show its applicability to real-size energy planning studies. Robust optimization is applied to address constraint uncertainties, while the minimax regret criterion is utilized for uncertainties in the objective function. This approach facilitates energy modelling exercises that can be more closely aligned with decision-makers' preferences for both feasibility and optimality. To demonstrate its effectiveness, the method is applied to a real-size strategic energy planning model, and the algorithm is shown to be able to provide detailed solutions in reasonable times. Ex-post evaluations confirm that this approach maintains robust optimization performance by effectively reducing the occurrence and magnitude of infeasibilities, while satisfying the minimax regret criterion across the entire range of uncertainties. Therefore, this integration preserves the distinct advantages of each methodology without any adverse effects when used together.

Index Terms- Strategic energy planning; Decision support; Uncertainty; Robustness; Robust optimization; Regret

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