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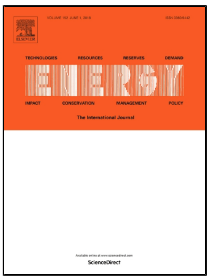

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Comparison of alternative decision-making criteria in a two-stage stochastic program for the design of distributed energy systems under uncertainty

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Abstract

The design of distributed energy systems (DES) is affected by uncertainty, which can render designs suboptimal. DES design is further complicated by the various decision-maker attitudes towards uncertainty, which range between pessimism and optimism. An additional important factor is the risk of extreme outcomes (e.g. high costs) in highly unfavourable scenarios. Incorporating all decision-maker attitudes towards uncertainty in DES design enables more informed design decisions under uncertainty.

In this work, a two-stage stochastic program for the design of cost-optimal DES under uncertainty is presented. The model's key innovation is the use of multiple criteria that form the model's objective functions and reflect the whole range of attitudes towards uncertainty. As uncertain model parameters, building energy demands, solar radiation, energy carrier prices and feed-in tariffs are considered. In the model's first stage, DES design decisions are included, which are made before the uncertain parameters become known. In the second stage, DES operating decisions are made for multiple scenarios of the uncertain parameters. The model is used to design a DES for a Swiss neighbourhood and diverse optimal DES configurations are obtained for the different criteria. The systems' economic performance and characteristics are contrasted and the trade-offs between the criteria are highlighted.

Keywords: distributed energy systems; uncertainty; two-stage stochastic programming; decision-making criteria; risk neutrality; risk aversion

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