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Data-driven Mixed Probabilistic and Possibilistic Distributionally Robust Optimization: a Case Study for Joint Renewable Energy and Energy Storage Planning

It is often the case where historical data used to represent uncertainty need some expert-based opinion before being suitable for use in a planning problem. For instance, in a renewable energy and energy storage planning (REESP) problem, the solar generation data may be gathered using older generation of solar panel technology while the nowel solar panels intended for planning have improved efficiencies. This work introduces a mixed probabilistic and possibilistic (MPP) distributinoally robust optimization (DRO) framework which can encompass vague and ambiguous information in its ambiguity set. Then, it is shown that the DRO problem containing a variety of MPP data, including historical first- and second-moment information and also expert-based membership functions, may be reformulated as tractable linear or semidefinite program. Moreover, a partially random scenario approximation of the MPP-DRO problem is developed which can handle larger instances of the problem. To showcase the capabilities of the proposed framework in utilizing MPP data, a mid-term REESP problem is addressed using the proposed MPP-DRO framework. The numerical results on IEEE test systems lead to more efficient operation of the power system and lower cost DRO solutions for REESP in comparison with DRO solutions from solely probabilistic or solely possibilistic information.

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