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Climate ambiguity and optimal allocation of renewable energy capacities in the 2050 EU

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The Paris Agreement aims at creating the climate-neutral world by the middle of the 21st century. One possible and currently popular solution to achieve this goal is to integrate renewable energies into the existing power grid. However, this is a highly complex task, since renewable energies are intermittent due to their weather dependency and predicting weather long-term both at a sufficient time and spatial resolution is non-trivial. It is often the case that both weather predictions based on historical data and future climate predictions are of very limited precision. To accommodate both for aleatoric and epistemic uncertainties we address the problem of optimal allocation of renewable energy capacities in the context of distributionally robust optimization, where the best possible capacity allocation is found given the worst possible weather conditions. We determine the optimal mix for the future 2050 climate-neutral Europe in the financial portfolio framework, where we view mean production of renewable power plants as expected returns on the assets. In the suggested framework portfolio risk is diversifed based on probabilistic characteristics of the underlying assets. Taking into account probabilistic nature of weather variables provides additional safety guarantees which are of primary importance when modelling renewable-based power systems. We limit our analysis to solar and wind energy capacities and implement suggested approach using both historical data-based forecasts and climate predictions models for the EU.