Out of Sample, Out of Luck?

Data-Driven Distributionally Robust Optimization for Electricity Market Participation of Renewables

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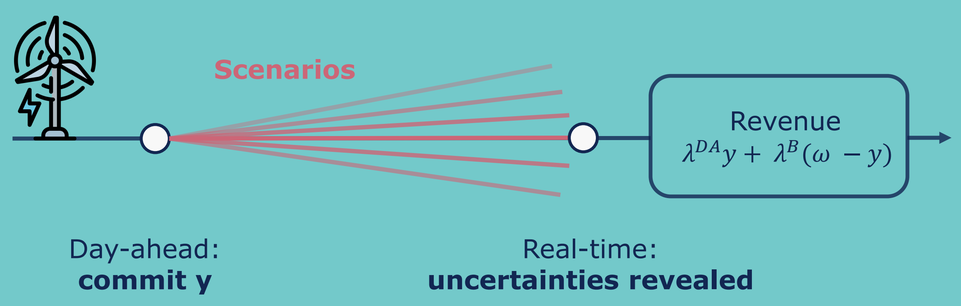
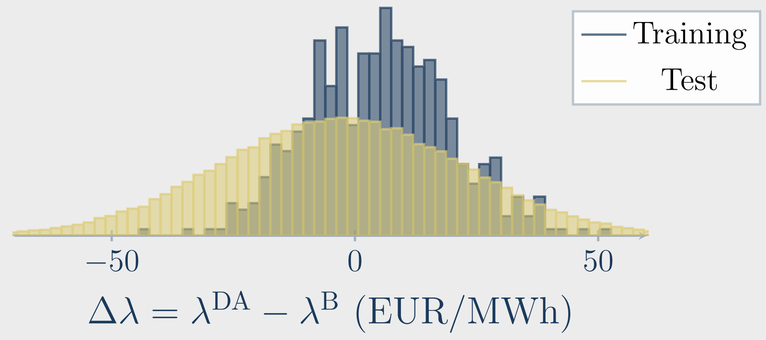
1 Bidding into the uncertain

Electricity market participation with renewables requires committing to an offer (y) under joint uncertainty in future generation (ω), day-ahead prices (λ^{DA}) and balancing prices (λ^{B}):



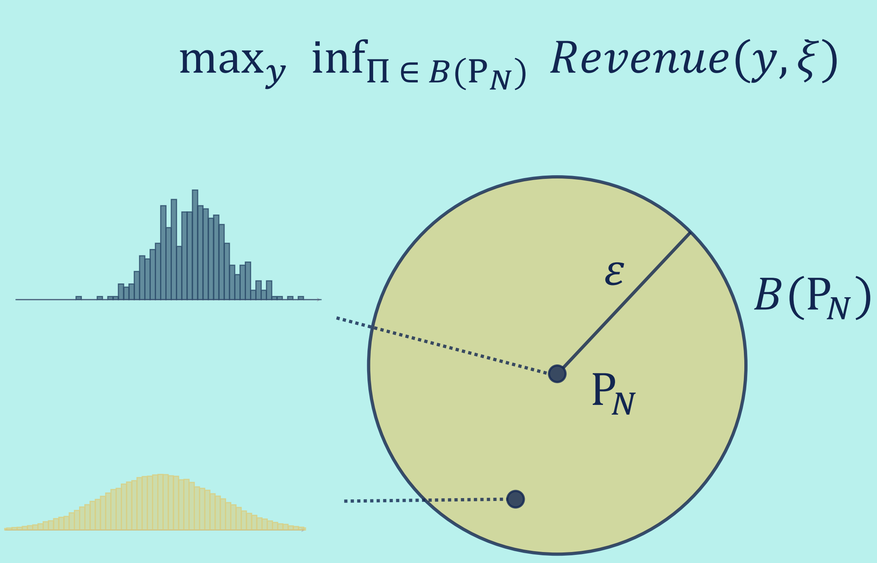
2 The in-sample illusion

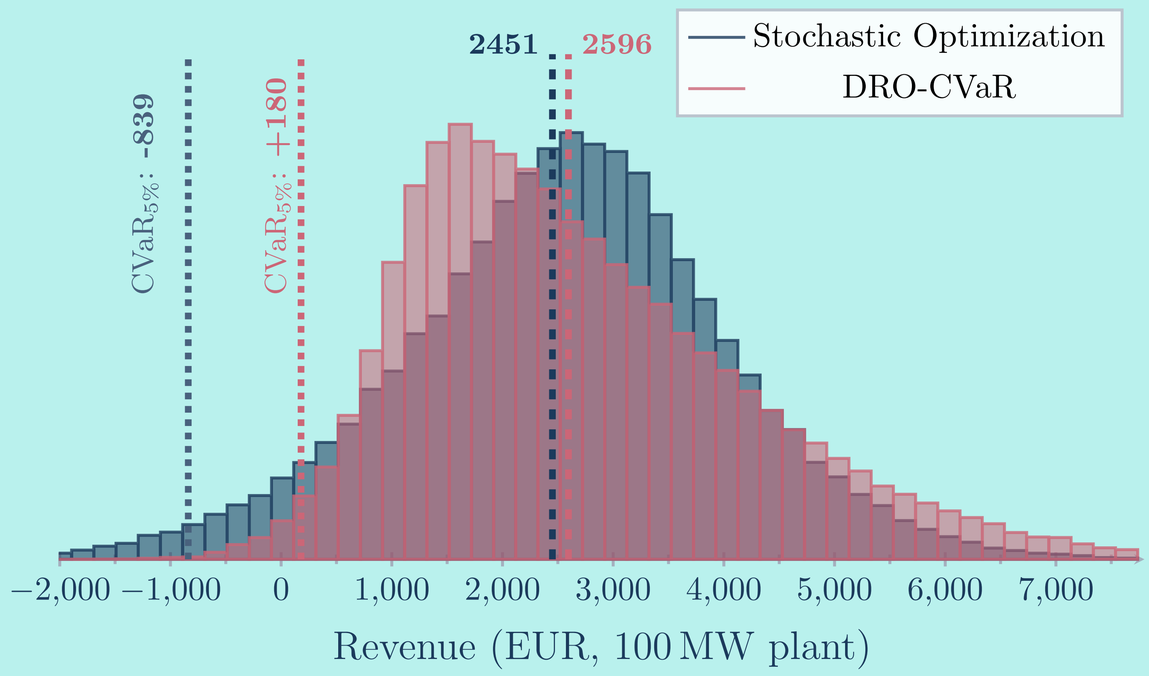
The classical approach to optimizing offers (y) under such uncertainties is stochastic optimization (SO) using scenarios drawn from historical data. However, under a distributional shift (like the one shown below), out-of-sample performance can drastically degrade.



3 The out-of-sample solution

Wasserstein distributionally robust optimization (DRO) hedges against distributional shift by optimizing not just over the empirical distribution (as in classical SO), but over an entire family of distributions, the *ambiguity set,* that are close to it. The result is a bidding strategy robust to out-of-sample shifts, in the example below, with higher mean revenue and dramatically improved tail risk.

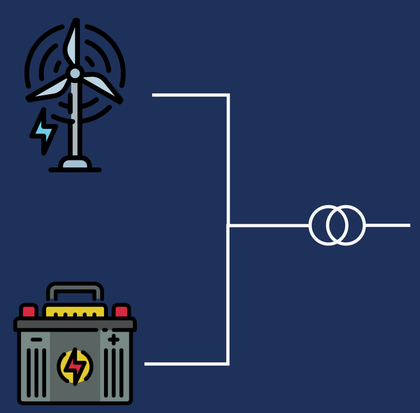




4 Out of sample, into practice

Challenges remain before DRO bidding can be deployed in practice:

- Storage integration: co-locating a battery introduces time-coupling constraints as well as constraints from “overplanting”
- Multi-stage formulations: Real bidding is sequential, and single-stage formulations do not capture intra-day/real-time re-optimization
- Robustness-performance trade-off: the radius ε controls conservatism, but the right ε depends on the data and market context



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Battery Bidding Under SOC Errors

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