ID de Contribution: **187** Type: **Contributed talk**

Capacity investment decisions in equilibrium: a distributionally robust approach

lundi 28 juillet 2025 17:40 (25 minutes)

In electricity systems, investment in generation capacity is subject to risk. The distribution of uncertain parameters on which investment decisions depend might not be fully observed in historical values. In Europe, this was recently illustrated by the crisis of exceptionally high power prices during the 2021-2023 period, which was subsequently followed by a regime of extremely low and even negative prices. In that vein, ambiguity aversion reflects a lack of confidence in the distribution of uncertainty, while risk aversion is concerned with realizations of uncertainty. We study a competitive market with investors who are averse to ambiguity. Such a market is represented as an equilibrium model, where each agent solves a Wasserstein distributionally robust optimization problem regarding its investment decisions. Investments could be hedged by contracts. We derive a convex reformulation of the problem, demonstrate the existence of equilibria, and prove a version of the welfare theorem in this ambiguous context. Via simulations, we find that, as with risk aversion, ambiguity aversion results in capacity-investment deferrals. We show however that, unlike standard results obtained with risk-aversion models, ambiguity cannot be hedged through financial contracts when their revenues are indexed on spot prices. Finally, we highlight that state-backed support schemes such as Contracts for Difference are welfare-improving and capacity-preserving under ambiguity.

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Classification de Session: Mini-symposium

Classification de thématique: Mini-symposium: Models and Methods for Stochastic Non-Convex Optimization and Equilibrium Problems