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Title: Computing a Strategic Decarbonization Pathway via Chance-Constrained EPECs

Abstract: A wholesale electricity market is a marketplace for transmission level electricity trading that often spans over multiple regional jurisdictions (e.g. states in the U.S. or nations in the EU). In this environment, regional regulators can act strategically and exploit the wholesale market interdependence to advance their renewable goals at the expense of neighboring jurisdictions. To understand the effect of this interdependence on strategically acting regulators, we formulate a stochastic equilibrium problem with equilibrium constraints (EPEC) exploiting recent advances in chance-constrained programming. This EPEC considers multiple regional regulators aiming to implement their renewable portfolio standard in the least-cost manner and internalizes operational uncertainties, which are relevant for power system expansion studies. Unlike traditional computationally demanding scenario-based stochastic EPECs, chance constraints capture the intermittent characteristics of renewable generation resources and allow for high computational performance due to the second-order conic reformulation. To cope with the remaining complexity of the proposed chance-constrained EPEC (CC-EPEC), which is an NP-hard problem, we first linearize bilinear terms through SOS1 variables and the binary expansion approach. Then, we customize a Progressive Hedging algorithm which reduces the complexity by decomposing the original problem into regulator-specific problems and recovers the consensus iteratively. The case study is carried out for the 8-zone ISO New England system covering six state regulators and highlights the effect of strategic policy-making with one and multiple strategic regulators, along with the effect of different retirement strategies on nuclear and coal assets.

Key words: