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Chance Constrained and Variance Aware Optimal Power Flow for Distribution Systems

Increasing penetration of distributed energy resources complicate operations of electric power distribution systems by amplifying volatility of nodal power injections. On the other hand, these resources can provide additional control means to the distribution system operator (DSO). In our work we seek to create a decision making framework to overcome the uncertainty of these injections and its impact on the distribution system operations. We develop an AC optimal power flow formulation for radial distribution systems based on the LinDistFlow AC power flow approximation and exploit distributionally robust optimization to immunize the optimized decisions against uncertainty in the probabilistic models of forecast errors obtained from the available observations.

Building on this stochastic optimal power flow, we investigate the impact of a variance aware objective function and bounds on voltage and flow variances. Furthermore, knowledge on the control of forecast-errors allows the implementation of statistical prediction and learning methods that we are exploring in a third step. The first part of the work has been published in "Data-Driven Distributionally Robust Optimal Power Flow for Distribution Systems" – 2018, IEEE L-CSS (https://ieeexplore.ieee.org/document/8359186/) and "Optimal Load Ensemble Control in Chance-Constrained Optimal Power Flow" (https://arxiv.org/abs/1805.09116). Papers on the second and third part are currently in preparation.