Distributionally-robust chance constrained and interval optimization for integrated electricity and natural gas systems optimal power flow with wind uncertainties

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Abstract

With increasing penetrations of gas-fired generation in power systems because of reducing gas prices and emissions regulations, the interdependent and coordinated operation of integrated electricity and natural gas systems (IEGSs) is becoming an urgent research topic. Meanwhile, the significantly increasing deployment of wind power necessitates that IEGSs operation considers wind power output uncertainty. How to model the impact of wind power uncertainty on IEGSs power and gas flows dispatch is challenging. In this paper, a hybrid distributionally-robust chance-constrained and interval optimization (DRCC-IO) based model is proposed to consider the influence of wind power uncertainty and its spatial-temporal correlation on IEGSs operation. First, the DRCC-OPF model is proposed to obtain reliable economic dispatch solutions for the electricity network considering the wind power forecast errors. The spatial-temporal correlation of the wind power plant (WPP) forecasts is considered with a sparse correlation covariance matrix. Then, the interval optimization (IO) model is used to model the impacts of the power variations of gas-fired units on the natural gas network. Finally, the proposed model considers the impacts of wind power uncertainty on both the electricity and natural gas networks. Case studies performed on a six-bus power system coupled with a seven-node gas system and an IEEE 118-bus power system with a 14-node gas system verify the effectiveness of the proposed method to improve system security and reduce costs of the IEGSs. The robustness of the wind power forecast errors can be controlled in the proposed model to trade off the security and costs of the IEGSs.

Keywords

Author Keywords: Integrated electricity and natural gas system (IEGSs); Economic dispatch; Spatial-temporal correlation; Distributional robustness
KeyWords Plus: COORDINATED OPERATION; DEMAND RESPONSE; GENERATION; STORAGE

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