Introduction

- Goal: Develop a stochastic optimization-based dynamic operation model to generate the optimal bidding strategies for wind power producers to participate in the Southwest Power Pool’s (SPP’s) electricity market.
- The wind power producer is considered as a price taker in the market.
- The model generates day-ahead optimal bidding curves for the wind power units while considering their operations in the real-time market.
- Uncertain parameters, including day-ahead wind power production, day-ahead prices, and real-time prices, are modeled using prediction-based scenario generation and reduction methods.
- Risk management is considered in the model to manage the risks associated with uncertainties.

Market Framework and Current Operation Strategy

- Market participants submit their day-ahead offers and bids from 00:00 to 09:30 AM every day.
- The market operator clears day-ahead prices from 09:30 AM to 14:00 PM.
- The bidding curves for the wind power units while considering their operations in the real-time market.
- Three random parameters in the model
- The capacity bid in the day-ahead market is the same as the wind power generation forecasted by the SPP operator.
- If the actual wind power generation on the next day is different from the capacity bid in the day-ahead market, the deviation should be traded in (sold in or purchase from) the real-time market.

Scenario Generation

- Scenario generation based on autoregressive integrated moving average (ARIMA) prediction for uncertain parameters and Gaussian distribution for prediction errors
- ARIMA prediction results of the 24-hour day-ahead electricity prices on June 1, 2015.
- 500 scenarios of forecast errors of day-ahead price for the first hour of June 1, 2015.
- Scenarios generated for 24-hour forecast errors.

Scenario Reduction

- Scenarios of 24-hour day-ahead prices on June 1, 2015.
- Three random parameters in the model
- Wind power production: 5 scenarios
- 5×5×5 = 125 scenarios

Results and Analysis

- Bidding curves for 6 hours on June 1, 2015
- Risk-aversion parameter sensitivity analysis
- Actual monthly profits for June-December, 2015.
- Profit improvement of the seven months in 2015 obtained from the proposed model.

Conclusion

- A dynamic operation model for price-taker wind power producers to participate in the SPP electricity market has been developed based on the stochastic optimization principle.
- Day-ahead bidding curves have been generated using the model for wind power producers to gain the maximum profits in the SPP Market.
- Case studies have been performed for a wind power producer using real data obtained from the SPP market. Results show that the proposed model enabled the wind power producer to gain over 6% more profits in the SPP market than the current operation strategy.
- Additional information (e.g., maintenance schedule and outage) and additional resources (e.g., energy storage if available) can help better manage uncertain risks in the real-time market.

Stochastic Wind Power Bidding in the Southwest Power Pool Market
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