BIDDING STRATEGY OF STORAGE HYDROPOWER PLANTS IN RESERVE MARKETS

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Overview

The increasing share of intermittent sources of energy will increase the need for frequency-control reserves. However, the current supply of reserves might decrease in the following years. The share of gas- and coal-fuel plants in the power mix is expected to decline in order to reduce greenhouse gas emissions. Hydropower technologies are often put forward as mature and low-carbon technologies able to contribute to cover this increasing need for reserves. Their flexibility and storage capability allow them to support the stable operation of the grid. The procurement of reserves being mostly market-based in Europe, the market design should send the correct price signals to encourage the participation in these markets.

Methods

This paper analyses the incentives provided by the French market design for storage hydropower plants to participate in reserve markets. To that end, a deterministic mixed-integer linear optimization model is presented. It determines the hours during which the unit produces and the markets where the unit sells energy or reserves. The objective function is to maximize revenues in the energy and reserve markets according to prices. The model considers the day-ahead energy market and all the reserve products existing in France, distinguishing between reserve capacity and reserve energy products. The plant is assumed to be a price taker and prices are known with certainty. This framework is applied to a seasonal storage and a pumped storage hydropower plants with the 2019 French market environment and prices.

Results

The results show that participating in reserve markets yields higher revenues than only participating in the day-ahead market for the seasonal storage hydropower plant. It always chooses reserve energy markets. However, the pumped storage hydropower plant sometimes participates in the FCR market or only in the day-ahead market. The apparition of some hours of FCR participation with the pumped storage plant is explained by its higher number of generating hours and by the higher volatility of reserve energy prices. These two factors also explain the higher efficiency of a FCR price premium and of the reduction of the contract duration with the pumped storage plant. However, they are inefficient for the seasonal storage plant, suggesting that the plant we consider would not be the most responsive to these incentive measures.

Conclusions

French market price signals incentivize our two hydropower plants to participate in reserve markets. Still, the FCR remuneration is lower than reserve energy, leading to no or low participation in this market. The incentive measures we applied to the FCR market suggest that the response to them is not only determined by the ramping capability. The generation frequency may also play a role in the trade-off between the different reserve markets.

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