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Effect of the accuracy of price forecasting on profit in a Price Based Unit Commitment

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ABSTRACT

This paper discusses and quantifies the so-called loss of profit (i.e., the sub-optimality of profit) that can be expected in a Price Based Unit Commitment (PBUC), when incorrect price forecasts are used. For this purpose, a PBUC model has been developed and utilized, using Mixed Integer Linear Programming (MILP). Simulations are used to determine the relationship between the Mean Absolute Percentage Error (*MAPE*) of a certain price forecast and the loss of profit, for four different types of power plants. A Combined Cycle (CC) power plant and a pumped storage unit show highest sensitivity to incorrect forecasts. A price forecast with a *MAPE* of 15%, on average, yields 13.8% and 12.1% profit loss, respectively. A classic thermal power plant (coal fired) and cascade hydro unit are less affected by incorrect forecasts, with only 2.4% and 2.0% profit loss, respectively, at the same price forecast *MAPE*.

This paper further demonstrates that if price forecasts show an average bias (upward or downward), using the *MAPE* as measure of the price forecast might not be sufficient to quantify profit loss properly. Profit loss in this case has been determined as a function of both *shift* and *MAPE* of the price forecast.

1. Introduction

With the aim for higher economic efficiencies, electricity markets have been and are being liberalized worldwide. Competition is set up both at generation and retail level. In the traditional regulated systems, electricity generation was centrally planned and operated through a classic Unit Commitment (UC) and an economic dispatch optimization, where costs were minimized. After liberalization, Electricity Generation Companies (GENCOs) and retailers of electricity no longer have a guarantee of recovering their costs. Furthermore, their only goal is to make profit. Thus, the focus has shifted from a cost minimization in the centrally planned system towards profit maximization in the liberalized market. This is a fundamental transformation, creating new opportunities for these companies.

In the context of liberalized markets, one can think of unit commitment in two ways: Security Constrained Unit Commitment (SCUC) and Price Based Unit Commitment (PBUC) [1]. The former is very closely related to the classic UC known in regulated markets. Furthermore, one can think of this kind of UC in a liberalized market where electricity demand is largely covered by long term contracts and only a limited fraction is traded through a power exchange. An Electricity Generation Company (GENCO) needs to perform a UC optimization here, in order to generate the electricity sold, at lowest cost. Another example is the SCUC in a power pool where an Independent System Operator (ISO) is present (e.g., the PJM market). This ISO centrally performs this SCUC, given all the technical information and bids of all the power plants of different GENCOs. PBUC optimization, on the other hand, is executed by a GENCO in order to maximize its profit. Given a forecasted price of electricity, this GENCO will optimize the scheduling and electricity generation of its power plants and sell the power at the prevailing price.

This paper focuses on the effects of the accuracy of price forecasts in such a Price (or Profit) Based Unit Commitment. A day-ahead power exchange is looked at. Market participants are free to submit supply or demand bids at their preferred price, for each hour of the next day. These auctions are then cleared simultaneously, resulting in a price of electricity for each hour of the next day, revealing which bids are accepted and which not. To gain as much profit as possible, a GENCO will try to make an adequate forecast of this spot price of electricity. Given this price profile for the next day, the GENCO will optimize the commitment of its power plants, taking into account the technical characteristics of the power plants and prevailing fuel prices. The generation output resulting from this optimization will then be sold on the power exchange.

The approach makes two important assumptions. First, it assumes that the bids of the GENCO have no significant effect on the resulting spot price of electricity. This assumption is justified when considering a GENCO selling relatively small quantities in a

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