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NEGATIVE IMBALANCE PRICES: A CASE STUDY FOR BELGIUM

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Abstract. Because of the integration of renewable power generation technologies, attention rises for the issue of downward adequacy. Recent events have shown that limited downward flexibility during moments with excess supply could cause negative electricity prices. This paper analyzes the occurrence of negative prices in the Belgian imbalance market through both empirical and regression analyses, showing a negative relation for the net forecast error and a positive relation for the day-ahead net load forecast with the imbalance price.

Keywords: Day-ahead forecasts, Flexibility, Forecast errors, Imbalance markets, Negative Prices

EXTENDED ABSTRACT

The presence of renewable power generation technologies increases the need for system flexibility, due to the large variability of their power output profile. This variability may refer to both output variations and prediction errors [1]. For both types of variability, flexible capacity balances the power system. In contrast to scheduled variations, prediction errors require ramp capability providing up or downward regulation being activated in real-time [2]. Historically, system operators, regulators and policy makers were mainly concerned about upward adequacy, which is the ability of power systems to meet peak demand and avoid load shedding or blackouts. However, currently attention rises for the issue of downward adequacy; is the current power system able to cope with over-generation situations? Recent events have shown that system inflexibilities create periods with excess supply. The issue of conventional power plants not being able to ramp down or shut down in periods of excess supply is referred to as the "incompressibility of power systems" and is recently observed in different European electricity markets reflected by negative electricity prices. Although the exact impact of more renewables generation depends on several parameters, large-scale RES-E deployment will definitely increase the need for additional flexibility [3]. The occurrence of negative prices on the imbalance market can be seen as a market signal that represents a scarcity of downward flexibility when facing positive system imbalances [4]. Previous studies [5, 6, 7] show that when there is either a low system load combined with moderate renewable generation or a moderate system load combined with high renewable generation, in combination with a high level of base-load units operating and limited available interconnector capacity, negative price can occur. The objective of this paper is to analyze the occurrence of these negative prices in imbalance markets while focusing on the Belgian case, taken as a representative example for the EU-28.

The TSO operates on both the procurement and the settlement side of the imbalance market. On the one hand the TSO calculates the total system imbalance resulting from the imbalances of BRP's (Balance Responsible Parties), and compensates this system imbalance by activating regulating volume provided by BSP's (Balance Service Providers). On the other hand it settles imbalances with BRP's by applying an imbalance price [3, 8]. In case of a positive system imbalance the TSO will activate downward reserves, which can result in both positive and negative prices. These downward reserves actually represent electricity producers that are willing to lower their output, and since their energy is already sold in the forward market, they are usually willing to pay the TSO a sum that represents their saved operating costs. However, when facing scarcity, some downward flexibility providers may bid negative activation prices, i.e. being paid for the service. In this case, the BRPs having a positive imbalance have to compensate the TSO instead of being paid for their excess supply [9].

When studying time series of the Belgian imbalance prices during the one-year period from the 1st of December 2012 until the 30th of November 2013, it can be noted that negative prices are recorded in 6.78% of the time, while minima are registered at -313.38 €/MWh [10]. As literature states that inflexible base load units, RES power injections, and system load are potential drivers for the occurrence of negative prices and as flexibility is needed for both output variations and forecast errors, these explanatory variables were analyzed. For the occurrence of negative prices there seems to be a positive relation with the forecasted wind and solar power generation, and also with the nuclear power generation, and a negative relation with the predicted load and net load. In addition, periods experiencing negative imbalance prices are characterized by more wind and solar power than forecasted, and less load than forecasted. The flowchart in Figure 1 shows those variables and their influence on the imbalance price determination. However, a key variable that was not analyzed is 'power plant outages', as this falls outside the scope of this paper. Two paths (being the day-ahead and real-time path) are shown, representing the available reserves and the requested reserves, each with their impact on the imbalance prices. First, it can be noted that the day-ahead forecasts determine the theoretical day-ahead predicted net load, and lowered by the planned inflexible base load units this determines the amount of scheduled flexible base load, mid load, and peak load units. The amount of planned conventional flexible power units consequently determines the available reserves for the next day. Second, the forecast errors and power plant outages determine the BRP's real-time imbalances, which aggregated form the total system imbalance. The system imbalance determines the net regulated volume, which represents the requested reserves by the TSO. The interaction between available reserves and requested reserves ultimately determines the imbalance price.

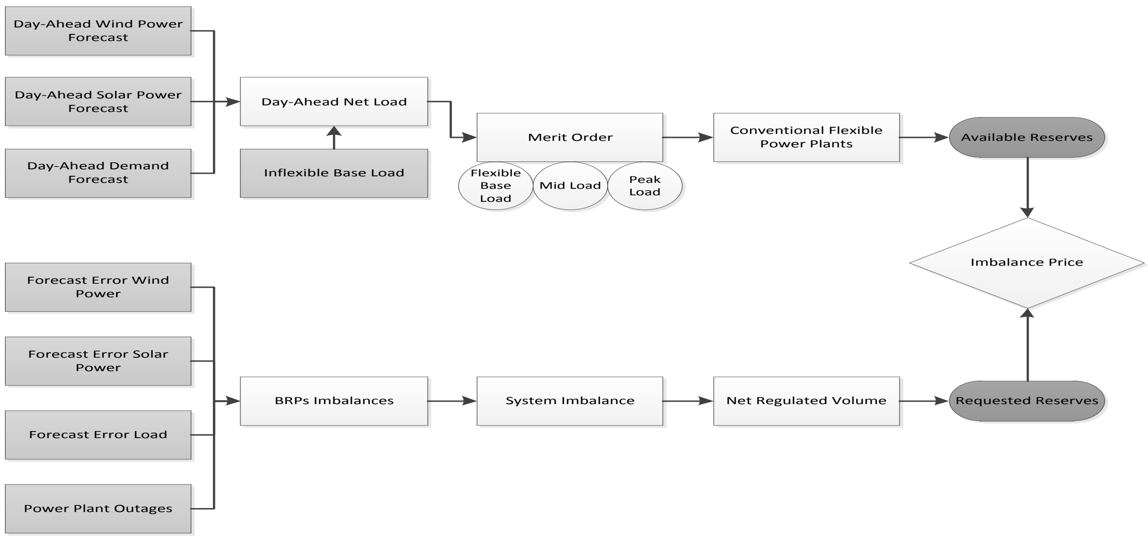

Figure 1. Flowchart identifying potential imbalance price drivers.

In order to verify the assumption that the day-ahead net load forecast (aggregating the day-ahead load, wind and solar power forecast, and the planned inflexible base load units) and the net forecast error in real-time (aggregating the load forecast error, and wind and solar power forecast error, with a positive net forecast error indicating a positive system imbalance) have a significant impact on the imbalance price, a multiple linear regression analysis was executed with the explanatory variables being the day-ahead net load forecast and the net forecast error. The outcome confirms the assumed negative relation for the net forecast error and the positive relation for the day-ahead net load forecast with the imbalance price.

Negative prices facilitate investments in a wide range of flexibility sources. The first one is electricity storage, which is able to store energy in times of a surplus in electricity generation, and to discharge in times of a surplus in electricity demand. Second, the deployment of demand-response technologies in both residential and industrial areas is also able to provide more system flexibility. Third, flexibility facilitators such as additional interconnector capacity between regions and countries may aid in compensating imbalances across different control zones and thus increase the geographical flexibility. Fourth, investments in flexible generation units are also incentivized by the lack of flexibility, which is represented by the occurrence of negative prices.

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