A double pricing and penalties "Separated" imbalance settlement mechanism to incentive self balancing of market parties

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***Abstract*—Increasing penetrations of variable renewable energy sources increase the usage and costs of reserves due to their stochastic nature. As Balance Responsible Parties all market participants pay the balancing costs of their imbalances according to the imbalance settlement mechanism of each market zone. The European balancing markets and the imbalance settlement mechanisms still have different rules across Europe, but normally, the prices of upward and downward regulation are higher and lower than spot prices, respectively, originating penalties. Against this background, this work presents an alternative "Separated" imbalance settlement mechanism that consists of unbalanced parties paying/receiving directly the costs/revenues of the balancing markets needed to balance them. In this mechanism, the net costs/revenues of Transmission System Operators with energy balancing mechanisms are zero. Furthermore, by separating the payment of penalties between unbalanced directions, this mechanism also incentive unbalanced parties to self-control their dispatch, mitigating part of their deviations. Two case studies have been presented to test the application of this mechanism in Portugal and Spain, comparing its outputs with those of the mechanisms in place in these countries during 2019. Outputs from the studies prove the benefit of using this mechanism to reduce penalties, mainly in the case of active market players that can partly control their dispatch.**

***Index Terms*—balancing markets, balance responsible parties, imbalance prices and penalties, imbalance settlement, variable renewable energy sources.**

I. Introduction

The legislation of the European Commission for regulating the European Internal Market of Electricity (EIME) encompasses measures of market design and harmonization that can motivate the integration of variable renewable energy sources (vRES) and the demand side, as well as, incentivizing their active participation in electricity markets [1]–[3].

The increasing penetration of variable renewable energy sources (vRES) across Europe is raising the usage and costs of reserves due to their low predictable generation. At the same time, the emergence of new flexible players, such as local citizen energy communities (CECs), can significantly impact balancing markets and create new opportunities [4]

As Balance Responsible Parties (BRPs) all market participants pay the balancing costs of their imbalances. The reduction in the electricity prices, originated by the self-cannibalization effect of vRES, coupled with the increases in their imbalance costs could pose a challenge for future non-discriminatory integration of vRES into the electricity markets as active market players. Without feed-in tariffs, other incentives, or changes in the existing market design, for future investments in these sources may lack attractiveness compromising the expected decarbonization of the power systems [5]–[7]. Furthermore, providing support schemes to vRES may contribute to market distortions, increasing the incidence of negative spot prices and reducing the return of the other suppliers [8], [9].

The EIME legislation harmonized the rules of the day-ahead and intraday markets, which increased the efficient usage of cross-border trades in those markets. Notwithstanding that effort, the balancing markets and the imbalance settlement mechanisms still have different rules across Europe [2], [10]. Typically, BRPs inducing deviations pay/receive the costs/revenues of balancing markets according to the imbalance settlement mechanism of each control zone. Normally, upward and downward regulation are more costly than spot prices, resulting in penalties. Otherwise, depending on the imbalance settlement (IS) mechanism, Transmission System Operators (TSOs) may have an economic surplus or compensate BRPs [11], [12]. In Europe, the imbalance settlement mechanisms strongly differ between countries. As an example, in Nordpool countries and Spain, only those who deviate in the dominant balance direction (i.e., with a negative impact on power system operation) may pay penalties. In contrast, in Portugal, even under the same electricity market as Spain, The Iberian market of electricity (MIBEL), all unbalanced parties directly and equally pay/receive the balancing costs/revenues [12]–[14]. The mechanism used in Nordpool and Spain may be considered discriminatory since only those contributing to deviations in the dominant direction pay penalties [15], [16]. Also, unbalanced parties are not compensated independently of the balancing prices, which may originate an economic surplus for TSOs. However, if the costs of system balancing in the dominant direction are lower than those in the non-dominant