

Renewable Integration: The Role of Market Conditions

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Abstract

The 2022 energy crisis highlighted the dependence of Europe electricity sector on imported gas and the need to accelerate the connection of renewables to the power system. However, the allocation of generation and demand in electricity markets is not always technically viable and, where needed, system operators must activate or curtail specific generators not cleared in the day-ahead markets to ensure system reliability. This is a well-known operational, but under-researched, issue related to high integration of renewables. In Spain, most activated units are combined cycle or coal, while an equivalent volume of scheduled renewables (wind) must be curtailed to balance generation and consumption. Most of these actions are not used to alleviate congestion or grid bottlenecks, but to ensure system stability which highlights new challenges, but little empirically analyzed, in efficient integration of renewables. These actions impact on social welfare since all customers bear the costs of these actions, resulting in additional gas imports and CO₂ emissions. We estimate how these actions could evolve under different scenarios. We find that additional renewables have increased the costs and CO₂ emissions related to network operational needs. Moreover, the installation of small generation behind the meter might become a regressive policy since all customers will bear the additional operational costs. Finally, higher electricity consumption decreases the costs of solving operational needs, which highlights another social welfare benefit associated with the electrification of demand. Until the renewable or storage technologies evolve further, conventional generators (coal, combined cycle or nuclear) are needed for safe operation of systems with high rate of renewables, and countries need to assess when they disconnect them from the network.

Keywords Renewables, decarbonization, generation mix, redispatching, renewable curtailment, synchronous generators, day-ahead market, network constraints, gas crisis, system operator, smart grids, digitalization

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