Contribution ID: **108** Type: **not specified**

Utilization of reserve capacities in electricity markets to mitigate price spikes: Impact on national and surrounding bidding zones

Friday 27 March 2026 12:10 (20 minutes)

Motivation

In the European electricity market, which is fundamentally designed as an energy-only market (EOM) and structured into bidding zones, scarcity prices of sufficient magnitude and frequency are main drivers of investments in additional generation capacity or flexibility. Whether these price peaks and the associated revenues are sufficient to enable the (re-)financing of assets in the electricity market is questioned in the literature under the term "missing money"[1], [2]. The European Union fundamentally adheres to the EOM but allows the implementation of capacity mechanisms under the aspects of security of supply and resource adequacy. The preferred form of a capacity mechanism is the strategic reserve, as currently implemented in Germany. Resources associated with the reserve mechanism cannot be remunerated by wholesale electricity markets and must be held outside of the market [3].
Particularly in Germany, there has been an intense debate since the energy price crisis in 2022 about limiting electricity prices and how to reduce electricity costs. In this context, potential additional use cases for reserve capacities which are held outside of the market are discussed. According to the coalition agreement of the current government, available reserve capacities should not only be used to ensure security of supply but should also be used to expand the supply curve in the electricity market [4] once the wholesale electricity price exceeds a predefined price threshold (strike price) [5], [6]. The resulting expansion of generation capacity is intended to reduce price spikes and stabilize market prices. This national unilateral market intervention is not only critical from an EU legal perspective, it also requires a detailed analysis of effects nationally and internationally to identify potential market distortions.
This contribution complements the existing discussion [6], [7] with a quantitative analysis that identifies the effects of utilizing reserve capacities at a specific strike price in the German electricity market not only on short-term market outcomes (generation quantities and electricity prices) but also long-term effects on investment decisions in generation capacities and storage technologies, both within the German bidding zone and across the European electricity market. Due to the existing uncertainty regarding the realization of climate years and the associated uncertainty in the generation of fluctuating renewable energy sources as well as electricity demand profiles, the analysis also considers probabilities associated to three different climate years.

Methodology

The electricity market model is based on [8], [9], [10] and analyzes effects on investment decisions as well as short-term market outcomes in the electricity market of Central Western Europe. The electricity market model is extended such that reserve capacities can be utilized if market prices exceed a specific price threshold and represents endogenous decisions in investments and decommissioning of fossil generation capacities, electrolysis capacities and batteries in accordance with short-term market outcomes, including the decisions on generation quantities, storage operation and hydrogen production. Under the assumption of perfect competition, private firms decide about their profit-maximizing production quantities as well as long-term investment decisions in generation, electrolysis and battery capacities while taking probability assumptions regarding the realization of different climate years into account. Trading between bidding zones is optimized by considering inter-zonal transmission constraints.
The optimization problem with a concave quadratic objective function is implemented in GAMS.

The data basis consists of an aggregated representation of the European electricity market based on national bidding zones. The target year of the analysis is 2030 with an hourly resolution of trading periods. A total of six different reserve scenarios, which differ in terms of reserve size (5, 10, 15 GW) and strike price (250 vs. 500 EUR/MWh), are analyzed in comparison to a reference scenario (without reserve utilization).

Preliminary results

The preliminary results show that price spikes in all countries are reduced by the utilization of reserve capacities in Germany. Nevertheless, even with a reserve size of 15 GW, scarcity prices still occur. Although prices during peak price hours are reduced significantly due to reserve utilization, price effects are partially offset by adjusted investment decisions, which increase prices during the remaining hours of the year. Effects on annual demand-weighted average market prices are small and vary depending on the reserve scenario and the underlying climate year.
Utilizing reserve capacities on the spot market for electricity can not only lead to potential short-term price reductions but also to adjustments in long-term investment decisions in the electricity market. Reserve utilization incentives a market-driven phase-out of hard coal capacities and reduces investment incentives for batteries in Germany. The negative effects on battery investments are more pronounced at a low strike price and increases with the size of the reserve capacity.
Beyond effects on market outcomes and investment behavior, a potential trade-off between system cost reduction and loss of security of supply needs to be discussed. Due to additional revenues earned by the utilization of reserve capacities at the spot market, operating cost and to some extent capacity provision cost for reserve capacities can be covered, which leads to a potential cost reduction effect on network cost and therefore a reduction of total system costs. However, due to the additional use case and the resulting reduced availability as a backup to ensure security of supply, the potential loss of security of supply, which can have negative effects on system costs, also needs to be considered.

Author: PFEFFERER, Ulrike (Technische Universität Nürnberg)

Co-authors: SÖLCH, Christian (Technische Universität Nürnberg); EGERER, Jonas (Technische Universität Nürnberg); LANG, Lukas M. (Technische Universität Nürnberg); GRIMM, Veronika (Technische Universität Nürnberg)

Presenter: PFEFFERER, Ulrike (Technische Universität Nürnberg)

Session Classification: Scarcity & Reliability