Study Committee C2

Power System Operation and Control

Paper 11005_2022

Handling Intra-Zonal Constraints in the Upcoming European Balancing Markets

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Motivation

The Norwegian grid is especially prone to intra-zonal congestion. This has been handled manually so far, but with new balancing platforms and 15-minute settlement periods, an **automatic procedure** is needed.

The Norwegian TSO is developing a **bid filtering approach**, and this paper aims to present and explain this approach, as well as discuss whether it can be effective at reducing network overloads.

Norway transmission system with AC interconnectors to Sweden and HVDC connections to the European continent and UK

Approach

The paper explains the problem of handling intra-zonal grid constraints in the new setting of international balancing platforms and presents the processes and principles that constitute the bid filtering mechanism being developed by the Norwegian TSO.

The paper also asks:
to what extent does bid filtering improve system security compared with an approach without bid filtering?
Simulations on historical data sheds light on the discussion.

Objects of Investigation

The simulation setup involves

- Power system data recorded from the Norwegian grid on 23 August 2021
- Balancing energy bids and activations from the Nordic Regulating Power Market
- The Statnett bid filtering software (in its late-2021 state of development)
- A custom-built simulation framework for visualization and analysis

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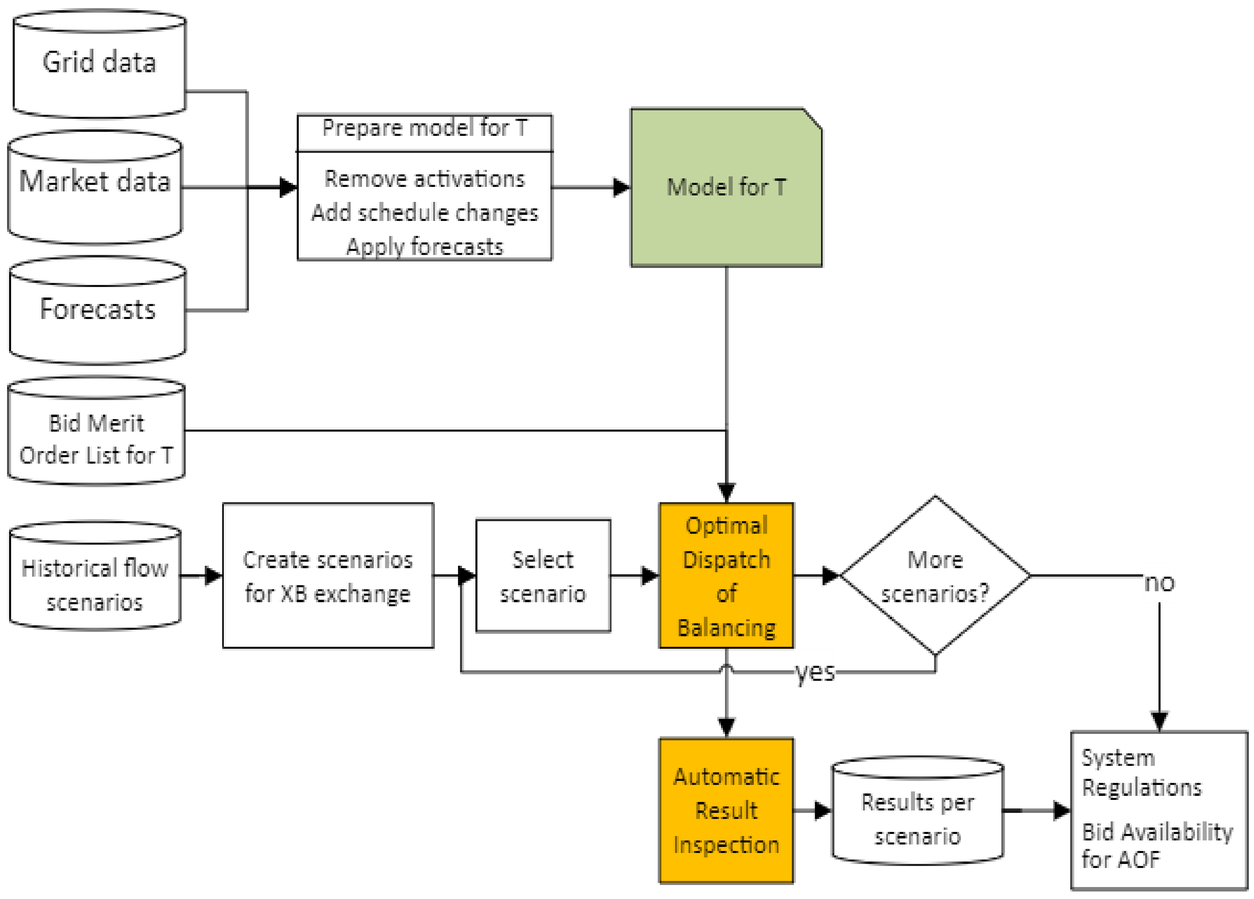
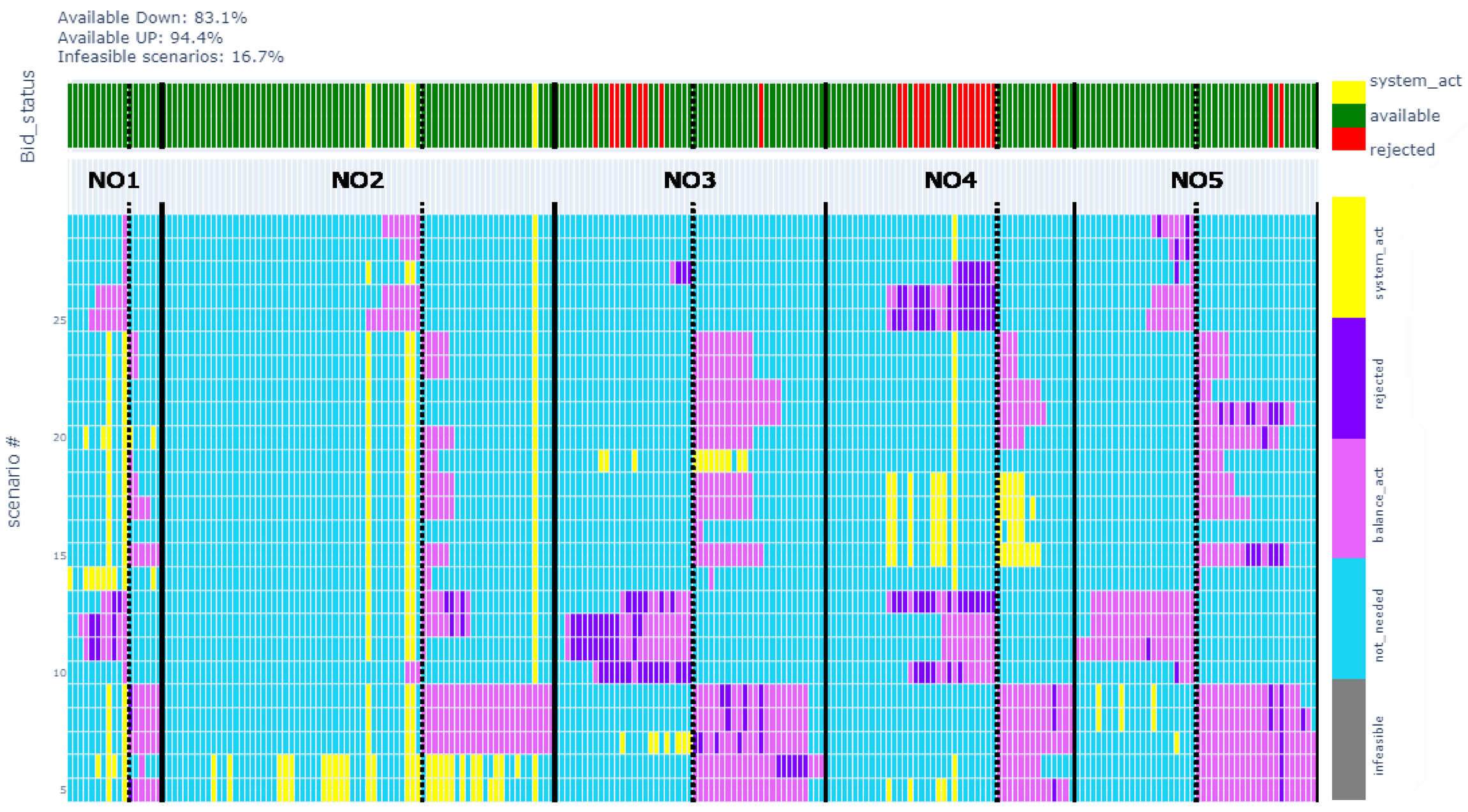
The Bid Filtering Approach

1. **Build a model for the target Imbalance Settlement Period** (ISP) (at time T), based on available information at T-x, with x somewhere between 15 and 25 minutes. This model covers the whole Norwegian system in detail.
2. Since filtering is performed before the clearing of the balancing market, **balancing energy exchange to neighbouring countries is considered a major source of uncertainty**. In the model, exchange scenarios are used to represent potential exchange outcomes.
3. A DC Optimal Power Flow (OPF) calculation finds the **optimal balancing dispatch for each scenario**, using balancing bids from Statnett's market system.
4. Inspection of these results reveals **which bids have been skipped due to congestion** and provides a basis for determining which bids should be made unavailable for cross-border exchange.
5. The process also results in **recommendations for system regulations** to avoid violation of security constraints.



Overview of the bid filtering process



Bid labelling and availability status at 08:00, in preparation for balancing activations at 08:30

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Simulation Setup

The simulation uses recorded data from 23 August 2021.

Historical mFRR balancing activations are replaced by bid selections from a simplified AOF (a zonal market algorithm).

In one of the two simulations, the bid filtering mechanism sets some bids unavailable before the AOF. In the other one, all mFRR bids are available.

Quantifying System Security

We calculate a comprehensive weighted **overload index**:

$$Q_{SC} = \sqrt{\sum_i P_{ex,i}^2 \cdot \frac{P_{limit,i}}{\sum_j P_{limit,j}}} \quad \text{with} \quad P_{ex,i} = \max(P_i - P_{limit,i}, 0)$$

Case study simulation results

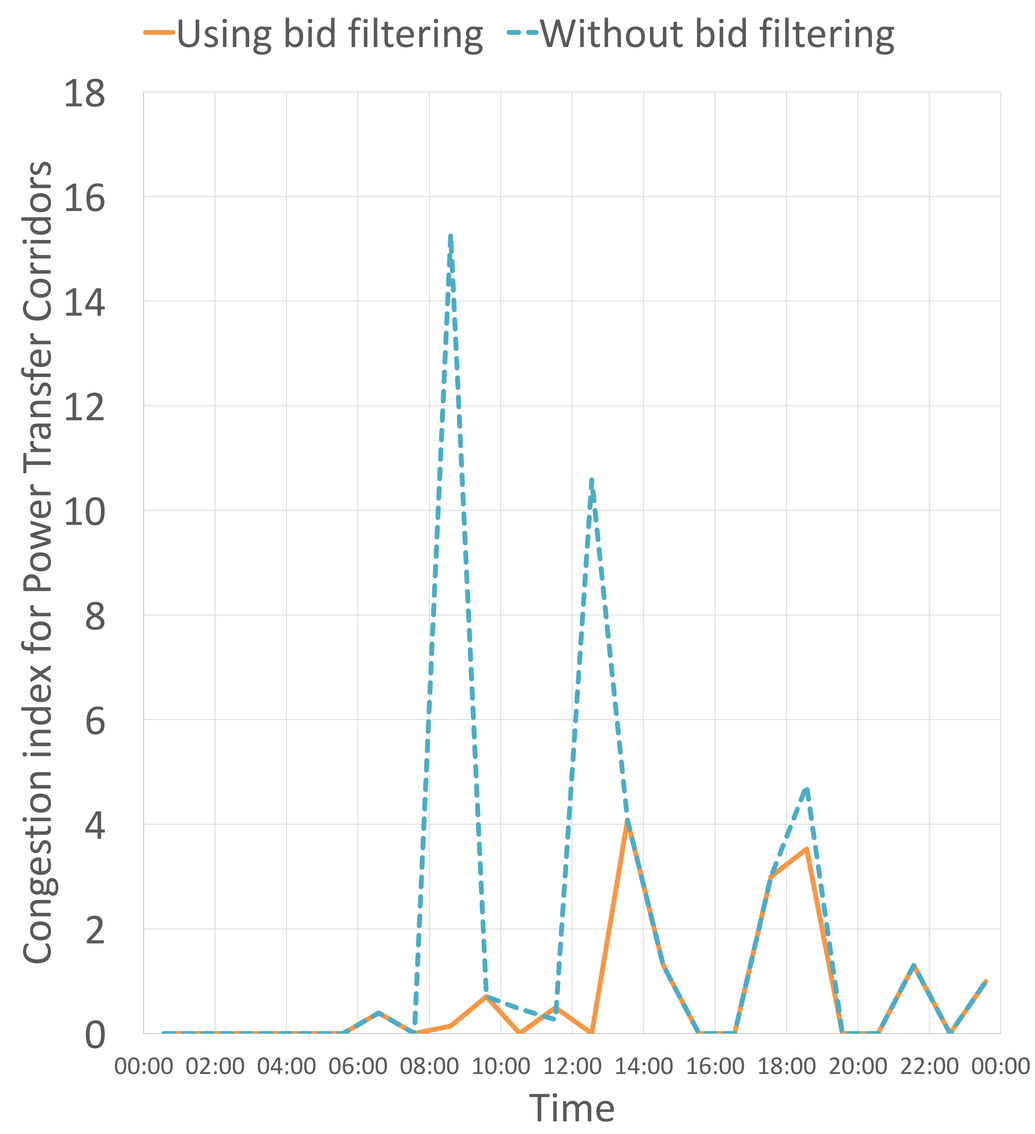
In 12 of the 24 hours, overloaded PTCs would **not be a concern**.

In 8 of the 12 hours where the simulation indicates PTC overloads, bid filtering was **incapable of improving the situation** with the current setup (probably due to data inaccuracies or overload that were accepted by operation for various reasons).

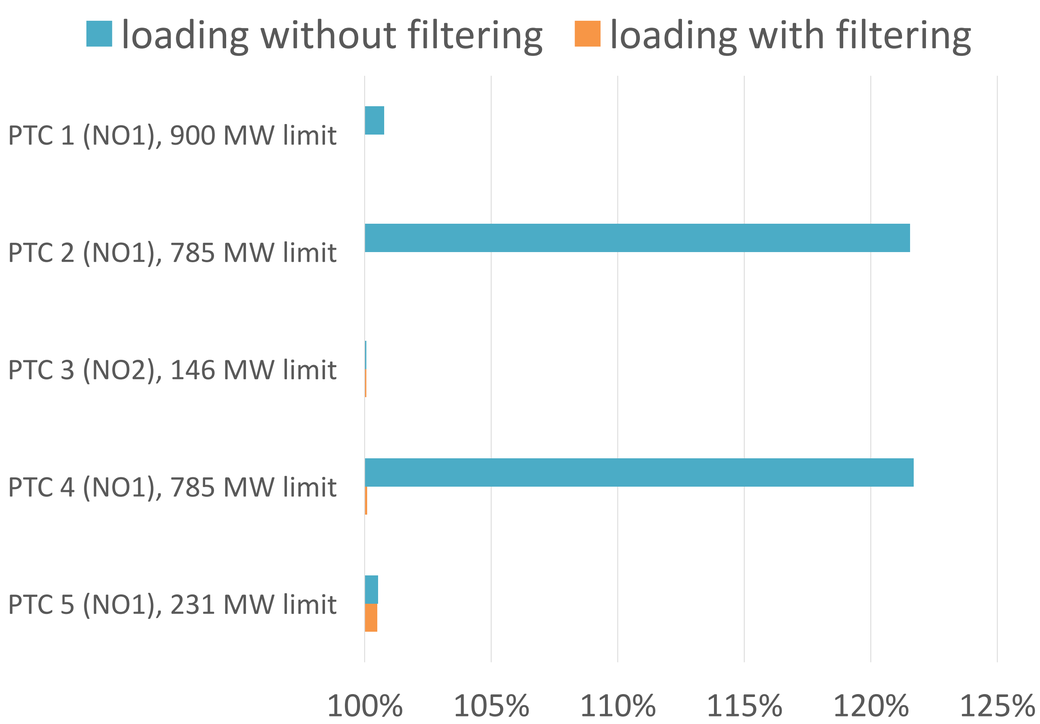
However, in the remaining 4 hours, bid filtering was able to **reduce or completely prevent** PTC overloads.

Conclusion

- The bid filtering system is able to distinguish bids that can safely be activated as well as bids that need to be skipped
- Bid activations that are necessary for system security are also identified
- The accuracy of the result depends on the quality and combination of scenarios
- The simulation case shows that bid filtering in some cases significantly reduces overloads on power transfer corridors after activation by the central platform



Overload index QSC·106· for one day, with and without bid filtering.



Overloads on individual PTCs at 08:30 in the morning.