Reconciling the zonal model with maximum grid utilization in the balancing phase

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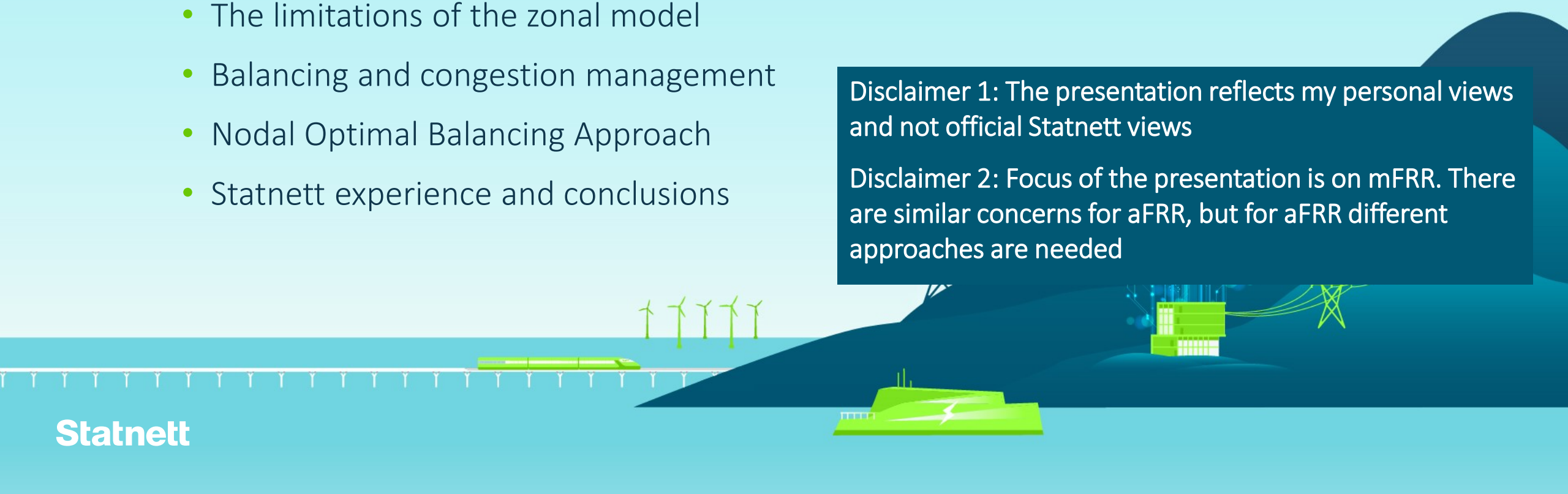
Overview

- System changes and balancing needs
- The need for high grid utilization
- Some conclusions from the ENTSO-E Vision
- The limitations of the zonal model
- Balancing and congestion management
- Nodal Optimal Balancing Approach
- Statnett experience and conclusions

Disclaimer 1: The presentation reflects my personal views and not official Statnett views

Disclaimer 2: Focus of the presentation is on mFRR. There are similar concerns for aFRR, but for aFRR different approaches are needed



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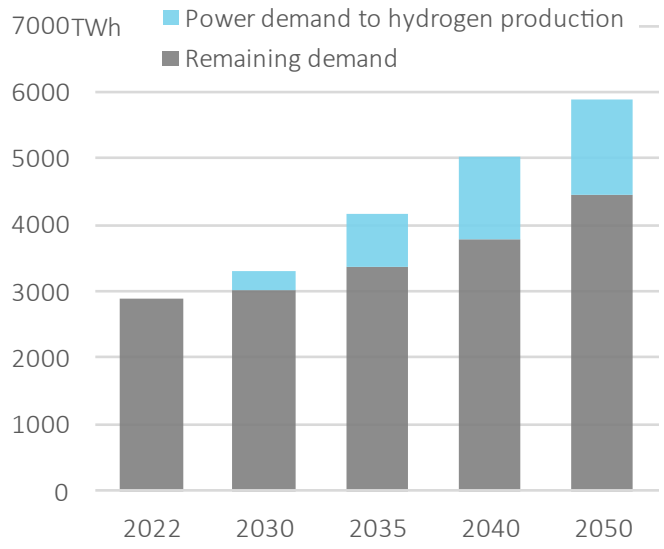
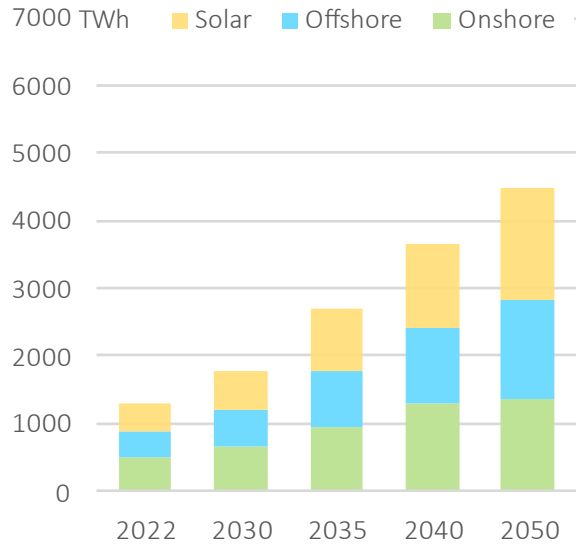
The European power system will be dominated by and wind and solar power generation

→ This will reduce predictability and increase balancing needs

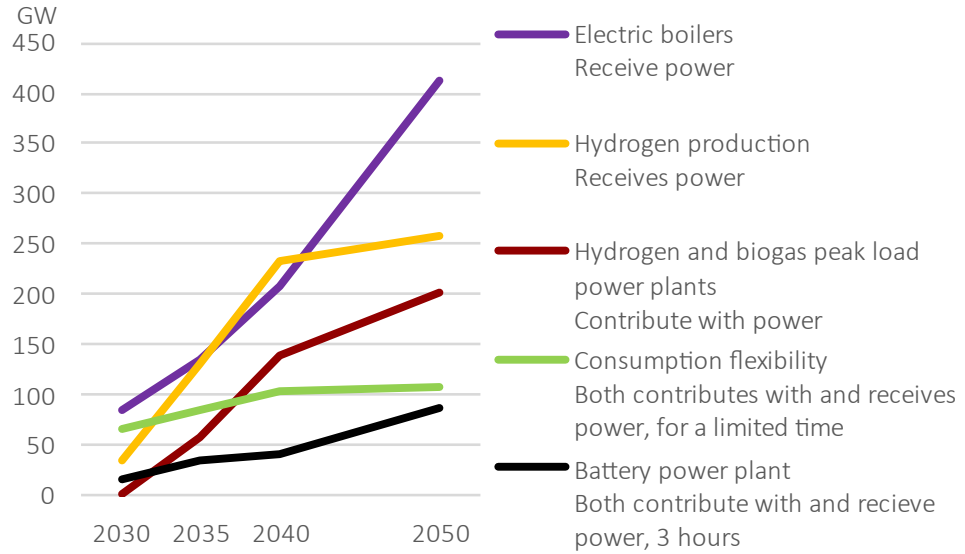
Electricity demand in Europe incl. Nordics doubles



Generation increase largely from solar and wind



Large volumes of new flexibility will be needed



Source: Statnett Long Term Market Analysis (in Norwegian)
https://www.statnett.no/globalassets/for-aktorer-i-kraftsystemet/planer-og-analyser/lma/langsiktig-markedsanalyse-2022-2050.pdf

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The impacts of the fundamental system changes

- Increasingly we will see flows that the grid was not designed for
- Huge variations in flows
- Reduced predictability of flows
- Grid expansion will lag system needs → high utilization of assets required
- Significant needs for balancing
- Significant needs for congestion management – in real time
- All grid connected resources need to contribute to the maximum of their abilities
- Is that possible without locational price signals?

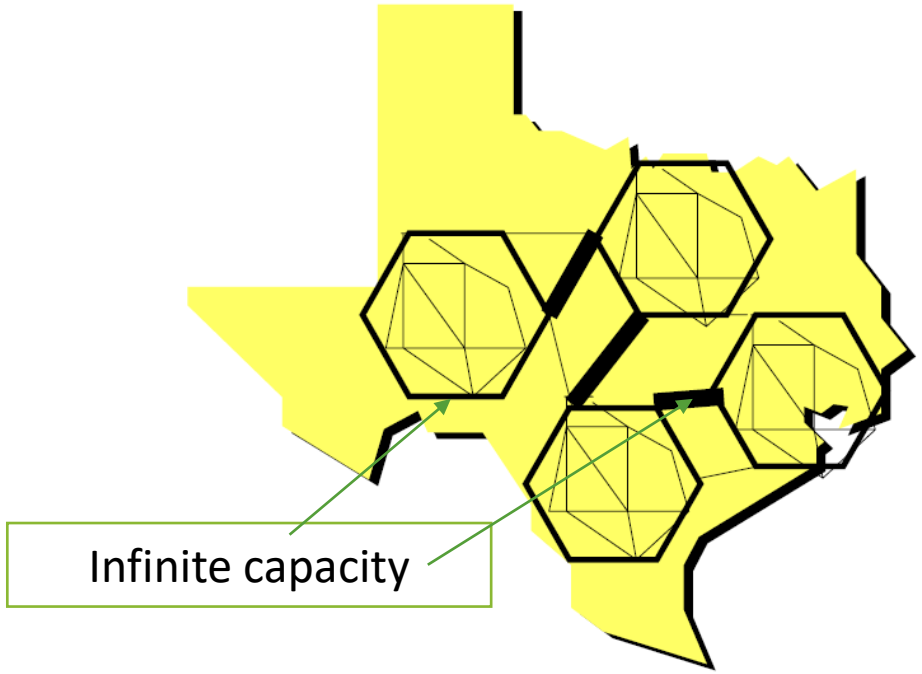
From ENTSO-E Vision "A Power System for a Carbon Neutral Europe"

- **Operating Future Grids**
  - For TSOs to operate the unprecedented growth in grid complexity and maximise the use of the grid capacity, there is a need to have **significantly enhanced granular, real-time visibility** on the system state and on flexibility sources [ ]
- **Market Design for a Carbon Neutral Power System**
  - Well-designed electricity markets will need [ ] to ensure that any incentives for market parties are **consistent with the physical network capabilities** and overall system security requirements
  - **Efficient price signals** will be essential to enable an optimal development of such a system as a whole, optimising the use of all energy resources across space and time.
  - The market design should ensure an efficient access to decentralised energy and flexibility sources (including demand response) to be used **where and when it is most beneficial**
  - Market design needs **to properly reflect grid constraints** and operational challenges in a highly complex and heterogeneous System of Systems
  - The electricity market design must be able to **better reflect the physical reality of the grid**. Optimal use of infrastructure limits the costs of RES curtailments and congestion management which are rising in many countries and are ultimately borne by consumers
  - **Different solutions may be applied** across the EU while ensuring the preservation of market integration

Does the zonal model present reality?

- NTC and Flow Based approaches assume the following*
  - All generators in a bidding zone have the same PTDFs with respect to the CNECs
  - Given a fixed total generation and demand in one zone, the sharing of generation within that zone does not impact [ ] congestion in other zones.

- This is what a system like that would look like:

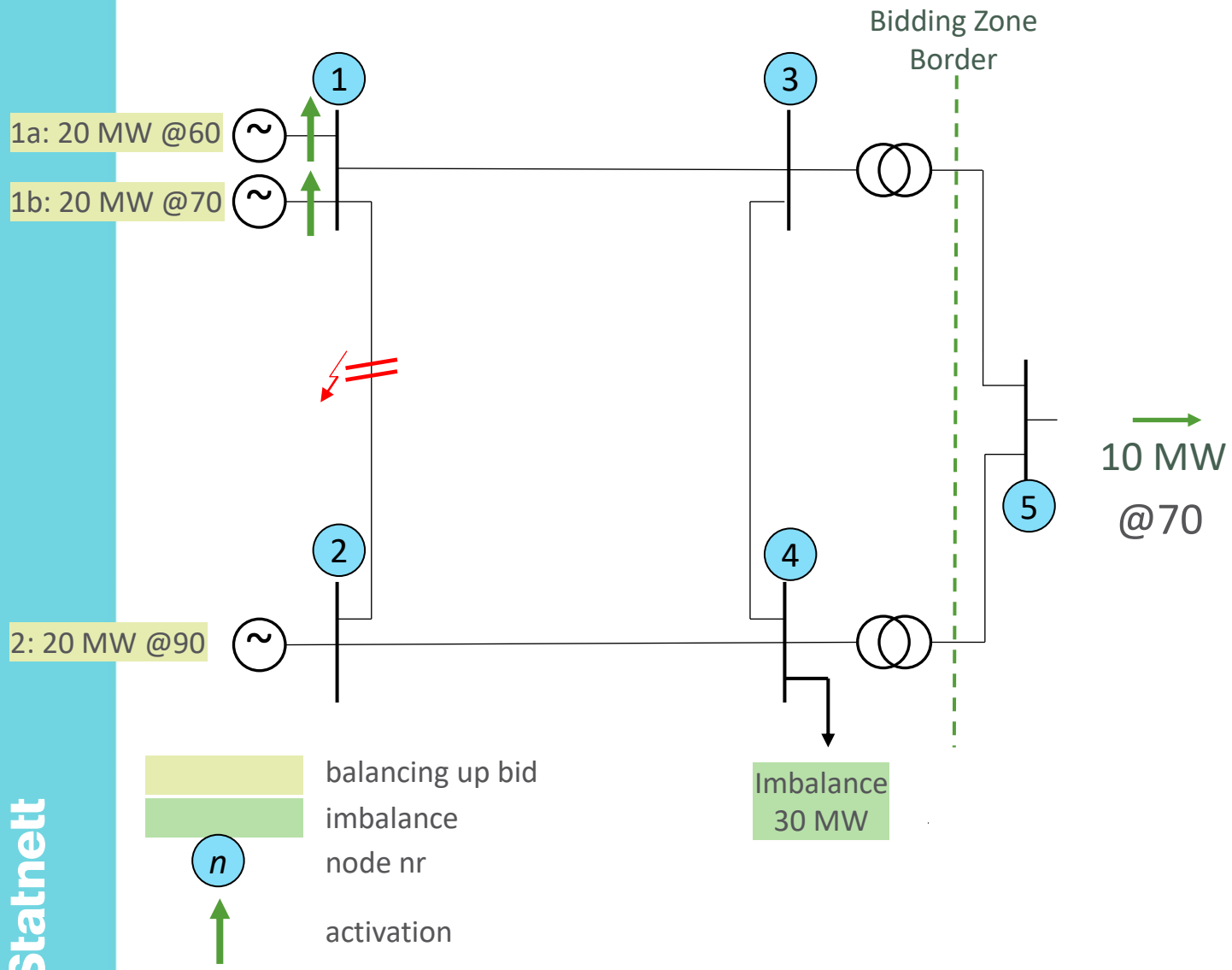


*Shift factors in ERCOT congestion pricing
Working paper by Ross Baldick, March 5, 2003

The limitations of the zonal model

- In a zonal model with portfolio bidding, the TSO can never know exactly where power will be produced or withdrawn
- To satisfy security constraints:
  - Need significant margins
  - Or the ability to redispatch
- Redispatch not possible in the balancing time frame
  - 30 seconds from MARI (mFRR) platform finalization to activation orders
  - Immediate for PICASSO (aFRR)
- Using grid margins is inefficient by definition – grid is not fully utilized
- However, nodal pricing is not a feasible option for Europe in the short term

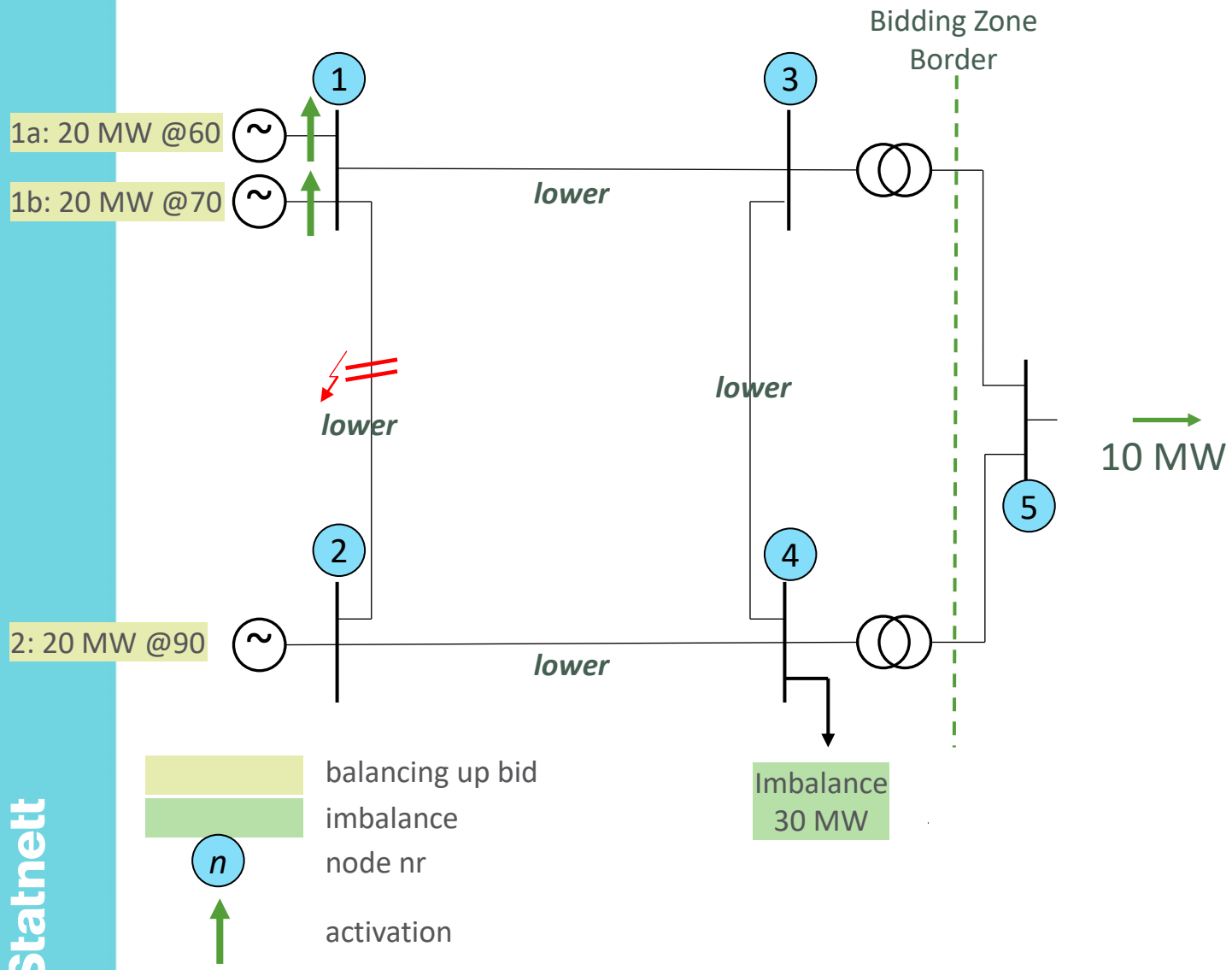
Example: simple grid BZ connected to MARI platform



- Balancing Platform result:
  - Gen 1a: 20 MW ↑
  - Gen 1B: 20 MW ↑
  - Export 10 MW
  - Price = 70

➢ Overload on line 1-2

Apply margins

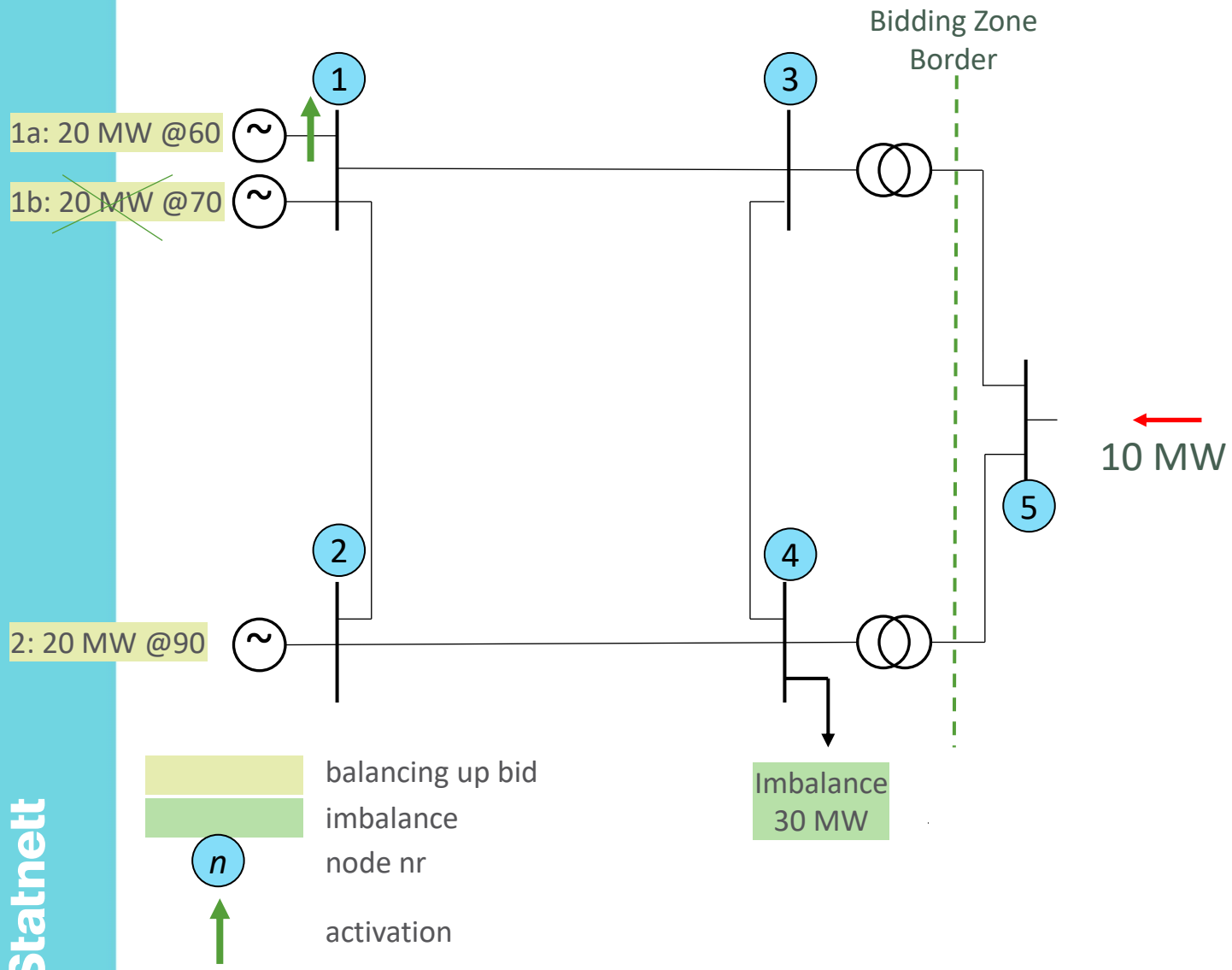


- Could overload have been avoided?

1. Reduce internal line capacities to create "headroom" for balacing
   - Use redispatch after DA market clearing

- Works but is <u>inefficient</u>
  - Poor utilization of existing grid

Bid filtering

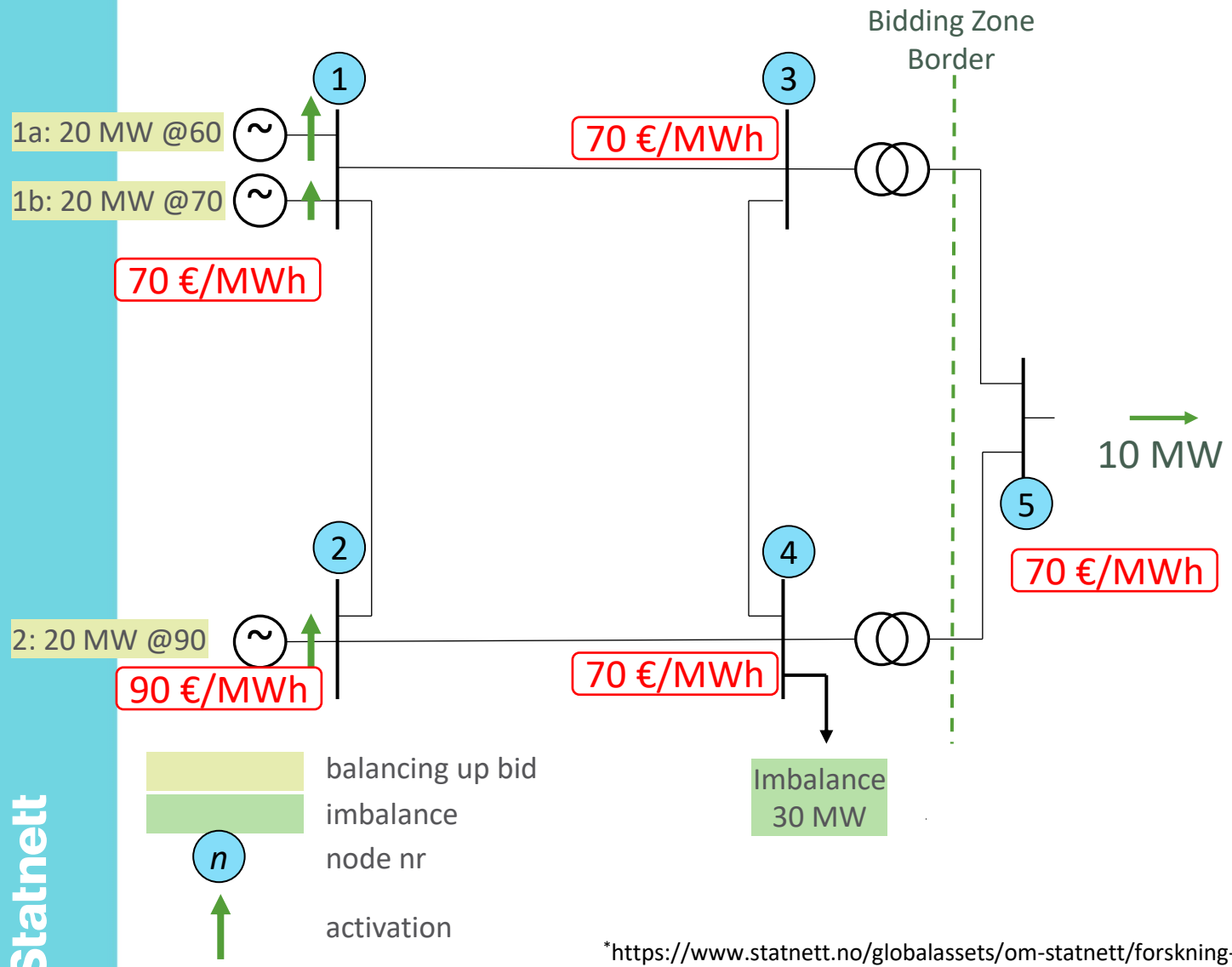


2. Bid filtering
   - Statnett develops this approach

- Apears to work satisfactory, but still imprecise because (15 min) future is unkown
  - E.g. where will imbalance occur?

Unit bidding required

Nodal Optimal Balancing Approach - NOBA



- Nodal Optimal Balancing Approach
- Fix Platform net position (10 MW)
- Optimal Power Flow to balance Bidding Zone at minimum cost
- Example result
  - Gen 1a: 20 MW ↑
  - Gen 1B: 5 MW ↑
  - Gen 2: 15 MW ↑
- Pricing: nodal pricing not compatible with preceding markets (DA, ID)
- Potential solution
  - Bids within Platform price receive Platform BZ price: 70
  - Other bids pay-as-bid
  - This is (in principle) not different from present Statnett practice
- Pricing strategies need further research*

Unit bidding required

*https://www.statnett.no/globalassets/om-statnett/forskning-og-utvikling/fou-konferansen/simbas.pdf

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Statnett experience

- Statnett has developed a bit filtering approach
  - Basis is detailed model with full update from Scada system
  - Runs 40 scenarios ~20 minutes before data submission to platform
  - Use results to flag certain bids unavailable for platform
  - Result is not perfect because final system state is unknown
- When platform activations are known, verify feasibility of results with load flow on same model
  - This step is easily done within the 30 seconds time frame
- Infeasible bids can be stopped at this stage
  - Creates imbalance
  - Final strategy not decided on
- Important point: Statnett already has a version of the software that is needed to implement NOBA

NOBA – pros & cons

- Pros
  - Largely consistent with existing European framework, no need for major changes
  - Maximum utilization of existing grid – critical for the green transition
  - Avoid/limit infeasible activations of balancing resources by platform
  - Price signals consistent with system needs, incentivizing "system friendly behaviour"
  - Constant shift towards the optimal solution in real time, reducing costs
  - Minimizing ad hoc TSO actions to avoid system security violations
  - No need for general adaptation – can be used by TSOs that deem it necessary
- Cons
  - Not "perfect" – local constraints not known during platform clearing
    - Can also result in inconsistent results
    - Combination with bid filtering will improve this
  - Some changes possibly needed in existing legislation and framework
    - But no major: most significant is that platform result is valid on the Bidding Zone basis and not for individual activation
  - (Unit bidding – already used in several countries)

Conclusions

- In the near future, the European power system will be **unrecognizably different** from today's
- Very **high utilization of the existing and gradually developing grid** within strict security constraints will be a prerequisite to realize Europe's ambitions for the power system in a timely and cost-efficient way
- Bidding zone and portfolio-based balancing not compatible with future extreme variability of flows, efficient grid utilization and equal treatment of small and large players
- Instead of letting the balancing platforms determine bid activations 1:1, the platforms' resulting **changes in bidding zone net positions** can be used
- TSOs can subsequently use these results for detailed optimization using **Optimal Power Flow**
- **Pricing options** available but further analysis needed

Et cetero censeo: we should move to nodal pricing

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