

# The dependency between NBM and Flow based for Statnett and Svk

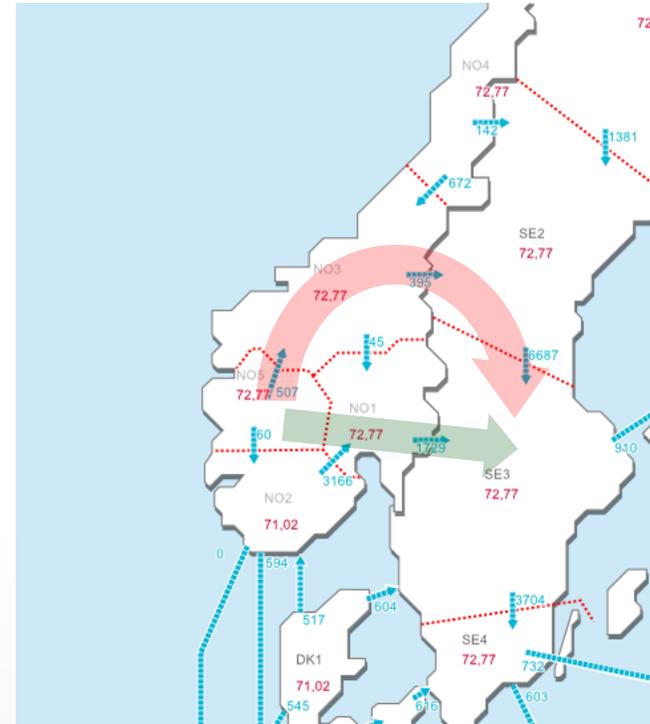
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# Content

1. Introduction: What is transit flows?
2. Alternatives for handling overloads due to transit flows
3. How can flow-based market coupling remove overloads due to transit flows?
  - Status from ongoing analyses of external parallel run
4. Challenges with handling transit flows in mFRR EAM (NBM)
5. Conclusions

# Overloads due to transit flows

- We often experience violations of security limits on power transfer corridors (PTCs) between bidding zones in Norway and Sweden, which is a result of transit flows
- Transit flows are a big challenge today and we observe hours with little reserves available compared to the overall regulation needs



*Example:  
Flow from NO5  
to SE3 that  
partly flow via  
NO3 and SE2  
causing overload  
on Cut 2 (SE2-  
>SE3)*

**Transit flow: Occurs when transaction from one bidding zone to another partly flows through one or more other bidding zones**

# The underlying problem: Deviations between flow in DAM clearing and actual flows

Net Transfer Capacities (NTCs)



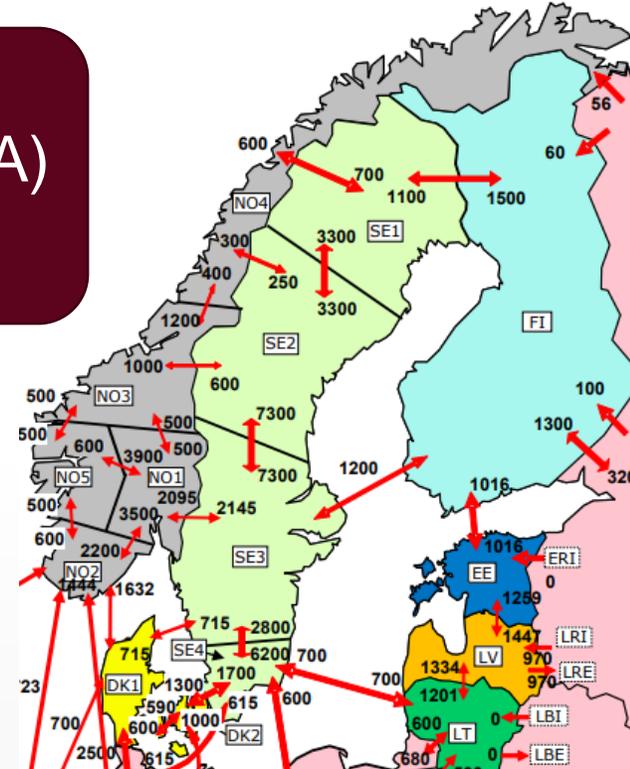
Day ahead market algorithm (EUPHEMIA) Transport model



Deviations between market flows and physical flows



Critical overloads on bidding zone corridors



# Alternatives for handling overloads due to transit flows when implementing NBM

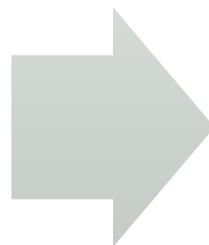
1	Flow-based market coupling	Preferred solution as clearing will ensure that transit flows respect transmission limits
2	Counter trade in intra-day market	Preferred alternative if not handled with FB, but uncertainties regarding possible solutions and when it will be implemented
3	Counter trade/redispach with mFRR energy activation market	Challenging to design a solution as part of the automated processes Scarcity of reserves
4	Reactive handling with mFRR energy activation market	Not acceptable to handle large overloads reactively on a regular basis. These overloads can be foreseen and prevented earlier.

# How can flow-based market coupling remove overloads due to transit flows?

## DAM clearing algorithm

### NTC:

- Clearing based on transmission model with NTCs for all bidding zone borders



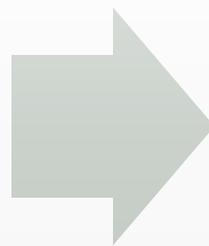
### FB:

- Clearing based on a network model defined by PTDFs and RAMs for CNECS.
- Algorithm takes better into account how changes in net position of bidding zones affect the load of critical network elements

## Determination of transmission limitations

### NTC:

- Operators set NTCs manually based on offline analysis, experience and expectations about the market situation



### FB:

- Formalized and systematic methodology for calculating the transmission domain based on a detailed grid model, CGM

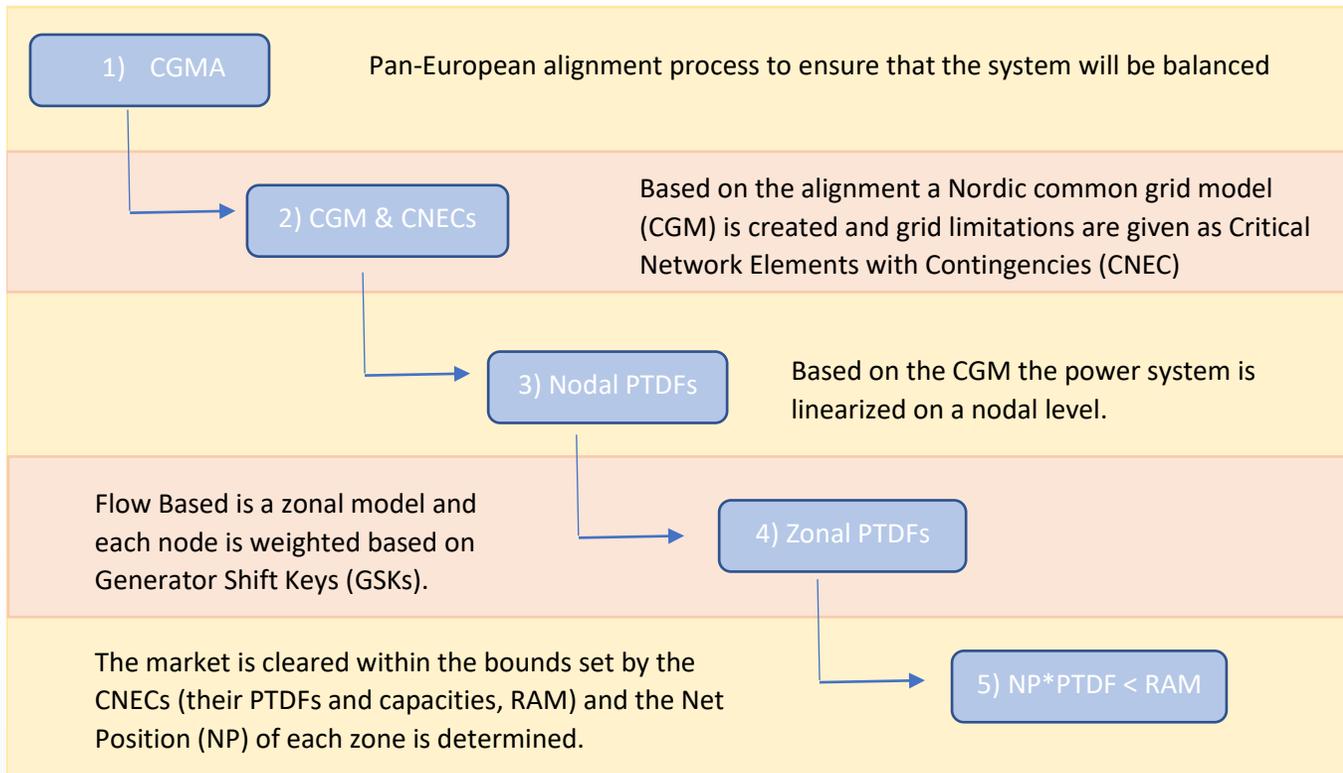
PTDF: Power transfer distribution factor

CNEC: Critical network elements with contingences

RAM: Remaining available margin

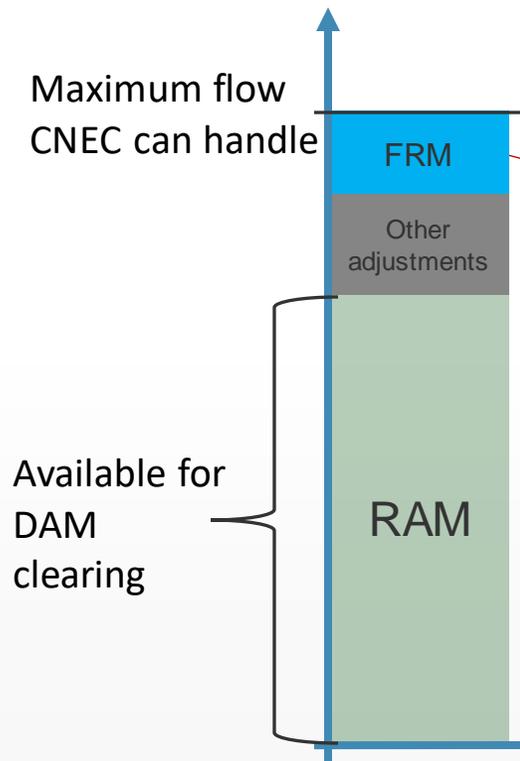
Net position: Load minus generation

# Steps of the FB calculation



*Flow based has a formalized calculation method, but it still involves assumptions and simplifications that may cause estimation errors...*

*...these estimation errors can also cause overloads due to deviations between the flows taken into account by the market and the actual physical flows...*



*..., but we will have margins (Flow Reliability Margin) that will be calculated based on statistics on estimation errors and thereby avoid severe overloads to happen*

# Summary – why FB should reduce overloads due to transit flows significantly

- With FB more information about physical reality of the grid is given to the market large overloads due to transit flows on bidding zone corridors are prevented
  - DAM clearing take into account how changes in production/consumption of a market area affect specific corridors in the grid via a network model
- It is still a simplified zonal model and there will be deviations between market flows and physical flows due to estimation errors
- The calculation of the parameters defining the transmission domain is based on a formalised and systematic methodology
  - It is based on a CGM which allows for more accurate calculation of flows in the grid
  - It allows us to identify modeling errors and improve on these
  - It allows us to calculate margins based on statistics that compensate for the estimation errors
- If FB works as expected it will remove the problem with large and frequent overloads that need to be handled with counter trade/redispatch

# How likely is FB to remove overloads caused by estimation errors?

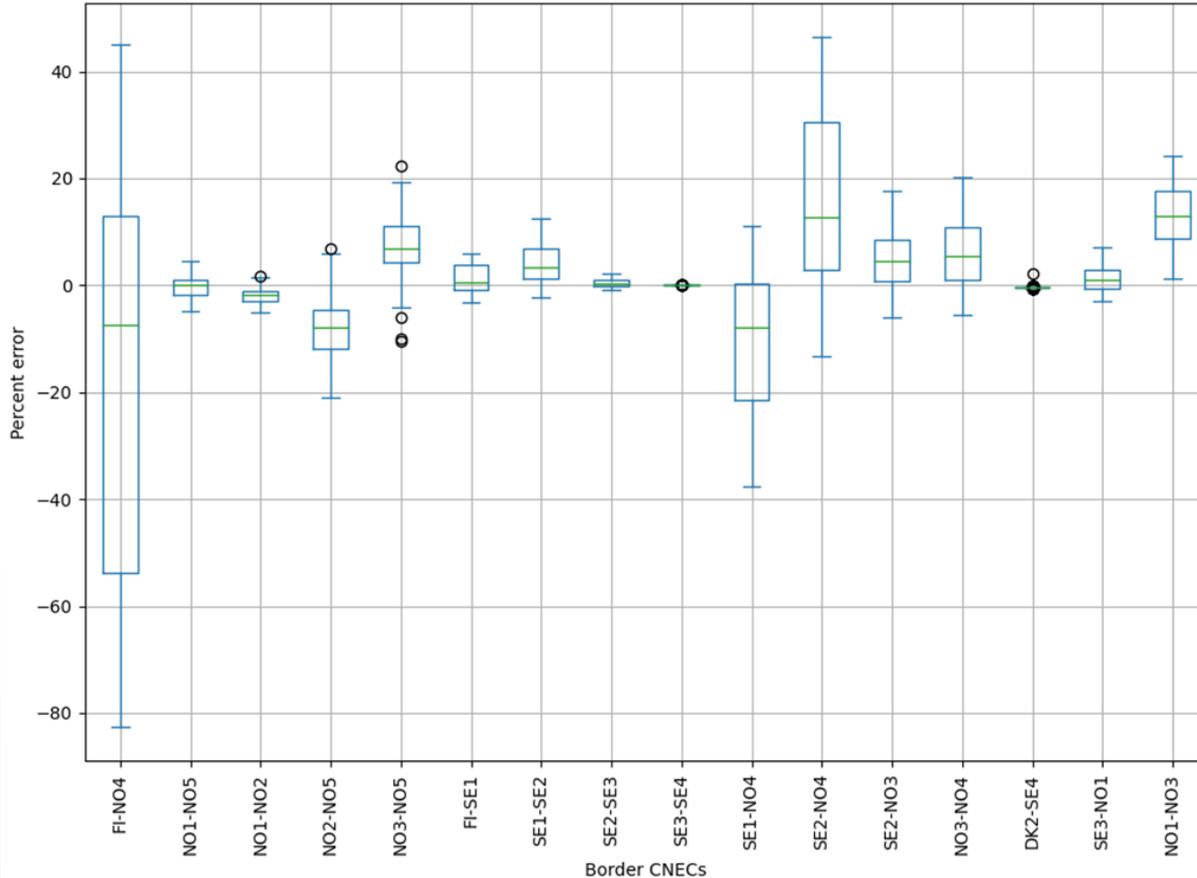
- There is an ongoing work on analyzing results from the external parallel run
- Before end of the year, we should have a clear assessment of how well the flow-based methodology will perform
  - But model improvements will be a continuous process

# How large estimation errors can we expect?

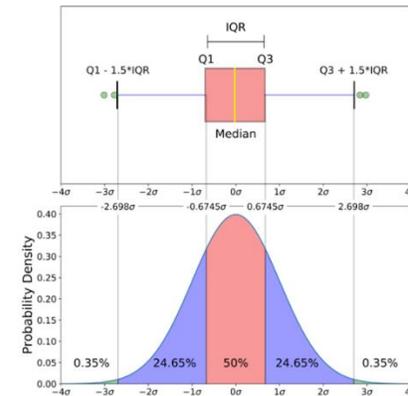
- Measured flows on bidding zone borders can be used to assess estimation errors and see how big margins that would be required to keep the market clearing within physical boundaries for transmission
- Method:
  - Calculate net positions per bidding zone based on the measured flows
  - Estimate flows using PTDFs
  - Comparing measured flow with estimated flow → estimation error
- Next slide shows estimation errors for the borders relative to the size of the corridor
  - Results for week 19 2022

# How large estimation errors can we expect?

Box plot of percentage difference between measured and calculated flow (general)



- Good estimates for most large corridors
- Modeling error discovered for FI-NO4, which also affect nearby borders
- Systematically skewed errors need to be looked into and possibly reassess model assumptions



# mFRR EAM

Transition from manual balancing to automated balancing with NBM

Today

Operators monitor Nordic frequency and load on critical corridors

TSOs co-operate in balancing on Nordic level

Manual selection of bids respecting market rules



With mFRR EAM

mFRR demand per bidding zone

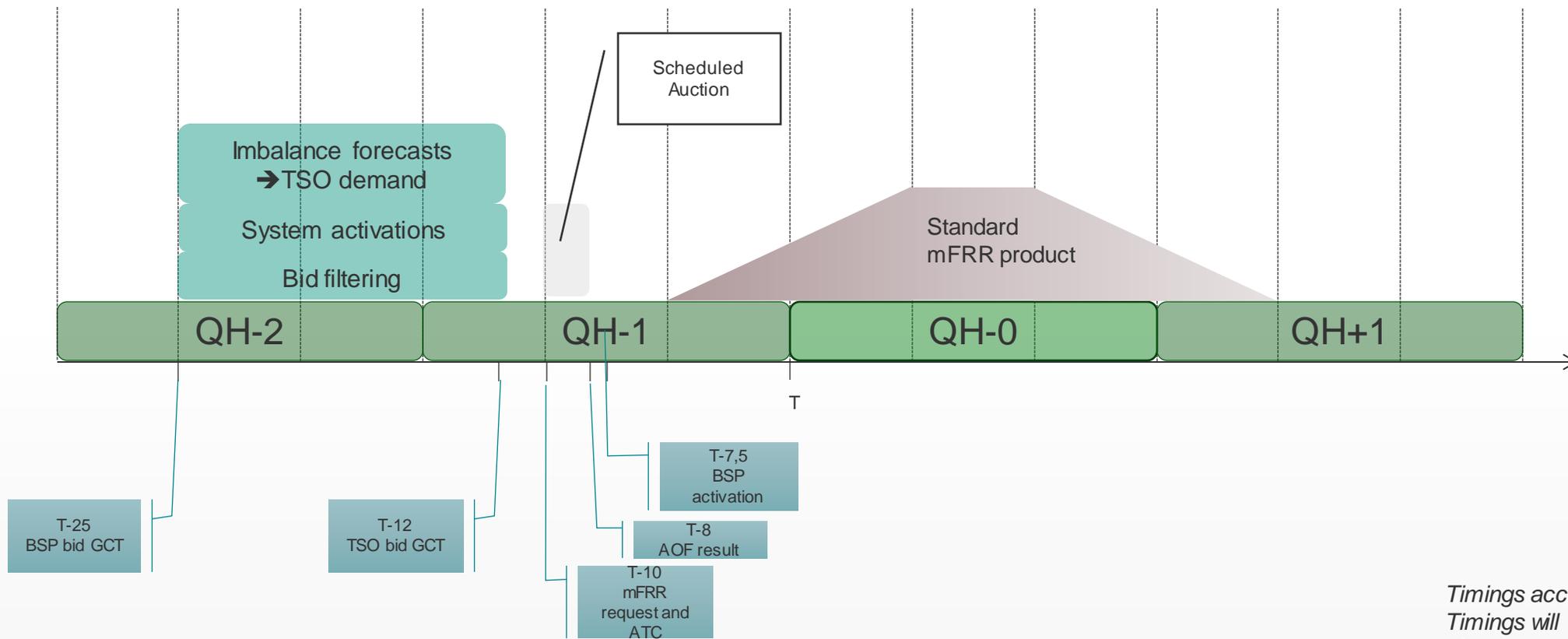
Each TSO responsible for ACE in bidding zones of its control area

Automated bid selection via mFRR market platform

Proactive bid filtering to handle congestions

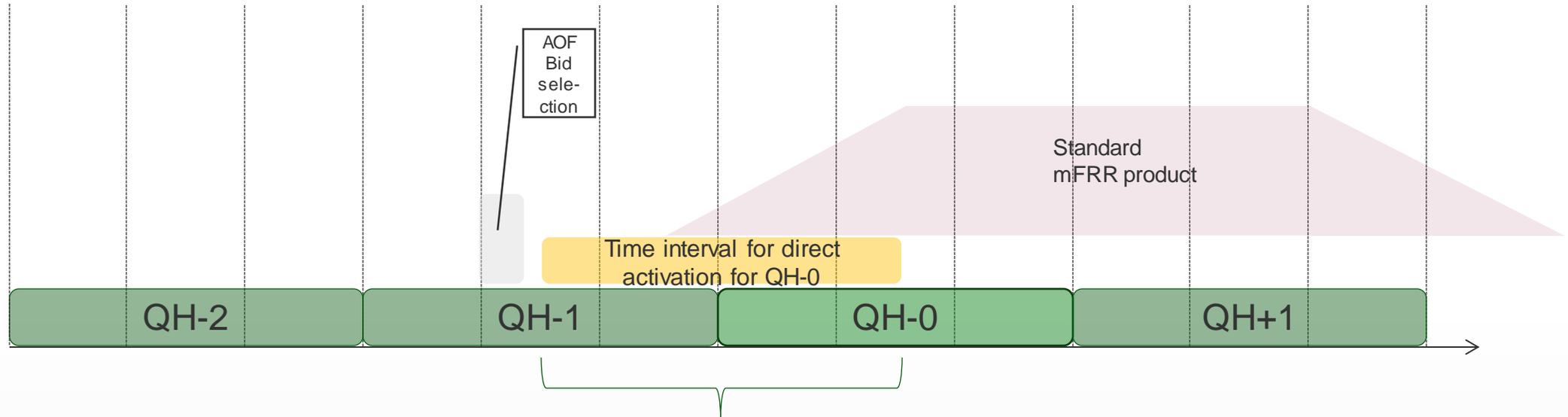


# Scheduled activation



*Timings according to target model  
Timings will deviate in transition phase*

# Direct activation



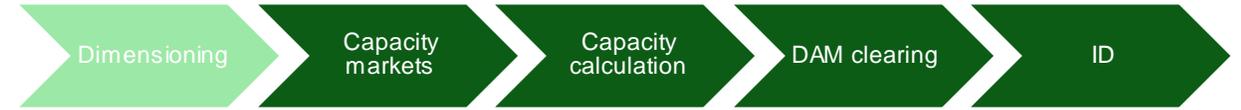
Remaining bids after scheduled auction can be activated to handle unforeseen overloads/imbances that should happen less frequently.

The operator will be more active in handling direct activation

# Challenges with mFRR EAM – automated processes

- Large regulations due to transit flows needs to be handled within the normal operations
  - Not acceptable with reactive handling of overloads due to transit flows using direct activations
- A process needs to be established that works well together with the other automated processes
  - The mFRR demand for these regulations must be calculated separately as the demand based on imbalance forecast will not take into account transit flows

# Challenges with mFRR EAM – securing reserves



- New formal dimensioning methodology for calculating the required reserve volume based on historic data on imbalances and reference incident
  - Historic imbalances do not reflect regulation needs due to transit flows and additional reserves need to be ensured for this
- We have scarcity of reserves today and automated balancing with NBM involves implementation of a more rigid sequence of actions and less flexibility for operators to mitigate risks with reserve scarcity
  - Managing overloads as early as possible in ID market would be advantageous as we have more flexible resources than later in the balancing time frame

# Conclusions

- We need to avoid reactive handling of large overloads due to transit flows on a regular basis
  - These overloads are not unforeseen incidents, but can be revealed evening after day-ahead clearing
- Flow based will prevent these overloads from happening as a network model is included in the market clearing algorithm
  - Deviations between market flows and physical flows can still happen due to estimation errors
  - Too early to make general conclusions, but preliminary analyses give no indications that large and regular overloads will be a problem after correcting for modelling errors
- The preferred alternative to handling it with FB would be to use counter trade in intra-day auctions
  - Still uncertainties around what TSOs will be able to do in the intraday market, and given time to development and clarifications we cannot count on having this ability at go-live of NBM
- It is challenging to develop a process for this in mFRR EAM that fits with the automated processes, it would require additional development
  - Delays of mFRR EAM would be expected